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Staging the animal oceanographer: An ethnography of seals and their scientists

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Staging the animal oceanographer: An ethnography of seals and their scientists

A dissertation submitted in partial satisfaction of the requirements for the degree
Doctor of Philosophy

in

Communication (Science Studies)

by

Natalie A. Forssman

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The Dissertation of Natalie A. Forssman is approved, and it is acceptable

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Natalie A. Forssman was the sole author of all material in this dissertation.

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ABSTRACT OF THE DISSERTATION

Staging the animal oceanographer: An ethnography of seals and their scientists

by

Natalie A. Forssman

Doctor of Philosophy in Communication (Science Studies)

University of California, San Diego, 2017

Professor Lisa Cartwright, Chair

This dissertation is an ethnographic, historical, and theoretically driven inquiry into the staging of the "animal oceanographer" at the edge of the sea. It examines research practices in which northern elephant seals (*Mirounga angustirostris*) are outfitted with tools of oceanographic sensing and data-gathering, allowing shore-based scientists to follow seals' oceanic activities in close detail. I follow the couplings of

humans, animals, technologies, and landscapes involved in this animal tracking and imaging work.

I use mixed methods of participant-observation ethnography, video recording, analysis of scientific papers, and a reflexive examination of techniques for attuning to embodied practices. My conceptual framework draws from environmental and postcolonial history and anthropology, modes of natural historic description, material feminisms, embodied interaction studies, animal studies and multispecies ethnography, and science and technology studies—particularly feminist approaches to corporeality and technoscience. The project is organized around the figure of the "edge": between habitats, between and within bodies, and between knowledge practices.

I begin by examining the evolutionary, historic, and epistemic histories of elephant seals, attuning to the material details of the coastal shore that matter for shaping both their sociality, and the ways scientists ask questions of them. Then, I examine the encounters between scientists and seals that turn the later into "animal oceanographers," analyzing the separating practices involved in this knowledge production, and in so doing drawing attention to both entangled histories with sealing science, and possible futures for asking non-reductive questions about non-human sociality. I trace the practices of intervention, care, and knowledge that emerge at the edges, surfaces, or interfaces between—and within—human and seal bodies and socialities. I end by examining how performing my ethnography with a particular device—a small, body-worn, viewfinderless camera—created openings across the edges or interfaces between mine and my informants knowledge practices, generating partial and achieved affinities.

Introduction

On early mornings over the course of the winters and springs of 2013 and 2014, I travelled with researchers from Long Marine Laboratory at the University of California Santa Cruz to a gate, just twenty miles up the coast from their lab, behind which lies Año Nuevo State Reserve. After opening the lock that keeps out surfers and tourists, we'd drive slowly down the gravel road watching for coyotes, bobcats, and rare endangered snakes ahead. When we arrived at the parking lot and hopped out of the truck, sounds filled the cool morning air: deep clapping echoes of the calls of huge male elephant seals, layered over the babble and din of thousands of large marine bodies clamoring, sleeping, giving birth, mating, and defecating in close quarters. So many mammals in a single place sound uncannily urban, like the echoes of a bustling street heard from afar.

Seals and sea lions (collectively referred to as "pinnipeds," from the Latin for "fin-footed") are descendants of land mammals whose terrestrial adaptations were gradually re-purposed for life at sea. They are top predators in their ecosystems, with bears—not whales—as their closest evolutionary cousins. They forage in the ocean, yet they are still strongly tethered to and reliant on its edges, including the surface of the water, where they breathe, and the edges of coasts or ice floes to come ashore. Many species of pinnipeds carry out crucial parts of their life history, including breeding, mating, and molting at these "haul-out sites," where they engage in the annual social practice of pupping and subsequently mating, in large gregarious assemblages.

We'd unload our equipment from the truck: Measuring tapes and sticks; miniaturized GPS, temperature, depth, and salinity-recorders; small vials for blood, tissue, snot, whiskers, and feces; drugstore hair-dye used to write a unique four-digit identifying number upon an elephant seal's fur; a large red sling and scale that can hold, hoist, and weigh an animal that is more than half a ton; and a locked box of veterinary drugs that includes valium, used in humans to combat anxiety, and ketamine, used to induce a dissociative state.

As we walked closer to the elephant seals, hauling our gear, the sounds intensified and the smells began. The odor is coastal, of salty air and seaweed decomposing in the sun. But we also catch powerful whiffs of strange and otherworldly excrement. Most of these animals last ate in deep pelagic waters, foraging for deep-sea fish and squid up to a mile under the ocean's surface. They arrive on this beach from the vast swath of the North Pacific south of the Aleutian Islands and north of Hawaii, hauling out onto this Central Californian beach: to give birth, lactate, and subsequently mate to produce the beginning of next year's pups, repeating this patterned gathering and subsequent dis-aggregation every year.

Scientists recognize two species of elephant seals: the southern elephant seal (*Mirounga leonina*), which inhabits the southern ocean around Antarctica, and the northern elephant seal (*Mirounga angustirostris*), which inhabits the northeastern Pacific. Elephant seals are the largest members of the taxonomic family Pinnipedia, with the southern elephant seal being slightly larger than its northern counterpart. Northern elephant seals haul out onto land two times each year in California. Between

December and January, males and then females arrive at the terrestrial breeding ground, staying until about March, to give birth, nurse and wean their pups, and subsequently mate before returning to sea. Between May and June they come ashore a second time—this time the females preceding the males—to molt off last year's coat of fur, and grow a new one. Interspersed with these two periods spent on shore, they undertake long and far-ranging foraging journeys. The majority of their lives are thus spent at sea.

The researchers I repeatedly followed to this beach are interested in understanding how elephant seals, as top predators, move and eat in their deep and distant ocean habitats. They outfit seals with the tools of oceanographic sensing and data gathering, allowing shore-based scientists to follow seals' at-sea activities in remarkable detail. Successive generations of graduate students and post doctoral researchers—with the help of undergraduate field volunteers—have followed the bi-annual migrations of elephant seals in order to link their behaviors and movements with ocean features, aiming to identify the habitats associated with "foraging success," which they hope can in turn "inform management strategies" (Robinson et al., 2012).[1] Studies pursued in this research group vary from asking how swimming mechanics and body shape relate to foraging, to investigating variation across individuals and across seasons in foraging locations and styles, to using computer models of migration trajectories to find out what cues these animals use to find their way across thousands of miles of open ocean, to tracing how mercury and persistent organic pollutants bioaccumulate

[1] The questions asked by the scientists that this dissertation project follows range from "pure" physiology and ecology to more "applied" conservation research—the thrill of discovery about theses elusive animals and the desire to protect ocean ecosystems at different times taking precedent in guiding their inquiries.

differently according to differing depths and locations at which seals feed, to asking how climate change influences distribution and migration patterns. These questions all orient around eating, using seals' activities of searching-for and obtaining prey as the prism through which elephant seals and their couplings with ocean environments are probed. This coupling of eating and environment is investigated through both digital traces in the devices attached to seals' bodies, and fleshy traces obtained when they haul ashore.[2]

Yet in order to ask their questions about these mysterious organisms and their solitary pelagic doings, my informants engage a large aggregation of animals on shore. Rather conveniently, this pile of marine bodies comes nearly to the doorstep of their lab, bearing traces of faraway worlds across thousands of miles, drawn together on a single patch of solid ground. On this beach, I repeatedly observed and video-recorded the careful skills of negotiating this tightly packed group of animals to isolate an individual female and turn her body into a physically characterized object—a platform for

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[2] These investigations of traces of oceans in and on bodies are related to other forms of research practices with pinnipeds that use them as a way to investigate oceans, practices which I learned about as part of the preliminary research for this project. Before focusing on the specific research group at UC Santa Cruz that became my focus, I travelled to several sites along the California coast where seals and sea lions haul themselves ashore and divulge intimate details of the ocean worlds they inhabit to those scientists that have devised ways of reading them. In the Channel Islands off Santa Barbara, a government scientist studying long-term population trends of California sea lions told me how she had glimpsed an El Niño event in her data before physical oceanographers confirmed it with theirs, by noticing a mass die-off of young pups in her annual population count. In San Diego, during another mass stranding event of California sea lions, I helped a veterinarian dissect a dead seal pup, tracing the path of disease, toxicity, and starvation through each organ. In Sausalito, a scientist explained to me that marine mammals are "aggregators," "integrators," and "sentinels" of their environments. On sea lion "unprecedented mortality" and oceanographic conditions, see Melin et al. (2010). For a veterinary perspective on marine mammals as sentinels, see Bossart (2011). For a variety of STS studies on "sentinel devices," see Lakoff and Keck's (2013) edited collection.

gathering oceanographic traces.[3] I watched and learned how to attach recording and tracking devices, to extract samples from nostrils, blubber, and veins, and to measure her dimensions and mass. In lab meetings, conversations in the field, and at conferences and academic talks, I learned about seals and the various ways they are known across behavioral, ecological, and physiological disciplines.

In his *Natural History of the Quadrupeds* (1830), the influential French naturalist George-Luc Leclerc (also known as the "Count of Buffon") described "the seals" thus:

> The structure of this animal is so strange, that it served as a model, upon which the imagination of the poets framed the Tritons, Sirens, and Sea-gods, with a human head, the body of a quadruped, and the tail of the fish. The seal, in effect, reigns, in this mute empire, by his voice, his figure, his intelligence, and his talents, which are common to him with the inhabitants of the land, and render him so superior to the fishes, that they seem not only to belong to another order of beings but to a different world. (Leclerc, 1830, p. 143)

Leclerc describes this animal as a "model," differentiated from the other creatures of the sea by its unique voice, figure, intelligence, and talents. Indeed, pinnipeds have been subject to a variety of culture inscriptions.[4] Yet, today, along the beaches of California, seals are enrolled in a different kind of semiotic work. Rather than a "model" upon which is thrown the "imagination of the poets," today they are delegates for the data-gathering and synthesizing work of ocean scientists. The agency

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[3] The majority of my informants' research subjects are adult female elephant seals. I elaborate on why this is the case in Chapter 1.
[4] In addition to the images of "the tritons, sirens, and sea-gods," another cultural inscription is the fascination over their mating system, which has been called a "harem." I discuss this in more detail in Chapters 1 and 3.

of the “oceanographer” — he or she who maps the ocean — is interposed upon the bodies of individual seals.

In peer-reviewed publications and popular science “outreach” framings, my informants and their collaborators from around the world often refer to their research subjects as “animal oceanographers.” The “animal oceanographer” is cast as a character that “samples” and “observes” the deep ocean, an “autonomous” sensing and data gathering “platform” that can help researchers characterize “in-situ oceanographic conditions” (Biuw et al., 2007). In this dissertation project, I use this provocative figure—and the implication of a scientific vision tuned to distant doings in the deep ocean—as the foil through which I investigate research practices on shore. I undertake an ethnographic, historical, and theoretically driven inquiry into the *staging* of the animal oceanographer, following the couplings of humans, animals, technologies, and landscapes involved in this data production work at the edge of the sea. I examine these research practices with conceptual and methodological tools from the interdisciplinary field of science and technology studies (STS), which combines history, philosophy, sociology, anthropology, and media and communication studies to examine the everyday practices, politics, and socially and culturally embedded nature of knowledge production.

Here, in this opening to the project, I introduce my informants’ research, the animals they study, my theoretical and methodological attunements, and the chapter summaries that offer a guide to the dissertation’s structure. I shape my introduction to the site, theoretical framework, and chapter summaries of this dissertation project around the material-discursive form of the edge.[5] I think with "edges" to tackle the semiotics of mapping practices, the material entanglements involved in the making of place, the dynamics of encounter and interaction, and the enactment of bodies, objects, and sites.[6] Beginning with "Edge as Frontier," I situate the figure of "the animal oceanographer"—and my informants' epistemological orientation to the edge of the sea—in terms of persistent cultural conception of edges as sites of intellectual expansion and interfaces of culture with nature's wild unknown. This contextualizes my informants' research—and the figuring of the "animal oceanographer"—within epistemological frameworks persistently applied to discussing the deep ocean, including discourses of ever-expanding knowledge, the necessity of mediation, and the strange otherworldly features of this watery realm.

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[5] I use the term material-semiotic from both the actor-network theory and feminist science studies traditions. See Law (2009) for a review of the meaning of the term in the actor-network theory tradition. I also use the term "material-discursive," which is from Barad (1999), interchangeably. Haraway defines the "material-semiotic actor" in her famous essay on "Situated Knowledges" (1988) as follows: "This unwieldy term is intended to portray the object of knowledge as an active, meaning-generating axis of the apparatus of bodily production, without ever implying the immediate presence of such objects or, what is the same thing, their final or unique determination of what can count as objective knowledge at a particular historical juncture" (Haraway, 1988, p. 595). As Asdal, Brenna, and Moser (2007) put it in their history of science and technology studies, the term "material-semiotic actor" forces us to acknowledge that "Objects are not just resources for our knowledge and science's knowledge. They are active and co-creating, even though they are never unproblematic and can determine how we discuss them. … Knowledge objects are actors with life and agency. They are not discovered or revealed through scientific practice. Instead, narratives about the real world require that we converse with, and participate in a social relationship with, the objects."

[6] The conceptual approaches I bring to this consideration of "edges"—and to this project as a whole—include environmental and postcolonial history and anthropology, modes of natural historic description, material feminisms, embodied interaction studies, animal studies and multispecies ethnography, and science and technology studies—particularly feminist approaches to embodiment and technoscience. I introduce these approaches and the role they play in my analysis through my explication of the different edges this project investigates later in this introductory chapter.

Yet, this dissertation project asks about other kinds of edges, beyond the edge of the sea as a frontier of knowledge. Thus, having situated the practices and contexts of my informants' work within this framing, I then turn to a more detailed framing of my intervention, sketching my concerns as in conversation with, yet in contrast to those of the researchers this project follows. In "Other Articulations of Edges," I introduce the edge as the ethnographic site of this project, and situate my focus on the coastal field, rather than the university laboratory. In "Edge as Lively Site of Life and Knowledge Production," I engage this coastal edge not as a smooth apparatus of at-a-distance knowledge, but as a site of material and epistemic coalescence its own right; within this articulation of the edge, I introduce Chapter 1. In "Edges Between and Within Bodies," I introduce my commitment to closely following dynamics of interaction and intra-action among humans and animals; within this articulation of edges, I introduce Chapter 2 and Chapter 3. In "Edges Between Knowledges," I connect this project with literatures in science and technology studies that have discussed "boundaries" between traditions of knowledge and the stakes and possibilities of interdisciplinary engagements between the natural and social sciences; within this articulation of edges, I introduce Chapter 4.

I close with a discussion of the mixed methodological attunements I cultivate in this project, which are also attuned to the shapes of surfaces and edges. I use tools from ethnomethodological and practice-oriented social science methods, which provide me with a relational or ecological orientation to human-animal-technology-landscape entanglements. Alongside this, I pay reflexive attention to techniques and technologies of recording, rendering, and representing, frameworks that I inherit from feminist technoscience approaches to embodiment, materiality, and technology.

This introduction thus has a somewhat unconventional structure, where the theoretical conversations I engage, my chapter summaries, and the task of situating the terms employed by my informants in a larger discursive field coalesce into a single inquiry driven around "edges." I unpack different articulations of the edge of the sea, and other edges that I suggest to occur at and within it, when it is examined as a site in its own right. I proceed in this way in order to show how following a particular form or shape—the meandering line of the coast, the contours of embodied interactions that splice and recombine entities, or the shifting embodiments and devices of interdisciplinary practice—forms the style of inquiry I explicitly cultivate in this project.

Edge as Frontier

The coastal edge is a place that lies at the interface between terrestrial and marine habitats, where the bodies of seals move across the material boundary of the tideline in seasonal rhythms. It is the site where seals, by virtue of these edge-spanning behaviors, are outfitted as "oceanographers." The figure of the "animal oceanographer," equipped with spatial and sensing technologies and heading off into the deep unknown, is culturally situated within imaginaries of the ocean as "final frontier."[7] In this

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[7] Connections and cross-fertilizations between cultural conceptions of the ocean and of space as "frontier" proliferated at the end of the 1960s. Historian of oceanography Helen Rozwadowski suggests that the imagination of the ocean as frontier in the postwar period was rapidly supplanted by an emerging

articulation of the edge, seals head off *across* the boundary into the unknown and barely human-explored deep ocean.

The deep ocean's "largely unexplored nature" is a persistent feature of popular and scientific discourses about the marine realm, such as the oft-repeated statistic that only 10 percent of the ocean floor has been studied in any detail (Felt, 2012, p. 297). Oceanography is a relatively new science but one with roots in colonial projects of mapping and claiming space, entangled in the relationship between the expansion of empire and the naturalist explorer/scientist. The "seal oceanographer," in gathering knowledge from the "wild unknown," partakes in continuing some of these naturalist-like practices. Because the ocean is positioned as the last frontier of human exploration, oceanography the science in some ways continues a colonial practice of traversing the oceans; situating the knowledge the seal oceanographer produces in the power/knowledge nexus.[8]

Environmental historian Gary Kroll argues, "the ocean in the twentieth-century imagination took on many of the characteristics that were typically associated with

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conception of outer space as the "next frontier" (Rozwadowski, 2014, p. 20). Indeed, the U.S. Navy around this same time began to refer to the "unexplored" deep seas using an evocative phrase: "inner space." As funding and the cultural imagination of the era began to look towards space, the U.S. Navy used this image to promote projects such as SEALAB – a set of experimental underwater habitats inhabited by "aquanauts" – which were intended to parallel space-station work and manned interplanetary travel. The deep sea as "inner space" positions the ocean as a deep and mysterious unknown on our own planet, in contrast to the "outer space" of the solar system and galaxy. In its simultaneous suggestion of both self and other, it implies that ocean space hovers somewhere between the familiar and the unknown, and somewhere between materiality and mind. In his historical study of the science of cetaceans in the 20th century, D. Graham Burnett has argued that, in the context of this "Navy propaganda," the image of dolphins as "a kind of neighboring extraterrestrial, awaiting contact" was reinforced (Burnett, 2010, p. 50). See McIntyre (1974) and Warren (2010) for takes on cetacean "mind" and "consciousness."

[8] Power/Knowledge is a term from Foucault (1980). On this nexus specifically as it relates to studies of colonial geographical power, see Carter (1987) and Kennedy (2013). Hoffman (2016) adeptly reviews these large and varied literatures in her historical study of malaria maps.

frontier territories" (Kroll, 2008, p. 7).[9] The concept of the "frontier," as part of the imaginary of the American West since the beginning of the nineteenth century, frames certain landscapes as "zones" that were the source of expansion, creative energy, and individualism (Cronon, 1991, p. 31).[10] Furthermore, frontiers are figured as interfaces of culture onto nature.[11] As anthropologists and environmental historians have shown, the making of frontiers is a material-discursive practice that constructs certain places as "edges" between civilized and savage. These scholars have succeeded in rethinking the relations of center and periphery that this model of the West as center implies. Yet, the frontier is is not only a discursive construction—frontier discourses frame particular

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[9] Kroll's diverse case studies of representations of the sea in popular science, policy, and cultural texts show how oceans were characterized as: "[A] trove of inexhaustible resources, an area to be conserved for industrial capitalism, a fragile ecosystem requiring stewardship and protection from "civilizing" forces, a geography for sport, a space for recreation, and a seascape of inspiration" (Kroll, 2008, p. 7). Rozwadowski (2012b) argues that the metaphor of "frontier" became attached to the ocean in the 1950s and 1960s. She reads science fiction author Arthur C. Clarke's lesser-known novels on the ocean to analyze the cultural significance of ocean-as-frontier. Showing how Clarke imagined the ocean through the rubric of Western landscape—where whales take the place of cattle, and "vast plankton farms stood in for endless wheat fields"—Rozwadowski argues that Clarke derived his views of the frontier from Turner (1893/1921), imagining a model of "succession" in human relations with the sea from exploitation and resource extraction to farming (Rozwadowski, 2014, p. 14).

[10] The "frontier thesis" was proposed by historian Fredrick Jackson Turner in 1893, and, according to environmental historian William Cronon, it "profoundly shaped American historical thought." In Cronon's words, Turner proposes that: "[T]he Wests of the United States had recapitulated the social evolution of human civilization as Europeans and easterners repeatedly encountered the "zone" of "free land" and "primitive savagery" – what he called "the frontier" – that was the source of American energy, individualism, and political democracy" (Cronon, 1991, p. 31). Turner's "frontier" imagined landscapes in terms of natural succession: trappers and hunters, then cattlemen and miners, then farmers, and finally industrialists. Cronon's study of the entangled emergence of Chicago in the intersection of the urban and the rural is an explicit counter to Turner's thesis. Despite its shortcomings as a theory of history, the idea of the "frontier" certainly shaped the way the landscapes of the West were imagined, and, as Kroll argues, it shaped how seascapes were imagined as well.

[11] See Helmreich (2011) for a discussion of the ambiguous place that oceans have operated in anthropological categories of "nature" and "culture." Helmreich focuses on seawater in particular.

places as edges, and give rise to practices that re-make them in that discursive mold.[12] The frontier discourses in which the "seal oceanographer" participates contribute to constructing the coastal edge as a site of creative intellectual energy, and the expansion of knowledge into the great unknown.

Yet another persistent framing of knowledge of the oceans is in terms of "barriers" which "limit" sensing, and thus give rise to the necessarily mediated nature of what we know about these environments. Helen Rozwadowski, a historian of oceanography, and Stefan Helmreich, an anthropologist of oceanography, have discussed these material challenges to knowledge of the oceans. Rozwadowski identifies three material characteristics that have acted as barriers, preventing human access to knowledge about the ocean (Rozwadowski, 2012a).[13] First, the ocean is opaque, frustrating our human sense of sight, which is so important to how we understand the land. Second, to most of us, the ocean is a two-dimensional surface that resists permanent marks and appears quite impervious to human activity. Finally, the ocean is vast, so that efforts to comprehend it are limited either to a small corner, or involve systematic coordinated operations. According to Rozwadowski, these material

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[12] On the discursive and material making of frontiers, as both geographical positions and sites constructed by discourses and infrastructures of capital, see Cronon (1991), Tsing (2000), Swanson (2013). On re-articulating the center-periphery relations implied in these framings of "edges of empire," and in so doing, provincializing European histories and concepts, see Ellen (2003). Environmental history and postcolonial anthropology help us notice how physical borders in landscapes are not given in advance, but often exist for very particular projects, projects that themselves entangle the material and discursive by re-inscribing culturally constructed boundaries as "natural." The Tijuana River Estuary project highlights how political borders are edges that both gather and demarcate both humans and nonhumans (see Stern, 2017). See also Anzaldúa (1987). In a West Australian context, see Turnbull (2005).

[13] It is important to note that the material features that Rozwadowski identifies are products of technologically-situated ways of perceiving and knowing the ocean. It is for this reason that she proposes "fusing the history of science and technology with environmental history" (Rozwadowski, 2014).

features of the ocean have imposed "strict physical limitations on human investigators, whose scientific understanding of [ocean environments] was necessarily mediated through complex technologies" (Rozwadowski, 2005, p. 5). Like Rozwadowski, Helmreich identifies the metaphors that cast the ocean as distant from human cognitive schemes, or what he calls "alien." The figure of the alien is used to describe the unfamiliar worlds of marine microbes, because both the scales and the contexts inhabited by marine microbes are "inaccessible to prosthetic-free human experience," inviting the vernacular of science fiction. In both of these articulations, the material features and scales involved in producing knowledge of the oceans necessitate mediation: either the mediation of complex technologies of sensing, or the mediation of combining and calibrating multiple data sets in order to produce knowledge at the relevant scales.[14]

A third feature of knowledge about the oceans relates again to its material features: not as barriers, but as constraints that organize space, habitat, and movement in ways strange to the terrestrial-bound human imagination.[15] In an undergraduate course on "Marine Mammal Biology" that I took at the Scripps Institute for Oceanography in

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[14] While Rozwardowski frames these mediations in terms of "access" and "barriers," Helmreich's treatment of mediation is more nuanced. He discusses how marine biologists themselves engage with "mediation—watery, televisual, digital, biotechnological—at every step in their journey, from data collection to analysis" (Helmreich, 2009, p. 32). Further, he argues that the worlds of microbial oceanographers on a research vessel don't necessarily work to "erase all traces of mediation," as some media theorists have claimed is media's aim. Rather, the world on board the research vessel "deliver[s] an alternation between remote and intimate sensing" (Helmreich, 2009, p. 45).

[15] See Steinberg (2001), Steinberg and Peters (2015), and Bear and Bull (2011) for proposals from cultural geography about how thinking with the oceanic materialities can re-invigorate social theory, see also the edited volume *Thinking with Water* (Chen, MacLeod, & Neimanis, 2013). For a critique of appeals to water's form in social theory, see Helmreich (2011).

2012, John Hildebrand opened by stating that the marine environment is difficult to glean knowledge of because it is vast, fluid, and composed of a dense medium where sound and light travel differently. Furthermore, it is connected, in the sense that there aren't obvious material barriers that partition species or habitats. And, resource distribution is what ecologists call "patchy," which implies that organisms are mobile over large geographical areas, and also implies that they must have detailed ecological knowledge in order to make these journeys. Yet, all of these material features and the principles of spatial organization they imply are somewhat incompatible with ecological tools for learning about terrestrial landscapes. Thus, a limitation to knowledge of the oceans is sometimes sketched as a failure of imagination: to perceive or understand this radically different organization of space and sense.

The Animal Oceanographer

Into these discourses of an unexplored, difficult to access, and strangely scaled and organized environment enters the figure of the "animal oceanographer," which is cast as an answer to some of these intractable puzzles of mapping, accessing, sensing, and understanding the marine environment and its organisms. My informants' knowledge practices are situated in discourses of the edge of the sea as a frontier to an inaccessible and strange world beyond their direct grasp.[16]

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[16] "Sensing beyond the boundaries" is the subtitle to a paper that outlines the benefits of bio-logging science (bio-logging is one of the terms used to describe the practice of attaching animals with sensors to gather environmental data): "Bio-logging is certain to increase in its importance and to influence the way we study events and processes that are beyond the usual boundaries of perception and that are remote from the observer" (Boyd, Kato, & Ropert-Coudert, 2004).

Narratives of the "animal oceanographer"—in both peer-reviewed papers and popular pamphlets and websites—are tied into technoscientific narratives that seek progression towards all-encompassing vision. Internal histories of "bio-logging" tell the story of an approach whose expansion has been tied to the development of devices that are small enough to attach to wild animals, yet accurate enough to provide data at frequencies useful for modeling (Ropert-Coudert, Beaulieu, Hanuise, & Kato, 2009). While many large marine species have been bio-logged, elephant seals have been particularly "good candidates" for these studies because of their large body size, because they haul out to breed and molt with highly predictable seasonal and geographical fidelity from year to year, and because they are available for surveying in appreciable numbers (Ropert-Coudert et al., 2009).[17] These histories of the research method written by early pioneers and practitioners talk about the ease of outfitting elephant seals with the earliest devices in ways that suggest them as test subjects on a path to ubiquitous surveillance. As Etienne Benson discusses in his study of the early history of animal tracking and telemetry, these projects of marine mammals as "oceanographers"—which cast animals as "components of a global infrastructure of environmental surveillance"—emerged from a postwar Southern Californian

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[17] Both northern and southern elephant seals have been the subjects of long-term bio-logging studies. In the southern ocean, an international project, Southern Elephant Seals as Oceanographic Sensors (SEaOS), was coordinated between 2004 and 2006 (Costa et al., 2010). In the eastern Pacific, *Mirounga angustirostris* at Año Nuevo state park in California have been tracked and monitored with "bio-logging" devices for more than thirty years (for some of the earliest studies, see Le Boeuf, Costa, Huntley, Kooyman, & Davis, 1986; Le Boeuf, Costa, Huntley, & Feldkamp, 1988; Le Boeuf, Naito, Asaga, Crocker, & Costa, 1992). Data from these seals has been included in the Tagging of Pacific Predators project as part of the Census of Marine Life (see Block, Costa, & Bograd, 2010).

convergence of “naval engineers, academic [zoologists], and theme-park entrepreneurs” (Benson, 2011, p. 75), which together construct these animals as both tools *for* research as well as objects *of* research. This, argues Benson, is an “infolding of figure and ground” not so different from our own participation in networked telecommunications infrastructure that proceeds in successive loops of instrumentalizing actors in order to make patterns visible, and then separating individuals out as “documenters” of the world (Benson, 2011, p. 77).[18]

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[18] An appropriately ambivalent attitude to the forms of surveillance that emerge in this configuration of a “wired wilderness (Benson, 2010) are examined in Leanne Allison and Jeremy Mendes’ digital documentary, *Bear 71*, which explores the always-mediated nature of “wilderness” in Banff National Park by charting the life and death of a radio-collared grizzly. Allison and Mendes layer multiple modalities of film and data: wildlife radio collars, trail cameras that capture the activities both humans and wildlife, and the pervasive cellular data networks that allow continuous documentation of “wilderness experiences” by tourists and hikers. The end of Bear 71’s life is captured by a camera attached to the front of a train carrying cargo from the Canadian prairies to the Port of Vancouver.

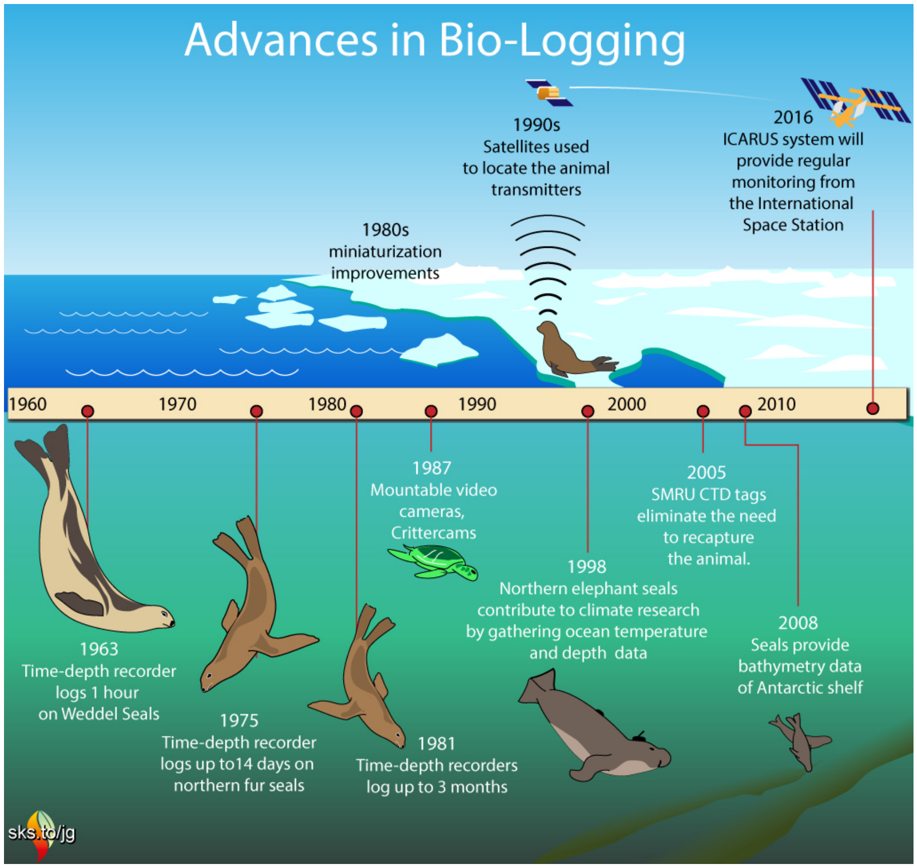

Figure 0.1: Progression of the technological development of bio-logging of pinnipeds. The timeline emphasizes "miniaturization improvements." Image by John Garrett, Skeptical Science Graphics, Licensed under a Creative Commons Attribution 3.0 Unported License.

The figure of the "animal oceanographer" also has clear connections to narratives of the frontier as a site of creative energy and expansionism, where researchers marvel at the endless innovative proliferation of unexpected questions opened by the earliest trials of these devices.[19] These discourses also suggest seals as outsourced laborers in an austerity economy of "operational oceanography," where they

[19] The connection to exploration is present in references to elephant seals as "oceanographic explorers" or "ocean explorers of the future," or the data portal named "Marine Mammals Exploring the Oceans Pole to Pole (MEOP)" (SMRU Consulting, n.d.).

are cast as "relatively economic platforms" for "long-term monitoring" (Fedak, 2004), with the strong advantage that they are "autonomous" (Boehlert et al., 2001).[20] In this configuration, seals become "platforms" for "oceanographic sampling" and "ocean observing" (Fedak, 2004; Simons, Tremblay, & Costa, 2009), "autonomous ocean profilers" (Costa et al., 2010) who "survey" environments (Fedak, 2004). Various framings of agency—of both the act of data collection, and of the animal that collects—are at play here: seals sense, observe, sample, survey, profile, and monitor the ocean—the full gambit from passive "platforms" to active "observers."[21]

The same questions of *scale* that color the discourses of oceanography as "necessarily mediated" are also at play in the discourses of the "animal oceanographer." There are two relatively separate visions of the quality of data gathered with these "bio-logging" research techniques, and which applications it is best suited for. In the first, there is a quest for vast and integrated data sets, which plays into the persistent construction of oceanography as a "systems science" with a "global vision" (Benson, 2012; see also Edwards, 2010). In this framing, exploiting the labor of these autonomous bathymetric samplers carries with it particular trade-offs: that the animals

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[20] In other words, the rationale is 'they were going to go to these places anyway, so why not get them to gather data for us while they're at it.' In a related vein, Root-Bernstein & Jaksic (forthcoming) discuss how the frameworks of "ecosystem services" have been conceived in terms of economic utility, giving ecosystems economic valuation or monetization. While this framing is not as prevalent in the framing of the "animal oceanographer" as an "economic platform," it is worth pointing out the ways that economic rationales pervade conservation discourses, where monitoring, cycling nutrients, and maintaining succession patterns is 'outsourced' to nonhumans.

[21] Agency, activity, and passivity have long been topics of interest in actor-network theory (ANT) and post-ANT, where agency is situated in systems of relations, not inhering in the individual. See Latour (1987) and Law & Hassard (1999). Mol (2010), defining ANT as a set of "sensitive terms and enduring tensions," discusses how "passivity and activity are ambivalent and shift around more easily" in this tradition.

could have physiological or behavioral effects on the devices that gather the data (Simmons, Tremblay, & Costa, 2009), that the scales the seals move and gather data at could be all wrong for ocean models (Hebblewhite & Haydon, 2010), and that their patterns of use of the marine environment are "adaptive" and therefore present an unbalanced data sample (Fedak, 2004; Simmons et al., 2009). For researchers that aim to use the data gathered by animals for physical and chemical ocean models, these issues pose problems of "calibration" and "integration."

On the other hand, other uses of these data sets have had different aims, less along the lines of "operational oceanography." My principle informants, while they collaborate with physical and chemical oceanographers, self-identify as physiologists, spatial ecologists, and conservationists. For them, oceanographic insights produced by this "data-rich species" (Robinson et al., 2012) are most interesting in combination with physiological data from the body of the animal, in order to characterize "in-situ oceanographic conditions" (Biuw et al., 2007), "field physiology" (Costa & Sinervo, 2004), and "physiology in the wild" (Burgess, Tyack, Le Boeuf, & Costa, 1998). Highly specific studies of how seals respond to minute changes in their environments—previously the purview of the controlled methods of the laboratory—have through these "bio-logging" methods become pursuable in the field. These methods have the potential to provide marine biologists with information about not only the behavior and physiology of these far-ranging and deep-diving predators, but also information about the marine environment, including the physical and biological features that elephant seals are oriented toward and navigate according to—including underwater topography and steep temperature gradients—as well as the distributions and abundances of their prey species alongside these same metrics. These insights about the marine environment, in turn, feed back into providing my informants with insights about elephant seal environments, physiologies, foraging ecologies, and life histories, allowing for models of how the environments of these animals—and hence their distributions and abundance—may shift over time with changing ocean conditions. These differences of approach speak back to the discourses of the ocean as "necessarily mediated," and according to some interpretations, "limited" by this feature. Here, the issue of whether mediation by the body of the animal is embraced and actively pursued as the research question, or whether statisticians aim to erase it through careful integration of multiple data sets, is at play.[22]

Finally, discourses of the animal oceanographer are positioned in relation to the third pervasive characterization of knowledge of oceans discussed above: the strangeness of the medium and its principles of organization. In pelagic marine ecosystems—areas of the ocean far from shore and far from the ocean bottom—habitat is structured in a fundamentally different way than in air or on land. In terrestrial ecosystems, habitat is defined by what ecologists call "primary producers": trees and grasses that organize the familiar biomes such as savannas, grasslands, and rainforests.[23] However, in the open ocean, habitat is defined not by large photosynthesizing plants,

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[22] I do not claim a radical relativism on the part of my informants. Rather, different orientations to scale produce different orientations to what counts as 'data' and what is merely 'artifact.'
[23] The fact that these biomes are named after their most conspicuous plants shows how deeply terrestrial ecosystems are structured by their primary producers.

but by the physical, chemical, and biological properties of water masses. Additionally, there is a great heterogeneity with respect to these properties of water, shaping ocean habitats that are not static in space or time, but are rather moving on a variety of temporal and spatial scales: some cyclic and seasonal, and some as effects of climate change. My informants, whose research supports the articulation of the animal oceanographer that embraces it as a view into "the secret lives of sea mammals" (Costa, 1993) or "a view of the ocean from Pacific predators" (Block et al., 2010) see its exciting potential lying in exactly the fact that animals' strategies for moving through space are "adaptive"—in other words, that their trajectories through their environments are evolutionarily, ecologically, and developmentally patterned. For my informants, elephant seals' movement trajectories—coupled with physical and chemical data gathered by the devices attached to their bodies—allows vision of how habitat is structured in this unfamiliar marine realm. Daniel Costa, head of the Costa Lab at Long Marine Laboratory, had a favorite evocative way to present the work of the lab to the non-initiated, through the puzzle of how to see and know habitat in the deep ocean:

> We still see the ocean primarily as deep or shallow or nearshore or offshore. But just as there are different habitats on land, the ocean has fine-scale features that are very important to the animals. We want to be able to look at the ocean as say the equivalent of 'this is a grassland' or 'this is a forest' (Costa, quoted in Sullivant, 2007).

The Tagging of Pacific Predators project—completed before I began my fieldwork in the lab but still structuring many of its methods and questions—identified hotspots of predator activity in the North Pacific, in areas that (to unmediated vision) appear relatively featureless. The authors of those papers call this area a "Blue

Serengeti" (Block et al., 2010), showing that many species of top marine predators—including sharks and large fish like tuna, marine mammals, and sea turtles—migrate to and feed in this portion of the North Pacific.

Thus my informants are drawn to the edge of the sea in order to glean "sea signals" from the bodies of seals, and devices attached to them. In lab meetings, which often involved researchers going over in-progress data analysis together, there was a fixation on finding these "sea signals" in the samples taken from the seal's body and in the digital streams from her devices. These were moments in the flood of data that pointed to doings in distant habitats, indexes to far-away environment-body couplings. The seals are of interest because they move *across* the land-sea boundary, carrying traces from the far and deep unknown.[24]

Other Articulations of Edges

As the previous section argued, the coastal edge is an interface between two environments, but it is also produced as such through material-discursive practice of inscribing it as "frontier," which figures it as a platform from which knowledge of distant places is done. It is also, in a very material sense, a site of interchanges between these two very different environments, a topic that has recently become a direct area of

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[24] The frontier discourse of the "animal oceanographer" begs several questions beyond the scope of this dissertation project: what are the politics produced by the maps of the seal's oceanographic activities, and the implications of precision-locating the "blue Serengeti": for biogeography, for marine governance, and for the making of environments as resources through mapping knowledges? In this project, rather than further taking apart frontier narratives in order to answer these questions, I instead aim to articulate different kinds of edges, which I introduce in the sections that follow.

interest in ecology.[25] These material interchanges, as mentioned previously, are the source of what my informants call “sea signals”: because seals haul ashore, and carry with them material traces of distant ecosystems. As discussed in the previous section, the discourse of the edge of the sea as a “frontier” frames practices at that edge in terms of movements towards the unknown, and in terms of knowledge as a project of overcoming barriers, making the “alien” knowable. Yet, in excess to being a site of movements and flows across, the edge is also a site of stoppage and friction, of *local* dynamics produced by the meeting of different kinds of environments and practices. In other words, it is an interface between these two very different environments, but the material features of this interface produce formations that are richly particular in their own right. The edge is a place where materials and practices become encrusted in specific ways.

In this dissertation project, I examine *how the seal oceanographer is staged*. What are the everyday practices involved in setting up the conditions for these “sea signals” of distant body-environment entanglements and habitats? My informants are interested in body-landscape-technology entanglements at distant locales, and they read them off of the bodies of seals and the devices attached to them. For them, the edge is a site of movements *across*. Yet, in this project, I investigate how their own bodies are entangled in the coastal milieu that allows them to stage these questions, how the edge of the sea is a habitat for bodies, technologies, and styles of knowledge. Thus, there is

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[25] This is what ecologist Jim Estes, also situated at the Long Marine Laboratory at UC Santa Cruz, calls “inter-ecosystem connectivity” or “cross-ecosystem linkages” (Estes, 2016, p. 228).

an affinity between their questions and my own, a shared interest in attuning to body-environment-technology entanglements. But our focus is different: they tune their interest on the ocean, the doings of nonhumans in it, and the processes and laws that structure that relationship; I tune my interest on the coastal shore, the local doings of landscapes, humans, seals, technologies, and knowledges that together stage the animal oceanographer.

In her study of the masutake mushroom, Anna Tsing (2012) provides the useful term "unruly edges" to describe the particular life forms that thrive at interfaces between habitats. She examines "agrarian seams between fields and forests," margins of zones of cultivation between animal and plant husbandry and wild varietals. She finds these "unruly edges" to be "disordered but productive," and precisely the places where prized mushrooms grow. Tsing's discussion of these "seams," "edges," and "patches" is in conversation with the landscape ecology concepts of "edge effects," "habitat fragmentation," and "patches." These terms describe changes in population or community structures that occur at edges, and this branch of ecology attends to the shapes and structures of these edges, and the biodiversity they afford. These studies also look at human effects as "edge effects," including human paths and human-induced erosion as disturbances that open niches for some life forms, while closing them for others.[26]

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[26] This brief discussion on the "edge" in ecology and biology includes only landscape ecology approaches, but in biology more broadly the edge or boundary takes on many roles as a site of inquiry. For example, Margulis and Sagan (1995) argue the cell edge is key to the emergence of life, again a theory about the productive material dynamics at sites where difference meets.

Attuned to these ecological terms for describing "edge effects," and the human-induced makings of landscapes that often produce them, this dissertation project examines "embodied interaction" and "body-work" at the edge of the sea. These are terms I draw from the science and technology studies (STS) tradition of laboratory studies, a field that has asked how knowledge of distant and hard-to-see phenomena is done in practice.[27] Like these studies, the subject of this dissertation is local embodied doings, and my methods come from a double commitment: to detailed and close analysis of everyday doings with attunements to practice from ethnomethodology, combined with feminist technoscience approaches to materiality, corporeality, and technology. I elaborate on how I work with these mixed methods, and their sometimes-divergent commitments, in a later section of this introduction, entitled "Methodological attunements."

While studies of the embodied coordinations of knowledge work have often taken the research laboratory—and the practices of interpreting and visualizing data—as their site of investigation, the site of this dissertation is the biological field site, where

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[27] I borrow the term "embodied interaction" from Morana Alač (Alač, 2009, 2011, 2014; Alač et al., 2011), and the term "body-work" from Natasha Myers (2006, 2008, 2015). Janet Vertesi (2012, 2015) also works at the nexus of visualization, embodiment, and interaction. These recent studies all look at the interpretation and visualization of data, and the role of the body in these practices. Alač and Vertesi work in the ethnomethodological tradition, while Myers is more grounded in cultural studies of science and technology and the feminist technoscience tradition of Donna Haraway, Joe Dumit, and Stefan Helmreich. The focus on the body in STS is strongly influenced by feminist science studies' long tradition of interrogating the social and material construction of women's bodies in medical discourse and practice, see for example Martin (1987, 1994), Cartwright (1995), Hartouni (1997), Casper (1998), Casper and Clark (1998), Oudshoorn (1994), and Murphy (2006).

data collection and device attachment are coordinated.[28] In the lab, in front of their computer screens, my informants work to pull the "sea signal" out of their data, to separate out and give shape and dimension to a distant and difficult to sense underwater habitat. They also work with a variety of models of animal movement that help them interpret that raw data in the schemes that simplify and abstract motivation, eating and wayfinding. Yet, to gather this data—to attach or recover the devices, make the measurements, and collect the samples—they work at the coastal shore. While their knowledge practices in the lab are fixated on the deep ocean, in the field they immerse themselves in the ecology of the coastal beach: its tides, weather, and scents, the behavior of their study species when it is on shore, and the everyday politics of who can do research where, when, and in what ways.

Seals are creatures of the shore, and I focus on the field because seal scientists self-identify as creatures of the shore as well. In one of my first introductions to pinniped science, a senior scientist summarized a key identity marker that differentiates whale and seal scientists. She depicted whale scientists as somewhat detached from their research subjects, the whales. Sitting in large research ships, she joked, they always had "clean clothes," their binoculars and cameras tuned on distant horizons. They sit for hours in the same position, hoping for glimpses of tail flukes and fins that

[28] A small group of scholars in science studies and human geography have taken the field, rather than the lab, as their site of consideration. Kohler (2002) studied the historical construction of the "lab-field border," examining "landscapes and labscapes." On the "geographies of science," see Agar and Smith (1998), Powell (2007), and Forsyth (2013). In terms of ethnographic engagements, Goodwin (1995) and Roth and Bowen (1999) look at vision in the field. Lorimer (2007, 2008), Ellis and Waterton (2005), and Ellis (2011) focus on affect and multiplicity in biological fieldwork practices of amateurs and professionals. Candea (2010) looks at practices of scientific "detachment."

could disclose a key identifying mark or an important behavior. Seal researchers, rather, she described as a little more earthly—as “always covered in shit”—and thus, implicitly but not so subtly, a little more tough: crawling around in shore muck and excrement of their research subjects, ruining their clothes, and never holding their nose. I indeed found that seal scientists spend their time sneaking and crawling through the shit, seaweed, and sand of the shore, trying to gain purchase on their research subjects. Año Nuevo is a mucky place, where massive piles of bull kelp decompose in the sun. If not careful while walking the beach, and especially while walking as a group, we would often find ourselves unintentionally herding swarms of sand fleas feasting on the rich matter that is washed and carried ashore. “Field gear” was always old discardable clothes: old jeans with holes, backpacks we didn’t care for, and cheap dollar store rubber boots. This was a difference of bodily comportment and habitus that was emphasized with pride, and also described as a kind of test or warning. In recommending me to go help out her colleagues in the field, this research scientist wanted to make sure that I understood and was ready for fieldwork’s daily practices: the dirty work of getting so close to the animals, and the hard physical labor and able-bodiedness it required. Implied in this intimate relation with the animals of study was an assumed authenticity.

This framing of the field in terms of an intimacy or closeness with the animals also has wrapped up in it epistemological claims about the kind of knowledge gleaned from knowing one’s research subjects up close. The project head of the government scientists I worked with on the Channel Islands, doing population studies of California sea lions, said she felt lucky to study a thriving and numerous population where her study subjects come ashore and make themselves visible and available to the eyes and implements of researchers. To her, this was preferable to studying cryptic or endangered species, wrapped in regulatory red tape, but also not abundant enough to ask statistically driven questions. This was echoed in many conversations with seal scientists, a sense of the importance they place on getting to know their study subjects through the repeated and direct observations of the field. They spoke of this access as providing them with interpretive frames that they would lack without that fieldwork context. Researchers also admitted how much they loved being in the field, and implied that the outdoor lifestyle of fieldwork was a large part of what drew them to research biology as a profession. The filth that seal researchers get covered in is tied to their identity as authentic scientists, a morality of the field as opposed to the armchair, desk, or even computer screen.[29] For seal scientists, the bodily comportment of fieldwork on the beach permeates their identity as scientists, and the possibility of the kinds of questions they ask.

I also focus on the field because it allows me to investigate a multiplicity of fields and fieldworks: the coastal beach is my field, as an STS researcher, as well as the field of my informants, the scientists. Furthermore, it is the site where seals are made as "fieldworkers," where scientists interpose the agency of the "animal oceanographer" onto the bodies of seals. These multiple senses of fieldwork at play in the same site

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[29] Chapter 4 elaborates on the bodily comportment of fieldwork, and its relation to knowledge claims about closeness and authenticity.

allow me to examine the variety of epistemological orientations to “the field” and “fieldwork.” Furthermore, it allows me to examine both the *work of science,* done by people, but also the *bodily work asked of the seals*. I examine on the one hand the embodied doings of researchers to produce knowledge—their coordinations and everyday practices with one-another, with technologies, and with seals—as well as how seals are enrolled in knowledge-making schemes and, thus *their* body-work. I ask what animals are asked to become in these arrangements of bodies.[30]

Edge as Lively Site of Life and Knowledge

This dissertation project focuses its attention on the edge of the sea as a site of particular and local dynamics, produced by the meeting of different habitats and practices. In pursuing this mode of attention, I am guided by both the curiosity of human-altered ecologies in Tsing’s “unruly edges,” and the laboratory studies orientation to local embodied practices. I am also guided by Rachel Carson’s attention to the edge of the sea as a site of very particular lifeforms—an example of curious and

[30] There is a large literature on human-animal relations, which is foundational to this project. Donna Haraway’s (1989, 2003, 2008) work has been highly influential to the field of “animal studies” in all of its strands. Vincianne Despret’s work (2004, 2008a, 2013), much of it only recently translated (Despret, 2012/2016) has also been influential. The following edited volumes have been crucial to the formation of the field of “animal geographies”: Emel and Wolch (1998), Philo and Wilbert (2000), and Arluke and Sanders (2009). “More-than-human” geographies have been formed as a field of study in response of the limitation of only focusing on “the animal” (Lorimer, 2005; Braun, 2005; Whatmore, 2006). More recently, “multispecies ethnography” has coalesced as a field in anthropology, focusing not strictly on animals, but on relations between organisms: see Kirksey and Helmreich (2010) for a review, and see also Kohn (2007) and Fuentes (2010) for influential studies. For philosophical and theory-driven work on human-animal relations, see, among others, Lippit (2000), Buchanan (2008), and Wolfe (2010). For studies within interaction analysis or distributed cognition approaches, see Laurier, Maze, and Lundin (2006), Goode (2007), and Keil (2015).

close natural historic noticing. All three of these approaches share what Michael Fischer calls, referring to ethnography, "jewelers-eye accounts" (Fischer, 2007, p. 567).

Chapter 1: At the Edge of the Sea, takes the reader to this edge of the sea, echoing Carson's sensitivity to the area between the tidelines as both an interface between habitats, and a richly particular place in its own right. Her way of attending to this lively zone paints it as a site of both biological and epistemic richness where the specific features of different substrates make specific multispecies practices possible. I expand on this mode of attention by asking, how does this site afford livabilities not only for multispecies bodies, but also for particular ways of asking questions? I insist that understanding the ecological substrate upon which knowledge practices encrust themselves is part of the important work of situating those knowledges.[31] Social and cultural critiques of Western knowledge have done important work to locate knowledge traditions that claim universality in the specific material circumstances that gave rise to their claims.[32] These studies have aimed not to relativize all knowledge but rather to query how different claims are grounded differently, and to interrogate the

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[31] My use of the term "encrustings" is an effort to revive and expand vocabularies for doings and practices—both human and nonhuman—beyond the techno-managerial metaphors of some ANT formulations of agency. This is developed further in the methods section of this Introduction, as well as in Chapter 1 and Chapter 3.

[32] Haraway's influential "Situated Knowledges" (1988) is a key text here. However, here my model is not the principle of situated knowledges in the abstract, but close histories of knowledge grounded in specific materials. Sarah Ahmed's (2006) analysis of the writing tables upon which phenomenology's universal accounts of perception and mind were made, as Cartwright and Rice (2016) point out, understands writing tables as "catalyz[ing] philosophical reflection across time while also providing the physical surface upon which the philosopher writes" (Cartwright & Rice, 2016). Angela Creager's (2013) *Life Atomic* narrates major developments in biomedical research from the perspective of the radioisotopes that flowed through networks of laboratories and ecosystems. For an early actor-network-theory example, see John Law's (1984) study of Portuguese sailing ships and the everyday methods of long distance control.

particularities that underlie universal claims so as to make generalizations with more care and responsibility to their histories and effects.[33] I contribute to these projects of situating universality by reading the evolutionary, ecological, and historical affordances on the biology and behavior of seals as epistemic affordances on the knowledge that scientists make when they outfit seals as "oceanographers." This is an account both of a landscape, and of the style of knowing it engenders.

The chapter looks at how the edge of the sea gathers seal bodies, encrusting them in very particular arrangements on the shore, as a closely packed aggregation. This gregarious social formation begets a very particular "ecology of practices" (Stengers, 2013) between seals (conspecific sociality), and between humans and seals (multispecies interaction). I take the edge not only as a lively site of life—a set of biological fecundities—but also a site of epistemic productivity, where knowledge is made from the particular encounters, behaviors, interactions, or practices that take place there. Multispecies practices are encrusted to the shore, but also, I argue, human practices of knowledge production. I examine the material, interactional, and sensory dynamics that allow my informants to perform their particular research techniques.

Edges Between and Within Bodies

The edge of the sea is thus an edge between habitats, which makes it for my informants a site where materials, bodies, and forms of vision and knowledge

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[33] Here I follow feminist techno-science studies in thinking responsibility in terms of response (response-ability): not an accounting of blame, but a practice of being responsive to the things we make (Despret, 2004; Barad, 2007; Haraway, 2008).

production move *across*, but also where materials, bodies, and knowledge-making practices are gathered and encrusted: the particular bodily forms and socialities of seals shaped by the particularities of this place, as well as the situated human knowledge practices that encrust the conditions of their possibility upon the bodies and social forms of seals. Yet, in being a gathering of such concentration—of so many bodies gregariously packed together—this edge of the sea produces a topology of multiple edges and surfaces within this tightly packed aggregation: between bodies, and within them. These are sites of encounters, behaviors, interactions, practices—between animals, and between humans and animals. I undertake my inquiry into edges between and within bodies through literatures and methodological attunements from animal studies, material feminisms, and embodied interaction studies, which together allow me to look at material and bodily composition and de-composition practices, their historical meanings, and their stakes.

While Chapter 1 provides an overall frame for understanding these encounters over evolutionary and historical time, Chapters 2 and 3 examine these encounters in close detail, in the moment-to-moment dynamics of interaction.[34] These chapters also take as assumption that the practices that transpire in the interstices between humans and animals are shaped not only by the historically and materially specific ways that animal bodies and socialities are made over evolutionary and historical time, but also

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[34] The methods for following and analyzing these dynamics of encounter, the histories of these methods, and how I use them in this dissertation project, are discussed in a later section of this introduction, "Methodological attunements." In those methods, the "edge" or "surface" is again a central site and method of inquiry, as I will elaborate below.

through historically and materially specific ways of asking questions—the histories of disciplinary knowledges. These chapters in very different ways each examine the *separating* practices that allow representation and individuation. In drawing attention to entangled histories (Chapter 2) and possible futures (Chapter 3) in thinking relations of part to whole—of body parts to bodies, and of bodies to social aggregates—I follow the practices of intervention, care, and knowledge emerge at the edges, surfaces, or interfaces between—and within—human and seal bodies at the edge of the sea.

In **Chapter 2: Rendering Practices**, I focus on seal *bodies.* I look at how the methods of taking bodies apart on land reference histories of other uses of the seal body, as a highly valued form of oil, ready-at-hand to be industrially exploited because of elephant seals' tendency to gather on land, which makes them vulnerable to terrestrial practices. In this chapter, I examine "rendering practices" in two ways. First, I examine practices of rendering on shore, where the sedated elephant seal is virtually de-composed—through tools of measurement, modeling, and representation—into fat and non-fat materials, giving researchers tools for visioning and modeling the edges *within* bodies: in particular, the layer between adipose tissue and muscle, and its variable thickness around the three-dimensional surface of the seal body. The technologies and forms of apprehending bodies used in these rendering practices reference industrial practices of turning bodies into material resources, implying how marine mammal science is entangled with histories of harvesting bodies for oil, fixating upon their fats. Further, these rendering practices require a careful negotiation of the seal body as active and passive, between a sedated body and a living research subject. The second sense of "rendering practices" I discuss connects these practices of rendering on shore to the rendering of seal's distant activities at sea. Closely reading the published papers of my informants and their collaborators, I show how the methods of characterizing the seal as a ratio of fatty materials to non-fatty materials allows the seal's dive-track data to be partitioned into different "activities," or what I call "doings" or "practices" in this dissertation, following in the material-semiotics tradition. Researchers have learned to read the shape of dive trajectories as indicators of "body condition," which they in turn read as an indicator of "foraging success." Thus, the practices on shore that render the seal body passive and measurable allow the reading of it's activities of seeking prey and navigating, which in turn render it as an internally motivated, active, and agile predator. This chapter thus suggests that historically and materially specific ways of asking questions have led to particular ways of characterizing seal bodies and their movements through the ocean, and the delicate everyday negotiations involved in these practices. I propose that embedded in these "rendering practices" are styles of taking bodies apart that treat bodies and physiology as reducible to automotive and mechanistic metaphors.

In **Chapter 3: Engaging the Aggregate**, I focus on seal *socialities*. Like Chapter 2, this chapter looks at specific moments in the practices of researchers with seals, the moment-to-moment "embodied coordinations" or "body-work" of human-animal interaction. I examine how researchers disentangle the individual seal body from the aggregate formation. Grounded in historical materials and conceptual arguments from feminist biologies, I point to critiques of the term "harem" and how it frames female sociality, prematurely settling agency and sociality, and casting female elephant seals as passive. In response to these critiques, and with knowledge of the power of language to structure observations of social forms, I revive terms and modes of attention from 1960s descriptive engagements with elephant seal sociality in aggregate, which use the term “pod” rather than “harem” to describe these formations. Analyzing repeated observations and video captures of how the “pod” of female elephant seals are approached by researchers, I follow the undoing of the pod in order to learn about how it is put together. Descriptions and photographs allow me to highlight key points in the transformation from aggregation of flesh to individual animal oceanographer, and I work with classic STS methods of tracing how scientists make neat individualized research subjects out of messy encounters, attending closely to the “hows” of everyday doings. These methods come from a set of concerns in STS to insist that how objects are “achieved,” and they highlight how knowledge practices discipline the world into their formations. Yet, this chapter poses the question of whether this methodological toolkit, instead of amplifying individualizing practices by drawing them out of the ethnographic record, could instead point to flickers of non-individualizing logics that are revealed *through* scientists’ practices of turning tangled encounters into objects of knowledge. Thus, rather than only examining how the “procedure” of approaching the pod and producing the individualized animal oceanographer turns nature into a disciplined entity, tangible within the methods and models of a science that atomizes bodies and processes, I highlight vernacular knowledges of the pod revealed through methods for undoing it.

Chapters 2 and 3 show that the particular questions scientists ask of seals are by no means natural or determined by some essential essence of these animals. This is STS's classic insight that situates knowledge production, refusing the model of "nature's book" as merely something to be read, providing more nuanced and participative models of knowledge and interpretive practice. A key insight of STS has been that, "practices produce orders." These chapters suggest that the making of the animal oceanographer is locally and historically particular, entangled with landscape, industrial, and epistemic histories. In drawing attention to the multiple knowledge traditions at play in these practices, and inserting my own preferences about which knowledges I want to "amplify" (Myers, 2015), I follow feminist theory's refusal of relativism, to see all knowledges as equal, and to work to amplify those that are tacit, unspoken, and have a possibility for reviving the agency of those entities and processes that have been rendered silent.

Edges Between Knowledges

This discussion of knowledge traditions leads me to the final form of edge I examine in this dissertation project: between genealogies of knowledge production. Epistemic boundaries are an object of inquiry in this project in multiple ways. First, different historical trajectories of knowledge production de-compose and compose seal bodies and socialities differently, and these differences matter. Secondly, I engaged in moments of comparison throughout my ethnographic, historical, and theoretical engagements: I put the knowledge practices of my informants, which examine the bodily doings of the seal oceanographer, in conversation with my own knowledge practices, which follow embodied interaction and becoming. In so doing, I bring approaches to "animal behavior" and "human practice" into conversation in a multitude of experimental ways in this project. Thus, edges between knowledge practices is a theme that runs through this dissertation project.

Like the other investigations into edges introduced so far, in **Chapter 4: The Camera-Body in the Field**, I investigate these epistemic edges materially, through the devices and bodily practices of their inquiry. This chapter traces how performing my ethnography with a particular device—a small, body-worn, viewfinderless camera—created certain openings across the edges or interfaces between mine and my informants practices, creating moments of partial and achieved affinity.

This chapter thus engages a final literature on edges: edges between knowledge traditions, which has been a topic of persistent interest in STS, first as a question of epistemological demarcation, and later as a question of knowledge "practices."[35] Yet despite persistent focus on objects and practices, these inquiries of the 1980s were still largely about epistemological boundaries and edges—the material features of

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[35] In the 1960s, historians and philosophers of science considered the epistemological demarcation of science from non-science, asking what conditions needed to be met for a particular set of claims to be counted as "science" (Duhem, 1894/1996; Popper, 1963). The early and influential concepts of "thought collectives" (Fleck, 1935/1979) and "paradigms" (Kuhn, 1962/1996) defined knowledge communities as relatively bounded social worlds, and, particularly with Kuhn's "paradigm," edges between these knowledge traditions were assumed to be hard and relatively impermeable. As humanistic studies of science began to incorporate sociological and anthropological approaches, questions about boundary *practices* began to emerge. In studies that have tended to feature materiality and practice, "boundary work" and "boundary policing" (e.g. Collard, 2012) have been used to name practical and situated efforts to shore up barriers between fields of knowledge and practice. Many of these inquiries have followed practices through things, by focusing on the very influential concept of "boundary objects" (Star & Griesemer, 1989). Haraway insisted, "objects are boundary projects" (Haraway, 1988), and focus has turned to how knowledges span boundaries in specific and situated, non-totalizing, ways.

boundaries were not fully attended to in this early period of STS scholarship. Emblematic of a broader turn towards "materiality" in humanities and social science scholarship, Karen Barad's (2007) concept of "agential cuts" drew attention to the distinct and consequential material features of boundaries. Emphasizing the connection between the materiality of objects and knowledge, Barad forged the conjoined term "onto-epistemology," highlighting the fact that the borders and edges she attends to in the experimental apparatuses of quantum physics are explicitly about both knowledge and materiality.

I take from practice-oriented STS the analytic to attend not to static definitions or demarcations, but rather practices done *at* boundaries. Chapter 4 looks at the forms of embodiment that emerge around representational devices, and the social relations they engender. I discuss how working in the field with a viewfinderless camera shifted attention and bodily comportment in the field from eyes to hands. Further, I discuss how working with a camera as a device of data collection, as I present the results of in Chapters 2 and 3, opened opportunities to consider the forms of interdisciplinarity and collaboration that emerge in ambivalent relations of interest and disinterest between disciplines. I consider how the bodily practices of repetition and reciprocity made possible by entering the field with a camera allowed the cultivation of "partial affinities," relations across disciplines—and across species—that don't rely on "inhabiting" the perspective of the other. This chapter also further develops my inquiry into the edges between bodies—between humans and animals—by working with

Vincianne Despret's term, "embodied empathy," as a way past the impasse of anthropomorphism debates.

Methodological Attunements

Another way I think with edges between knowledge practices in this dissertation project is by employing a methodological toolkit with a diversity of commitments, which produce tensions as well as emergent "edge effects." My methodological attunements for following entanglements of humans, animals, environments, and technologies have already been briefly introduced in the section entitled, "Other articulations of edges," where I discussed my attention to local embodied practices—in the tradition of STS laboratory studies—and my focus on practices in the field. Here, I provide more detail about the mixed methods of this dissertation project, and connect them to the themes of material and epistemological edges, embodied interaction, and the violences of separating practices that have been introduced above.

From ethnomethodological studies of everyday practice, I bring a commitment to descriptive practices "at the surface," which is an attention to "doings," rather than "perspectives." These descriptive and micro-analytical social science traditions are "ecological" in their orientation to practices, and I aim to foreground histories of connection between methods in the ecological and social sciences by using the term "ecology of practices" to describe the settings that I examine. I pay reflexive attention to how intellectual traditions for attending to fields of practice are entangled with the development of devices for recording, and representational conventions for rendering. I thus pay attention to the everyday practices and politics of recording and rendering in both my informants' practices, and as part of how I use micro-analytic forms of description and analysis. This attention is part of a more general orientation to corporeality and technology from feminist technoscience approaches, along with the commitments from feminist practice to amplifying subjugated knowledges, as well as thinking and imagining otherwise.

Reading at the Surface

Edges and surfaces are the site and theory of this research project, the analytic through which I follow and theorize the various forms of encounter at boundaries that this dissertation follows—between landscapes, between bodies, between species, and between knowledge traditions. But the analytic of the edge is also a methodological attunement to looking at "embodied coordinations" (Alač, 2009, 2011, 2014; Alač, Movellan, & Tanaka, 2011) and "body-work" (Myers, 2006, 2008, 2015).

Literary critic Heather Love (2010) has proposed the term "surface reading" to describe a particular strain of social scientific methods and commitments that align with the methods of this dissertation project.[36] What I have referred to as "bodily doings," "embodied coordinations," or "body-work," Love calls "the descriptive turn," or "surface reading"—a method of textual analysis "that would take its cue from observation-based social sciences including ethology, kinesics, ethnomethodology, and microsociology," and engage in practices attention that are "close but not deep" (Love,

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[36] Love is a literary critic, and her essay on "surface reading" proposes to bring these methods into literary criticism. Despite lying outside the field of social sciences, her articulation of "surface reading" brings out the complementary strains in various social science traditions that are more difficult to articulate from within the intellectual traditions themselves.

2010, p. 375). She draws this “surface reading” in contrast to the “depth hermeneutics” that guides much reading of social behavior in the social sciences and humanities, where “traditional humanist categories of experience, consciousness, and motivation” are foundational. She argues that these interpretive practices are a humanist holdover from approaches to religious texts, where the ethical demand to attend to “the opacity and ineffability of the text” in order to uncover its “divine and inscrutable message” necessitates what Paul Ricoeur (1970) famously called a “hermeneutics of suspicion.” In contrast, practices of “reading at the surface” attend to “surfaces,” “operations,” and “interactions,” and hold the potential to “suggest an alternate model of reading that does not depend on the ethical exemplarity of the interpreter or messenger” (Love, 2010, p. 375). These are reading practices not of ‘decoding’ or ‘unveiling,’ but of description.

Love’s critique of the humanism underlying “depth hermeneutics” is important amidst recent calls from across the social sciences and humanities to rethink the humanist assumptions of our research approaches, to match our methods to theories of the “posthuman” or “more-than-human” (Haraway, 2008; Wolfe, 2010). Amongst the imperative to turn to the “more-than-human” (Whatmore, 2002; Braun, 2005) and “more than representational” (Lorimer, 2005) across the humanities and social sciences, there is a renewed interested in engaging “the material” (Alaimo & Heckman, 2008; Coole & Frost, 2010), “the affective” (Gregg & Seigworth, 2010) and “the embodied” (Wilson, 2004; Blackman, 2012) instead of, or in addition to, “textuality” and “representation” (Barad, 2003). Many have bemoaned the lack of methodological strategies to match these theoretical overhauls, and cultural geographers in particular have had several suggestions that synthesize from across ethnography, performance studies, and film studies (Latham, 2003; Lorimer, 2010; Merchant, 2011). Heather Love identifies already existing strains of social science observational practice—in particular the pragmatist sociology of Erving Goffman (1961; 1971) and Bruno Latour (2005)—from which practices of "reading at the surface" can be forged. Thus, instead of heeding calls that reach for the "more-than" or the "new," Love encourages us to re-approach already existing traditions of inquiry that pay close attention to the relational production of things and bodies, and stay close to description.[37]

Ethnomethodology's attention to practices, coordinations, and the production of "social order" was influential in early laboratory studies in STS. Additionally, cognitive science work (Hutchins, 1995a, 1995b) informed by cultural historical activity theory (Cole, 1998) provides frameworks of sociality, cognition, and bodies as "distributed," and of human cognition as shaped and structured by relations and interaction with the material world. These frameworks externalize what was previously assumed to be housed inside the human subject, so that objects and interactions on the "intermental" plane of social and physical relations shape the "intramental" plane of perception, cognition, and emotion (Leontiev, 1979). Ethnomethodology, in a similar move though grounded in a different intellectual history, aims to "respecify" traditional humanist categories such as "experience," "consciousness," and "motivation," always asking how these competencies are locally produced through practices, rather than inherent in the

[37] For an important critique of the discursive construction of "newness" in the "new materialisms," see Ahmed (2008). On the importance of descriptive methods, see Tsing's (2013) formulation of "arts of noticing," treated in more detail in Chapter 3.

contained individual, and thus moving from a phenomenological interest in subjectivity to the social phenomenology of intersubjectivity and "social order."[38] These traditions, despite their diverse intellectual heritages, all share methodological attunements that seek to examine cognition and intersubjectivity as "a public phenomenon" (Streeck, 2009).

In this dissertation project, I follow in the traditions of distributed cognition and ethnomethodological studies of everyday practice by taking the situated observation, rather than the interview, as my key form of data. In my observation-of and participation-in the fieldwork of my informants, I paid attention to the movements of bodies, including the gestures, skilled bodily practices, and coordinations between researchers when working with seals. I also paid attention to how objects and artifacts are used to accomplish practical work, both cognitive and material. I watched and participated in these everyday practices, and also recorded them repeatedly with a small body-mounted video camera. In aiming to learn to perform these skilled coordinations with my own body, I worked not towards understanding "from the inside" the practices of my informants, but rather worked towards the embodied affinities produced by mimesis.[39]

While they would most certainly not align themselves with the radically "constructivist" worldview of the social studies of science tradition, my informants

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[38] In the words of ethnomethodology's founder, Harold Garfinkel, the project is to examine how these competencies arise as "locally, endogenously produced, naturally organized, reflexively accountable, ongoing, practical achievements" (Garfinkel, 1991, cited in Bjelic & Lynch, 1992).
[39] Chapter 4 discusses these issues of "insides" and "outsides," and, following from Despret (2013), how mimesis is a practice not of cognitively inhabiting the other, but cultivating bodily affinities.

employ methods that are also attuned to doings and bodily practices, using terms like "reproductive ecology" or "foraging ecology" to name these inquiries. When they make the seals' at-sea behavior visible in dive track data through close attention to the relationship between the seal's body and her environment,[40] they offer potential for understanding the "ethos" of nonhumans, by tracing their habits and habitats (van Dooren & Rose, 2016). In doing so, they allow a move away from a focus on how nonhumans *see* the world—a question that can assume a mind/body dualism (see Crist, 1999). Instead, they ask detailed questions about how these animals bodily engage their worlds: how they *do* them. This methodological imperative has affinities with social science methods that focus on doings and practices, by orienting to material action rather than inferred motivations, by focusing on "how" rather than "why" questions, and by conducting empirical work where the privileged form of "data" is the situated action.

Practices, Doings, and Ecologies

Within STS, ethnomethodology's concerns about "respecification" and the interest in cognition as "distributed" inherited from cultural-historical activity theory (Leontiev, 1979) have been taken up in the practice-oriented traditions. Just as ethnomethodology has respecified phenomena such as "perception," STS scholars have respecified the category of "knowledge" as something locally and provisionally produced in practices, and distributed across objects and bodies. These "praxiographic" methods (Mol, 2002; de Laet, 2012; Law & Lien, 2013) have aimed to question

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[40] This work is discussed in detail in Chapter 2.

distinctions between practices of knowing and the practices of the objects and entities known. They have closely traced how scientific practices turn entities into the kinds of things that can be data, allowing the world to be captured, traced, and known.

These empirical studies of scientific practice have examined how researchers re-configure and re-organize the materialities of their objects of study, allowing those objects to fit into particular inscription devices and research paradigms. This work comes out of a commitment to rethink the assumption that nonhuman objects, phenomena, organisms, and assemblages unproblematically "represent themselves," that nature is an open book to be read by scientists. Rather than this Enlightenment model of knowledge as revealed, these careful studies have drawn attention to the ways the objects of scientific investigation are made represent-able within research apparatuses, according to situated material, institutional, cultural, and political contexts.

This style of "constructivist" STS was pioneered in the "laboratory studies" tradition, where sociologists, historians, and anthropologists have closely examined the material cultures of scientific knowledge production, using metaphors from engineering and crafting practice to characterize scientific work as actively producing, fabricating, or making its facts.[41] Empirical studies have focused on how knowledge practices "reorganize the materialities" (Mol, 2014) they encounter in lab, field, and clinic into objects that bring forth interpretable data. Close studies inspired by this tradition as well as "material culture" traditions in anthropology have argued that objects are not timeless

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[41] See Latour & Woolgar (1979) and Knorr-Cetina (1981) for early studies. These discussions were deeply imbricated in debates about realism in the "science wars."

entities, but moments and material positions, which must be achieved and constantly maintained in practice (e.g. Domínguez Rubio, 2016). These forms of attention to the careful work it takes to produce objects of knowledge help us to notice how the entities that scientists track, trace, and talk about are not ready-made, but have to be produced.[42]

This project employs these methods of examining how practices and doings 'produce orders' and 'reorganize materialities' by closely examining the practical and material work of making seals into "animal oceanographers" at the coastal field site. In Chapters 2 and 3, I look at the material negotiations of researchers with the bodies and socialities of seals, using stills from video footage taken in the field that highlight key moments in their practices. In so doing, I focus on how the seal body as a particular kind of object that can assume the agency of the "animal oceanographer" is achieved and maintained. In Chapter 2, this involves looking at how tensions between activity and passivity are negotiated. In Chapter 3, this involves looking at how researchers need to produce an individualized body out of a radically gregarious sociality, and the material practices of that negotiation.

Across the biological and social sciences, there are various terms for following what I am calling "doings": "behavior" (used by biologists, usually in coupling with evolutionary logics), "interaction" (coming out of the symbolic interactionism tradition

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[42] In one of the most classic examples, Mol's attention to the "achievement" of the body in medical practice shows us that the flesh encountered by the doctor does not cohere or easily articulate with the instruments designed to examine it, but must be made to do so through active material negotiations. Within anthropology, material culture studies has examined the efficacy and agency of objects, but has recently turned attention to how that efficacy and agency is produced through material-semiotic negotiations. Together, these studies teach us that, for both artifacts and bodies, "objectness" requires achievement and constant, often invisible maintenance.

of Mead (1934) and others), “doings” (often used in the post-ANT tradition: see Law, 2009), “practices” (popular in anthropology, and strongly influenced by the work of Bourdieu (1980/1990), for example). In this dissertation, I move between these terms, while acknowledging their different histories and connotations to divergent disciplinary audiences. For example, social scientists have critiqued the term “behavior,” because so many ways of talking about behavior inherit assumptions from behaviorism, as well as the evolutionary logic of sociobiology so despised in the humanistic social sciences.[43] On the other hand, those that use the term “practices” have often assumed, explicitly or implicitly, that practices are done exclusively by humans.

In their focus on fields of interaction, material doings, or practices, practice-oriented methods are self-consciously “ecological,” in their commitment to attend to action and agency as “distributed” across bodies and objects, rather than housed within the individual. Indeed, historians have traced a close coupling between the development of the sciences of ecology and the pragmatist tradition in the humanities and social

[43] Sedgwick and Frank (1995) famously diagnosed this trend in theory the mid-1990s when they stated that “the distance of [any account of human beings or cultures] from a biological basis is assumed to correlate almost precisely with its potential for doing justice to difference (individual, historical, and cross-cultural), to contingency, to performative force, and to the possibility of change” (Sedgwick & Frank, 1995, p. 496). Largely influenced by calls like theirs, and related ones in volumes edited by Alaimo and Heckman (2008) and Coole and Frost (2010), the field of “new materialisms” has claimed its ground on taking considerable interest in materiality—biological and otherwise. See for example Elizabeth Grosz’ “Darwin and feminism: Preliminary investigations for a possible alliance” (2008). On how some of these accounts leave something to be desired from an STS perspective, see Abrahamsson, Bertoni, Mol, and Martín (2015).

sciences, including the work of John Dewey, George Herbert Mead, Charles Sanders Pierce, William James, Erving Goffman, and Gregory Bateson.[44]

In this dissertation, I use the term "ecology of practices" as a way to holding onto these practices, doings, interactions, or behaviors as always situated within larger ecological fields. "Ecology of practices" is Isabelle Stengers' term, inspired by her work with Vincianne Despret, a philosopher of ethology. The term thus imports a relational and ecological imperative into science studies thought, insisting that practices cannot be understood in isolation, but are made with and through their milieu. Stengers explains, "an ecology of practices may be an instance of what Gilles Deleuze called 'thinking par le milieu,'" using the French double meaning of milieu, both middle and the surroundings, or habitat:

> 'Through the middle' would mean without grounding definitions or an ideal horizon. 'With the surroundings' would mean that no theory gives

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[44] According to historian of science Greg Mitman (1992), "ecology represented the borderland between the biological and social sciences through the study of interrelationships between and among individual organisms and their environment" (Mitman, 1992, p. 1). Focusing on the history of animal ecology at Chicago, he suggests cross-fertilizations between the "interactive model" that pervaded embryological research, and the pragmatic philosophy of John Dewey and George Herbert Mead (Mitman, 1992, p. 3). Rejections of metaphysical dualisms such as mind/matter, subject/object, and stimulus/response by pragmatist philosophy were in conversation with ecological approaches, where "the individual could only be defined with respect to its environmental interactions" (Mitman, 1992, p. 27). Furthermore, the pragmatic philosophical tradition of Dewey, Mead, Pierce, and James has been foundational to the concepts, methods, and metaphors of symbolic interactionism, micro-sociology, grounded theory, situational analysis, ethnomethodology, and gestural analysis, which all have resonances with approaches to biological life in natural history, ethology, and ecology, giving situational analysis a "long-standing ecological bent" (Clarke, 2005, p. 10). Clarke, like Mitman, points to Chicago as a foundation for these studies of the ecological as social and the social as ecological, where concepts and metaphors such as "territory, geographic space, maps, [and] relations among entities in a shared terrain" infused studies of the social (Clarke, 2005, p. 10). There are also direct connections between observational methods in the social sciences and ethological models for the study of animal behavior. Communication studies scholar Jurgen Streeck (2009) traces a genealogy of gesture analysis methodologies that includes interactionist approaches coming out of the work of George Herbert Mead, the micro-studies of the interactional order conducted by Erving Goffman, and Gregory Bateson's "natural history" method, which was forged through studying both Balinese dance and the play of juvenile sea otters.

> you the power to disentangle something from its particular surroundings, that is, to go beyond the particular to something that we would be able to recognize and grasp in spite of its particular appearances. (Stengers, 2013, p. 187)

In this dissertation, I work with Stengers' term in order to expand the meanings of "doings" and "practices" to consider the more-than-human. I use "ecology of practices" in this project in order to cultivate attunements to mimetic and layered multispecies, embodied, epistemic, and technical practices. Each chapter takes a slightly different approach to investigating these "edge ecologies."

Recording and Rendering

Practice-oriented methods have long been in intimate connection with ecological methods and techniques, and they have also been in long relation with developments and changes in recording technologies. Like the forms of vision of seals-at-sea made possible by my informant's tooling, methodological innovations in these traditions of inquiry have been dependent upon particular devices, and the aspects of interaction they capture and make salient.[45]

In my ethnographic research, I continued in this tradition of interdisciplinary practice with devices by bringing a camera into the field, to follow the minutiae of interaction, and later render it for analysis. I collected data in this way following the traditions of interaction analysis and ethnomethodology. In this tradition, video is re-watched, transcribed, and gesture gaze are drawn out as crucial features of interaction.

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[45] For example, in ethnomethodological studies, the move from voice recorders to video recorders allowed a shift from the rhythms of talk and turn-taking as a primary object of study, to concerns with gesture, bodily position, and interaction with objects and technologies.

However, it is unconventional to use a body-worn camera in ethnomethodological studies. In destabilizing the frame, this recording device makes it more difficult to follow the unfolding action of all participants.[46] A body-worn camera limited the extent to which I can interpret my video footage through the classic analytics of ethnomethodology, which involve transcription of talk, interruptions, pauses, and gestures. Given the poor sound quality of the recordings, and the device's tendency to only render audible the sayings of its wearer and those she is immediately in conversation with, the flow of talk was not as easily a focus of my analytic attention as it would be with other recording devices. Likewise, while cameras in ethnomethodological video recording are often positioned in order to make it possible to view the gestures and gaze of interactants, gesture and gaze were captured differently with my camera: the gaze of the wearer constantly shifted the frame of the camera, while the gestures of the hands were visible in the bottom of the frame, literally "framing" the action. I thus work with my video footage in this dissertation in a way that is more limited than traditional ethnomethodological analysis, using snippets of talk and stills that capture hands as they work with groups of animals and other researchers. Sometimes the hands are my own, but often I attached the camera to my informants to capture their skilled practices.

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[46] Yet, just as the pervasiveness of the camera brought ethnomethodological attention to different features of interaction previously unexamined, I worked with this device partially in order to experiment with asking about which features of interaction new paradigms of recording and representing might allow us to follow. Just as with previous entanglements between the social and biological sciences that follow their phenomena "ecologically," might "body-mounted following" be a technique that will move from the sphere of biological to social scientific practice, with its potential to re-invigorate the study of material relations in social scientific research practices?

Thus, my own technologies and techniques of recording and rendering make certain choices, and enact certain reductions. Like the techniques of my informants, they work through holding certain things still, and pulling others apart—dynamics discussed in detail in Chapters 2 and 3 in relation to the knowledge practices of my informants. In this sense, my methods too have violences, including the violences of reductionism and mechanization. I take seriously the importance of considering the particular amplifications our social scientific representational practices produce. This is particularly vital in this project given the relations of affinity between my informants' styles of noticing seal body-environment-technology interactions, and my own methods of using a camera in order to follow body-work on the beach. In other words, I can't critique them for making certain analytic reductions, simplifications, and renderings without considering the ones I myself make. I sit somewhere between the approaches to methodological reflexivity of Charles Goodwin (1994), who is in the tradition of ethnomethodology and interaction analysis, and Natasha Myers (2015), who is in the tradition of cultural studies of science. Goodwin acknowledges that his methods of cutting the world up are the same ones as those of the practitioners he analyses, and sees this as part of how perception and representation works, full stop.[47] Myers aims to

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[47] Goodwin (1994) draws on the ethnomethodological and distributed cognition traditions to show how the interaction of experts with objects produces and sustains professional expertise. He employs the methodological and documentary conventions of conversation analysis (Sacks, Schegloff, & Jefferson, 1974) in order to organize, highlight, and code talk into chunks for analysis. This is his analytic method, but the analytic method of those he studies (police officers in a trial of police brutality), he shows, use analogous methods of defining a domain of scrutiny, highlighting, and coding as well. For Goodwin, practices of highlighting, coding, and representing structure the perceptual field, and are at work in any material representation, practice of documentation, or discursive strategy. He is reflexive about his own practices of seeing and transcribing, acknowledging, "it is not possible to work in some abstract world

excavate and amplify the often unspoken registers of her informants' practices, in order to ask how biological practice might be otherwise, and thus refuses to engage the representational conventions of video ethnography.[48] I consider these issues of amplification most explicitly in Chapter 3, where I ask how practice-oriented video methods might be used in order to amplify more-than-human practices, considering older descriptive traditions in biology. In the conclusion, I contend with the violences of knowledge through practices of separation, asking about which kinds of separations generate knowledges worthy of amplification, in both my biological and social science research practice.

Feminist Technoscience Approaches and Commitments

This discussion of the politics of rendering leads me to discuss feminist approaches to technoscience, embodiment, materiality, and technology, a key analytic

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where the constitution of knowledge through a politics of representation has been magically overcome." He recognizes that the representational and notational conventions he employs in his analysis give a certain kind of structuring to his qualitative data, a structuring that is by no means the only or the 'correct' structuring (Goodwin, 1994, p. 607). Yet, he doesn't contend with the implications that his own practices of 'rendering' interaction have so much in common with those used by police officers on trial to justify police brutality and turn it into a technical matter.

[48] In her ethnography of protein crystallographers, Myers' interest is in closely following how scientists use their bodies in the laboratory to model and render minute crystal structures, and she presents her findings in narrative form. She states that, "video ethnography poses a challenge to my research. To make movies, or isolate snapshots … mid-gesture, is to cut into what I see as a larger social and semiotic context for expression and meaning making" (Myers, 2015, p. 273). Myers worries that the methods of video ethnography don't allow the features she wants to amplify in biological research practice to be salient in her analysis, and she reaches towards other modes of amplification instead, working chiefly with descriptions and few images that show the bodily movements and choreographies that are her topic of interest.

in this project.[49] While these can be thought of as ‘theoretical’ orientations, they are also methodological and political attunements that disrupt and give pause to some of the methods I have discussed so far.[50]

The methodological traditions discussed above—attendant to surface reading, ecologies of practices, and recording and rendering—have moved past a humanist human by respecifying cognition, distributing it in the material world, and attending to ecologies of practice. Yet, humans are still focal in these studies, and even when they are in interaction with the more-than-human world, what is analytically drawn out is *their* doings. Furthermore, the assumed agency of these “doings” are often gendered, technocratic, and humanist in persistent and sometimes invisible ways. The model of agency implicit in this doing venerates “action,” “making,” and “engineering” practices. Feminist approaches to embodiment, as a methodological orientation, lead me to notice other kinds of practices being done besides “ordering,” and the other gendered engineering metaphors for what it means to “do.” Furthermore, I ask who/what else is doing the “doing” besides the focal do-er in so many of these studies—people? From a cultural geography perspective, Sarah Whatmore critiqued of the “technical inflection” of many ANT studies, where knowledge actions have been framed in the vocabulary of

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[49] For example: Martin (1987, 1994), Haraway (1989, 1991, 2008), Sobchack (1992, 2004), Cartwright (1995), de Laet and Mol (2000), Mol (2002), Thompson (2005), Ahmed (2008), Despret (2008a), Alaimo (2010), Grosz (2011), and Myers (2015).

[50] In this way, my methodological attunements parallels what Clarke (2005) does in aiming to take the sociological tools of “grounded theory” and “situational analysis” around the “postmodern turn.” In her methods handbook, she shows these methods are adept to make this term, with some tweaking that attends to taking situatedness and differences seriously (Clarke, 2015, p. xxviii). While my project is not to re-write these methods in light of theoretical imperatives, I follow Clarke’s insights that present methods can be repurposed.

engineering. She faces this shortcoming by combining ANT attunements with corporeal feminism:

> Both modes of inquiry share a relational conception of social agency and acknowledge embodiment as integral to the unstable fabric of subjectivity, but their respective emphases on material configuration and experimental being frame the political and ethical import of the question 'what is a self' very differently. My intervention in these debates focuses, purposively, on non-human animals as creatures 'saturated with being' but which have been thoroughly excluded from conventional humanist notions of the subject and which sit uneasily with the extended casting of social agency figured by ANT in the guise of 'quasi-objects' or material artifacts. (Whatmore, 2002, p. 36)

Along a related line, and inheriting from medical anthropology a focus on bodies, Annemarie Mol and Marianne de Laet (2010), in their influential study of the Zimbabwe Bush Pump, use materialism and feminist embodiment discourses to critique laboratory studies' metaphors, working with the term "fluidity." Mol, in her article on "terms that help us attune," provides some other suggestions of modalities of doing: associating, tinkering, adjusting, coordinating, affording (Mol, 2010). Anthropologist of synthetic biology Sophia Roosth (2010) has made a feminist intervention of amplifying craft rather than engineering knowledges as a fruitful way to understand scientific practice. These amplifications of other forms of "doing" lead to the suggestion that "ordering practices" might not be a universal modality of "doing," but just one kind of visible action in an ecology.

In this dissertation, I respond to these provocations in different ways in different chapters. In Chapter 1, I use Rachel Carson's term "encrustings" to describe how human and nonhuman practices sediment themselves onto landscapes, resisting languages of "constraint" and "affordance." In Chapter 2, I ask what practices of separating bodies produce, refusing to take it as assumption that STS looks at practices of separation without critically asking ourselves why we focus in particular on those practices above all others. In Chapter 3, I most explicitly deal with amplification, by asking “who gets to do the doing,” in both seal sociality and STS methods, and inverting the assumed hierarchy of agency between humans and people, while again considering what politics a focus on separation enacts.

Thus, the methodological attunements of this dissertation project together suggest that the social sciences have rich practices of describing and noticing doings, practices, and ecologies. Yet, like the scientists we study in STS, we must attend to the politics and implicit vocabularies of these methodological orientations if we are to consider these methods in a “more-than-human” vein.

Chapter One: At the Edge of the Sea

> The edge of the sea is a strange and beautiful place. All through the long history of Earth it has been an area of unrest where waves have broken heavily against the land, where the tides have pressed forward over the continents, receded, and then returned….Only the most hardy and adaptable can survive in a region so mutable, yet the area between the tide lines is crowded with plants and animals. In this difficult world of the shore, life displays its enormous toughness and vitality by occupying almost every conceivable niche. Visibly, it carpets the intertidal rocks, or half hidden, it descends into fissures and crevices, or hides under boulders, or lurks in the wet gloom of the sea caves. Invisibly, where the causal observer would say there is no life, it lies deep in the sand, in burrows and tubes and passageways. It tunnels into solid rock and bores into peat and clay. It encrusts weeds or drifting spars or the hard, chitinous shell of a lobster. It exists minutely, as the film of bacteria that spreads over a rock surface or a wharf piling, as spheres or protozoa, small as pinpricks, sparkling at the surface of the sea; and as Lilliputian beings swimming through dark pools that lie between the grains of sand. (Carson, 1955, p. 11)

In 1955, Rachel Carson described the teeming life at the edge of the sea with the eye of a curious naturalist, narrating a diversity of ways that organisms get entangled in, dependent upon, and attached to the substrate of the coastal shore. For Carson, the shore environment is a set of material "boundaries" between life zones (p. 27), as well as a "demonstration" of ecological, geological, and evolutionary principles (p. 20). She attends to the shifting temporal and spatial arrangements of this boundary, articulating how "the tidal rhythm is … reflected in a biological rhythm" (p. 32). With a fine eye for material detail, the pages of her book dwell with the organisms that crowd and carpet, hide and lurk, burrow and tunnel, and encrust in the littoral zone, filling "almost every conceivable niche" (p. 11). Her poetic and precise prose attends to the shore as vivid evidence of both evolutionary and ecological processes, exemplifying "the relentless drive of life" as well as "that intricate fabric … by which one creature is linked with another, and each with its surroundings" (p. 11-12). Carson evokes the coastal shore as a site from which we may read the planet's history, describing it as a space that is primordial, as well as the site of key evolutionary transitions—including our own ancestor's exit from the watery abode.[51] The edge of the sea in Carson's figuring has a double status: as a lively habitat for a multitude of organisms, and as a kind of textbook from which the universal principles of evolution and ecology can be read.[52]

Taking the reader to the edge of the sea, this chapter builds on Carson's sensitivity to the foreshore as an interface between habitats, and a richly particular place in its own right. I expand on the core of her mode of attention to this lively zone, a site of biological and epistemic richness where the particular features of different substrates made specific multispecies practices possible. Her descriptions deploy fascination with

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[51] This fascination with our fishy amphibious ancestors is part of many accounts of the sea shore, for example, in organismal biologist Neil Shubin's *Your inner fish: A journey into the 3.5-billion-year history of the human body* (2008), written for a popular audience. Carl Zimmer's *At the Water's Edge: Fish with Fingers, Whales with Legs* (1998) is another example. Like Carson, Zimmer uses the water's edge as a pedagogic opportunity to explicate key concepts and moments in macro-evolution: the movement of early animals ashore 530 million years ago, and the movement of the ancestors of whales from land to sea about 50 million years ago, and the ancestors of pinnipeds from land to sea about 25 million years ago. See also McMenamin & McMenamin's *Hypersea: Life on Land* (1994), a controversial theory of how life moved from sea to land and in so doing needed to develop forms of connectedness in order to gain nutrients, which in the ocean are "passively accepted."
[52] Carson's trilogy of books on the ocean—*Under the Sea Wind* (1941), *The Sea Around Us* (1951), and *The Edge of the Sea* (1955)—were key in constructing a mid-century aesthetic of wonder about the ocean, in part by "domesticating" it (Hagood, 2013). See, for example, her imaginary description of walking out past the edge of the sea into a kelp forest, or her repeated descriptions of the shore's inhabitants as "flowers that are not plant but animal, blooming on the threshold of the deeper sea" (Carson, 1955, p. 13). Yet, while these ways of writing about the ocean cast it as relatable to the human, Carson didn't write it as related to human affairs until *Silent Spring* (1962). This effort to "domesticate" the ocean runs counter to the one that figures it as "alien," discussed at length by Helmreich (2009). For details of these arguments, see Alaimo (2012), Hagood (2013), Hayward (2013). De Wolff (2014) weaves them together in her diagnosis of the "tendency to approach the ocean through a 'duality of wonder and waste,'" (De Wolff, 2014, p. 19), and her work to move past these figures in her analysis of gyre plastic.

the materiality of the edge of the sea to tell biology's story, to explicate the universality of evolution and ecology, refracted through the particular life trajectories of specific organisms. In this chapter, I deploy fascination about the edge of the sea for a different project: to tell a story about how biology is *done*. How does this site afford "livabilities" (Tsing, 2015) for not only multispecies bodies, but also for particular forms of knowledge practice? Understanding the ecological substrate upon which knowledge practices encrust themselves allows us to situate those knowledges. I thus aim to give both an account of a landscape, and of the style of knowing it engenders, a 'grounding' of the "animal oceanographer."

As an ethnography of the intertwined practices of scientists and seals, the coastal shore—specifically the beach at Año Nuevo—is the central site of this project.[53] For elephant seals, the coastal shore is a crucial site of breeding, the place where they temporarily haul their bodies out of ocean food webs to conduct mating activities. For the researchers I followed to Año Nuevo, the edge of the sea is a platform for investigations of deep ocean environments. It is the place where they encounter elephant seals, outfit them with their devices, and enlist them in their knowledge-making projects. Año Nuevo's shoreline is thus a site of life's lively proliferation, as well as a place where epistemic practices proliferate—it a habitat for both the

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[53] The area is referred to with various names: Point Año Nuevo, Año Nuevo State Park, Año Nuevo Reserve, Año Nuevo Natural Reserve, Año Nuevo State Reserve as part of its double status as a University of California Natural Reserve and a California State Park. The area is managed both by the University of California, and by the California Department of Parks and Recreation. For clarity, except when discussing these administrative categories, I refer to it simply as "Año Nuevo," as my informants do.

reproduction of bodies and the production of knowledge.[54] The *biological fecundities* that unfold here are the on-shore mating activities of elephant seals, which are structured in one of the more peculiar reproductive formations among mammals. They feature intense polygyny, large physiological and behavioral differences between males and females, and a strongly hierarchical sociality.[55] The principle *epistemic fecundities* that unfold here are the opportunities this site presents to researchers who aim to investigate deep ocean habitats from shore by scrutinizing, instrumenting, and instrumentalizing seal bodies.[56]

The practical doings that make the staging of the animal oceanographer possible—my informants' particular techniques of monitoring, approaching, controlling, instrumenting, and extracting from seals—are, as much as the seal's forms of gathering on shore, shaped by the particular physical, interactional, and sensory affordances of the edge of the sea. Further, my informants' methods respond to the

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[54] The linkage between the production of knowledge and the reproduction of bodies has been a topic of interest in feminist readings of Marx. See Goody (1976) and Delphy (1988). Martin's (1987) study of the cultural assumptions that underlie perceptions of the female body, also informed by a Marxist perspective, analyzed the "industrial metaphor" of woman's bodies as productive machinery, illuminated how labor and delivery are figured as factory work, with birth as the production of goods to be managed by physicians. In placing the production of knowledge and reproduction of bodies in conversation in this chapter, I build on these traditions, but I follow Martin's mandate to point out economic framings of bodies in order to imagine how they might be otherwise. I do this in part with the help of alternative metaphors for "doings," such as "encrustings," which I draw from Carson's (1955) work, as well as "affordances" and "responses" (Despret, 2004; Abrahamsson, Bertoni, Mol, & Martín, 2015).

[55] All of these features have made this mating system a site of interest for behavioral scientists, including with respect to the concept of the "harem" in biology, which has been critiqued by feminist biologists. I will discuss these critiques later in the chapter, and elaborate them with respect to my fieldwork in Chapter 3.

[56] Researchers scrutinize seal bodies by taking samples and measurements, and outfitting the seals with tracking devices that turn their movements through the far and deep ocean into visible and tangible data. The sampling regimes, tracking devices, and renderings of movements in the deep ocean are the subject of Chapter 2.

particular interactional and representational opportunities presented by seal bodies in their shore habitat, to the vulnerabilities that seals are exposed in human-altered coastal landscapes, and to the power of uninterrupted vision to monitor and control. I propose that the practices of seals and the practices of scientists who study seals are *both* made possible by the invitations this habitat has offered to mammalian bodies over evolutionary time, and its specific features today as an anthropogenic environment.

Año Nuevo

Año Nuevo State Park is coastal reserve on California's central coast, consisting of a set of sandy beaches wrapping around Point Año Nuevo, sitting roughly halfway between Santa Cruz and Half Moon Bay. The inner part of the reserve is composed of coastal scrub, while the area surrounding it is farmed with the crops common to this region, such as strawberries and Brussels sprouts. These forms of water-intensive agriculture cause seepage down the sand cliffs that surround the reserve's beaches, an example of how this protected area is entangled in the cultivated and human-shaped environment that surrounds it. Yet, the landscape of the reserve is also exceptional, and stands apart from other points along the windy coastline between Santa Cruz and San Francisco. Along the coastal highway that snakes up to San Francisco, it is one of the few places where the heavily used road bends inland, cutting a track away from the coastal promontory.

Figure 1.1: A small grouping of elephant seals clusters in the foreground, while researchers depart in an inflatable boat for Año Nuevo Island in the background. Image by Natalie Forssman. Año Nuevo, 2014.

The coastal edge of the reserve consists of a set of sandy beaches that wrap around the point, and a small treeless island that is closed to the public, with abandoned lighthouse buildings that form a silhouette against the sky.[57] In the house, California sea lions are said to sometimes make their way up the stairs and into the bathtub.[58] This story and uncanny image, circulated among those who do field research in and around Año Nuevo, indexes a pervasive feeling that the whole reserve is swarming with insistent barking pinniped bodies. Additionally, though, it draws out the amusing but also somewhat disturbing sensation that these seals and sea lions do not exactly inhabit a site of pristine nature, but something else: a landscape that was once quite heavily used by humans, a marine mammal version of "the world without us."[59] Middens excavated by archeologists at Año Nuevo are sedimented records of a long history of use by Chumash and Ohlone people (Gifford-Gonzalez & Sunseri, 2009). "Kitchen middens," some archeologists have argued, are signatures of the human altering of landscapes long before the industrial revolution (Erlandson, 2013). Their presence haunts this landscape by evoking a rich and barely-recorded history of use by people who were thereafter subject to the violences of settler colonialism, which removed them from relations-with and knowledges-of this landscape. Fragments of past practices are

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[57] The lighthouse closed in 1948: "The Coast Guard determined that the expense of maintaining the island was too great, and a marker buoy with automatic light, sound, and radar reflector replaced the fog signal and light. In 1955, the federal government sold the island to the state of California. The state classified the island as a scientific preserve, eventually restricting public access and use in order to protect the seal breeding colonies" (California Department of Parks and Recreation).
[58] This was a problem even when the lighthouse was operational: "Although fences were built to prevent the sea lions from coming into the gardens and the houses, the fast-growing herds of seals however, often over-ran the house" (California Department of Parks and Recreation).
[59] I borrow this phrase from Alan Weisman's (2007) book, an experiment in imagining how human-made infrastructures would crumble and be overrun by multispecies life if humans were to suddenly disappear.

today only glimpses, mediated through these middens. These middens are "currently being damaged by northern elephant seal breeding activities at Point Año Nuevo," yet another erasure of these traces, which draws attention to the fact that such an intensive use of this space by northern elephant seals is a somewhat recent arrangement—otherwise these middens would likely not have survived intact into the present.

The thousands of seals and sea lions that arrive at Año Nuevo in predictable seasonal rhythms are slowly but inexorably dismantling the traces of past enactments of this landscape, making it anew. There are so many of them that they disrupt some of the fragile ecological relationships of this coastal shore, producing unlivabilities for some species of coastal plants and nesting seabirds.[60] On the island, vegetation researchers in the last several years erected a set of fences to keep the sea lions from overrunning all of the delicate coastal vegetation. On the mainland shore, there are so many elephant seals hauled out that it is difficult to walk the length of the beach at high tide. But it hasn't always been this way. Northern elephant seals were declared extinct in 1874 due to industrial sealing, but a very small bottleneck population survived in an unknown

[60] See the Año Nuevo State Park map of "natural resource sensitivity": https://www.parks.ca.gov/pages/21299/files/10_ano_natural_resource_sensitivity_final.pdf
This is particularly the case on Año Nuevo Island, one of the few predator-free islands in California and thus a nesting and breeding site for several species of seabirds, who rely on the native plants to hold the soil stable for their burrows. While northern elephant seals largely stay along the islands shores because of their limited terrestrial mobility, California sea lions have long trampled the entire island. The Año Nuevo Island restoration project is run by Oikonos, a conservation non-profit, to help populations of breeding auklets by reducing the sea lion trampling that destroys native plants and leads to erosion. They built the "Habitat Ridge," a "sea lion exclusion fence" made from local Eucalyptus wood and designed to blend into the landscape. They also installed "sustainable erosion control fabric" to stabilize the soil, and planted thousands of native plants. Working with ceramicists and students from California College of the Arts, they designed "clay nest modules" for Rhinoceros Auklets, which were embedded underground before the 2011 nesting season. Since then, populations of Rhinoceros Auklets have increased, and Cassin's Auklets and Pigeon Guillemots have started to use the modules as well (Carle, Beck, Smith, Coletta, Calleri, & Hester, 2016).

offshore location. The species received legislative protection from both Mexico and the United States in 1922, and by 1960 the population in both countries had increased to 15,000 seals, at which point they began to fan out from their main breeding grounds at that time, on Guadalupe Island in Mexican waters. In 1955, researchers first sighted elephant seals hauling out on Año Nuevo Island, and breeding began there in 1961 (Radford, Orr, & Hubbs, 1965). In 1975, the first pregnant female came ashore to pup on the mainland of California, at Año Nuevo Point, escaping the increasingly overcrowded beaches at Año Nuevo Island (Le Boeuf & Panken, 1977). Between 1995 and 2006, the number of elephant seal pups born in a breeding season at Año Nuevo stabilized at between two and three thousand, signaling that this rookery had met its "carrying capacity," running out of suitable beach space that could allow the population to continue to expand at its heretofore exponential rate (Le Boeuf, Condit, Morris, & Reiter, 2011). In the early 2000s, Año Nuevo was surpassed as the largest mainland rookery by another haul-out site about 150 miles down the coast, at Piedras Blancas (Lowry et al., 2014). The growth and population dynamics of northern elephant seals have been closely observed at Año Nuevo since their first arrival on the island, making this site a "serendipitous" system to study the population dynamics of relatively long-lived mammals, in a population that has grown from a handful to thousands in only a few decades.[61]

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[61] I use "serendipity" here in the sense of ecologist Jim Estes' recent book (2016), where past actions by humans to nearly wipe out a set of ecological relations allows those relations to be elucidated. Le Boeuf et al. (2011) trace the development of the colony at Año Nuevo from 1961 to 2010 by recording the births and mortality of pups. They found that pup births peaked at Año Nuevo Island in 1980, and stabilized on

The sense that pinnipeds are overrunning past human infrastructures at Año Nuevo sits alongside the fact that this site is today heavily used by researchers, and visited by community members and tourists as a place of environmental education. Año Nuevo Island is part of the University of California Natural Reserve System, a set of sites of ecological importance set aside for research and pedagogic activities of the ten University of California campuses, as "living laboratories and classrooms."[62] It thus has a conservation mandate, but also an educational one—for both students of the UC system, and for the general public. Research in the elephant seal rookery is therefore sanctioned, but also heavily controlled. A limit of ten researchers are allowed to work in the reserve at a time, and they are required to perform their most interventionist procedures on the animals in the early morning, before the general public has a chance to see them, or in the late afternoon.[63] There are paths and trails that wind through the reserve, but several of them are closed to the public, except via guided docent-led tours. This area is designated as a "Wildlife Protection Area," with restricted access by guided walk or permit only.

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the Año Nuevo mainland between 1995 and 2006. They also found that "the pattern of pups born annually at Año Nuevo was determined primarily by the influx of young breeding females dispersing from larger colonies to the south" (Le Boeuf et al., 2011, p. 496), where females pregnant for the first time "pioneer the establishment of new colonies" (Le Boeuf et al., 2011, p. 486).

[62] For a listing of UC Natural Reserves and their conservation and educational mandate, see: http://www.ucnrs.org/

[63] In the video footage I gathered, the sun is always low on the horizon, and the shadows are long. The reasons for doing procedures at the early or late part of the day have less to do with explicit rules, and more with the annoyance of having to "interpret" the scene for the "tourist," and risk angry emails. I elaborate on these dynamics in Chapter 4.

Figure 1.2: The boardwalk that leads to the seal rookery at Año Nuevo, making the view of the center of seal activity wheelchair accessible. Image by Natalie Forssman. Año Nuevo, 2014.

The swarming proliferation of elephant seals at Año Nuevo is cyclical and seasonal. Starting in late December or early January, adult males start coming ashore. Then the pregnant females begin to arrive, hauling their heavy bodies ashore, rather conveniently timed with the start of the academic quarter, when a fresh crop of undergraduates majoring in Ecology and Evolutionary Biology are enrolled as willing field volunteers. Some of these pregnant females carry sensing, recording, and transmitting devices, glued to them on this beach, and which they have carried half way to the Aleutian Islands and back. January to March is the height of activity on the beach.

The birth of a new pup is visible from afar from the white flocks of gulls that rush towards the mother and young pup, tearing apart the placenta in a gruesome feast. This profusion of life draws foxes and sometimes bobcats to the area as well.[64] It also draws researchers, who approach and sedate the individual animals that carry the expensive and delicate equipment, so that the tags can be removed, and physiological measurements and samples taken.[65] Seal pups are nursed for about five weeks after birth. This effects a dramatic transformation upon the nursing females, whose bloated bodies shrink into long black figures, their hip bones sometimes visible as they lie on their sides, their skin slack and loose. Meanwhile, their pups balloon beside them, their small frames seeming to barely contain the bulk of fat that they rapidly acquire.

During this time, the males are involved in their own bodily dramas, working out territorial divisions in the beach's limited space. The central rookery of seals is flanked on both sides, both up and down the coast, by beaches principally occupied by juvenile males, animals that cannot hope for a spot in the reproductive hierarchy this season, and might never attain one in their lifetimes. In the center of the colony, right near the viewing platform where guided tours make their way down the beach starting at 10am, birth, death, and sexual politics play out, including the mating contests between the large dominant males. It is these theatrical and bloody contests that draw the most visitors, who gather on the viewing platforms to watch the spectacle.

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[64] On Isla de la Guadalupe, a remote haul-out site for northern elephants in Mexican waters, feral cats have been documented to covertly drink or "steal" the milk of exhausted post-natal mothers (Gallo-Reynoso & Leo Oritz, 2010).
[65] They remove the tags just after the pups are born, and then attach new ones just before the females leave for sea again.

Amidst all of this activity, researchers carefully watch the females as they interact with their pups, trying to predict when they will begin their migratory journeys, so that they can attach devices just before they depart, and thus follow their satellite-mediated journeys. After the females have weaned their pups, they begin to draw their emaciated bodies back down to the shoreline, to disembark. At this time, the males for mating approach them. Accounts of this mating activity have long emphasized the passivity of the females in this arrangement, but some studies have focused on how they actively manage the space of the beach in ways that have been invisible to researchers, selecting certain males to mate with and others to protect them.[66] The males continue to hold territorial space on the beach until the females are gone, but the pups remain. Referred to by researchers as "weaners," the pups tumble and stumble around the beach as they find their way in their bodies, even after their mothers leave the beach to forage. At this time, the research activity of "weaner weighing" commences, where a large number of the year's pups are captured, pierced with plastic flipper tags, and weighed, the first act of inserting them into spreadsheets that will follow their activities for years. This activity is labor intensive, and whole classes of undergraduate field volunteers are recruited to help out, drawing fresh volunteers into the circuit of the lab, and producing young biologists. The weaners stay on the beach and depart between early April and late May, but during this time there is a short lull in research activities on the beach, coinciding with the exams period in the academic quarter system.

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[66] Chapter 3 revisits these accounts of the mating activity of elephant seals, focusing on these persistent discourses of female passivity and suggesting modes of response to them.

Starting in around mid-March, adult elephant seals again begin returning to the shore, this time for the molt, which, like the mating aggregation, is a seasonally coordinated gathering. The juvenile females and males ("juvies") are the first to arrive. Later, in May, most adult females return, and some older males. The adult males come ashore in the later part of June and stay on the beaches through August. The animals slough off their previous year's pelage, leaving patches of grey fur littering the beach, which researchers have recently determined to be a source of mercury contamination in local seawater, causing concentrations of Methylmercury to spike roughly eightfold at Año Nuevo during the annual molt, levels that are usually found only at sites of industrial contamination. As top predators in ocean food chains, elephant seals gather these heavy metal pollutants—which exist in surprisingly high concentrations in the areas of the water column where they forage—fix them into their flesh, and draw them back ashore.[67]

The bodies and bodily materials drawn together at Año Nuevo display the fecundity of the edge of the sea. As large sea mammals that proliferate on shore, northern elephant seals are an impressive, fleshy demonstration of the abundance of the

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[67] Cossaboon, Ganguli, and Flegal (2015) compared the concentrations of Methylmercury (MeHg) in seawater at Año Nuevo State Reserve to neighboring coastal sites in Central California. They found concentrations were roughly eightfold higher at Año Nuevo during the molt, when thousands of seals shed their fur and grow a new pelage. They conclude, "excreta and moults from this marine mammal colony, and presumably other marine predator populations, constitute a major source of MeHg at the base of the local marine food chain" (Cossaboon et al., 2015). Members of the laboratory that is the focus of this ethnography (Peterson et al., 2015) showed that the specific foraging pattern and location (foraging ecology) of individual elephant seals influences the extent of mercury bioaccumulation. Previous research has shown that MgMe contaminants in the mesopelagic zone (between 200 and 1000 meters in depth) are greater than in surface waters. Peterson et al. found that this extended to the foraging patterns of individual animals—that deeper diving and offshore-foraging seals had the greatest mercury concentrations.

North Pacific Ocean and biomass it supports. More darkly, they also hint at the human-caused perturbation of ecological webs in some of the deepest, farthest, and most "pristine" reaches of the planet. In their sheer numbers, elephant seals have overrun the limited space of the shore at Año Nuevo, making it theirs. Their activities in some ways support terrestrial ecologies, and in other senses endanger them: small carnivores and sea birds feast on their bodily cast-offs and remains and the deep-sea calories and nutrients therein, yet at the same time the seals trample the delicate plants and animals of the tidal and coastal sand bluff ecosystems. In all of these relations, the elephant seals that haul-out at Año Nuevo are a demonstration of the coastal edge as a rich site, both as an ecosystem in its own right, and as a site of "inter-ecosystem connectivity" (Estes, 2016, p. 228). Not only pinnipeds, but also other animals and materials—foxes, seagulls, and disturbing amounts of deep-sea heavy metals—draw together and coalesce here. As a meeting place between environments, the edge of the sea is a rich ecology of practices: a meeting place between worlds, and a niche with very particular affordances for the many organisms that make it their habitat.

This is not even to mention the humans that this startling display of life draws to the coastal edge as well: both members of the public, and researchers from a diversity of biological disciplines. The ecological productiveness of this coastal edge makes Año Nuevo richly symbolic of "wilderness," a special site where large carnivores are visible up close, uncaged, going about their business seemingly indifferently to the humans who observe their activities.[68] This scene also invokes discourses of "recovery," where elephant seal's incredible and unlikely return from extinction paints them as almost heroic figures in conservation narratives.[69] Through its biological fecundity, Año Nuevo becomes a site of lessons about humanity's hubris with respect to the environment, as well as a place where cautious optimism about how renewed, non-lethal relations with other creatures can perhaps be cultivated.

Researchers contribute to this discourse of the semi-heroic "recovery" of elephant seals, and it forms a background to their practices and ways of conceiving their fieldwork site. Yet, their interest in Año Nuevo—as performed through their everyday activities there—is more practical. The flow of bodies and materials that gather and coalesce in this littoral zone makes this site intellectually fruitful for scientists as a platform for asking questions of the deep ocean. And the arrangements these seal bodies

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[68] Historians, anthropologists, and geographers have examined cultural and material constructions of "wilderness." See Cronon's famous (1996) essay on "the trouble with wilderness," which critiques nature/culture divides and looks at the history of wilderness as "a human creation." See also Spence's (1999) history of how the making of wilderness in the United States' national park system involved removal of American Indians. From a cultural geography perspective, Whatmore and Thorne (1998) examine the "moral geographies of wilderness, which presuppose an easy coincidence between the species and spaces of a pristine nature."

[69] "Recovery" is a concept in restoration ecology (see Dobson, Bradshaw, & Baker, 1997), but Westwood, Reuchlin-Hugenholtz, and Keith (2014) point out that it is not well defined in academic or legislative literature. They recommend it be understood not purely in terms of conservation numbers, but in terms of medically defined categories of diagnosis, treatment, stabilization, and rehabilitation of functionality (Westwood et al, 2014, p. 158). Early in my ethnographic research on pinnipeds, a marine biologist pointed out that "extinction" or "decline" receive most of the attention in conservation science and discourse, while the social and spatial implications of "recovery" receive considerably less popular and scientific attention than they should. This includes questions of what happens when people suddenly find themselves living in close quarters with wildlife that have long been expatriated from particular habitats, but are returning in increasing numbers, such as the case of California sea lions and harbor seals in La Jolla, California. African elephants and issues of crop raiding are a notable example where conservation success implies social and economic costs for those who live near recovered wildlife. See Mackenzie and Ahabyona (2012) for a study situated in Uganda. See Thompson (2002) for a science and technology studies example that compares "competing philosophies of nature" in elephant conservation and recovery in Kenya.

gather in make them easy to approach, to monitor, and to intervene upon. Rather than a symbol of ecological richness, for researchers the fecundity of the shore forms a productive knowledge apparatus. Researchers gather on the coastal edge to instrument and instrumentalize seal bodies by turning them into "oceanographers." Seal bodies, comfortable in both terrestrial and aquatic environments, mediate the deep ocean for scientist. In these practices, seals are figured as knowledge workers that span the edge between land and sea, bringing rich data sets ashore.

The remainder of this chapter examines Año Nuevo as a habitat for seals and a knowledge apparatus for scientists. Taking cues from historical and behavioral ecology, I situate the knowledge practices of my informants in a historically contingent ecology of practices by unpacking how this landscape's particular and contingent features afford and enact the encrusting of both seal bodies and scientific practices upon it. Researchers, like the seals, use the edge as a site to span worlds of practice, and rely on its particular material, interactive, and sensory affordances. I undertake close readings of scientific papers, which situate the shore's ecology of practices in evolutionary and historical time. In my readings of these papers, I aim to link the ways animals relate with one-another, the study of which has long been the domain of sciences of behavior grounded in evolutionary theory—ethology, behavioral ecology, and sociobiology—with the forms of encounter that transpire between humans and seals.

I thus marshal tools from the biological sciences, aiming to "work with" rather than "objectify" (Fischer, 2007, p. 569) the conceptual apparatuses of my informants, who are interdisciplinary biologists with an orientation to the animals and habitats they study which combines spatial, physiological, ecological, and behavioral sciences. The critical social sciences and humanities have rightly been suspicious of natural sciences that seek to link behavior to biology for their reductions of human practices to deterministic simplifications.[70] Yet, following the provocation of feminist science studies scholar Elizabeth Wilson, I ask, "What new modes of embodiment become legible when biological reductionism is tolerated and explored" (Wilson, 2004, p. 3)? I argue that the logics of physiological, spatial, historical, and behavioral ecology provide ways to tell detailed stories about the entanglement of bodily practices and knowledge practices in the specificities of place.

But, while I use *frameworks* for noticing the entanglement of place and practice borrowed from my informants, I do so in order to challenge their *framing* of Año Nuevo. Implicit in their way of approaching their research site is a view of it as a platform or infrastructure for watching, cataloging, and analyzing body-environment entanglements elsewhere. Against this tendency, I tune my attention not upon this sea-edge as an interface that vision and knowledge flows *across*, but rather as an ecology of practices with encrusted local particularities that matter.

An Edge that Gathers

On shore, pinnipeds carry out their reproductive activities: giving birth, nursing young, and mating. And their form of reproductive sociality is particular and peculiar. Pinnipeds are unique among the order Carnivora in having a polygynous social system,

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[70] See for example Donna Haraway's (1989) critique of the biobehavioral sciences through primatology. Chapter 3 discusses feminist critiques of sociobiology in more detail.

and highly visible physical differences between males and females.[71] Darwin states that "the sole polygamist in the whole group of terrestrial Carnivora" who "alone presents well-marked sexual characters" is the lion. He continues,

> If, however, we turn to the marine Carnivora, the case is widely different, for many species of seals offer, as we shall hereafter see, extraordinary sexual differences, and they are eminently polygamous [sic]. Thus the male sea-elephant of the Southern Ocean, always possesses, according to Péron, several females, and the sea-lion of Forster is said to be surrounded by from twenty to thirty females. In the North, the male sea-bear of Steller is accompanied by even a greater number of females. (Darwin, 1871, p. 268)

The polygynous social organization of pinnipeds garnered the name "harem" in early natural historic descriptions of seals and sea lions. An 1833 zoological description of southern elephant seals, describes the "furious and bloody combats" between (southern) male elephant seals. Turing then to the females, the author notes that,

> During these murderous conflicts, the females remain indifferent spectators to the rage they have excited, and submit to the conqueror, who assumes the mastership of the herd. The sailors call him Bashaw, comparing him to the jealous and despotic master of a Turkish harem. ("The proboscis-seal, or sea-elephant," 1833, p. 152)

Repeatedly, it has been emphasized that this mating organization is extreme and unique, and the interest in and preoccupation with it was doubtless tied up with the orientalist fascination with the "harem."[72] It has also been of interest as the topic of sexual selection in behavioral ecology has received increasing attention.[73]

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[71] A carnivore is an animal or plant that eats the flesh of animals. Most, but not all, carnivorous animals are members of the Carnivora order, which includes bears, cats, dogs, weasels, and pinnipeds. Elephant seals are the largest animal in the diverse order Carnivora.
[72] Later in this chapter, I return to the concept of the "harem" to name animal sociality, with a discussion of its possible ecological specificity. Chapter 3 further discusses the use of this term to name animal

Yet the structures of aggregation of pinnipeds on shore—the particular ways they gather and arrange themselves there—spring from the specific niche that the shore environment presents to their bodies as a place of reproduction. Situating the sociality of elephant seals on shore in the specificities of their environment offers a way to work against the generalizing leaps that too-quickly connect the elephant seal rookery to the "Turkish harem." To situate a social form in the environment that gives rise to it is a key lesson of Isabelle Stengers' "ecology of practices." She insists that just as "there is no biologically grounded definition of a baboon which would authorize not taking into account the presence or absence of baboon predators in the environment… [and] in the same way, I would venture there is no identity of a practice independent of its environment." Extending this insistence on particularity to the work that theories do, she insists, "no theory gives you the power to disentangle something from its particular surroundings, that is, to go beyond the particular to something that we would be able to recognize and grasp in spite of its particular appearances" (Stengers, 2013, p. 187). Yet, Stengers insists, "Thinking *par le milieu* does not give power to the environment," it "emphatically does not mean that the identity of a practice may be derived from its environment. In this section, and each that follows, I examine a particularity of the coastal landscape and the "ecology of practices" it gives rise to, not as deterministic causes and effects, but as "involvements" (Stengers, 2013, p, 187), "affordances" and

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sociality, the social and cultural critiques of this description, and possible modes of response, in more detail.

[73] See Gross (1994) for a history of behavioral ecology from within the field circa the mid-1990s, where he declares interest in sexual selection on the rise. Recently, sexual selection has been of interest in feminist theory; see Grosz (2011) and a response by Hird (2012).

modes of “response” (Despret, 2004; Abrahamsson et al., 2015, p. 15). In each of three sections, I think first in terms of the practices of elephant seals, and then in terms of the practices of the researchers that ask questions of the seals. In this way, I situate both the bodies and socialities of seals—and genealogies of knowledge—within the particularities of this landscape.

I begin by closely reading a behavioral ecological schematic model (Bartholomew, 1970) that seeks to explain the propensity of pinnipeds to gather in close quarters with one-another—what biologists refer to as “gregariousness.”[74] Bartholomew’s insight was to hypothesize that their adaptation to living with, along, and across the boundary between land and sea can explain this tendency of their breeding practices to take place “under extraordinarily congested circumstances.” This, coupled with their limited terrestrial mobility, implies that seals “frequently crowd as close together as physically possible.” Over evolutionary time, he hypothesizes, these physical particularities of environments and bodies have shaped the bodies of seals, and their ways of being social, into an arrangement unique among mammals. Bartholomew’s behavioral ecological reasoning proposes deep-time entanglements between social and interactive formations and the environments in which those they are situated, grounding “harem sociality” in the specificities of the shore. I read Bartholomew’s model to suggest that pinnipeds on shore are something very different than pinnipeds at sea, because of the bodily and interactive opportunities that the shore

[74] Biologists use the term “gregarious” to describe animals that herd or congregate together; the term names a particular form of conspecific sociality, which is similar to but different from its everyday use as a type of friendliness.

provides them. Starkly dividing their reproductive and eating lives between two environments, I argue that pinnipeds are "multiple" in the sense of Annemarie Mol's *The Body Multiple* (2002), in that these two different spheres of practice—eating at sea, and reproducing on shore—enact different bodies.[75] At-sea eating practices, and on-shore reproducing practices produce different modes of embodiment and different socialities in seals. And the scientists this ethnography follows rely on these differences—their research practices require and exploit this multiplicity. More specifically, their fieldwork techniques exploit the behavioral affordances of the shore seal in order to ask questions of the ocean-going seal, and that their research practice relies upon traces of the later in the former. I elaborate these points after unpacking the particularities of the behavioral ecological model.

Bartholomew's Model for the Evolution of Pinniped Polygyny

In 1970, zoologist George Bartholomew sought to schematically model the evolutionary constraints that led to the exceptional social system of pinnipeds. In his influential paper, he catalogs the selective factors that combined, over millions of years, to bring about this form of mating aggregation, and the behaviors that pattern it. He, like

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[75] "Enactment" is the term that Annemarie Mol (2002) uses to talk about how different practices perform different realities. It is in line with how Karen Barad (2007), following Judith Butler (1990), uses the term "performance," as well as how Bruno Latour (2000, 2004a) and Vincianne Despret (2004) have used "articulation." Each term shares the sense that, more than offering different *perspectives* on a single world, different doings produce different worlds, making different ontological realities possible. My analysis pushes beyond how the term "enactment" and "multiplicity" have been used in the "praxiographic" or "empirical ontology" traditions. Analyses there have been grounded in material doings, but the ones doing the doing have always been human. In this section, I build to the argument that the landscape enacts bodies, and thus it is not only humans that have the power to make worlds. I give much more space to a discussion of how and why to extend the praxiographic analytic to consider more-than-human practice in Chapter 3, so dive into these issues only briefly in this chapter.

natural historians and zoologists before him, noted the uniqueness of the pinniped social organization among mammals, stating that, "very few mammals are as apt to gather, with as little care for the personal space of the individual as the seal on shore," and "except for cave-dwelling bats, the polygynous pinnipeds are the most gregarious of mammals" (Bartholomew, 1970). Bartholomew sought to explain this peculiarity of pinnipeds—their tendency towards gregariousness—in behavioral ecological terms.[76]

Bartholomew proposed that everything about pinniped bodies and socialities can be understood from the "amphibious mode of life," from understanding those bodies and socialities as adaptations to a life lived along and across the edge between land and sea. Elephant seals are amphibious creatures in the sense that they carry out a life divided between two starkly different habitats: the deep ocean on the one hand, and open sandy beaches on the other. And their habits in these two environments are utterly different. At sea, they are solitary hunters, repeatedly diving and seeking prey in the three-dimensional space of the pelagic ocean. On shore, however, they never eat and are very rarely encountered as solitary individuals. Rather, the terrestrial environment is the gathering place of their reproductive activities, the site where they give birth to their pups and then subsequently mate, before returning to the ocean.[77] Bartholomew's

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[76] Beyond being a fascinating evolutionary story about seals, Bartholomew's paper also grounds the work of my informants. The P.I. of the lab that I follow in this ethnography, Dan Costa, told me that his whole research career is inspired by and attempts to elaborate Bartholomew's thesis. See Costa (1993) for a direct elaboration of it.

[77] It is also the site where they haul out to molt off their fur and grow a new coat. They remain on shore and fast while molting because the molting process disrupts thermoregulation. In this chapter, I chiefly focus on the shore as the site of their reproduction rather than molting. Chapter 3 engages more with terrestrial elephant seals during the yearly molt.

proposal is that the social organization of pinnipeds on shore is an evolutionary-ecological answer to the divergent constraints and opportunities presented by two very different habitats. Thus, while seals' closest evolutionary cousins are bears, it is not the genealogical relations to these relatives, but the ecological constraints of their amphibious lives, that shapes their behaviors above all other factors.

In their evolutionary history, pinnipeds were terrestrial mammals that "returned" to the sea in order to exploit high marine productivity about 25 million years ago (Lipps & Mitchell, 1976). The adaptations that they developed for eating at sea can be understood with reference to the distribution, abundance, and size relative to their bodies of the species they prey upon (Hildebrand, 2012).[78] Because they forage offshore and thus don't rely on highly productive marine upwelling, elephant seals eat prey that is distributed through the environment at such a scale that it is advantageous to forage alone (Costa, 1993).

However, sexual reproduction demands that seals encounter their conspecifics at least some of the time—for breeding. Northern elephant seals forage across the ocean basin of most of the eastern north pacific, necessitating coordination in order to make sexual reproduction possible. Reproductive synchrony, the adaptation where a species coordinates its reproductive activities in both time and space, helps to solve this difficult

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[78] So, for example, humpback whales have developed co-operative foraging strategies in which they encircle large schools of fish. For them, there is an advantage garnered by foraging with their conspecifics. Filter feeders like blue whales that feed very low on ocean food chains, by contrast, don't engage in collaborative foraging because there is no advantaged gained from encircling their prey, and if they were to forage alongside their conspecifics, they would probably get less to eat from sharing the meal.

constraint. Reproductive synchrony allows the coordination of disparate bodies from across an ocean basin into a concentrated breeding colony. In Bartholomew's terms, this adaptation "allows the congruent organization of a large number of ecological, physiological, and behavioral elements that would otherwise be incompatible."

The simultaneous requirements of foraging disparately and breeding collectively are coordinated together in the life history strategies of seals. But because they happen completely separate from one another (by contrast, most terrestrial mammals eat, have sex, and give birth to offspring in generally the same spatial area), seals have very different reproductive behaviors than many other mammals. At the coastal edge, female pinnipeds are not constrained by the competitive requirement to keep a distance between themselves and their conspecifics, which their style of foraging requires. As Thelma Rowell puts it, a "requisite of the harem mating system is that females must aggregate, and a high level of female gregariousness is only possible if the exigencies of foraging provide no constraints" (Rowell, 1987, p. 657). Thus, female seals gather at the shore to give birth and subsequently breed, and there is no constraint of trophic resources that requires them to hold their bodies apart from one another in that habitat, because they do not compete for food resources there. Indeed, studies of development of elephant seal rookeries over time propose that beach space is one of the few material limits on continued exponential expansion of the population, what population biologists call its carrying capacity (Le Boeuf et al., 2011).

Male seals, on the other hand, aren't quite as free from Darwin's famous principle of limited resources alongside potential for unlimited reproduction, which drives evolution—the "struggle for existence" (Darwin, 1859). Framed in the Darwinian logic, biologists have understood the females in the shore environment as a "resource" for males. This leads to the mating system conducted in incredibly close quarters, with females that pack very closely together, hardly seeming to acknowledge the boundaries of their own bodies, while males have a lot to "gain" (in terms of biological fitness) from mating with as many females as possible. The outcome of this, over evolutionary time, is a very intense social world for seals who must constantly manage relations with conspecifics, with whom they share very limited space. This, in turn, gives sexual selection—as an adaptive logic in contrast to natural selection—a large sway in this environment, producing a highly structured mating system where males navigate their place in the hierarchy with mating contests, the outcomes of which determine who will control the "harem." In order to win these contests, males have evolved highly specialized physiologies that they use to fight one another, and to impress females, leading to sexual dimorphism in physiology and behavior, where the sexes look and behave very differently from one-another. However, these fights are usually what ethologists call "ritualistic," in that the bodily movements that were once associated with aggressive behaviors become signals of that behavior, allowing fights to be enacted with minimal bodily injury to either party.[79]

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[79] Linguist John Haiman (1994) calls this "non-linguistic ritualization," and states that it has been in the lexicon of ethologists since Tinbergen (1952). He provides a few examples: "the wolf's snarl as a preparation for aggression evolves into or is replaced (over time? in many interactions) by the same snarl as a signal of anger….the mare automatically lowers her head and bends her ears back when preparing to kick with her hind legs. The bent-back ears alone now function as a signal of hostility….the searching behavior of bees at food sites (elements of which are attested in the behavior of a number of other non-

One of the dimorphisms between the sexes in elephant seals is that their sociality on shore seems to be governed by completely different logics. It is relatively easy to characterize males in the logic of the "struggle for existence."[80] Interactions between males are so easily recognizable as two self-contained individual bodies confronting one-another in a competitive dance in which the strength of a neck snap, the bite of a jaw, the height of a torso, or the pitch of a thunderous vocalization are ever in comparison, enacting difference between the two bodies. Within an arena that assumes competing individuality, however, female elephant seals' ways of moving and behaving are deeply strange, and even somewhat uncanny. Rather than self-contained entities whose boundaries are clearly defined and intensely policed, females don't seem to behave like individuals at all. They hardly seem to be aware of the edges of their own flesh, as they lie in massive closely packed aggregations, and a movement in one body reverberates through the pile.[81]

A Body Multiple

I read Bartholomew's schematic model as a proposal that the coastal edge allows the gregarious and polygynous sociality of pinnipeds to evolutionarily emerge, by taking competition for food resources out of the equation on shore, leading to a

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social and emphatically non-communicative insects) becomes stylized and evolves into the celebrated bee language" (Haiman, 1994, 4).

[80] Whether the "struggle for existence" is the principle logic that grounds evolution has been contested since Darwin's writings, intertwined with debates about competition or cooperation as the "state of nature." Peter Kropotkin's *Mutual Aid: A Factor for Evolution* (1914) is an early example.

[81] The concern of Chapter 3 is how the researchers interact with this strange sociality of female elephant seals, and produce out of it an atomized "animal oceanographer." There, I elaborate in more detail on the questions female elephant sociality implies for a biology grounded in the competitive logic.

wholly different social form to emerge, particularly among female elephant seals. Seal's social habitats on shore spring from their strategy of inhabiting dual habitats, and the extreme nature of their mating organization—reproductive synchrony, high gregariousness, and a mating system governed by sexual selection—are made possible by the fact that their feeding and reproduction occur in completely different habitats. In Bartholomew's terms, polygyny and reproductive synchrony in pinnipeds are "an integral part of a complex adaptive suite, including physiology, morphology, ecology, and distribution, which has evolved in response to an identifiable series of interlocking selective factors, all relating to an amphibious mode of life." Their adaptations allow "the congruent organization of a large number of ecological, physiological, and behavioral elements that would otherwise be incompatible." The coastal edge is thus an apparatus that coordinates multiple far-flung bodies in both time and space, drawing them together into a tightly packed and gregarious assemblage.

I read Bartholomew's model as a schematic transcript of multispecies behaviors, interactions, and practices, and a proposal of how these social and bodily practices "coordinate," "tinker," "adjust," and "afford" one-another over evolutionary time, and also "coordinate," "tinker," "adjust," and "afford" with their environment.[82] And I take

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[82] I use these terms from Mol (2010), an account of actor-network-theory that casts that intellectual tradition as a set of "terms that help us attune." I use Bartholomew's paper as a set of terms to help me attune to the ecology of practices of elephant seals, where bodies and socialities must be understood in terms of their environment. Of course, plenty about Bartholomew's model is fair game for critique: the teleological and engineering logic in which biological descriptions and evolutionary mechanisms are cast, the figuring of females as passive, of food and bodies as resources, and much more. Despite some of the economic and engineering jargon of Bartholomew's thesis, which casts biology in the language of "congruent organization" and "adaptive suite," I insist that these are "terms that help us attune."

Bartholomew's schematic model as revealing something important about the ecology of practices that this dissertation project investigates. I take this model of actions, interactions, and practices between seals and their environments and use it to understand what is special about the coastal shore for scientists, how their ways of knowing—like the social forms of seals—are encrusted onto that coastal edge in particular ways. Entangling an explanation of the practices of scientists with these evolutionary explanations of behavior has potential for rethinking both human practice and more-than-human practice, by situating them in a shared set of material and interactive constraints and opportunities, a shared ecology of practices.

I suggest that the stark partitioning of seals' lives into eating and reproducing implies that the seal body is "multiple" in the sense of Annemarie Mol's *The Body Multiple* (2002). Seals on shore are not the same as seals in the ocean, because the constraints and affordances of each habitat produce different assemblages and relations. The "empirical philosophy" (Mol, 2002) or "empirical ontology" (Law & Lien, 2013) tradition in science and technology studies (STS) has focused on how "practices generate orders" by examining "what objects come to be in a relational, multiple, fluid and more or less unordered and indeterminate (set of specific) and provisional practices" (Law & Lien, 2013, p. 365).[83] Yet, these accounts draw a firm line between the praxiological and the ecological. Human practices are to be considered as shapers of objects, as in Mol's famous study. Nonhuman doings, however, are treated as the stuff

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[83] For example, Law and Lien attend how different modes of ordering produce different salmon: mechanic vaccination practices enact different salmon than the visual practices of feeding and deciding if the salmon have eaten enough food.

of scientific results, to be analytically deconstructed *as* human practices: of ecological knowledge making.[84] But a praxiological framework can be taken further, to understand how the landscape of the coastal edge "does bodies," producing the seal body as "a body multiple." The gatherings of seal bodies on the coastal edge are a set of materialities that come to be because of the particular spatial and temporal constraints of the coastal habitat. At the evolutionary level, the edge environment between land and sea affords seals' very specific temporal, corporeal, and social configurations, and their habits are a response to these affordances. Thus, it is not only scientific practices that produce different enactments of the world, but the agency of different landscape arrangements as well. Not only human practices generate orders, but nonhuman practices as well. If we take seriously Stengers' call to think *par le milieu*, we must consider that a landscape can produce "a body multiple," just as much as varying clinical practices do.

The Seal Multiple as Limit and Opening

The knowledge practices of researchers that outfit seals as "oceanographers" are made possible by this evolutionarily and materially shaped ecology of seal practices: the amphibiousness of their life history strategy that shapes their bodies as "multiple." My informants' knowledge practices in this environment rely on the multiplicity of seal

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[84] So, for example, when Law and Lien discuss the biology of salmon, they discuss it as being "done" in "practices of description" among some of the other practices. They take as example descriptions of the salmon's lifecycle, descriptions that "link [that lifecycle] to both geography and genetic segregation." They manage to talk about descriptions as "doing" salmon, but not the landscapes those descriptions capture as "doing" salmon as well.

bodies, and the habitat-spanning status of the edge. Firstly, because edge concentrates and coalesces seal bodies—and the material traces they gather of the ocean—as an epistemic resource for scientists. Second, because researchers rely on the interactive repertoires with seals as reproducers, rather than seals as eaters, to do their everyday work in the field.

Seals use the edge of the sea to remove their bodies from ocean food webs, temporarily exiting themselves from relations of eating in order to avoid the potential for being eaten. Yet, as bodies that are composed from foraging in those ocean food webs and will return to them, when elephant seals haul themselves ashore, they haul traces of those relations onto the beach, justifying scientists' interest in them as delegates for studying the deep ocean. Because of what material feminist scholar Stacey Alaimo (2010) calls the "transcorporeality" of bodies, their porousness to their environments, seals haul traces of the sea ashore.[85] But it is more than a general porousness of bodies that makes elephant seals good for investigating the ocean from shore. Because they fast while on shore, they bring a tremendous amount of marine-made flesh to the beach. The "congruent organization" of marine feeding and terrestrial parturition makes their bodies on shore as stored energy, a resource they draw upon for their taxing reproductive activities on land.

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[85] Alaimo's concept of "trans-corporeality" (2010) theorizes "the human" as "substantially and perpetually interconnected with the flows of substances and the agencies of environments" (Alaimo, 2012, p. 476). Alaimo's concept of "trans-corporeality" is in conversation with recent feminist work on bodies and objects as "entanglements." Karen Barad (2003, 2007) uses the term "entanglement" to describe how matter is never discrete, that its existence is always in relation (Barad, 2007, p. 6). Alaimo's "trans-corporeality" draws this focus – on boundaries that are ever in construction, and on "material interchanges across bodies" – into conversation with environmental ethics and environmental justice.

Studying marine animals from shore thus proves very convenient for researchers, because directly observing eating activities of marine mammals is difficult, expensive, and impossible for human bodies without technological coupling.[86] This creates unique affordances for scientists, who are able to gather samples from the deep ocean on shore, because the seals they study eat in the pelagic ocean and then bring those "energy reserves" to their mating activities. With bodies framed economically as repositories of calories, the seals are "motivated" to eat as much as they can before fasting on shore, and thus autonomously build their bodies as repositories of "sea signals" for scientists to read.[87]

Thus, when my informants discussed data and samples in lab meetings, they debated whether a given data point displayed a "sea signal" or not. The sample was interesting to them to the extent that it could tell them something about the ocean. They weren't interested in what that sample could tell them about the shore, and the shore was treated almost as "noise" in their data: it was the site of their fieldwork, but not of their intellectual inquiry. While elephant seals' amphibiousness is a doubleness of life

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[86] Stefan Helmreich (2009) insists that knowledge of oceans requires "transduction" because of the alienness of ocean habitats to direct observation by human bodies, particularly through the visual modality, which is the dominant sensory modality in Western culture. Helmreich's inquiry into knowledge of oceans is thus also an inquiry into sound-based knowledge making. In this project, it is not sound waves that transduce the vibrations that allow scientists to generate representations, but the bodies of seals that span the edge between land and sea, and the devices researchers attach to them.

[87] Costa (1993) discusses how Otariids ("eared seals," such as sea lions) and Phocids ("true seals," such as harbor seals and elephant seals) couple foraging at sea and nursing young differently. Phocids fast throughout the nursing period, while Otariids go for short foraging journeys and then return to their pups. This has made Otariids more reliant on productive nearshore prey, chiefly governed by seasonal upwellings of nutrient-rich waters. On the other hand, Phocids have been free to evolve feeding strategies that take them much farther from the reproductive rookery, into places where prey is more spatially diffuse.

that allows them to use interactional features of both habitats, and to store up energy reserves one habitat to use in the other, that doubleness is also a tool of medium-spanning vision for scientists, allowing them to see the ocean from shore.

This presents scientists with the opportunity to stage a research program that investigates the eating activities of a top predator in a habitat where it doesn't eat. Studying elephant seals in their marine habitat presents many practical difficulties: when at sea, elephant seals surface only every thirty minutes and travel great distances. This makes it difficult to locate their bodies in space and time, and to study those bodies in any systematic fashion. It is nearly impossible to observe where and when and upon what they feed because eating occurs far beneath the ocean's surface, and to sedate them to extract bodily samples during their foraging migrations would be difficult without killing them.[88] And, it is difficult to "follow" the doings of a particular individual because seals drift in and out of sight, diving deep and surfacing rarely.[89] A

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[88] It's not that researchers don't do bio-logging projects on other marine animals—it's just a lot more logically difficult. The Tagging of Pacific Predators Project, discussed briefly in this dissertation's introduction, is one such example, and included air-breathing vertebrates such as sea turtles, albatrosses, pinnipeds, and whales, as well as several species of tuna and sharks, sunfish, and the Humboldt squid. In her chapter on the National Geographic Channel's *Crittercam*—nature documentary meets reality television—she attends to how "Crittercam people have to solve, *physically*, how to get the videocam [sic] packages onto beings. … Many weeks of unsuccessful attempts to attach a camera to a whale (almost a whole research season) were reduced to a couple of minutes of TV time showing one failed attempt after another to plant a camera hanging off a long pole onto a giant moving whale from a boat" (Haraway, 2008, p. 256).

[89] One member of the lab, who studies elephant seal dietary preferences, told me about her excursion on a Japanese scientific voyage, to the parts of the North Pacific where she had long closely studied the dive trajectories of elephant seals, at a distance. There, she and her collaborators fished for deep-sea species of fishes and cephalapods, to gather fatty-acid signatures for later lab comparison with elephant seal blubber samples. This was the closest anyone in the lab gets to an experience of getting to 'see' the habitats that they study remotely, and it hardly comes close to directly observing that habitat, since elephant seals feed up to a mile under the ocean's surface.

long-time collaborator with the Costa Lab puts this elusiveness and mysteriousness of seals' underwater doings well: "they are not diving animals, but surfacing animals."

Yet, elephant seals as terrestrial organisms are easy to locate both spatially and temporally: their reproductive coordination produces predictable temporal and spatial patterning from year to year. Between January and March, they can always be found giving birth and mating on particular beaches in California. Additionally, individual animals display remarkable "site fidelity," usually returning to the same beaches throughout their lives.[90] Scientists that wish to know about these animals can therefore coordinate their research activities *with* this mating apparatus of the organism they study. The rhythms and patterns of research activities are attuned to the rhythms and patterns of seal activities. Because female elephant seals aren't constrained for resource in the shore environment, they are gregarious and synchronized when they haul their bodies ashore. What is presented to researchers who study elephant seals is thus a large gathering of flesh, providing an abundant choice of potential research subjects for the scientists, and making possible research methods that follow particular individuals and

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[90] The extent to which the researchers rely on the consistency of these animal coordinations is made evident when these patterns diverge from their expected paths, which relates to Star and Bowker's famous insight that infrastructures become visible when they break (2006). The kinds of consistency expected of different bodies also highlights gendered assumptions. Female elephant seals, as research subjects, are expected to behave in certain consistently patterned ways that articulate easily with the research apparatus of the scientists. This expected consistency is in contrast with how male animals are approached. So, males are rarely outfitted with the tracking technology because they are more likely to die at sea. The consistency expected from these bodies becomes a matter of differences in the sexes: male bodies behave in exceptional ways from a population biology perspective, while female bodies behave in predictable ways, consistently producing one pup per year, and thus motivated to return to the beach. Meanwhile, male bodies are more predictable in a behavioral sense than female bodies, because of their ritualized shows of dominance. The behavioral unpredictability of females is unpacked in more ethnographic detail in Chapter 3.

their offspring from year to year. This solitary foraging animal's adaptation to coordinate their reproduction in time and space makes available to the scientists that study seals a large array of possible research subjects. Several research subjects can be approached and outfitted in a single fieldwork trip. The temporal and spatial synchrony of their reproduction allows a similar temporal and spatial synchrony of fieldwork practice, creating efficiencies that allow data to be easily gathered.

Furthermore, studying predation directly is dangerous. In separating their lives into an eating component and a reproducing component, the seals make it possible for researchers to study a large predator in fine-grained detail with little fear of "becoming prey" (see Plumwood, 1995). Studying a large carnivore within an ecology of practices where it doesn't eat is the very contradiction that makes my informants' research practices possible, and gives them a unique practical advantage among biologists. The entity that their research doings strives towards knowing is one very different from what they intersubjectively encounter. This opens up opportunities in interaction because the organism they encounter in practice is a more relatable and benign social interactant for humans than the one they might encounter at sea—a predator in that habitat that would be both elusive and dangerous. When researchers interact with elephant seals in their shore habitat, they interact with a particular facet of their study subject: its shore body, whose attentions are tied up in reproductive activities, rather that its sea body, a hungry predator. Part of scientists' work involves turning the shore seal—encountered as a pod of gregarious piling bodies—into the sea seal—an atomized individual.[91]

The multiple opportunities and protections provided by the edge have evolutionarily shaped the particular behaviors of seals. Further, the shore environment, and the bodies that gather there, also allows the encrusting of particular knowledge on the sea-edge. To view the scientists' practices as reducible to a flow chart of determinisms is not my goal here, but instead to draw out how the particular ways seal bodies gather at this sea-edge afford particular ways of asking questions. "Thinking *par le milieu* does not give power to the environment," it "emphatically does not mean that the identity of a practice may be derived from its environment…. the issue is not one of power but of involvement" (Stengers, 2013). I have argued that the very possibility of figuring the seal as an oceanographer that brings reports of the sea to shore is made possible by particular features of the edge, which produces female elephant seals that gregariously gather on the edge of the sea, hauling stores of marine calories for use in their own reproductive activities. Researchers come to Año Nuevo to exploit this gathering, to read from the fleshy pile traces of pelagic worlds.

Landscape Afterlives

Northern elephant seals' habit of hauling out on the coastal edge allows them to carry out an amphibious life between land and sea, but it also makes them vulnerable. The material traces of ocean environments that seals haul ashore are treated as

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[91] Ethnographic examination of the embodied work of this transformation is the subject of Chapter 3.

"resources" in various ways, by different actors. For the seals themselves, they are stores of calories that allow them to fast on shore, while engaging in the taxing bodily work of nourishing their pups or competing for mates. For the researchers, they are traces, samples, and data for investigating the ocean from the coastal edge. But the same proclivities that make seal bodies a concentrated epistemic resource for scientists—making it easy and convenient to turn their oceanic bodily materials into data—also make them vulnerable as concentrated material resources for other practices. These include the eating practices of terrestrial predators like bears and wolves, as well as both subsistence and industrial practices of humans. Most devastatingly for the species, elephant seal bodies were treated as repositories of easily mined oil in 19th century industrial sealing.

Given their vulnerability on shore, northern elephant seals have historically sought offshore islands to haul-out. In a 1833 description of "the proboscis-seal, or sea-elephant" of the southern ocean, a Victorian natural historian notes,

> In rendering it compulsatory [sic] on the seals to come on shore to bring forth their young, Nature seems to have voluntarily devoted them to death and destruction. In fact, devoid of any means of defense, and scarcely able to drag themselves along the ground, the seals everywhere fall victims to the larger animals, and above all, to man; so that, equally avoiding these two kinds of enemies, the timid herds only multiply in abundance on those remote islands, and those solitary rocks, where, in the midst of eternal ice, the savage beasts of prey exist not, and man has not yet fixed his habitual abode. ("The proboscis-seal, or sea-elephant," 1833, p. 148)[92]

[92] The description is of the southern elephant seal, and proposes a Latin name for the species that has since been superseded. This description is of course situated in the specificities of southern ocean

While the above description is of the "timid herds" of *Mirounga leonina* in the southern ocean, the same arrangement was likely true of *Mirounga angustirostris* on North America's west coast. Yet, today in California, northern elephant seals inhabit the mainland shore, because there are no longer lethal threats for them in this environment. "Savage beasts of prey" have been expatriated or driven to extinction.[93] And, since the Marine Mammal Protection Act (MMPA), enacted in 1972, marine mammals are federally protected from attempts by 21st century humans to harass, hunt, capture, or kill them. This jumbled ecology of practices between humans and seals further contributes to their convenience as research subjects—making them intellectually fecund for scientists—and shapes the ways that researchers approach them and pose questions to their bodies.

This section again closely reads ecological evidence and hypotheses about elephant seals. In the section previous to this one, I examined a behavioral ecological schematic model (Bartholomew, 1970), interpreted it through the STS framework of "practices produce orders" and "the body multiple," and used it to understand the edge-spanning knowledge practices of my informants. In this section, I read historical ecology findings about elephant seals alongside accounts from the history of sealing. I aim to situate northern elephant seal sociality on shore with respect to their present habit of hauling out on the populous mainland shore of California. I contrast this present

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landscapes (such as "eternal ice"), but it captures the link between vulnerability and remoteness well. I was not able to determine its author.

[93] The California grizzly (*Ursus arctos californicus)*, depicted on the state's flag, is one famous example. This subspecies is now extinct.

landscape, what I call a "jumbled" ecology of practices, with the remote shore environments that elephant seal sociality is understood by behavioral scientists to have evolved within. When read alongside the story of human industrial practices that nearly hunted them to extinction, this spatial or "biogeographical" history of elephant seals as a species help us interpret the ecology of practices between humans and seals on the beach at Año Nuevo, situating the human-seal interactions that this project examines in a broader spatial and temporal juncture.

Where Were the Northern Elephant Seals?

Given the boon of nutrients and sustenance that marine bodies present to terrestrial ecosystems, amphibious and euryhaline organisms are very vulnerable to terrestrial predation on shore.[94] This is particularly true for elephant seals, who feed on some of the deepest ocean prey consumed by any mammal except sperm whales. Thus, the bodies they haul ashore establish terrestrial connections to food webs very far away, what ecologists call "inter-ecosystem connectivity" (Estes, 2016, p. 228). The fact that the shore is for elephant seals an ecology of practices where reproduction is practiced

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[94] And can therefore be important ecological connectors. Euryhaline organisms are organisms that can survive in a number of salinities, or whose lifecycle involves a migration between freshwater and marine environments. Pacific salmon are euryhaline, and their lifecycle is an evocative example of how marine nutrients make their way into terrestrial ecologies. As the David Suzuki Foundation puts it, "Salmon don't grown on trees, but trees are grown on salmon." Landscape ecologists have shown marine materials making their way deep into mountain forests far upstream from the coastal edge. Pacific salmon, by swimming upstream to spawn, and then dying, bring the materials of the deep ocean — fats, proteins, and nutrients — far into terrestrial landscapes, sustaining forests. Bears and wolves feast on the abundance of the coordinated spawning migration in rivers, their eating activities then carrying these materials far from rivers, transporting them in their feces, which nurture trees. Landscape ecologists have shown that the iconic forests of the Pacific northwest, incredibly rich ecosystems just a few thousand years after glaciers scraped these mountainsides clean, are in large part due to the constant "feeding" of these ecosystems with nutritious fish fertilizer from the ocean.

further exacerbates this vulnerability, because their attentions and energies are tied up: for the females in the protection of their young, and for the males in maintaining the mating hierarchy. While the large body size of adult elephant seals makes them hard to kill by most terrestrial predators, the pups don't enjoy this same protection. This is another constraint that leads to the adaptation of reproductive synchrony or "herding" behavior; the ecological strategy of the aggregate gives the group overall protection at the expense of the individual.

Thus a further adaptation that northern elephant seals have developed in response to the vulnerability they expose themselves to when they undertake their mating activities on shore is the tendency to haul-out on remote offshore beaches, rather than the mainland sites that risk presenting their bodies as a tempting feast or resource in terrestrial ecologies. Offshore islands without terrestrial predators—and without human settlements—have been their ideal breeding grounds, because they have the double advantage of being places of refuge from the ocean's trophic webs, without accordant full participation in the webs of the terrestrial ecology.

Where were the northern elephant seals, prior to the era of industrial hunting? This is the question asked by Rick et al. (2011), historical biogeographers that reviewed several studies of Native American kitchen middens, reading them as indexes of past abundance of northern elephant seals. Their perspective situates today's intensively used and highly visible elephant seal rookery at Año Nuevo in a longer temporal context. They reviewed the archaeological literature on middens between Alaska and Baja California to determine the relative abundances of different pinniped species at each of these sites, in order to provide a "trans-Holocene perspective on northern elephant seal distribution and abundance." Archaeologists use middens to estimate past species abundance and distribution, assuming that the proportion of a given species in a midden is a good index of the effort required to hunt that species, and hence a good estimate for abundance.[95] In their review of the archeological data, Rick et al. found incredibly low occurrences of northern elephant seals in California. In contrast, today's population census places the number of animals that breed in California at around one hundred thousand. At Point Año Nuevo, where thousands of elephant seals now come ashore twice a year, only a single elephant seal bone was identified in middens that contained hundreds of fragments of remains of other pinniped species.[96] The authors of "Where were the northern elephant seals?" concluded that the settlement of the coast and larger islands by Native Americans influenced the "ancient abundance and distribution" of Northern elephant seals in coastal California. Furthermore, they suggest that large mainland carnivores might have further discouraged this species from establishing rookeries on mainland beaches. Together, these dynamics likely displaced

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[95] This same relationship between "abundance" and "effort" is used by my informants when they crunch spatial ecology data, to estimate the abundance of the deep-sea prey species that elephant seals forage upon. A rational economic actor who samples the world in a consistent and representative fashion is assumed in both models. I elaborate on the agency of the animal oceanographer that is assumed in these models in Chapter 2.

[96] On the Channel Islands, another site where northern elephant seals haul-out in great numbers today, there was a similar paucity of northern elephant seal remains. See Rick et al. (2011, p. 1163) for references to the archeological studies from which these findings were aggregated. The Channel Islands are one of the longest sites of continuous human inhabitation on the California Coast, and have many middens that are studied by archeologists. On San Miguel Island, where I worked with population biologists, researchers often collaborated with archeologists. See Walker, Kennett, Jones, & DeLong (2002), as cited in Rick et al. (2011).

northern elephant seals from “many of their favored habitats” (Rick et al., 2011, p.1165).

The hypothesis that northern elephant seals were displaced from coastal sites they might have otherwise favored (and do indeed favor today) by the threat of people and other large terrestrial predators is corroborated by the strong archeological record of human presence at today’s largest elephant seal haul-outs. These archaeological sites contain kitchen middens that signal long histories of human habitation and use of coastal resources at these locations, up to 13,000 years. The lack of presence of past elephant seals is matched by a discernable presence of past humans, and therefore space and safety at these sites for northern elephant seals to conduct their reproductive activities might have indeed been constrained and limited by human activity. The authors conclude that the ecological strategy of northern elephant seals in the Holocene was to haul-out on beaches with minimal human use, such as Isla de Guadalupe (about 150 miles off of Mexico’s Baja California Peninsula) and the Farallone Islands (a group of sea stacks about 30 miles offshore from San Francisco Harbor).

The past abundances and distributions of northern elephant seals, however, are difficult to trace, because historical ecology provides only part of the picture: a material record of human interactions with these animals, where the only readable traces are events of humans killing elephant seals and depositing their remains in conspicuous piles. Since, as the authors demonstrate, these interactions were rare, the data points are few. The presence of northern elephant seals is only readable by their exploitation, so, for example, the lack of prehistoric human presence at Isla de Guadalupe “prevent[s] a comparison of abundance" (Rick et al., 2011, p. 1165). It's possible to see where elephant seals were *not* present, places like Año Nuevo's where a single bone was found. It's harder to see where they *were* present, because there is no index of their past presence that lies outside this relationship with human hunting practices.[97] Their ways of dying at sea are invisible in the archaeological record because of archeology's reliance on the propensity of terrestrial landscapes to accumulate sedimentary traces, and because nonhumans don't necessarily accumulate remains into concentrated "middens."[98]

Thus, prior to their incredible abundance on California's coast in the last half-century, northern elephant seals' coastal habitat was likely remote offshore islands, and it is probable that their population was constrained by this shortage of "favored" breeding space, and thus their overall abundance and distribution as a species was different—and less—than their highly visible proliferation today. We can therefore assume that elephant seals, in their relatively rare interactions with hunters in the last 13,000 years, were cryptic and mysterious, not often drawn into interactions with

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[97] A midden mediates the ability to see an interaction *with humans*; it is not an "objective" measure of abundance, but one situated relative to past human practices. This leads to difficulties in estimating past abundances, especially with marine organisms that don't automatically leave terrestrial traces in a layered way. Since historical ecology and biogeography's data points are traces of human-nonhuman interactions. This field could benefit from the expansion of ways of interpreting human-nonhuman interactions that multispecies anthropology provides. In addition, the grounding of historical ecology's findings in social, cultural, and economic human practices could also benefit from critical anthropological analysis, but there is not space to go into these issues here.

[98] This has contributed to persistent Western cultural framings of the ocean as "timeless," see historian of oceans and oceanography Helen Rozwadowski (2012a). See, though, the case of a two-century old bald eagle's nest on San Miguel Island in the Channel Islands as a tool to assess pinniped abundance in the 19th and 20th century (Collins, Guthrie, Rick, & Erlandson, 2005). Eagles, like humans, gather sedimentary traces of consumption practices with discarded remains.

humans that enacted them as caloric “resources.”[99] Further, this implies that that trophic webs in the California Current were likely different as well, with less elephant seals presenting “top down forcing” on ecological relations, leaving room for different predator-prey relations.[100] Elephant seal bodies gather at the coastal edge, and those bodies are themselves gatherings of deep ocean worlds. If, as Rick et al. powerfully suggest, they previously gathered somewhere else, and their gatherings were smaller, then presumably they gathered different things, different oceans sedimented in different bodies, transporting different ecological relations ashore.[101]

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[99] For example Rick et al. note that the very rare remains of northern elephant seals that *were* found in these middens were of juvenile males. Researchers today know that juvenile males are more prone to haul-out far from the center of the main rookery. So, for example, the beaches around the main rookery at Año Nuevo are increasingly populated with juvenile males as you get farther and farther away from the pupping and mating area. In addition, Le Boeuf et al. (2011) showed that the growth of the rookery at Año Nuevo was significantly due to the arrival of “primiparous” females, those pregnant for the first time. Young molting females have also been known to haul out in unlikely places, such as Esquimalt in Victoria (in 2009), and Ambleside Beach in West Vancouver (in 2013), locations that are very far from the main breeding colonies in California, but close to a small and relatively recently established rookery at Race Rocks south of Vancouver Island. This leads to the speculation that the elephant seals that *did* come into (lethal) interaction with people prior to the industrial sealing era were possibly young males or females that hauled ashore in an unlucky spot. This leads to the question of what the encounters between humans and seals were—what the repertoire of interactions between them was like—if interactions were so rare. A further question of interest, but beyond the scope of this chapter, is if and how elephant seals were figured in indigenous cosmologies.

[100] “Top-down forcing” or “trophic cascades” are names for the ecological process in which predators alter the behavior of their prey, thereby ‘releasing’ the next ‘layer’ in the food web from being consumed, and hence increasing their abundance (Ripple, Rooney, & Beschta, 2010). A famous example is “how wolves change rivers,” an evocative phrase coined by science journalist George Monbiot (2014). He describes how the reintroduction of wolves in Yellowstone limited the browsing of deer on trees near rivers, and thus altered the course of the rivers by stabilizing their banks, leading to less erosion, less meandering, and more pools. The reforested valleys and gorges also opened habitat for birds and beavers. See the viral video here: https://www.youtube.com/watch?v=ysa5OBhXz-Q (accessed 17 April 2017).

[101] Marine mammal science has long failed to examine the multiple ways marine mammals influence ecosystems—as consumers, as predators, and as prey (see Kareiva, Yuan-Farrell, & O’Connor, 2006). Marine mammals have instead been subjects of physiological and behavioral research, legacies of the transformation of cetaceans in the twentieth century from resources to cultural symbols (see Burnett, 2012). However, ecological interest in marine mammals has grown with heated debates about the marine mammal sequential collapse hypothesis in the north Pacific (Springer et al., 2003).

Uncanny Repertoires

It is important to ask, “Where were the northern elephant seals?” in order to understand the ecology of practices of humans and elephant seals at Año Nuevo today: the ways researchers approach seals, the bodily repertoires they use to do so, and how the seals respond. The answer this “where” question tells us is that elephant seal behavioral repertoires evolved far from interaction with human practices. One of my informants at Año Nuevo told me that his fascination with sea birds and marine mammals was with the strange and alien forms of interaction that these animals have with humans: the feeling, as he put it, of “them looking at you and not knowing what you are.” His first introduction to marine mammal and seabird research was working on a Pacific atoll. He told me about the very tangible physical constraints of the atoll as research site, spaces that—while they have become key sites of American imperial power—are in many ways fundamentally alien to human bodies because of the nesting sea birds that depend on every inch of dry land on these small islands. As biologists studying seabirds, he explained to me, the trick in this research project was not to crush their eggs, which were spread along the entire interior of the island. The everyday puzzle for researchers on this island, separated from but intimately connected to their ability to do research there was: where and how can a human place its body in such an environment? He told me that they responded to this by setting up their camp on the beach, where storm tides would come in, drowning their tents and possessions in water. This was the feeling of being in a place where “you don’t belong,” being pushed to the very edge of a space that was so clearly not theirs. Interacting with elephant seals gives the same uncanny feeling of inhabiting a world with spatial politics that exist outside of the human, because elephant seals appear so ambivalent about human presence, to the point of self-harm. In the jumbled landscapes of the Anthropocene, biologists can live and work on formerly uninhabitable islands, but seals can also live and breed on formerly uninhabitable shores, making their regular harassment by researchers a part of that place for them, but not enough to drive them away.

Industrial Hunting and De-extinction

Alongside this long history of non-interaction between humans and elephant seals—and the uncanny feelings it gives rise to in present encounters—sits another story. In the 19th century, there were suddenly a lot of interactions between elephant seals and humans, and these interactions were lethal to seals. Industrial sealing was able to exploit the evolutionarily shaped bodily vulnerability of northern elephant seals on shore with remarkable ease.[102] Northern elephant seals began to be extensively hunted for their oil in 1810, which was considered second only to the oil of sperm whales in its suitability for industrial applications. It was used for lamps, lubricating machinery, and the manufacture of paint, soap, and candles. On North America's west coast, the hunting of elephant seals was sparked by the intersecting constraints of a reduced sperm

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[102] There is also the question of whether northern elephant seals (briefly) shifted to mainland habitats prior to sealing with the death and destruction of existing human-nonhuman relations in California with European colonization of North America. Such speculations have been made with respect to the passenger pigeon (*Ectopistes migratorius*) and American bison (*Bison bison*), both of which early Euro-American colonists report encountering in unbelievable abundance, potentially because of the ecosystem perturbations that were an effect of the rapid death of millions of indigenous people from European diseases such as smallpox. In the case of seals, this is a question that is difficult to answer because the biogeographically, archaeological, and historical records are difficult to interpret. But see the edited volume by Braje and Rick (2011), which asks questions like this with the tools of historical ecology.

whale population from over-whaling, and the increased need for oil and lubrication generated by the 1849 gold rush in California: elephant seal oil kept leather machine belts supple. By 1860, elephant seals were too rare for large scale hunting of them to be economically viable (Townsend, 1885).

In 1870, just four years after their description as a species in the Linnaean taxonomy, northern elephant seals were declared extinct. Yet, a series of scientific expeditions were very interested in collecting the last remaining specimens, and preserving them for posterity in their collections (Townsend, 1912). Thus, with brutal irony, natural historic voyages managed to continue to locate and kill elephant seals after they were declared extinct, and could easily have rendered them actually extinct if they had had just a little more success in their collecting voyages. Today, biogeographers suspect that one of the final refugia of elephant seals was Isla de Guadalupe, off the coast of Baja California, and geneticists have determined from blood samples that the species passed through a bottleneck of between 20 and 30 individuals, resulting in a "strong founder effect," where the roughly 100,000 northern elephant seals that haul-out in California today are descended from this shockingly small group.[103] To explain how such a small bottleneck was able to persist and eventually

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[103] See Bonnell and Selander (1974), Hoelzel et al. (1993), and Hoelzel, Fleischer, Campagna, Le Boeuf, and Alvord (2002) for studies of the effects of the genetic bottleneck on the present population. Beyond the conclusions of these authors about the morphological and fitness effects of a less diverse population, there are other more speculative questions that might be asked, about a whole diversity of ways of being an elephant seal that were likely lost. For example, behavioral researchers like Sarah Mesnick have begun to investigate the disruption of dolphin social networks. While we can only scratch the surface in knowing what genetic diversity might have been lost, it is even harder to ask what social or developmental knowledge might have been lost in this 'elephant seal apocalypse.' Further, we don't

recover, biogeographers venture that that elephant seals' large time spent at sea made it impossible to truly kill them down to the last one, despite everyone's best efforts.[104]

Like so many stories of island endemism and extinction, most famously captured by the dodo (*Raphus cucullatus*), human arrival in isolated island ecosystems signaled an end to many of these adaptations to and with the unique attributes of isolated islands (Cronk, 1997). More specifically, it was certain forms of human practice, not humans "in general," that were the most devastating to elephant seals.[105] In this case, the arrival of a global market for seal oil signaled an end to many of these adaptations to- and with- the unique attributes of isolated islands.

As a creature adapted to spaces without terrestrial predators, acts of approaching elephant seals are done with ease. Given descriptions such as the following, it becomes clear how a market demand for seal oil, combined with the ease of capturing them in even in their remotest island refuges, drove them so quickly to almost-extinction:

> The mode of capturing them is thus: the sailors get between the herd and the water, then, raising all possible noise by shouting, and at the same time flourishing clubs, guns, and lances, the party advance slowly toward the rookery, when the animals will retreat, appearing in a state of great

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know what losing all of this diversity means for their sociality with their conspecifics, and with humans today.

[104] The story I have detailed here is one that is told, with more or less detail, in several scientific papers about elephant seals. I relied on these secondary sources (such as Rick et al., 2011), and examined many of the primary sources myself where they were available. However, my contribution does not constitute a contribution to the historical literature via primary source documents.

[105] The concept of the "Anthropocene" (Crutzen, 2006) has been critiqued for failing to account for the politics of assembling an "anthropos" (Latour, 2013). "Capitalocene" and "plantationocene" (Haraway, 2015) have been proposed as alternatives that actually name the institutions and practices that should be held accountable, as opposed to equalizing blame on all humans, and thereby ignoring colonial histories and the critiques of development narratives. See also Chakrabarty (2009). Following the imperative to not allow the term "Anthropocene" to treat all human practices as equal, I aim to separate out human practices, and attend to their differences.

> alarm. Occasionally an over-grown male will give battle, or attempt to escape, but a musket-ball through the brain dispatches it, or someone checks its progress by thrusting a lance into the roof of its mouth, which causes it to settle on its haunches, when two men with heavy oaken clubs give the creature repeated blows about the head, until it is stunned or killed. After securing those that are disposed to show resistance, the party rush on the main body. The onslaught creates such a panic among these peculiar creatures, that, losing all control of their actions, they climb, roll, and tumble over each other, when prevented from farther retreat by the projecting cliffs. We recollect in one instance, where sixty-five were captured, that several were found showing no signs of having been either clubbed or lanced, but were smothered by numbers of their kind heaped upon them. The whole flock, when attacked, manifested alarm by their peculiar roar, the sound of which, among the largest males, is nearly as loud as the lowing of an ox, but more prolonged in one strain, accompanied by a rattling noise in the throat. (Scammon, 1874)[106]

Juxtapose the violence of this account with the situation of northern elephant seals today. The MMPA defines the conditions under which marine mammal “take” is acceptable; cases involve commercial fishing, highly regulated scientific research, and the protection of endangered species, such as Pacific Salmon. Defined in the Act, the term “take” means “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.” Today, with protection from human-inflicted violence, northern elephant seals inhabit the mainland shore, where the most lethal terrestrial organism to them—humans—are generally forbidden to interfere. For the first time, this shore contains no threats, human or otherwise, that seek to obtain their bodily

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[106] Charles Melville Scammon captained sealing and whaling voyages off the coast of California and later published his observations in a book entitled *Marine Mammals of the North West Coast of North America,* where he made it his task to concern himself with extinction. The description of elephant seal slaughter quoted here is from an 1852 voyage to Baja California, later described in that book alongside many other first-hand descriptions of marine mammal killing (Wallace, 2008).

materialities through lethal methods. It presents new opportunities for seals as a safe haul-out site, where they can go about their reproductive business.

Landscape as Trap

Yet, while no longer participating in capitalist webs of materials, seals today participate in epistemic practices that, like industrial sealing, treat their bodies as resources. In the 19th century, the methods of approaching them (as described above quote by Scammon) aimed towards extracting their deep-sea bodily materials, extracting their fatty reserves as reserves of oil. Today's researchers also approach the "flock" of elephant seal bodies, they too aim to "get between the herd and the water" and "advance slowly toward the rookery, when the animals will retreat, appearing in a state of great alarm." The differences between these practices matter immensely. The researchers do this work towards very different ends than the sealers or sailors, with considerably more attention to doing as little harm, and taking as much care, as possible. As individuals, these researchers choose to pursue biology and ecology knowledge making motivated by a passion for animals and for conservation. But the line of connection between their practices with the seals and those of hunters with the seals is important to draw out, too: they exploit the on-shore vulnerabilities of these bodies, and seek to capture and characterize them as repositories of energy stores.

Elephant seals gathering on the mainland shore present a significant boon to the knowledge apparatus of the researchers. Not only are seals amphibious marine bodies that gather at the edge, bringing marine worlds ashore. Not only do they present an opportunity to study a predator without "becoming prey." And not only do they pack their bodies together in gregarious formations, making many potential research subjects available. But they do all of this along an accessible portion of the California coast, close to urban areas and well-funded research centers. While the largest northern elephant seal rookeries today are still on offshore islands (Lowry et al., 2014), intensive research at these sites requires much more logistical coordination. For example, individual animals tagged at Año Nuevo occasionally don't obey "site fidelity," and frustrate researchers by traveling to a different rookery the next season than the one in which they were tagged. During the 2014 fieldwork season, an adult female went to San Miguel Island, in the Channel Islands. This resulted in a logistical headache, and non-trivial disruption of the rhythms of the field season: it required researchers to organize a small plane to go there and gather the devices, measure the seal's body, and take samples. When the researchers returned from this field trip, they confessed that they had failed to do all the required measurements multiple times, and concentrated just on recovering the valuable tag. They justified this by the days-long feat of locating the seal in an unfamiliar and hard to access landscape among thousands of animals.

In contrast, the location of Año Nuevo relative to the terrestrial infrastructure of scientific research makes it possible to coordinate a research program that requires incredible amounts of logistical planning, proximity to a lab with a super low temperature freezer to store samples and ship them to collaborators using FedEx, and an abundance of fieldwork labor from sister labs and unpaid undergraduate students, whose participation garners them course credit and resume bolstering. World-class researchers can fly into the international airport at San Francisco and be at the beach within hours, contributing their questions and perspectives to work in field and lab. The vibrant decades-long research program on northern elephant seals at Año Nuevo is made possible by the spatial proximity and interactional approachability of northern elephant seals.

Due to the particular way the landscape history played out, the edge affords unexpected livabilities. First, for the seals, who inhabit a stretch of coastline that they never did before. As a species, they have benefited from this situation, and there are probably more of them today than there have ever been. I extend the term "livabilities" here to understand the tenability of particular ecologies of research practice in particular places. I have argued that the re-shuffling of livable space for northern elephant seals has allowed a very particular ecology of practices between seals and researchers to emerge at Año Nuevo. The ease with which the researchers can approach the seals on the mainland shore is shaped by their history as a species that hauled out on remote offshore islands. The combination of closing Año Nuevo off to the majority of visitors during the breeding season (except those guided by a docent or doing research), the landscape changes in California that have expatriated most large terrestrial predators, and the protections afforded to elephant seals under the MMPA, together combine to make Año Nuevo seem a lot like a remote offshore island in the "umwelt" of northern elephant seals (von Uexküll, 1940/2010). Año Nuevo, in this way, becomes a kind of "trap" for seals, gathering their bodies into it by offering refuge without the usual risks of the terrestrial shore.[107] Alfred Gell's famous description of animal traps as "lethal parodies of the animal's Umwelt," "a nexus of intentionalities … via material forms and mechanisms" (Gell, 1996, p. 29), applies to the landscape of Año Nuevo, it's physical and interactional structure, and the invitations it offers to the bodies of elephant seals and scientists: for the reproduction of bodies, and the production of knowledge.

Today, northern elephant seals are the most approachable pinnipeds studied in the California Current ocean ecosystem. California sea lions are notorious for "bolting" in the hundreds into the water upon the approach of researchers. Working with them requires staying a much further distance away, wearing camouflaged clothing, and paying attention to the direction of the wind and of vision. A researcher on San Miguel Island told me that California sea lions can "recognize the human form" and have a keen sense of smell, justifying a lot of sneaking around. Similarly, harbor seals are notoriously "shy" among marine mammal researchers. It is elephant seals' particular adaptation to landscapes they no longer inhabit that makes them so approachable by—and vulnerable to—scientists. It is also what makes interacting with them so strange, producing in them a dodo-like sensibility, as if they don't know what humans are, or know that they are so dangerous.

Seeing, Controlling, and Knowing

As the previous two sections have contended, the coastal edge at Año Nuevo—and the bodies and socialities encrusted upon and enacted by it—affords a research

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[107] This idea is developed with Meredith Root-Bernstein in another context; see Forssman and Root-Bernstein (forthcoming).

program that examines elephant seals' foraging where they don't forage, allowing researchers to study a predator without the dangers and pragmatic difficulties of becoming prey. The edge makes this possible by producing the ecological strategy of amphibiousness in seals, and, through the constraints imposed by that form of life, producing the gregarious social behavior of female elephant seals, their tendency to pack their bodies incredibly closely together. Further, the jumbled and shuffled Anthropocene landscape of the mainland shore, produced through multiple histories of extracting seals' bodily materials, has led to a situation where a behavioral ecological strategy that once cut elephant seals off from terrestrial networks has now become intimately entangled in them. Today at Año Nuevo, these aren't webs of interspecies predation, or economic webs that enroll seals bodies into industrial trade as oil repositories, but ecologies and economies of knowledge. Knowledge practices on the shore are entangled with and made possible by both ecological histories of seals and their political economic histories on land and in the sea.

In this section, I examine a final feature of the edge of the sea that structures the ecology of practices of elephant seals, and also the ecology of practices of researchers with seals—shaping how my informants are able to approach their research subjects, and the particular forms of knowledge they make from their bodies in acts of turning them into "animal oceanographers." Here, I closely read another behavioral ecological thesis of about how elephant seals' social behaviors on shore spring from the particular features that the coastal edge affords. Like Bartholomew's (1970) paper that proposes "a schematic model for the evolution of pinniped polygyny," Thelma Rowell's (1987) paper, "On the significance of the concept of the harem when applied to animals" examines the material and ecological factors that give rise to the specificity of elephant seals' social formations. As in the previous sections, I aim to learn from this biobehavioral inquiry how to notice, reason about, and situate ecologies of practice in the specificities of place and habitat, in order to give an account of how the research practices of the scientists, too, are grounded in the same particularities that shape the social formations of the seals.

Comparison and Specificity

Rowell's paper examines and compares accounts of northern elephant seal mating behavior—obtained through correspondences[108]—with the social behavior of various species of primates that she has directly studied, in order to asses the extent to which "harem style polygyny" is a generalizable concept, and also the extent to which it is formed by the particularities of the environments in which it has evolved. A key feature of Rowell's approach to primatology and zoology is her commitment to responsible comparison: to specifying the conditions under which comparative leaps are justified. Most familiar to readers in STS, she has argued that primate behavior in the wild versus in captive environments was fundamentally different, and that the idea of

[108] Rowell's correspondences are with Burney J. Le Boeuf, who, with Richard Peterson, pioneered research on northern elephant seals at Año Nuevo. Le Boeuf joined the UC Santa Cruz faculty in 1967, was a mentor to Daniel P. Costa, the Principal Investigator of the research group in which I did my ethnographic research, as well as many other elephant seal researchers, and is a main or co-author on more than 80 academic papers based on research at Año Nuevo. His career evolved from comparative psychology, to behavioral ecology and sociobiology, to marine biology. Today, Le Boeuf is Professor Emeritus at UC Santa Cruz. For an oral history of his career, see Reti, Le Boeuf, and Jarrell (2014).

"male aggression" as a central term in primatology in the 1950s and 1960s emerged out of the specific research apparatuses and assumptions of early primatological studies, which were largely conducted in captivity where the animals had no chance to hide from one-another.[109] But her attitude to comparison is also playful: since her retirement, Rowell has been raising sheep, convinced that—unlike primates—these ungulates have not been given a chance in studies of animal behavior to be "interesting." As philosopher of ethology Vincianne Despret puts it from her conversations with Rowell, "what we expect from sheep [is] that they convert plants into mutton" (see Despret, 2005, p. 362) and thus "they have never been able to testify to what interests them since whatever it is that might interest them has been offered no affordance, no possibility of articulation with what interests those who attest on their behalf" (Despret, 2005, p. 363). Rowell suggests experimenting with some of the analytics and ways of asking questions of primates, in order to give sheep a chance to inhabit a knowledge apparatus that allows their interests to emerge.

These ways of critiquing her own discipline's style of making knowledge claims have earned Rowell the title of an "iconoclastic biologist of the 20th century" (Despret, 2008b). In the paper I focus on here, where she discusses "harem style polygyny" in northern elephant seals, she brings the same sensibilities, and the same caution about

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[109] Rowell has been a key voice in writing the history of primatology with feminist and science studies perspectives, as well as among the first generation of women in primatology. See Strum and Fedigan's edited volume (2000) for perspectives on the history of the discipline from both primatologists and science studies scholars. Related to the conference from which this volume emerged, Rowell has been enrolled in the work by Bruno Latour (2000), Donna Haraway (2008, 2016), and Vincianne Despret (2005, 2008b, 2012/2016). Despret is a close collaborator of Isabelle Stengers, whose term "ecology of practices" (2013) references baboons and Rowell's work.

how terms to describe animal behavior travel without sufficient attention to the settings that give rise to them. In this way, Rowell's style of behavioral ecology is a powerful antidote to some of the worst tendencies of biobehavioral reasoning, a logic of linking evolutionary constraints and behavior that can make essentialist leaps far too quickly, most controversially with theories about human relations between the sexes that don't interrogate their own assumptions or conditions of possibility with sufficient reflexive care.[110] Critiques that run in the spirit of Rowell's are important because they don't refuse to explain behavior in terms of biology. Rather, her nuanced papers suggest how much richer the intermeshing of biology and behavior is than many sociobiological comparisons manage to attend to, and how much work there still is to be done in closely observing, and carefully comparing, practices within and across species.

Given this commitment, when interrogating the orientalist and somewhat unreflective importing of the term "harem" into biologists' lexicon, Rowell's critique is not against comparing human social institutions to nonhuman ones, *per se*, but rather with the terms of the comparison:

> Like other human matrimonial systems, harem polygamy is primarily a politico-economic arrangement. It is a system of resource retention and acquisition, of display, and of inheritance of wealth. It is symptomatic of

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[110] For a sustained critique of sociobiology and evolutionary psychology discourses, see Haraway (1978, 1981, 1989). Gottlieb (2012) articulates parts of this critique well in relation to evolutionary psychological claims about human behavior. He points out evolutionary psychology's problematic tendency to turn folk wisdom about the relations between the sexes into assumptions about "what males do" and "what females do," which in turn guide the forming of hypotheses and the interpretation of data. He argues that "evolutionary psychologists have spent decades administering questionnaires to college students in an effort to confirm their ideas about what sort of partner was desirable in bed." The conclusion that 'women care more about power in their mate' (rather than physical attractiveness, which is supposedly what males care about), could very easily, he points out, be rooted in structural sexism, where men almost always have more power (and women are often objectified).

> inequality of possession, and can only arise in economic systems in which wealth can be hoarded and exchanged. … When a human marriage system is projected onto animals, it is the mating which it is supposed to represent which is intended. While the marriage system is partly, perhaps primarily economic and political, it is assumed that, for animals, only the mating system with its immediate and direct implications for selection and evolution is relevant; animals are presumed to have no economic or political considerations comparable with those of people. It is this assumption which I would like to reconsider here. (Rowell, 1987, p. 650-651)

Thus, Rowell's critique of applying the harem concept to animal society is not to accuse the concept of sexism and orientalism—of which it is most certainly culpable. Rather, she interrogates what exactly is being compared—which anthropomorphisms are well-founded, and which are not.[111] She concludes that the "harem" comparison is not apt because nonhuman animals have no extra-somatic material culture that allows them to acquire, retain, or exchange material wealth.[112] This is just the first of many instances in Rowell's article on the concept of the harem where she interrogates the terms of comparison.

Like Bartholomew, Rowell argues that harem structure, or what she carefully calls "harem style polygyny," is a very particular social formation, springing from certain environmental conditions. I would like to focus on just one characteristic that she argues for the importance of: the spectacular visual openness of the breeding grounds of elephant seals. Her reasoning is that "monitoring is a pre-requisite of

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[111] For a claim about where "anthropomorphism" might be well-founded, in relation to Darwin's work on "emotions" in animals (Darwin, 1872), see Crist (1996).

[112] See Strum and Latour (1987) for a related argument about how a lack of extra-somatic material culture puts some nonhuman social animals (in this case baboons) in the constant business of keep track of and managing their social worlds. They argue that baboons, unlike humans, cannot delegate the accounting of social relations to external artifacts or artifact-mediated cognitive structures.

control," and therefore she concludes that harem style polygyny—the control of females' interactions with sub-dominant males by the dominant male—are only possible in environments where the males are able to monitor all the interactions taking place: in other words, in sites where there are no corners, hills, caves, or dense vegetation behind which to hide and conduct activities out of the view of conspecifics. In these visually open environments, individuals are able to keep track of one another in ways that are not possible in landscapes where there are possibilities to carry out cryptic activities, where there are opportunities to escape surveillance.

Like Darwin did in *The Descent of Man* (1871), Rowell compares northern elephant seals to lions in their peculiar sociality within the order Carnivora. Before turning to his descriptions of the "remarkable sexual peculiarities in seals" (Darwin, 1871, p. 274), Darwin wrote that the lion is "as far as I can tell, the sole polygamist [sic] in the whole group of terrestrial Carnivora, and he alone presents well-marked sexual characters" (Darwin, 1871, p. 268).[113] In a similar vein, Rowell notes that among carnivores it is very uncommon to conduct mating and breeding activities in environments with such visual openness. But lions on the Serengeti plains are an exception: they also live in an environment where visibility is spectacular, and hence social monitoring is possible.

Rowell also compares northern elephant seals and Serengeti lions to studies of red deer in Scotland by behavioral ecologist Clutton-Brock:

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[113] Here Darwin is referring to the physiological dimorphism between the sexes in lions, the male lion's mane being the most obvious example

> The red deer is a good example. It is a species built to live in woodlands or thickets and over much of its range it inhabits forests. In Scotland it lives on deforested moorlands, and survives there in spite of rather marginal nutrition, probably because natural predators have been eliminated. *The excellent visibility in the moorland habitat allowed the first modern study of mammalian breeding behavior* [emphasis added] (Darling, 1937), and, more recently, the long-term population studies of Clutton-Brock and co-workers. Clutton-Brock et al. (1982) describe a harem-type organization of mating, with a rapid turnover of males controlling small groups of females. They express doubt, however, as to *whether such a system exists in the original forested habitat* [emphasis added]." (Rowell, 1987, p. 656)

The expression of doubt about whether a social system—assumed to be 'species-specific'—exists across habitats with widely different sensory affordances is the hinge in Rowell's powerful critique of the harem concept in biology. Rather than a critique that denies a system where males have sexual control over a number of females, her critique situates the conditions that could give rise to such a system, interrogating the material conditions of possibility for this "political physiology of dominance" (Haraway, 1978). Rather than denying that such a hierarchical and oftentimes violent sociality could or should exist, she traces how specific, particular, and peculiar the conditions that allow it are.

In environments of high visibility, Rowell argues, individual animals are able to keep track of one another in a way that just isn't possible in an environment where there are possibilities to hide, such as in the cover of trees. In the open visual space of the elephant seal rookery, male elephant seals keep track of the activities of all the other males in the vicinity constantly. Monitoring these interactions is a big part of what the males spend their time doing on the beach, and is physically taxing for them. When first going into the field, researchers would warn newcomers to take extra caution around males because “males don’t care about us.” What males care about is monitoring other males, their attentions and energies devoted to keeping track of those conspecific social relations, and they don’t have any attention to spare on the pesky researchers. This, explained my informants, makes them dangerous, as they have been known to charge at researchers who find themselves in the line of sight and movement between two aggressive and competing males.[114]

And, it is this facet of the male’s behavior—this activity of constant monitoring—that also makes them less-than-ideal “animal oceanographers.” Although males have been attached with bio-logging technology and their migratory movements followed, the vast majority of research subjects are females. Because the males are so fixated upon establishing, maintaining, and monitoring their place in the mating hierarchy in an all-or-nothing attempt to gain and hold onto dominance, they expend so much energy that they make themselves vulnerable when they return to sea to forage. A dominant adult male in its reproductive prime might hope for three good seasons of defending a large harem from other males, establishing his “ecological fitness” with many offspring before dying at sea.[115] Thus, male elephants seals enact a less cyclical relationship to the sea’s edge, making them less “predictable” candidates to carry the expensive devices. They cannot be trusted to have a vested interest in returning to the

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[114] The interactive repertoires of researchers and male elephant seals are a rich topic in their own right, one that I was not able to fully pursue in this dissertation due to space constraints. It demands further treatment in a subsequent book manuscript or article.

[115] This is particularly true for younger males: “Mating success early in life had an immediate adverse affect on survival of young males” (Clinton & Le Boeuf, 1993).

shore to produce pups again, unlike the females, who reach "ecological fitness" through consistently producing a single pup, year after year.[116]

The Conditions of Observation

The other part of Rowell's argument that is key for situating the structure of the harem is her attention to what she calls "conditions of observation." Alongside her interest in situating the animal under study in the sensory and intersubjective affordances of its ecology, she aims to situate the researcher in the same ecology of sensing, noticing, and monitoring. In her discussion of red deer, as I have highlighted above, she states that, "the excellent visibility in the moorland habitat allowed the first modern study of mammalian breeding behavior." The conditions of sensing that produce this animals' sociality are the same conditions of sensing that produced the possibility of a "modern study of mammalian breeding behavior." The breeding behavior of red deer in Scotland, and of elephant seals in California, are 'model'

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[116] It is important to emphasize that these forms of predictability, or the 'ease' with which a particular organism or sex is made into a research subject are not fixed biological attributes, but rather situated in relation to specific research questions and pragmatics. Interestingly, in lab-based behavioral and sensory research, male pinnipeds have been the preferred candidates, and there they have been understood to be more predictable than females. In the an article on imprinting in pinnipeds, Ron Schusterman, who founded the Sensory Ecology Laboratory at Long Marine Laboratory, along with his colleagues notes the following: "In our experience, mature males, despite their large size and aggressive posturing and signaling, are easier to control because their social communicative behaviors tend to contain more ritualized, stereotyped behaviors. Not only are their *intentions easy to read*, but they *respond very consistently* [emphasis added] to the trainer's use of the same signals (or an approximation). Given the behavioral ecology of polygynous pinnipeds, this is not surprising. Mistakes in interpreting social aggressive signals from other males or in the social aggressive signals a male gives can have serious effects on survival and reproductive success. Since female sea lions are smaller and less aggressive than males, many trainers find them less intimidating than males (and cheaper to feed). However, we have found females to be more dangerous…. On the rookeries, contests between females are less injurious than male contests but are also much more frequent and escalate rapidly. We hear of people being bitten by females much more often than by males." (Schusterman, Gisiner, & Hanggi, 1992, p. 351-352). Chapter 3 elaborates on the techniques my informants use to approach female elephant seals.

studies, in the sense that it has been possible to identify individuals and observe them for long periods of time and in a structured fashion. Yet, the very possibility of such model modern studies comes from the very same observation conditions that shape the social behavior of the animals studied. Rowell suggests that “harem style polygyny,” as a nonhuman social structure, may have taken on an outsized share of attention in ethnology, behavioral ecology, and sociobiology—not because of its generality in the animal kingdom, but rather because of its visibility to the researcher, and the ease with which it conforms to the “modern” ideals of behavioral science. Rowell calls this “the confounding variable of observation conditions,”

> To study social interaction, it is sensible to choose a site where you can see a lot of animals and follow individuals for long periods. But if the observer can see all the interacting animals, so can the animals themselves. That in itself makes some forms of interaction more likely, and some forms of organization possible. The result must be that we have a distorted view of animal social organization, in which those systems made possible by clear and continuous monitoring of others' behavior are overemphasized.” (Rowell, 1987, p. 656)

Rowell situates the researcher within the ecology of practices under investigation, but in a different way than other primatologists have discussed this issue. Barbara Smuts and Shirley Strum found in their field research that they might be seen as a fellow social interactant by the primates they studied, and found ways to account for this in how they moved and acted in the field.[117] But Rowell takes this in another direction, noting that the researcher is situated within an ecology's physical and sensory

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[117] Haraway (2008) discusses how Smuts learned that trying to act like a “neutral” observer didn't work in the field. Despret (2013) discusses how Strum learned that the baboons she studied changed their relation to her after she had urinated in front of them.

constraints as well as its social norms. This in turn shapes the way questions can be asked, variables monitored, and long-term studies coordinated.

The specific features of the edge of the sea—specifically the ocular features of open sandy beaches—shape and afford the ways elephant seals relate to one-another. Over evolutionary time, elephant seals have responded to the invitations this environment offers them with a peculiar sociality that emerges in this specific site. In particular, argues Rowell, the open sightlines of the sandy beach give rise to a sociality of monitoring and control. The power that male elephant seals have over the bodies and interactions of female elephant seals arises from the possibility of watching their every move. This in turn structures the relation between the sexes into "harem style polygyny."

But it also structures the conditions of possibility of the beach at Año Nuevo as a research site, as Rowell so adeptly notes. The researchers, like the male elephant seals, rely on *monitoring* and *control* as key prerequisites to the particular way they ask questions of the animals. As Rowell suggests, this sensory ecology shapes the ways human knowledge practices are made in this environment as well, and how they travel: "The result must be that we have a distorted view of animal social organization, in which those systems made possible by clear and continuous monitoring of others' behavior are overemphasized" (Rowell, 1987, p. 656). Rowell's concern here is with how theories about animal social organization travel in research communities. The studies of elephant seals and red deer are 'well-designed studies'—according to the conventions of an animal behavior research that prioritizes monitoring and control—and therefore became models of how to properly study animal social organization in other sites, with other species.[118] Yet, what made these studies so well executed and complete, and allowed them to travel as paradigmatic apparatuses for making knowledge about nonhuman social organization, is, Rowell suggests, something very particular to them. Further, I suggest that it might not be the talent of the researchers for meticulously carrying them out. It might rather be the architecture of the landscape, which meshes with an uncanny ease with an architecture of knowledge production that privileges vision and constant surveillance—an architecture well-suited to a style of animal behavior research that has aimed to model itself upon the hard sciences' quantitative ideals.

Rowell's insight about "the confounding variable of observation conditions" can be taken further, too, to situate not only the conditions of possibility for ethology, but also other knowledge projects involving animals, including the staging of the "animal oceanographer." Rowell's goal in her provocative paper was to situate and think critically about how facts and generalizations about animal social organization travel, but my question is ask how these same observation conditions, and the way they generate particular forms of sociality, allow the "seal oceanographer" to be staged in a very particular way. It is not a coincidence that the ideals of long-distance and omniscient vision of the ocean also align with the unbroken field of vision of the sandy coastal beach. And it is not by chance that northern elephant seals have been so well

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[118] The question of what an animal behavior research practice would look like that *doesn't* make monitoring and control its chief requirement is a provocative one, and Vincianne Despret (2012/2016) is one of the best at beginning to reach towards possible answers.

studied that they have been turned into paradigmatic knowledge workers not only for the behavioral sciences, but also the physiological, ecological, spatial, and oceanographic sciences.[119]

My informants—who seek to transform elephant seals into "animal oceanographers"—rely on monitoring, made possible by the open field of view of the beach, in order to outfit the animals. Many trips to the field in the early part of the season don't involve attaching tags, but simply doing "resights," which consist of looking for animals that have been previously attached with numbered flipper tags, and entering their status as "re-sighted" into the database. In another part of the field season, when the seals have grown new pelage after the molt, trips to the beach involve deciding which animal is the "right animal" to outfit as an oceanographer, which is done by examining their fur at a distance.[120] Research practices are prefaced on the ability to sight and monitor individuals over time, the same conditions of observation the lead to the forms of control and power in "harem style polygyny."

And the researchers, too, rely on control of the bodies of female elephant seals to do their research. The interactional repertoires that the researchers use to approach the gregarious group of female elephant seals are repertoires of bodily control. And, the

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[119] The ease which with researchers can monitor and control them has made them not only a model of animal social organization that has travelled far, contributing to an over-generalizing of the concept of the harem in biology, but this has also made them good research subjects of many other kinds of studies: studies of their metabolism, their on-shore locomotion, their hearing, seeing, vocalizing, studies of the mother-pup bond, of male-male aggression, and many other topics. There is an incredible amount that researchers know about this animal, and an incredible number of ways that researchers justify continuing to learn more about them, from using them as models for fasting, metabolism, and obesity, to a case to understand the effects of climate change on ocean food webs.

[120] Both of these sets of practices are discussed in significantly more detail in Chapter 3.

ways that the females respond to this approach are shaped in and with the same ecology of practices through which their sociality has emerged. In other words, the same conditions that produce them as rich repositories of sea signals, as vulnerable and approachable, and as visible and controllable, have shaped the emergence of practical methodologies in the field for surveilling, approaching, controlling, instrumenting, and instrumentalizing them.

Conclusion

In this chapter, I have introduced Año Nuevo as a site of bodily, material, and epistemic fecundities. I have given a descriptive sense of the comings and goings of elephant seals and researchers at this site. The edge of the sea at Año Nuevo is productive both biologically—as a zone of meeting between worlds that affords reproduction—and epistemically, as a site of knowledge work. It is a place of ecological and epistemic fecundity. The question I have asked is, *what affords these fecundities*? It is clear that the researchers rely upon the reproductive formations of the seals to produce their knowledge. But what features of these reproductive formations come to matter for them?

The scientists rely on the tendencies of seal bodies, which are themselves made possible by the affordances and invitations of the coastal edge. Together, the practices of seals and the practices of researchers form an "ecology of practices" that is deeply specific to this site. It is also historically specific, grounded as it is in a specific genealogy of knowledge values and norms that prioritizes concentration, ease of access, and visibility of epistemic resources. The propensity of seals to divide their lives into solitary and social components, at sea and on shore respectively, and alongside that, into eating and not eating, gives my informants' research program elegant parsimoniousness. Researchers can watch eating from afar without having to engage with research subjects that are eating or about to eat. Instead, they can enter this intraspecies shore ecology almost as fellow seals, moving animals around by appealing to the signals that those bodies respond to. In "An edge that gathers," I suggested that the coastal beach affords a research practice of studying predators without having to worry about "becoming prey." In "Landscape afterlives," I decribed how elephant seals are vulnerable on land, and that sealers and researchers have been—and are—able to exploit this, in such a way that they "become predator" in their interactions with them. In "Seeing, controlling, and knowing," I suggested that researchers exploit the same connection between visibility, monitoring, and control that male elephant seals do, in order to corral and control the females, and in a sense researchers "become conspecific" in these practices.[121] They exploit northern elephants seals' habit of mating and pupping in exposed open space, in clear sight. Unlike terrestrial predators, northern elephant seals are not "cavity masters," as Dan Costa, the lab P.I., often put it. The uncluttered nature of their reproductive environment makes possible an extreme sociality of dominance, control, and all-

[121] The term "becoming-animal" is from Deleuze and Guattari (1980/1987). Lorimer (2008) takes up the term in his article on bird censuses in the UK, discussing how researchers "become predator." Bear and Eden (2011) discuss how recreational anglers use fishing lures to "become prey." These studies build upon the concepts employed by Deleuze and Guattari in an empirical context. Donna Haraway has pointed out, that Deleuze and Guattari, in their use of this term, have a "profound absence of curiosity about or respect for and with actual animals" (Harway, 2008, p. 27). Further, Haraway argues for a relational and entangled concept of "becoming-with," rather than "becoming," as discussed in the next footnote.

encompassing vision of the mating environment. Thus, this site of reproduction of bodies, and the specific social interchanges that structure it, becomes for scientists a site for the production of knowledge. What is reproduced here are mediating agents for querying the ocean, indeed, genetically nearly identical delegates to the deep, which scientists can follow on their journey to inaccessible environments by interposing oceanographic agency onto bodies.

Thus, the particular features of the land-sea edge: its physical features that make it more or less traversable by particular bodily anatomies, and the particular ecology of sensing selves that this instigates, all shape the kinds of interactions that occur between elephant seals and humans, the “ecology of practices” in which their interactions are situated. Together, these constraints make elephant seals incredibly vulnerable on shore, and incredibly susceptible to external control, both of which are key to understanding the repertoires of interaction that occur on the beach between seals, and between seals and researchers.

I have insisted that certain landscapes afford not only certain ecological strategies, but also compel certain ways of asking questions. These entwined evolutionary, historical, and epistemic stories suggested that the framing of the “seal oceanographer” as a relationship of multispecies collaboration glosses over the evolutionary and historical power relations embedded in the way seals gather, and the way the scientists prey upon that gathering in order to produce knowledge.[122] Further, the framing of elephant seals as serendipitous research subjects, as “good candidates” (see for example, Ropert-Coudert et al., 2009), forgets how the “good” is constructed from historically specific epistemic norms. As Clarke and Fujimura asserted in *The Right Tools for the Job: At Work in the Twentieth-Century Life Sciences* (1992), ‘rightness,’ ‘tool,’ and ‘job’ are iteratively co-constructed competencies, tri-directional world-making apparatuses. And, while Robert E. Kohler’s (1994) study of how the Drosophilia became model laboratory organisms suggests that ‘rightness’ piggybacks upon an ecological or evolutionary compatibility with humans—a history of interspecies companionship—I insist that it also builds upon a compatibility with styles of questioning the natural world, the epistemic norms that govern science. Elephant seals were not synanthropes, but now in a sense they are.[123] They haul themselves ashore in sites where they are vulnerable to people, leading to uncanny interactive

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[122] I point this out not because I believe that knowledge can be untethered from power, exploitation, or instrumentalization. As Donna Haraway reminds us through her use of the term “becoming-with,” human practices with other species are not necessarily a cozy endeavor, and are often violent — it is not all about collaboration, seamless coordination, cooperation, and “getting along,” in part because becoming-with always involves the cutting off of possibilities for other possible forms of relation. Becoming-with is the “vulnerable, on-the-ground work that cobbles together non-harmonious agencies and ways of living that are accountable both to their disparate inherited histories and to their barely possible but absolutely necessary joint futures” (Haraway, 2003, p. 7). To point to histories of violences and contradictions that inform and shape scientists practices in the present is not to call them out as having blood on their hands. Rather, it is to situate their knowledge production within a genealogy that includes evolutionary, ecological, and political-economic landscape histories—as well as epistemic histories—and to forge ways of being responsible to those histories and the futures they make possible.

[123] Synanthropes are species that benefit from living near humans or at the edges of human infrastructures, such as rodents, pigeons, and urban wildlife (Johnson & Klemens, 2005). The definition does not include human domesticates.

repertoires, shaped in the afterlives of near-extinctions, recoveries, and altered landscapes and seascapes.[124]

This chapter has unpacked how the shore environment, which shapes the sociality of seals, in turn shapes how they are enrolled in knowledge projects. This matters for understanding the intellectual history of the biological concept of the "harem," as well as the interactions between researchers and seals to produce the "animal oceanographer." The universalisms of Western knowledge can be questioned both through situating their discourses in historical specificity, but also through close attention to the material and interactive arrangements that give rise to particular corporeal and epistemic arrangements.

[124] This leads me to ask whether our models of human-animal interaction have been overly dominated by assumptions of shared histories—"shared personhood" (Fuentes, 2010), multispecies "enculturation" (Fijn, 2011), and "shared pidgins" (Kohn, 2013). I end this chapter with the provocation that a landscape perspective—which see interactions between species as emergent from Anthropocene re-arrangements—might shift this tendency in multispecies ethnographic theorizing.

Chapter Two: Rendering Practices

This chapter unpacks the techniques and technologies central to the staging of the animal oceanographer. I interpret my informants' everyday work with animal bodies: first, seals' shore bodies, directly encountered in the field; then, seals' ocean bodies, examined and analyzed at a physical and temporal remove through dive track data. I work with the generative ambiguity of the chapter's title, "Rendering Practices," to discuss both, drawing attention to how practices involving the *decomposition* of bodies are entangled with the particular ways seals' lively activities are *represented*.

The first section examines everyday material acts of measuring the seal's body on shore, and the use of these measurements to create a model of her "body composition." These measuring practices aim towards bodily separation—a de-composition of the living animal into its component materialities—and they are thus "rendering practices" in that verb's sense as "to tear, to rip things apart, or extract, as in rendering fat from bone, and extracting proteins, and other usable parts from an animal carcass" (Myers, 2010). I pay close attention to the way researchers engage seal bodies with their own in material acts of measuring, in order to draw out some of the complexities of interposing the agency of the "animal oceanographer" onto the body of the seal on shore. I unpack how this work involves several tensions. First, I highlight a sometimes ambivalent interest in *shape* that pervades these practices, in which technologies of visioning and taking bodies apart generate a form of "professional vision" (Goodwin, 1994) that my informants call "morphometrics," a technique that reads bodies as decomposable into their component parts and materials. Second, I pay attention to the tenuous negotiation of *activity* and *passivity* in these practices of "rendering bodies" on shore, in which the seal must be rendered passive in order to be measured, but not so passive as to be killed. In closely examining these rendering practices on shore, I suggest that *histories* of other uses of the seal body are entangled in these mundane measuring practices.

I then turn to an examination of the representation of seal's at-sea activities, made possible by the measuring work done on shore, and the flood of data from the attached technologies. By closely reading a set of published scientific papers by my informants that together tell the story of breakthroughs in the techniques and technologies of reading dive track data, I trace how these practices of breaking seal bodies down—of decomposing them into their component parts—allow the character of seals' active at-sea doings to become visible. I thus examine researchers' work of reading the dive track data as efforts to "render (animal) practices," using the verb "render" to name "the creative ways that practitioners confront the limits of … vision" (Myers, 2015). Rendering, here, is performative representation. What the researchers aim to "render," I suggest, is the *practices* of seals: what they are doing in their deep ocean habitats and, more specifically, how those doings gather as traces in their bodies, and devices attached to them. This "rendering of practices," like the "practices of rendering" conducted on shore, involves tensions: a movement between shape and number, the violences of de-composition, and the complex negotiation of agency where the seal simultaneously assumes a role as a internally motivated and directed data-gathering delegate, and at other times becomes an object, drifting through ocean currents like a chunk of marine debris.

Practices of Rendering on Shore

Figure 2.1: The author measuring the length of a sedated female elephant seal. Image by Natalie Forssman. Año Nuevo, 2014.[125]

At our feet lies a sedated elephant seal. The spinal is set: a plastic syringe loaded with Ketamine, ready to inject small but frequent doses with a simple press of the

[125] The images in this chapter, excluding those from scientific papers, are stills from my ethnographic fieldwork, taken with a GoPro HERO3 camera, mounted to the head. In some cases I wore the camera, and in others I asked my informants, the researchers, to wear it. These images are not framed with a viewfinder, and, as in Donna Haraway's visual analysis of CritterCam cuts, fields, and scales, "part bodies of organisms and technologies predominate over whole-body shots" (Haraway, 2008, p. 255). I leave the artifacts of the image capture within the images—such as the curved horizon produced by the fisheye lens—in order to always draw attention to the material circumstances of their production. I discuss the intellectual traditions that inform my ways of using images and interactions from the camera in this dissertation's introduction, and I discuss how the camera was a participant in my fieldwork in Chapter 4.

suctioned plastic tube. This will ensure that our research subject remains relatively still for the next hour while we perform “the procedure,” a set of activities involving between four and seven researchers and volunteers gathering around the seal’s large body, repeating activities of touching, extracting, injecting, attaching, and measuring.[126] Using a Sharpie marker, the field crew leader draws eight black marks into the seal’s fur at set points along her spine: “ankles,” “neck,” “ears,” and “mid” are easy; “pelvis,” “umbilicus,” “sternum,” and “axilla” harder, requiring some practical knowledge of seal anatomy.

Then we begin to measure. Ropes, tapes, sticks, and ultrasound devices are drawn across, along, and around the seal’s body to take more than sixty readings. Her length is measured with a yellow tape, from her nose to each smudged black marking. A rope is wrapped under and around her thick body at each point, and then pulled out from under her heavy bulk to measure girth. Her height and width at each mark are also registered, from ankles to ears, three times. Clumps of wet sand are brushed away from her short dense fur, clear gel applied, and a small portable ultrasound device visually probes—just under the surface of her skin—to characterize her adipose tissue, on the left ventral, right ventral, and dorsal sides. This, too, is repeated three times at each location, a different person taking the reading each time. These measurements are logged on the data sheet, numbers shouted over the loud bellowing seals, the wind, birds, and surf. “One-one-three ax. Twenty-two umbi.”

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[126] I open with this somewhat schematic and third-person description of all the practices involved in order to highlight the kinds of simplifications of these practices that the scientific papers do. As the chapter develops, I bring the messiness, and myself as a participant in the researcher, into the story.

As these readings are taken, small plastic flipper tags are attached with a tagging device that resembles a staple gun, which punches a simple plastic tag with a number on it through the skin. Meanwhile, digital tags smaller than pill capsules are embedded under the skin, or read with a device that looks like a handheld grocery barcode scanner. Two-part epoxy is mixed, and a GPS satellite tag, a conductivity-temperature sensor, and an accelerometer are held to the seal's short fur and the skin that lies just beneath it and affixed with the hot and quick-setting glue. Meanwhile, vials of blood are drawn into tubes with different colored caps. Finally, just before the needle administering sedatives at her spine is pulled, we align ourselves along her length and together roll her large passive body onto a nylon sling, hoist it into suspension from an aluminum tripod, and register her weight.

Figure 2.2: Rolling a seal onto the nylon sling that will hoist her so she can be weighed. Image by Natalie Forssman. Año Nuevo, 2014.

During the course of my fieldwork, I accompanied researchers on such "recovery" and "deployment" procedures many times.[127] Procedures are the constant, everyday, repetitive work that organizes time in the field for my informants, and thus they structured my ethnographic fieldwork as well, with a flow of operations that became routine. They also require many sets of hands—particularly to do all of the measurements, some of which needed to be repeated with different "crews," in order to answer statistical questions about measuring error. Thus, my willingness to tag along was welcomed, and I attached my camera to my body, so that my hands were free to help. Like other novice volunteers in the field, I pulled on purple latex gloves and learned how to administer drug top-ups, draw blood, mix epoxy, judge that it was dry, perform ultrasounds readings, and measure girths, lengths, heights, and widths. I learned the right speed and force to apply when helping to roll a seal, and how to make sure that she was breathing with sufficient frequency.

If the procedure is going as planned, the elephant seal should only be drugged for about an hour. First, Telazol is administered with the "initial stick," which rapidly sedates the animal and "produces a state of unconsciousness which has been termed 'dissociative' anesthesia in that it appears to selectively interrupt association pathways to the brain before producing sensory blockade" ("Telazol for animal use," 2017). Then, after about ten minutes, when the animal is sufficiently unresponsive, the "spinal" is set,

[127] What is described above is a "deployment," but a "recovery" is very similar, except that the devices are removed instead of attached, and flipper tags read instead of embedded. The same bodily measurements are taken at both procedure types. Both "recovery" and "deployment" procedures are done twice a year: during the pupping/breeding season, and during the molting season. I participated in all four forms many times, about three times a week over a six-month period.

an intravenous line that allows the researchers to administer further doses of drugs, as needed, throughout the procedure. The field crew felt a particular sense of accomplishment when they finished a procedure in less than forty-five minutes. But it takes much less than an hour to wait for the epoxy to dry in a “deployment,” or to use wire cutters to clip off the zap-straps that affix the device to the seal in a “recovery.” What takes up the largest share of attention and time during a procedure is measurement. Measurement work requires the least skill. It does not involve flashy devices, or careful and skilled perforation of the seal’s flesh. But it is also that which requires the highest degree of collaboration among members of the field crew.

Figure 2.3: Three fieldworkers work simultaneously on measurments, two with the girth rope, and one with the ultrasound device for measuring blubber thickness. Fresh epoxy dries around a tracking device glued to the elephant seal’s back. Image by Natalie Forssman. Año Nuevo, 2014.

Most of the measurements are too large for one person to conduct alone. For example, taking the girth measurements involved one person crouching on each side of the seal's body, working together with a length of rope with a knot in it. Reaching our hands under the seal at the ankles or head, one person passes the rope to the other and we bring its two sides together around her dorsal (top) side. As the two parts of the rope meet, one person holds the place where the unmarked end meets the knot on the marked end, and pulls the length of rope out from the underside of the seal, but only just until the knot becomes visible. That person then holds the measuring tape from the place marked with their finger to the place marked with the rope. At the widest girth measurements, this involved stepping away from the seal in order to pull the whole length of rope straight, and required the help of a third person to hold the tape, because the span of rope exceeds one person's arm span. But, when stepping away, we had to remember to be careful to not step on a box of loaded salines, or into the range of another seal. Once the measurement is taken with the tape, we would shimmy the rope under the seal to the next measuring location. If we accidentally unthreaded it all the way, we would have to start again at the ankles or neck, because it's impossible to 'thread' the rope under the thickest parts of the seal.

These acts of measurement involve working together, moments of collectively reckoning her body against our own. Through the acts of wrapping measuring implements across and around the sedated seal's body, her sheer size is constantly evoked in implicit comparison with ours. The average person's arms don't span wide enough to measure the length of ropes involved. Many purple hands work together to perform material acts of measurement. Measuring work is co-produced action, but the purple gloves point to the fact that it is also a practice of separation. Procedures involve touching skin and fur, but sometimes also blood, blubber, glue, and marker dye. The gloves help maintain a distance in these rendering practices. As we pulled bodies apart, we maintained a separation between our own bodies and the body of the seal, protecting at once the sanctity of the samples gathered, and of our own bodies.[128]

Gluing or detaching the expensive GPS recorders, jaw-mounted accelerometers, and swim speed recording devices to the seals almost seemed to come as an afterthought in the everyday labors of field researcher on the beach, so much that sometimes (although rarely) researchers even forgot to attach the devices at all.[129] The devices attached to the seal's body are certainly the charismatic focal point of this research program: they are expensive, exciting gadgets that garner funding and fill funding proposals with the language of remote sensing omniscience. Yet, in the sometimes-jumbled flow of fieldwork, measurement takes precedence in the collective attention of the field crew.

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[128] Driving back from the field, some folks in the field crew would apply hand sanitizer before getting into the truck or having a snack. Others would rapidly start eating chips, bagels, and donuts without doing so. Some of those that practiced the former were concerned about possible pathogens that might be transferred from seal to human. In tension with this, the habit of "not caring" about being dirty is part of the machismo of field practice.

[129] For example, when doing a recovery, peering through binoculars to try to find our "target animal," one field researcher said as she approached the animal: "Hi sweetie. Both cameras. That's good. If she's got a camera, she should have a jaw accelerometer. But there's one female we forgot to put a jaw accelerometer on."

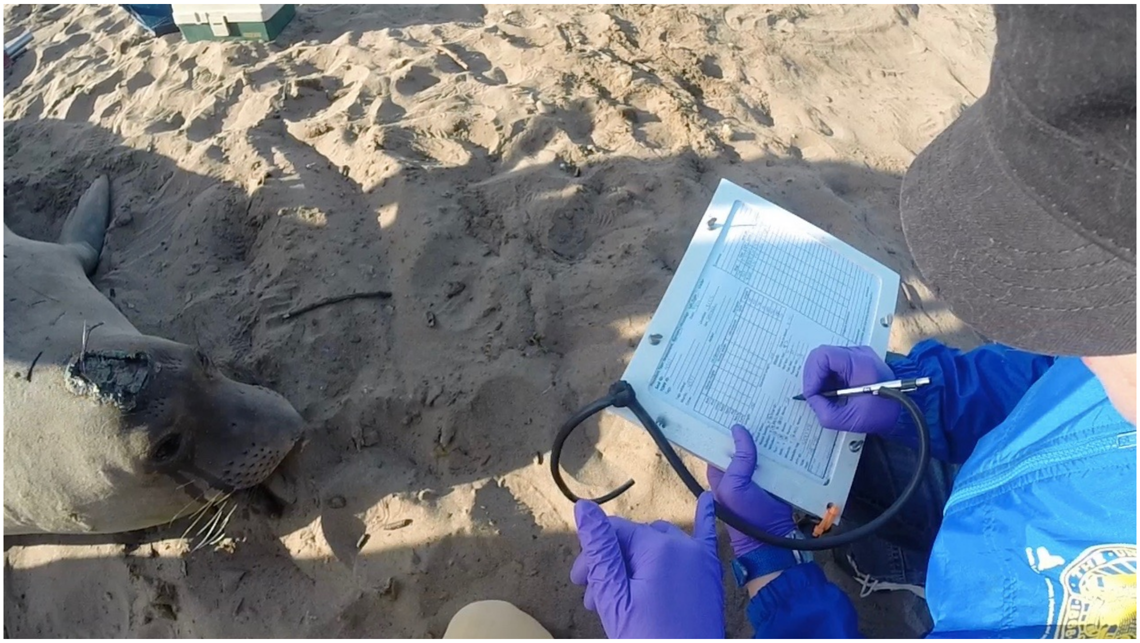

Figure 2.4: An old-timer fieldworker explains to a newcomer volunteer how to fill out the data sheet, with rows and columns for over sixty measurements of the seal's body, plus places to record drug dosages, tag and device attachments, and the markings on her body. The seal lies sedated on the left, and it has just had the satellite tracking device unclipped from the top of her head, while a matting of dried epoxy remains. Image by Natalie Forssman. Año Nuevo, 2014.

Here, I analyze the methods, devices, and practices of fieldwork taking cue from the ethnomethodological orientation to the "surfaces" of actors rather than their insides. In the field, the sensing and recording devices attached to the animals are "black boxes" which are only opened—and their sensory impressions and memories extracted—back in the lab. In keeping my analytic attention attuned on the field, I follow the acts of measurement, which are "a public phenomenon" (Streeck, 2009), with their results literally shouted into the air. I am therefore ambivalent about foregrounding "body-mounted technologies" as the central technique and technology of the research practices that I follow. Of course, body-mounted technologies are crucial to the making of the "animal oceanographer," and the research practices this chapter analyses are entirely dependent upon them, the data they produce, and the forms of questions they make possible.[130] Yet, it is the work of measuring, and the methods of characterising "body composition" and "body condition," which I unpack here. As I demonstrate, measuring work is that which allows the readings from the sensing and tracking technologies to become data-rich in very particular ways.

Shape Becomes a Number

Each place marked with black Sharpie, and each measurement taken, serves to render the shape and size of the elephant seal body. These measurements are called "morphometrics," but they don't signal an interest in descriptive sciences of form. Rather, the researchers aim to characterize the animal's shape as a step towards obtaining a number, or, more precisely, a ratio: of fat to non-fat tissue, to model the seal's body as a set of materials of different volumes and densities. They pursue this by abstracting her body into a geometrical object—a set of "truncated cones"—which are cuts of flesh with a fatty outer layer. Fat is of interest as "energy reserve" for the animal, a key metric in energetic and physiological studies of marine mammals.[131]

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[130] Elsewhere in this project, I closely interrogate the problematic of body-mounted following posed by these tracking technologies. In Chapter Four, I reflexively examine my own research device, a body-mounted camera, in experimental analogy with the technologies of my informants' research. In that chapter, I discuss the questions posed by body-mounted sensing technologies in more detail.

[131] In Chapter One, I discussed how seals' bodies are characterized as "energy reserves" and "resources" differently in different practices. There, I discussed how seals haul bodies ashore that carry traces of deep ocean ecosystems in the form of fatty blubber reserves, and how these have been of interest to terrestrial predators, sealers, subsistence hunters, and scientists.

But it is also of interest for its sheer physical properties: it has a lower density than other bodily materials, and when the animal is in the water, this translates into buoyancy. Thus, the researchers aim to estimate the volume of their research subject's fat reserves, in order to later model her buoyancy at sea.

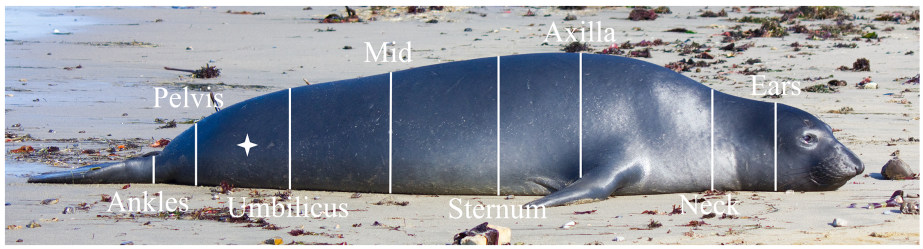

Figure 2.5: The points of measurement that are the first step in breaking up the seal's body into chunks of flesh. Image from Schwarz et al., 2015.

The outer layer of each "truncated cone" is modeled as a layer of adipose tissue, or blubber. In order to estimate the thickness of this layer, a key set of measurements in the field is the "blubber thickness" reading, performed at twenty-one places on the seal's body. When I first observed field practices in Spring 2013, two devices were being used to measure blubber thickness, and measurements at each location were taken three times, by three different users, to determine margins of error.

The first was the "Scanoprobe II," which provides a reading of blubber depth via a line of red lights, activated depending on the density of the tissue. This device's dominant sphere of application is agricultural, where it has been used to estimate "back fat" in livestock prior to slaughter. An early paper that used the Scanoprobe II for this application states, "estimating subcutaneous fat thickness in live cattle … is particularly useful in beef cattle genotype evolution and marketability research." This paper evaluates compares the use of visual and manual assessment with the readings of devices like the Scanoprobe II (Dicker, 1988). A later paper, in the 2006 International Congress of Meat Science and Technology themed "Harnessing and Exploiting Global Opportunities" employed the Scanoprobe II to measure "carcass composition in live pigs." The thickness of subcutaneous fat was measured a couple of days before slaughter and then, on the slaughter line, the lean meat percentage of carcasses was determined. Later, when the carcasses were commercially cut for meat, cuts were weighted and "regression analysis was used to evaluate the variation in the lean meat percentage of the pig carcasses against the ultrasound values."

The second device that we used to measure blubber thickness, which was in the process of being phased in during my field research and compared with the Scanoprobe II, was the "Signos Portable Ultrasound," a device that produces a visual time-based image of the composition of tissues just below the skin. This device allows the user to visually confirm the quality of the reading while using the device in the field, and made it possible to visually separate skin and adipose tissue in the lab, allowing for a more accurate estimate of adipose tissue thickness.[132] The newer device, with its visual display of information, is designed for a wholly different sphere of practice than the "back fat" device. USAID and PATH, "a leader in global health innovation," recommend this device for low-cost diagnostic ultrasounds for maternal and fetal health

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[132] However, in my experience using this device, I never felt confident that I was getting a "good reading," largely because I wasn't practically or conceptually trained to read the flow of physiological imagery the device produced, and therefore couldn't effectively value it. If I had spent more of my ethnography in the lab, rather than the field, learning to read the images from the visual ultrasound and turn them into numbers, I might have had a better tacit understanding of what constituted a 'good reading.'

in “low-resource settings” (PATH, 2014). The Signos is “the world’s most affordable simple to use palm sized ultrasound instrument,” and the concerns that go into the design of its interface are different than those of livestock rearing and processing. In the Signos, the potential dangers of seeing (rather than only measuring) the insides of bodies are reckoned with in the design, and therefore one of the concerns and metrics on the report is whether the device has a lock setting that ensures that it is not being “used for sex selection and female feticide.” These tools, inherited from different spheres of practice, carry different genealogies of measuring and representing bodies into the field. Histories of the quantification of body fat coming from the industrial meat industry, on the one hand, sit behind histories of visualizing women’s bodies in medical technologies on the other. Both of these histories crystallize particular decisions into the design of these handheld devices, and both matter for understanding “rendering bodies” as practices of quantifying fat and representing bodily interiors.

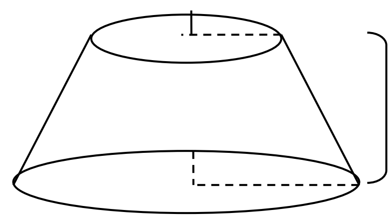
Figure 2.6: The author imaging blubber thickness with the Signos Portable Ultrasound, while an old-timer researcher checks that the seal is breathing well. Image by Natalie Forssman. Año Nuevo, 2014.

But they also impel practical differences: between the purely numerical register of the older device, designed to produce simply a reading to determine the "marketability" of cuts of meat, and the visual register of the new one, designed to allow vision inside of the body, along with safeguards to protect against the attendant dangers that such forms of vision carry. But, the vision made possible by the Signos device, still works towards obtaining a number, in this case a better number that subtracts the layer of skin from the layer of fat back in the lab.

The goal of abstracting shape into numbers is indicative in the fact that there is not a single diagram or drawing of the seal 'as' truncated cones in any of the scientific papers that explicate or use the method to estimate elephant seal body composition.

Instead, the reader of these papers is presented with geometric formulas and samples of code, which turn the shape of each truncated cone into a ratio of fat and non-fat.

S2. Calculating the volume of an elliptical truncated cone



$$V = \int_0^h \pi xy dz$$

x and *y* change linearly as a function of *z*.

$$y = m_b z + B$$

$$x = m_a z + A$$

At z= h, $b = m_b h + B$ and $a = m_a h + A$. By rearrangement, $m_b = \frac{b-B}{h}$ and $m_a = \frac{a-A}{h}$.

Make substitutes for x and y:

$$V = \int_0^h \pi \left[\left(\frac{a-A}{h}\right)z + A\right]\left[\left(\frac{b-B}{h}\right)z + B\right] dz$$

By integration:

$$V = \frac{\pi}{h^2}\left\{\frac{z^3}{3}(a-A)(b-B) + \frac{z^2 h}{2}[A(b-B) + B(a-A)] + h^2 ABz\right\}\Bigg]_{z=0}^{z=h}$$

Which becomes

$$V = \frac{\pi h}{6}(2ab + Ab + Ba + 2AB)$$

Figure 2.7: Appendix on the derivation of the truncated cone formula, where a single cone is mathematically characterized. From the supplementary materials to Schwarz et al., 2015.

```
# III. Calculate volumes using elliptical cones and elliptical truncated cones.
  # A. Calculate straight length for each segment.
    segment_str_length <- vector(length=Nstations+1)
    segment_str_length[1] <- (segment_curv_length[1]^2 - r_Height_samp[1]^2)^0.5
    for (j in 2:Nstations){
       segment_str_length[j] <- (segment_curv_length[j]^2 - ((r_Height_samp[j]-r_Height_samp[j-1])^2))
    }
    segment_str_length[Nstations+1] <- (segment_curv_length[Nstations+1]^2 - r_Height_samp[Nstations]^
  # B. Calculate volume of each segment including skin.
    segment_vol_ell_skin <- vector(length = Nstations+1)
    # 1. Nose to ears.
    segment_vol_ell_skin[1] <- (pi/3.0)*segment_str_length[1]*r_Height_samp[1]*r_Width_samp[1]
    # 2. Ears to pelvis.
    for (j in 2:Nstations){
      a <- r_Width_samp[j]
      b <- r_Height_samp[j]
      A <- r_Width_samp[j-1]
      B <- r_Height_samp[j-1]
      h <- segment_str_length[j]
      segment_vol_ell_skin[j] <- (pi/6.0)*h*((2.0*a*b)+(A*b)+(B*a)+(2.0*A*B))
    }
    # 3. Pelvis to tail
    segment_vol_ell_skin[Nstations+1] <- (pi/3.0)*segment_str_length[Nstations+1]*r_Height_samp[Nstati
  # C. Calculate volume of each segment WITHOUT skin.
    segment_vol_ell_noskin <- vector(length = Nstations+1)
    r_Width_samp_noskin <- r_Width_samp - SkinDepth_samp
    r_Height_samp_noskin <- r_Height_samp - SkinDepth_samp
    # 1. Nose to ears.
    segment_vol_ell_noskin[1] <- (pi/3.0)*segment_str_length[1]*r_Height_samp_noskin[1]*r_Width_samp_n
    # 2. Ears to pelvis.
    for (j in 2:Nstations){
      a <- r_Width_samp_noskin[j]
      b <- r_Height_samp_noskin[j]
```

Figure 2.8: Code for the derivation of body fat from the truncated cones method, in the programming language R. In step III.C, the animal's skin is removed. From the supplementary materials to Schwarz et al., 2015.

Yet, over the duration of my participant observation, one of the main questions being asked was "are seals circular or elliptical," a question about shape. Driven by this question, each procedure involved taking measurements with a device called "the poochometer." One collaborator in the lab, a physiological statistician, was concerned that one of the chief misassumptions of the "truncated cones" method was that "seals are circular on land," that is, that their girth is sufficient to characterize their shape. Thus, one of the hypotheses that we were out to confirm or disconfirm with our data collection was whether "seals are elliptical on land" (it turns out that yes, they are). The "pooch" or "slump" of the animal on land, produced by the effect of gravity, presents a complication to the abstractions of rendering her as a cylinder. The force that gravity exerts on her aquatic body is both an opportunity and impediment. It holds the body still and thus makes the measurement of mass possible, but it also complicates the abstractions that the researchers make in their models.

In order to answer this question about whether seals are circular or elliptical, we had to take another measurement at each location along the animal, using the poochometer. Additionally, since we were validating the precision and accuracy of measurements, one of the requests from this statistician was that we take the measurement three times, with three different “slumper crews” in order to determine the margin of error on measuring the “pooch” or “slump” produced on the elephant seal’s flesh on land. These are kind of semi-derogatory terms to highlight how absurd the field jocks found this particular practice. Having to do the poochometer measurements three times, with three separate slumper crews, frustrated the researchers in the field, highlighting a partial disconnect between the field jocks and lab nerds. One of the complaints made was that we had to sedate the animal for longer than we would otherwise have to in order to complete these repeated measurements. In the field, there was a implicit knowledge of how long things take, and the effects that adding one more set of measurement could take on the overall flow of a procedure. This was the collaborative coordination and organization of the collective action of taking many different forms of measurements and samples of an individual body.

Figure 2.9: Measuring lengths and girths using the poochometer, as an intravenous needle loaded with Ketamine is on the ready to administer further drugs to the animal. Image by Natalie Forssman. Año Nuevo, 2014.

The blubber thickness measurements, and the poochometer measurements, demanded the majority of our time and attention during the procedure, especially since they each needed to be performed three times. The question of how much of the blubber layer is skin, and to what extent seals are elliptical, are asked in the service of more accurately and precisely pulling the seal's body apart into its components. All of these questions of shape are transformed into a ratio of fatty and non-fatty materialities, a numerical metric that transforms shape into a number.

De-composing the Body

Measuring work is thus separation work. Acts of measuring, conducted at the skin, allow bodily de-composition and hence the modeling of "body composition." Measurements are conducted at the perimeter of the body. These acts make it possible to approximate the physical or chemical rendering of the body into fat and non-fat materialities. They are acts of "clarifying fats." In fact, the "gold-standard" of adipose tissue measurement *is* material separation. In this gold-standard practice, "labeled" water, a radioactive form of water, is injected into the animal, given time to move through the tissues through blood circulation, and then the dilution of these "labeled isotopes" is measured in a blood sample. This allows the calculation of "total body water," made possible because the ratios of tritium water to body fat are known through eviscerated carcasses:

> The conversion from TBW to adipose tissue mass or fat mass is created using eviscerated carcasses, wherein water mass is usually estimated by desiccation of homogenized tissue from half the carcass or various tissue components, and fat is extracted chemically from similar homogenized tissues. (Schwarz et al., 2015, p. 2)

The morphometrics conducted on the beach are thus indebted to a much more violent form of "rendering" where bodies are killed and gutted, and tissues blended, dried, and chemically treated. [133] This "conversion formula" is what gives meaning to the practices of measuring girths, lengths, and blubber thicknesses that I have discussed at length. The measurements gleaned in these practices can only be mobilized as data through their connection to these "eviscerated carcasses," which stand in as model organisms for fatty bodies across a variety of physiological lab practices.[134]

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[133] Today, the "conversion" metrics use the classic model organisms of the lab, guinea pigs and pigs.
[134] Schwarz et al.'s paper notes that the model organisms for these TBW conversion formulas have been guinea pigs and pigs, typical model organisms in physiology studies. For historical studies on model organisms in laboratory practice, and their significance in knowledge production, see Kohler (1994), Rader (2004), Ankeny and Leonelli (2011).

The violence of this kind of rendering also draws attention to the connection of "body condition studies" to earlier paradigms of practice in marine mammal science, speaking directly to the definition of "rendering" as "the melting down of fat in order to clarify it." In the genealogy of marine mammology, physiological studies are one of the longest-standing lines of inquiry, because de-composition of the animal was done in the service of extractive industries for whale and seal oil, and scientific study was a lucky beneficiary of this slaughter. D. Graham Burnett's (2012) study of the emergency of cetology in the 20th century unpacks this connection, digging into the archive to paint a picture of early marine mammal scientists up to their hip-waders in the gruesome work of de-composing whales aboard industrial whaling ships. Because of the particular kinds of data such practices were apt to produce, early cetology was oriented to whale bodies as energy reserves.

Like contemporary scientists, sealers and whalers were instrumentally interested in "body composition." In their quest to render oils from flesh, fats were not the key to studying mammalian "energetics," but instead crucial links in a global pre-petroleum economy, where whale and seal oils fuelled the machines of industry. While many species of pinniped were hunted for fur, elephant seals were hunted for their blubber, which was one of the highest quality machine oils available at the time, before the discovery of oil wells and the grand-scale onset of our current fossil fuel era.

My informants' pre-occupation with blubber thickness, and their desire to characterize it in high detail, thus suggests that the "back fat" ultrasound device is more than coincidental connection of their techniques and technologies to the numerical characterization of fat as economic resource.[135] In lab meetings, we often read papers that used sealing ship records or taxidermied museum specimens to estimate past biomasses and populations. A graduate student expressed incredulousness at the "validity" of such forms of data, but the lab P.I. gently chastised his students, saying, "You guys are lucky. Whaling body size data all comes from whaling." What is implied here is two different kinds of "luck." The first is the serendipity of seal life history strategies, this organisms' habit to come ashore and present their bodies to be measured, allowing non-lethal "body size data" to be easily obtained. The second is the interlinked moral break of *not* having to rely on such obvious violences for knowledge production. The reliance on death for knowledge made my informants deeply uncomfortable. This is evidenced in the marine mammal community's rejection of "Japanese scientific whaling," a loophole that Japan uses in the International Whaling Commission to manage to continue to practice large-scale whaling under the auspices of "foraging research," insisting that killing the whale is necessary in order to know what it is eating. First Nations and American Indian cultural seal hunts were treated with more sensitivity, but still ultimately frowned upon, even though some lab members were shipped seal body parts obtained from these kills for their research.[136]

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[135] The use of the "bomb calorimeter" back at the lab is another moment where practices of determining exactly how much fat is a contained in particular biological material are entangled with histories of industry, in this case industrial food sciences. A calorimeter combusts the materials put in it, determining the energy contained in the substance by the heat released in its combustion.

[136] On the longstanding tensions between environmentalists and indigenous peoples, see Wenzel (1991) and Nadasdy (2005), particularly around anti-sealing and anti-fur campaigns in the northern Arctic, including those led by Greenpeace. Recently, relations between Greenpeace and the Inuit of the Canadian arctic have been re-articulated around shared opposition to seismic testing in Baffin Bay; see Goodman (2014, July 22).

The measurement practices that have been the subject of this chapter so far link individuals to ecosystems through the metric of “energy reserves.” This co-implication of fats and fuels runs deep. By seeing the repeated measurements with the poochometer in the field as attempts to approximate and validate practices of putting animals in blenders or determining the thickness of their blubber by removing it, suddenly these practices are infused with histories of what it means, and has meant, to characterize “body composition,” and practices of care that underlie efforts to *not* render the animal ultimately passive.

These acts of de-composing the body produce particular forms of vision, which see whole bodies in terms of their morphometrics, such as in casual interactions about the size of particular animals when selecting an animal to sedate and sample:

Paul: Is he bigger than she is?

Julie: He’s not longer, he’s chubbier

Seeing bodies in terms of their *composition*, and decomposing them into component parts, is part of the “professional vision” (Goodwin, 1995) of researchers in the field. This kind of vision is required in the act of initially drugging the animal, where an estimate of her total mass is required in order to decide the quantity of sedatives to administer:

> Julie: The first thing that we’re going to do is going to be the drugging … Usually under the comment section, we put the initial dose that we draw … So it’s going to be 3.4cc’ss TN30. And the reason that we do that is because we actually, well especially on her, we have no idea what she looks like. So we have to draw up that much, but we might not actually give it all. And so … actually what you’re going to be doing is you’re going to be watching us. Usually when we give the initial stick, we’ll give some OK, like you’ll see us start backing up. Then you’re

> going to want to record the time on the watch. That's going to be the initial stick. Then when we get back, you'll go, 'Hey how much did you actually give her?' It may be 3.4, it may be 3.2, it just depends. (Transcription from fieldwork video, 2014)

Here, an old-timer researcher explains how the initial dose of Telazol is done, and how it is recorded on the data sheet, to a newcomer. Because the researchers "have no idea what she looks like," they must make a best guess of her mass, and then, in the tension-filled moment of administering the drugs, when they are right up close to the animal, finalize that estimate in the actual amount of drugs they administer in the "initial stick."

These acts of visually estimating morphometrics, and abstractly pulling bodies into their component parts, is a form of vision that extends, if jokingly, to human bodies as well. In the following interaction, the procedure is almost over, the only thing left to do is tare the scale. Julie jumps onto the aluminum poles and nylon sling that just held and lifted an elephant seal, to calculate the weight of the equipment used to weigh the seal, and subtract that to get the seal's absolute weight:

> Kate: So we can calculate how much Julie weighs now, right?
>
> Julie: Yeah. I can *tell* you how much I weigh.
>
> Danielle: Eighty-nine ((reading the digital screen of the scale))
>
> Valerie: Hey, that's my tare!
>
> Julie: ((laughing)) Your tare's eighty-nine?
>
> Valerie: Yeah, with the sling.
>
> Julie: It's your legs.
>
> Valerie: Yeah… can we talk about it?
>
> Julie: It's ridiculous.

This instance draws out multiple acts of bodily de-composition at work: the work of separating the animal's mass from the mass of the equipment used to measure her. Here again, human bodies are fully engaged in the measuring work: because the tarp and poles used to hoist the animal are so large that they cannot self-balance without a body on—or in—it. But it also suggests that an understanding of bodies as de-composable doesn't leave human bodies untouched, as Valerie is rendered into the sling, "legs," and then the rest of her. The pre-occupation with fat and weight in the study of seals moves, if imperceptibly, into the practices of the research team, and a particularly gendered concern with human female bodies, also, as objects composed of differently-weighted components.

Negotiating Passivity and Activity

As seal bodies are virtually rendered into their materials components on the beach, the tensions inherent in this transformation from living subject to passive object remain. Researchers' measuring practices indexically reference methodologies of bodily extraction and evisceration: this is the "gold standard" of their measuring procedures, the comparison that the seal's body as truncated cones is held against. Yet, my informants do not kill their research subjects. Indeed, the careful work of measurement and the nuanced calculations of margins of errors they strive towards are part of the aim to determine "body composition" without decomposing the body. In the flurry of hands and measuring implements that quickly get to work on the sedated seal that lies in the sand, it can sometimes be forgotten that it is a living body we interact with.

This is suggested in the following interaction, where I accompanied seven others into the field, among us a handful of new undergraduate volunteers. Kate, a first-year PhD student in lab—and thus a newcomer working to perform and produce herself as an old-timer, is instructing a new undergraduate field volunteer, Danielle, about how to use the poocometer. Kate begins to explain the process involved, how with two measuring sticks set at a right-angle, we will work our way along the seal's three meter long body, measuring the height and width at eight locations marked along her spine with a sharpie marker. Danielle and I are to form the first "slumper crew," shouting lengths and girths to another undergraduate, Andrew, as we go. After we have performed all measurements from the ankles to the ears, she explains, we will switch off, and another "slumper crew" will do the measurements again. After Kate has finished her instructions, Danielle and I move in toward the seal, keen to get started and prove our value to the team. But Kate stops us and says, half joking and half with earnest awe, "Pause, you're touching an elephant seal." We press our hands along her side, and her flesh is warm to the touch through our purple latex gloves.

Researchers do not aim towards complete and final passivity of their research subjects, and have no desire to kill them. Partly, that motivation is moralistic, as evidenced by the repugnance in their voices when they discussed indigenous seal hunts in Alaska, even though these hunts provide many samples that were key to research in the marine mammal community at large.[137] But the motivation is epistemological as well as moral. They require the seal's body on shore to be only temporarily passive, just passive enough so that morphometrics can be measured with their ropes and tapes, and thus the body's material composition rendered in their models. They produce this temporary state of passivity, where the body can be characterized as a set of materials, with the aid of powerful sedative drugs: Telazol, Ketamine, and sometimes Valium. Yet, a tension must be carefully negotiated: the drugs have the potential to render the body *too* passive; they risk killing her. But their "target animal" is only an interesting research subject to the extent that she can resume her "natural" behaviors. Thus, what is aimed for is not complete and final immobilization, but a temporary rendering-still. The scientist need to render her body passive so that it can be held still long enough to be measurable, but they can't render it so passive that they kill their research subject.

Old-timer researchers could recount cases of animals that had died in their care, and conversation sometimes turned to these 'lists,' which seemed to be held constantly in mind when they went about the work of sedating seals. Luckily, as they re-iterated many times, "elephant seals are hard to kill." One researcher explained that other species were much more sensitive to sedative drugs, and that working too long with elephant seals could make you less "sensitive," less attuned to key bodily signals, rougher in handling the animal, and more casual about administering drugs. They explained that one of the reasons elephant seals are hard to kill is that, as deep divers,

[137] And thus another layer of "rendering practices" performed in this chapter is the work that researchers do to distance themselves from the exploitative activities of other groups engaging with seals past and present, a form of judgment that is itself a rendering, and involves separating work.

they don't need to breathe very often. With a "good breath" required only every couple of minutes, monitoring breathing and keeping the animal alive is much easier to do with this particular physiology. As researchers' tools and attention is focused on an immobile object to be measured, sampled, and glued to, they must at the same time stay attuned to that body's physiology, and breathing becomes an indicator of the overall functioning of the physiological body.

During a procedure, "Watch her breath!" or, "Has she had a good breath?" were commands constantly issued or questions posed. After the initial dose to sedate the seal with Telazol, monitoring breath was a key way of reading how the animal is responding to the drugs, such as when a field worker says, "She's been breathing pretty good. She's been breathing good so far" (Fieldwork video footage, 2014). This is called "getting a breath." Amidst the shouts of measurements to be recorded on the data sheet, "Good breath!" was also vocalized for all to hear, when someone in the field crew was standing near the seal's head and observed her take a breath of air. Whether a breath had happened in the last couple of minutes was one of the ambient pieces of information about the seal's condition that was constantly kept track of by those in charge of the procedure.

But sometimes it wasn't enough to just *watch* breath; it had to be physically induced. When the animal was not yet entirely sedated, old-timers would carefully approach, and then check the animal's responsivity and try to get the animal to breathe at the same time:

> She is visibly sipping…I wanted to lift up her head and see if she would breathe... She's visibly sipping… She's moving for sure…

> ((Approaches the seal, tickles her nose, and the seal lifts her head slightly)). Hey sweetie.

When the animal was even less responsive, a good breath could be “gotten,” by lifting her head, as in the image below. Prior to lifting her head, Alixe noted, “She’s super mobile, but she’s not…like…giving a good breath…See? She’s kind of *funny*…she’s super *aware* and responsive.”

Figure 2.10: Lifting her nose to help her breathe, after sedation but prior to a procedure. Image by Natalie Forssman. Año Nuevo, 2014.

After this operation, another person in the field crew would often check its success by asking, “You get a breath out of her?” This discernment of “good” and “bad” breaths took place not only during the sedation, but also when looking for a good candidate for a procedure, where reading breath is a way to read the status of the animal, how they might respond to a procedure, and a way of reading the time they have so far spent on the beach:

> One of them got back yesterday, but we saw her this morning, and I knew she hit the beach the night before. They don't breath as well when they just hit the beach. (Fieldwork video footage, 2014)

Thus, as the practices of abstracted rendering — in the sense of pulling the seal's body apart — are done, other practices that aim to maintain her bodily integrity, to treat her as a living being, take place at the same time. The tension between the seal as a living, active body and as a passive body that can be rendered as its component materials, are constantly being negotiated together. Researchers negotiate this tension by closely watching the seal's breathing, which becomes an overall indicator or her status as a living body more generally. In some cases, activity and passivity are complicated further, when she has been rendered so passive that she must be "helped" to breath, like a recipient of CPR.

The tension between the living body and the measurable body requires delicate balance, because it can also go the other way. The seal can also be *too active*, and this, too, is carefully monitored and anticipated. "Watching her breath" is just one part of the more encompassing role of "watching her head," to make sure that she isn't overly awake and aware, and, if she is, to administer more Ketamine. When reading or applying flipper tags, it was important to shout "Touching flippers!" loudly enough so that a team member situated near the animal's head was aware that the seal might suddenly move its toothy head around. To anticipate this possibility, one rule of bodily practice in the field was that one was never allowed to fully kneel in the sand while measuring, gluing, or sampling. Only one knee could be on the ground, the other leg in a squatting position, always ready to jump up. Field crewmembers had to keep their own bodies active in anticipation that the seal might suddenly become active.

Acts of measurement were often in conflict with the work of keeping the seal's body passive, and anticipating that she might move or respond.

> Paul: One thing that I like to do is try to keep the flippers tucked. That way if she does decide to wake up, she can't lunge forward. Obviously you need to get in there to do stuff so remember to just …
>
> Andrew: Tuck it
>
> Paul: Yeah

Here, a field leader is teaching an undergraduate volunteer one of his tricks. Paul's admission that, "obviously you need to get in there to do stuff" points to the tensions between the body as measurable and the body as active. The seal's armpit, just underneath the front flippers, is the location of the "axilla" measurement, and thus the "stuff" that you need to "get in there to do" is measurement. But, as soon as that measurement is completed, remembering to "tuck it" ensures that the animal won't suddenly be in a position to "lunge forward." Thus, not only the drugs render the animal still, but also simple acts of arranging her limbs in particular ways that anticipate possible movements.

Another tension arises between enacting measurability and enacting passivity, when it is time to roll the seal onto the large sling, in order to hoist her in the air and measure her mass. At this point, the "spinal" administering drugs must be pulled, because to roll her while it is still inserted in her lower back would bend the needle, injure her, and cause her to respond in pain and become hard to manage. But, we would wait until the absolute last possible moment to do so. First, we line up along one side of her, position part of the sling on the other side, and roll her halfway, so she is resting on her side for a moment. Three of us hold her in that position while the fourth person "pulls the spinal," and then we proceed to roll her, all the way onto her back, and fully onto the sling.

Rendering of Practices at Sea

This chapter so far has examined fieldwork practices on the coastal beach, where seal bodies are rendered measurable by the drugs and doings of scientists. Researchers require the seal's body on shore to be passive and motionless in order to be characterized as cuts of flesh, composed of fatty and non-fatty substances. But this involves a tension between a passive body, subject to the measuring implements of scientists, and an active body, which can resume its "naturalistic behaviors" after the procedure, and therefore gather data on the behalf of scientists, assuming its role as "animal oceanographer." The work of the procedure, which on first impression deals with a passive object-like body, thus carefully negotiates the work of rendering the body as object, while maintaining it as living. The delegation of the role of "seal oceanographer" onto the body of a particular elephant seal requires this careful negotiation of passivity and activity. The practices I have elucidated here are "rendering practices" in a double sense: in that that they aim towards the virtual, if not chemical, separations of bodies into fat and non-fat. But they are also rendering practice in the sense that they aim towards the production of representations, to give detailed form to the seal bodies that are the central protagonists in physiological and ecological models. Rendering the seal body as an object, as I will describe in the next section, is crucial to scientists' ability to see her as a purposeful and motivated organism as she moves through the ocean, a form of agency key to her role as "oceanographer."

So, while the previous section, "Practices of rendering on shore," unpacked everyday material acts of measuring the seal's body at the field site, this section, "Rendering of practices at sea," will illustrate how these material acts of measuring make it possible to see the doings of elephant seals in the ocean: the interpretation of distant animal activities in nuanced detail. I examine a selection of published papers by my informants, their mentors, and their colleagues that together sketch a history of the findings, dependencies, and abstractions that have made the rendering of seals' at-sea practices possible.

As with the measuring practices on shore, the work of measuring the seal's body at sea requires a careful negotiation of the seal an active living body, and the seal as passive and measurable. And, like the measuring work on shore, moments of passivity are used to glean knowledge of the body's material composition. Analytically taking bodies apart on the shore allows a particular form of vision of at-sea doings. Thus, the rendering practices on shore discussed in the previous section are connected to the researchers' ability to render animal practices at sea. This section thus shifts the meaning of "rendering practices" to a new register, where it is used to name the work of making distant animal activities tangible. "Rendering practices," here, is a synonym for "representing activities." These representational acts are made possible by separation work discussed in the previous section, but they also perform their own de-compositions, as well as re-compositions. These "rendering practices," which model "body composition" without chemical rendering, allow seals' activities to be seen through their moments of passivity.

Deep-sea Renderings

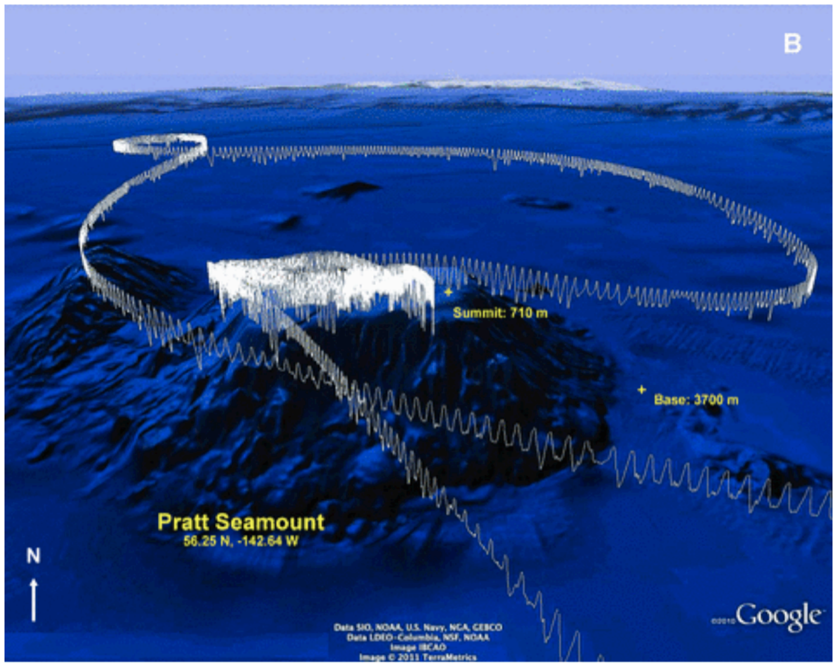

Figure 2.11: Dives of a female elephant seal foraging on Pratt Seamount in the northeast Pacific. Image from Maxwell et al., 2012.

The above image displays the diving track of a female elephant seal, made possible by the sensing devices glued to her body,[138] and interposed against Google Earth imaging of a group of underwater mountains, coordinated data drawn from US

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[138] This animal, named "M627," was outfitted at Año Nuevo with a satellite platform transmitter terminal and a satellite-linked time-depth recorder.

governmental seafloor data (NOAA).[139] The ocean's depths are made transparent, only the deep aquamarine color suggests that we are looking at an image of a watery, rather than terrestrial, space. The image orients our attention away from the ocean as a flat surface, and towards different planes and surfaces. The ocean is cast not as a dense medium that restricts vision, but rather as as three-dimensional space traversed by the seal body that produced the white track. The water's surface is not drawn in the image, but is instead implied, as the topmost point of each dive track wiggle. The seafloor, in contrast, is textured and shaded as landscape, with mountains that rise from its abyssal plain, the summit of the highest peak nearly 3000 meters of vertical height. The seafloor basks in a point light source that produces shadows and shades, at depths under the ocean's surface that photons never reach. By redirecting our attention to these contours, the sea is rendered as a three-dimensional space through which the seal's body moves with seemingly purposeful intent.

Expressed in this image is a staggering skill of underwater navigation, as well as the ecological richness of seamounts, locations of the deep sea floor that reach towards the sea's surface and produce a confluence of habitats and interspecies interactions.[140] The seal enters the field of vision along the right edge, and finds her way to this rich

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[139] See Smith and Sandwell (1997) for how digital bathymetric maps of the world's oceans are constructed from spacecraft surveying of the gravity field over the oceans, and then calibrated by ship-based depth soundings. See Felt (2012) for an account of the early history of seafloor mapping.
[140] In the words of the paper's authors, "researchers have demonstrated that a range of pelagic taxa including tuna, swordfish, whales, dolphins, sharks, marine turtles, and seabirds congregate at, or otherwise exploit, waters overlying seamounts" (Maxwell et al., 2012). The authors quote reviews by Pitcher et al. (2008) and Morato et al. (2008). See also Morato, Hoyle, Allain, and Nicol's (2010) article titled, "Seamounts are hotspots of pelagic biodiversity in the open ocean."

feast, where she repeatedly dives to hunt and eat. The paper this image is pulled from investigates how elephant seals interact with this seafloor topology and the ecological communities it engenders. M627, the individual elephant seal in this image, is figured as "manag[ing] the remarkable feat of returning to this same seamount chain in the huge featureless patches of the North Pacific Ocean."

In this section, I examine the particular seal that is drawn from the dive track data: how, out of the sinuous white line in the image above, researchers glean the seal's activities, her body condition, her eating habitats, and features of the habitats she utilizes. Each angle, speed, depth, and length of dive is transformed such that it can be read as information on the seal's body condition and on her activity. This is made possible through methods of reading the diving trajectories that have developed over more than 20 years.

But it is a very *particular* body that is pulled out of it this tracking data, a body encapsulated by one of physiology's most straightforward metrics—"body condition," which is defined as the relation of body mass to body volume. Thus, rather than sketching my informants' practices as aiding in the production of an all-encompassing form of vision and knowledge, I attend to the specific moments where certain phenomena are operationalized, and the highly specific renderings which that work produces.

As I will describe, the work of drawing the seal's body and her activity out of her dive trajectory data involves a complex negotiation of the animal as an active subject—purposefully moving through her environment in directed and agentive ways—and a passive object—a cylinder of blubbery flesh, ready to be measured.

Early Dive Trajectories: Rendering Activity

In some of the earliest records of elephant seal dive trajectories, researchers noticed patterns in the repeating up and down movements of the elephant seal as she dives (Le Boeuf et al., 1986; Le Boeuf et al., 1988). By looking closely at the speed and angles of these dives, they noticed that these patterns carry in their shape key information about what the animal is doing.

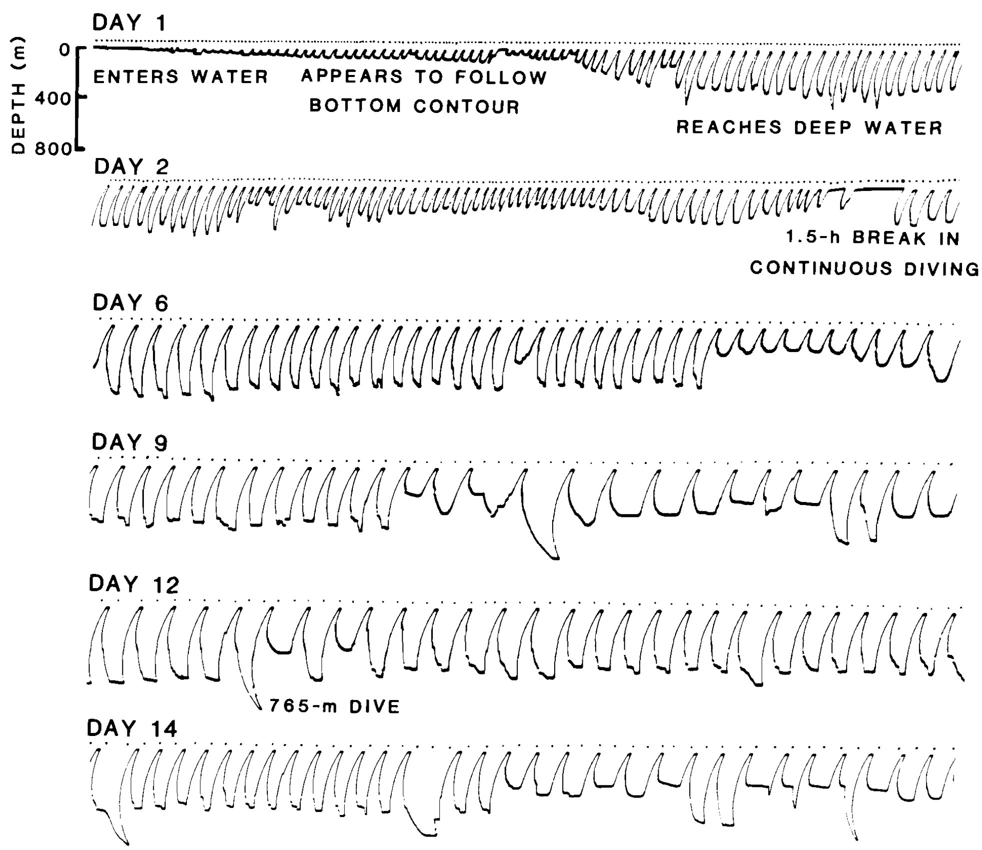

Figure 2.12: Sample of some of the earliest dive data. Image from LeBoeuf et al., 1988.

Le Boeuf et al. (1992) studied the records of a single female elephant seal's 71-day journey from central California to the deep pelagic waters off the content shelf of British Columbia, examining changes in swim speed with a time-depth recorder (TDR) and a swim speed-distance meter (SSDM). With the dive tracks drawn from these devices, they examined dive angles and speeds, and concluded that the dive shapes could be classified into five different types.

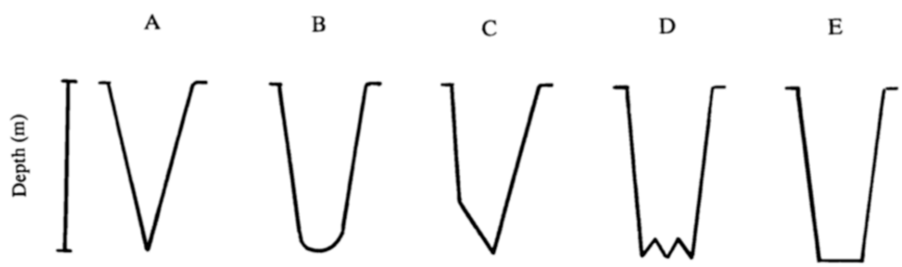

Figure 2.13: Schematic representation of the five dive types. Image from LeBoeuf et al., 1992.

Some shapes indicated that the animal was "transiting"—moving from place to place—while others indicated "foraging"—concentrating on deep-water feeding. "Transit" dives were characterized by particular features of "their temporal patterning, distance travelled, and form" (Le Boeuf et al., 1992, p. 793). In particular, transit dives covered the greatest … horizontal distances," and "the mean angles of descent and ascent were shallower than for the other dive types." The authors found the greatest frequency of transit dives at the beginning of the animal's foraging migration, conforming with the assumption that during that time she was making her way to northern feeding grounds off of Vancouver Island, and not eating very much along the way. Averaging dive durations and distances in the record, they concluded,

> Making 60 transit dives per day, each one covering 1.3km, the seal would have traveled 78 km per day: 1326 km in 17 days. The frequency of transit dives per day then decreased (to less than 20% of the dives per day) after day 17 to the end of the record on day 42. This was an interval when the female was ostensibly feeding and had not yet started her return to Año Nuevo. (Le Boeuf et al., 1992, p. 793)

The transit dive record thus paints a picture of the seal's way of travelling as "energetically efficient," because by coasting "downhill," or swimming aided by gravity in the downward part of the dive, she could transit to her foraging grounds with "reduced effort" compared with swimming along the surface.

Feeding dives (Types D and E in the schematic representation), on the other hand, had a very different shape, with "abrupt" angles of descent and ascent, and "one third of the total dive duration" spent at depth." Type D dives, where their characteristic "wiggles," "are consistent with the animal *searching, pursuing,* and *capturing* [emphasis added] prey in the water column" (Le Boeuf et al., 1992). Type E dives, on the other hand, without the "wiggles" were thought to indicate feeding at the ocean bottom. This is further supported by the finding that, within a series of the E dives, the animal dove to roughly the same depth on each subsequent dive:

> Though the depth sometimes changed slightly during the course of a bottom segment, the succeeding bottoms in a series of type E dives began close to the depth at which the preceding bottom ended. Thus, it appears that the animal's movement was *tracking* [emphasis added] the bottom topography….Swim speed was slow and depth was relatively invariant, suggesting that the animal was swimming over a flat shelf or seamount, perhaps *hunting* [emphasis added] for bottom-dwelling sharks, skates, or rays." (Le Boeuf et al., 1992, p. 793)

A final type, however, was functionally the most mysterious of all: the authors called it a "process dive" and hypothesized that the animal was sleeping or resting.

They figured that these dives “might serve a physiological function such as clearance of anaerobic metabolites, food processing, or rest or sleep.” Because the swim speed was so slow during this type of dive, they ventured that “the animal may have stopped swimming during the segment and drifted down passively” (Le Boeuf et al., 1992, p. 794). Unlike the energy-conscious yet active “coasting” or “swimming” of the transit dive, or the even more active “searching,” “pursuing,” “capturing,” “tracking,” and “hunting” activities of the feeding dives, it was thought that the process dive might be a moment of passivity in the elephant seal’s otherwise very long and alert foraging journey.

Passive Drifting: Rendering the Body

The process dive appears to be the one moment of non-activity in the elephant seal’s foraging migration, a moment lacking in behavioral activity, even if it is rich in metabolic activity. Indeed, in subsequent scientific papers, researchers begin to refer to it not as the “process” dive, but as the “drift” dive, indexing its external physical characteristics rather than its behavioral or physiological function. In this shifting of terms, the active nature of digestion is backgrounded, and this dive type is painted instead as a state of non-activity, wherein the seal’s body is a physical entity moved by external forces, like a drift of leaves or snow. The seal body passively floats or drifts in the drift dive, but it is a mobile passivity: the body continues to move downward in the water column.

Yet, this moment marked by a lack of behavioral activity, a moment far from the lively activities of searching, pursuing, capturing, tracking, and hunting, the drift dive became very useful to researchers, and is central to their research methods today. While *wiggles* at the bottom of certain dives became key indicators of "foraging *effort*," the *angle* of drift in the "drift dive" became a key indicator of "foraging *success.*" The later, success rather than effort, has become a much more valued metric in the study of "foraging ecology."[141]

The drift dive's shape and trajectory are able to serve as an index of foraging *success* because of a relation between buoyancy and diving behavior, experimentally investigated in a subsequent paper with many of the same authors (Webb, Crocker, Blackwell, Costa, & Le Boeuf, 1998). By attaching weights to juvenile elephant seals to make them more or less buoyant, and then closely following their dive trajectory data as they made their way back to the rookery, these researchers determined that the descent rate of the animal during its dives closely correlates to its total buoyancy.

At the time of their study, the authors claimed, "buoyancy in marine mammals has received little attention" (Webb et al., 1998, p. 2359). That view has certainly changed, in the regard of elephant seals. Today, the relationship between speed of descent in the drift dive and the buoyancy of the animal is a central insight that allows question generation in the lab. Drift rate is an analogue for buoyancy, which in turn is correlated with relative body fat, what researchers call "body condition."[142] Thus, just

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[141] Such as the study by Viviant, Trites, Rosen, Monestiez, and Guinet (2010), which uses accelerometers to detect "prey capture events."

[142] See for example the following papers that use that term in relation to northern elephant seals: Biuw, McConnell, Bradshaw, Burton, and Fedak (2003), Noren and Manguel (2004), and Schick et al. (2013). On body condition and "fitness," see Jakob, Marshall, and Uetz (1996). On body condition in the cattle

as in the measuring practices on shore, researchers read the seal's body in the drift dive in order to decompose it into its materials: fat and non-fat.

Further research on the specific characteristics of the "drift dive" has followed, to understand its metabolic, behavioral, and sensory features and functions. For many elephant seal researchers, the strangeness of the drift dive is part of their otherworldly fascination with these animals, who are thought to carry out mysterious lives at far depths under the ocean's surface. Elephant seals dive deeper than almost all other marine mammals, exceeded only by the sperm whale (*Physeter macrocephalus*), Melville's notorious "white whale" (Melville, 1851/1988). As one longtime collaborator with the lab excitedly put it, "Elephant seals are not diving animals, they're surfacing animals!" This captures the excitement and curiosity that drives this lab's inquires into what elephant seals are doing in deep underwater realms. In one particularly techno-poetic articulation, Mitani et al. (2010) used tri-axial acceleration and magnetometry sensors to study the precise pattern of the drift in close detail.

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industry, see Edmonson, Lean, Weaver, Farver, and Webster (1989) and Ferguson, Galligan, and Thomsen (1994).

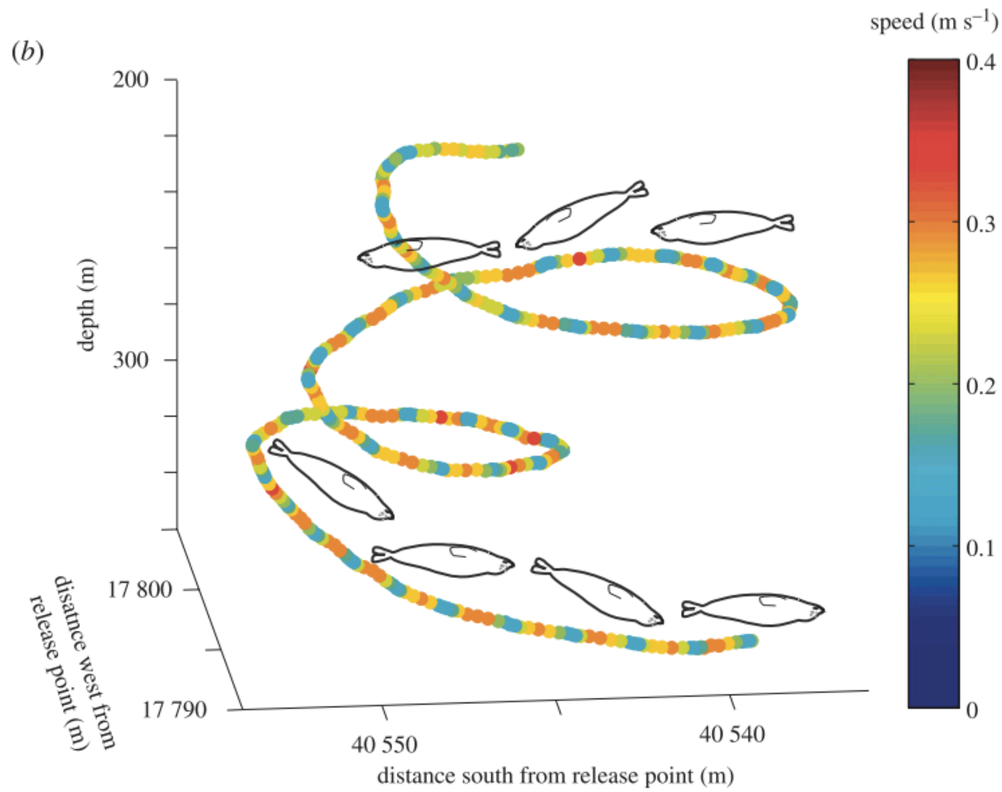

Figure 2.14: A diagrammatic representation of the three-dimensional movement pattern and speed of an individual elephant seal through the water column, representing her as "drifting like a falling leaf." Image from Mitani et al., 2010.

A previous paper (Davis, Fuiman, Williams, & Le Boeuf, 2001) had used animal-borne video cameras to closely monitored "flipper stroke recordings" to determine when the animal stops stroking, to determine the moment of the "switch from active swimming to passive gliding" (Mitani et al., 2010). Mitani and colleagues, from their close monitoring of the three-dimensional drift pattern, conclude that elephant seals "drift like a falling leaf" as they fall through the water column. More than an evocative metaphor, this is a direct physical comparison. The authors found that as the seals fall through the water column, their stomachs pointed skyward and they fall in swirling patterns, their flippers not moving:

> During the belly-up phase, almost no flipper strokes were performed, and the body wobbled slowly by pitching and yawing in all drift dives. A line drawn through the seal's long axis would trace circles at the head and tail, at a cycle of about 10s …similar to the precision of a spinning top, without the spin. (Mitani et al., 2010, p. 165)

But more than providing researchers with a precise and poetic description of the shape and pattern of drift, the specific characterization of this passivity is crucial to the significance of the drift dive as an "immutable mobile," a data object that can travel.[143] By precisely characterizing the drifting pattern, the drift dive can be *abstracted* as technical passivity, with a time-stamp of when it begins. Passivity is thus defined in a technical sense: flippers not moving, and reaction times to stimuli much delayed. Mitanni and colleagues describe their research subjects hitting the ocean bottom and lying immobile, with "no reaction to the sudden shock upon contact with the sea floor" for "4.8+3.1 min." They thus confirm that during the drift dive, elephant seals are truly disengaged from the motivated activities of searching, tracking, pursuing, hunting, and capturing, and even the small twitches of the flippers involved in swimming or coasting. Instead, these listless animals drift to the ocean's floor, reaching depths of 300 meters under the surface, and then they lie there for up to eight minutes before making their way back to the surface.

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[143] This echoes the work of turning morphometric measurements into a number in the measuring practices on shore. In both cases, what appears to be a morphological interest in shape or form is quickly transformed into a number that can travel and be easily interested into other questions and models.

The Body in the Movement: Rendering Eating and Habitat

The drift dive, when abstracted as passivity in the models of researchers, has a sphere of application beyond its interest as a bizarre but elegant strategy for sleeping and metabolizing while at sea. Mitanni and colleagues shed light on the nature of this passivity, evocatively capturing it in ways that do not hide the deep sense of mystery and fascination that infuses their study. Yet, through the precise characterization of this passivity, the drift dive is able to take on other semiotic meanings. It sheds light on not just the mechanics of passivity, but also the mechanics of activity, namely, the activity of foraging, and how it is expressed in the body as a gaining of fat tissue. The drift dive thus allows the reading of eating off of the dive trajectory.[144]

At the moment she is completely passive and still, the seal is being held and measured by her watery environment.[145] Buoyancy is "the force that causes objects to float," and her body's physical reaction to the force that environment has to hold a body —whether she has neutral, positive, or negative buoyancy— tells researchers her "body condition." Reading the drift dive is thus a moment of drawing the seal's body, and in particular its fat content, out of the dive trajectory data. It is a moment of rendering. Not

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[144] The model of eating that this allows is a very particular one: of food as fuel, converted into fatty energy stores, which are part of the "energy budget" of the organism. This way of talking about food and energy was pervasive in the lab, with researchers asking questions like, "what does it take to run this seal?" This figures the seal as a technical object akin to a car, with inputs and outputs.

[145] This evokes Karen Barad's discussion of measurement as an agential practice: "Measurements, including practices such as zooming in or examining something with a probe, don't just happen (in the abstract)—they require specific measurement apparatuses. Measurements are agential practices, which are not simply revelatory but performative: they help constitute and are a constitutive part of what is being measured. In other words, measurements are *intra-actions* (not interactions): the agencies of observation are inseparable from that which is observed. Measurements are world-making: matter and meaning do not preexist, but rather are co-constituted via measurement intra-actions" (Barad, 2012). For a discussion of measurement in quantum physics, see Barad (2003) and Barad (2007).

only are her activities of foraging and transiting made visible, but also the composition of her body, and how it changes over time.[146]

Yet the elephant seal as an *active* entity is also of course crucial in order for her assume the particular form of agency required of “the animal oceanographer”: To the extent that she is a predator at sea, purposefully seeking her prey, and going at great depths and distances to do so, reading her body composition off of moments of activity is interesting and worthwhile. If her buoyancy didn’t change in reaction to heterogeneous features of her environment, it would not be of interest to scientists. It is thus not the seal’s body as a buoyant object alone that is interesting to researchers, but that body read alongside the *other* moments of her foraging journey, when she is an active seeker of prey. Activity and passivity are read together: through her passivity, her activities are revealed. The moment that the elephant seal is most passive becomes a moment to paint a data-rich picture of her doings, her activities.

Her moment of inactivity provides an “integrated” picture of what she was previously doing, because those doings (eating, framed as turning food into body fat) are integrated into her flesh. Doings are rendered out of passivity. In an elegant paper

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[146] At this moment of passivity, she is akin to the “runaway sneakers and rubber ducks” of physical oceanographer Curtis Ebbesmeyer’s “Flotsametrics,” a citizen-science research program which collects ocean debris in the service of understanding ocean currents. By tracing the final resting places of human-made ocean debris on coasts, gathered by beachcombers, Ebbensmeyer’s project relies on the passivity of these objects, the fact that they are subject to the ocean’s currents, to read those currents off of their shore locations. The fact that they have no say in where they end up, that they can be inserted in models as fully passive entities, is what gives them indexical power. In a similar sense, the moment of absolute passivity in the elephant seal’s dive data becomes one of the moments richest in data, allowing a reading of features of her environment that would otherwise be invisible to the researchers.

that analyses the dive trajectories of southern elephant seals,[147] these methods of reading body condition off of the dive trajectory are used to map zones of the ocean where most intensive foraging occurs, producing a heat map of activity, and in addition displaying how zones of intensive foraging map to particular features of the bodies of water involved. In this data-analysis, the flesh integrated into the body of the seal at particular locations is dis-aggregated from it, in order to use that flesh to point to prey-rich locations. In these data acrobatics, involving bodily aggregations and di-aggregations, the body is decomposed in order to map the environment it just moved through.

This is allowing scientists to ask new questions about habitat utilization.[148] For example, Bailleul et al. (2007) performed an analysis on bio-logging data that examined associations between foraging behavior (Determined by high increased sinuosity in tracks – i.e. (actual path length)/(shortest path length)), dive density (Determined by number of dives per kilometer covered), and changes in body condition (Determined by variations in drift rate in the drift dive) to "identify the oceanographic conditions of successful foraging." They found that some elephant seals focus their foraging activity on zones with particular temperature signatures. Costa et al. (2010) correlated habitat types of Wedell seals (*Leptonychotes weddellii*), Crabeater seals (*Lobodon*

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[147] While the scientists I followed do their focal research at Año Nuevo State Reserve on Northern Elephant Seals, some members of the lab also work on Southern Elephant Seals, in Antarctica. I analyzed the data of this paper, based on fieldwork far from what I myself observed, but using the very same methods that were partially developed in the lab I observed.
[148] The seal's body is made passive in order to render the habitat readable, and therefore allow it to have active causative power in the model.

carcinophagus), and Southern Elephant seals (*Mirounga leonina*) with the properties of water masses and used these correlations to make predictions about how the habitats of these species are likely to shift with climate change. They found that southern elephant seals have a tendency to utilize deep water that wells onto the edges of the continental shelf of Antarctica. Oceanographic models predict that climate change will cause more of this circumpolar deep water intruding onto the continental shelf, forming ideal habitat for the prey of elephant seals. Thus, Costa et al. (2010) suggest the Southern Ocean is an environment that is changing in favor of elephant seals, but also state that these same changes will likely negatively impact that foraging of Crabeater and Weddell seals. This habitat characterization, and models of possible changes in the habitat of different species, are made possible by the minute attention to where elephant seal bodies gain and loose mass.

This section has examined the reading of the elephant seal's "body condition" off of the dive trajectory data. Just as in the practices of measuring the seal body on shore, passivity in the seal's at-sea behavior is crucial for the rendering of the body into its components, which allows body condition, foraging success, and a picture of pelagic habitat use to be read off of the dive trajectory data. While on shore a sling holds the seal's body in order to measure it, at sea it is the specific density of water that does this holding work. Here we can see how 'holding' is enacted differently in these two mediums, and that passivity in the sea is not a 'holding still,' but a dynamic holding that reflects the entangled lifeworlds of seal and sea, where the world does the measuring by holding the seal as it falls. But, as with the seal that lies sedated on shore, passivity alone is not enough. Rather, it is in the delicate and careful balance between activity and passivity that the reading of the seal's body is done. Rendering of the seal on shore requires a further separation: of sea from seal, made possible by the sea's edge, discussed in Chapter One. The rendering discussed in this section collapses that separation, and actually hinges one the entanglement of body and world when the seal is at sea. Yet, rendering of the seal's practices requires practices of pulling entities apart, operationalizing them, and holding them still, as in a classic ethnomethodological article on ecological fieldwork by Roth and Bowen (1999), which also focuses on practices of measurement, focusing on "seizing" and "sizing," where practices of measurement are embodied. They argue that, though "ecology is often thought of as a discipline that emphasizes the organismic and holistic view of nature," it is often the case that the animal and environment are separated in the various acts of measurement, only to be united later in the "final computer spreadsheet" (Roth & Bowen, 1999, p. 756).

Conclusion

In this chapter, I have worked with the multiple valences of "rendering," proposed by Natasha Myers in her recent study of protein crystallographers as a verb for understanding the performativity of models and scientific facts. She uses "rendering" to draw attention to models as things that are made, using the term to amplify the creativity of scientific vision, to describe how models not only represent, but also perform the molecular realm. In a syllabus for a course titled, "Rendering Life Itself," (2010) Myers points out that rendering can be a representation, an act of producing representations, a performance, and a certain set of practices of working with images in computer modeling. Yet she adds that, “heard in a different register, to render is also to tear, to rip things apart, or extract, as in rendering fat from bone, and extracting proteins, and other usable parts from animal carcasses” (Myers, 2010, p. 3).

I have sought to connect rendering as representation (and the act of making representations), to this other register, of rendering as de-composition. I have used “rendering practices” in a double sense, to name both the practices of rendering the seal’s body on shore, and the work by which her practices at sea become visible through creative and generative methods of interpreting spatial and physiological data. “Rendering practices” names the scientists’ work of *breaking bodies down*, and also acts of *making doings visible*. Rendering thus has a double meaning. In the first, it is what is done *to* the body of the seal, as the work of de-composing it, into its component materialities. In the second, it is what is done *with* that de-composed seal body: representational work that allows seals’ distant ocean doings to be traced and analyzed. *Rendering* indexes both separation and representation, while *practices* encompasses both the practices of scientists on shore, and then the practices of seals at sea.

Bringing (scientists’) *practices of rendering on shore* and the *rendering of* (seals’) *practices at sea* together highlights how these activities enable one-another, and also what they say about the kind of agency that is interposed upon the body of “the animal oceanographer.” The seal body is simultaneously objectified and subjectified. On shore, through sedative drugs, it is rendered passive, its agency temporarily suspended, so that it can assume a different form of agency at sea, and in scientists’ models and research questions. The shore practices suggest that in order to interpose the agency of the animal oceanographer onto the body of the seal, it must assume a passive state, and that passive state is crucial to interpreting the readings from the dive track data. The seal also assumes a passive state at sea that makes rendering possible, but the passive state at sea is a mobile one, a dynamic and moving passivity.

Further, there are different movements between shape and number—form and quantity—that happen in both the measuring on shore and the interpretation of the dive track data. On shore, the *shape* of the seal body—its abstraction into a “morphometric” entity—gets transformed into a *ratio* of fat and non-fat materialities. At sea, the *shape* of the dive trajectory—a line traced through space—gets transformed into a breakdown of *different activities*: including foraging, and also the resting and metabolizing activity that allows the reading of foraging “success.”

There are also different kinds of decompositions and re-compositions at play here. On shore, the body is decomposed into fat and non-fat. At sea, the body is held apart from its environment in order to make that environment readable, to see in minute detail the deep-sea fish that get integrated into the seal’s fat stores through eating. On shore, the seal is held apart from the sea in order to be weighed, held still, and thus rendered. Each of these rendering practices requires different separations, and my examination of these rendering practices suggests the crucial role played by the land-sea boundary in making them possible. The boundary allows the holding apart of seal and sea, while the reading of the dive trajectory holds them apart again in order to put them back together, to make the habitat that the seal moves through visible by following the seal's activities in it. It is through turning their animal research subjects into fully objectified, de-composed bodies, that the seal's at-sea activities become workable data objects for scientists back in the lab. Like the measuring work on shore, rendering the seal's practices at sea requires negotiating the interplay between passivity and activity, where the seal's eating and swimming practices are made visible through her moments of passivity. I have described how determining the "composition" of a living seal, the ratios of materials of which she is composed, is tenuous work, because as she is virtually de-composed through measurements, she must at the same time be kept alive. Working with seal bodies on shore thus requires careful negotiations of activity and passivity.

Further, these different modalities of decomposition and re-composition highlight the fact that not all renderings-as-separations are equivalent. Researchers' practices of rendering the seal's body as a set of materials echo the previous era of sealing, where seals were also rendered passive in order to extract their bodily materialities, that is, killed and mined for resources. Yet, unlike sealing practices, the bodily materials are knowledge resources, not natural resources transformable into monetary capital. Specific measurements taken of the sedated seal's body allow scientists to model her "body composition" without a full material (and irreversible) decomposition of that body. The mundane and repetitive work of measuring the seal's body references the reductionisms and violences of rendering as the chemical clarification of fat, and histories of marine mammal bodies as oil resources. But the rendering practices conducted by my informants on shore aim precisely *not* to kill seals, *not* to treat them as material resources, but to rather trace their movements and paths through their habitats with the overarching goal of protecting the species and the deep ocean. Through these measurements, the seal body is rendered as an object — a shape, a ratio, or a set of materials. This raises questions about what kind of a "resource" data is, and the forms of violence done to bodies in order to extract it. Yet, violences of rendering, decomposition, and separation are not the same for all renderings. Following divergent yet entangled practices and genealogies draws attention to the explicit work that my informants do to enact another separation: of their own interventions on marine mammals from subsistence hunting and industrial sealing. Despite these efforts, tracing the geneology of their methods and practices locates physiological methods on marine mammals as part of a particular and historically contingent set of inquiries that shapes the questions asked of seals today.

Perhaps the most obviously straightforward "rendering" that I have presented in this chapter is *Figure 2.9*, if rendering is to be understood as computer imaging. I presented an image of an adult female elephant seal, named M627, tracing a line through a three-dimensional ocean. Here, ship sounding and spaceship gravity sensing data is marshaled and combined to shade the ocean floor as a textured mountainscape. At the same time, a flood of numbers indexing locations, times, and depths from M627's satellite-connected sensors and recorders is recomposed as a wiggly line tracing its way through the watery realm. Here, rendering is a computer-assisted practice of making abstracted solids appear solid or three-dimensional; it is an act of turning numbers into shape. The mediated representations of what seals do in the deep ocean are produced from their dive track data, but also produced through the practices conducted on shore, the repeated measurements of the seal's body that I observed and helped to conduct by prodding, touching, and rolling elephant seal bodies on the beach.[149] Rendering is de-composition, but it is also re-composition and re-presentation, a performative practice of drawing.

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[149] Chapter 4 engages in a reflexive discussion of my ethnographic method as someone involved in the research I studied, doing the touching and helping.

Chapter Three: Engaging the Aggregate

The spatial ecologists that this project follows to the edge of the sea rely on the beach's status as a reproductive gathering for seals in order to stage the "animal oceanographer." In Chapter One, I introduced the littoral zone as a gathering and edge from which researchers—showing up in groups of four to ten in lab trucks in the early morning—coordinate their distant vision of pelagic ecosystems. In that chapter, I examined the features of the coastal edge that have shaped the specific ways that elephant seals gather and interact—both with one another, and with scientists that approach them.

Yet, these piling bodies on shore, the dense aggregations of elephant seals that haul-out at Año Nuevo—are not the epistemic focus of the physiologists, ecologists, and ocean scientists that I followed to the shore. The subjects and objects of their investigations are not seals in interaction with their conspecifics on shore, but rather individual seals as physiological input-output entities, gaining and losing mass as they move through the deep ocean. In Chapter Two, I closely examined how researchers interact with the individual seal on shore after she has been separated out from her conspecifics and sedated. There, I examined the forms of equipment-mediated vision and bodily practice involved in perceiving and interacting with elephant seal bodies as physiological entities, of reading flesh hauled ashore to interpret movements and activities in the deep ocean.

Despite the fact that on-shore social behavior is not the subject of their research, my informants know a great many things about the social behavior of seals on shore: from their deep natural historical knowledge of their organism of study, through conversations in the field, lab meetings, and interdisciplinary collaborations with pinniped researchers who focus on animal behavior, and through their own practical negotiations with gregarious formations of elephant seals on the beach in order to produce “the animal oceanographer.” Rather than an object of their knowledge practices, the forms, shapes, and arrangements that seal bodies gather in on shore are an entity that they must practically contend with *in order to produce* their research object. Researchers’ interactions with the aggregate are thus not guided by the production of experimental or observational knowledges in the methods of animal behavior research. Rather, they are pragmatic, vernacular, responsive to idiosyncratic situational differences, and involve skillful bodily negotiations.

In this chapter, I turn to a discussion of how my informants approach, perceive, and negotiate the aggregate formations of female elephant seals. I draw out their vernacular knowledges of gregarious female elephant seals on shore—knowledges that are evident in, and produced through, these practical interactions with a peculiar form of nonhuman sociality. Through doing this, I propose tools for attending to groups of female elephant seals that see their aggregate formations as neither easily reducible to the analytic of individuals, nor controlled or structured by the male dominance hierarchy—and its framings of agency, action, and interaction—that the oft-used behavioral ecology term “harem” names. In order to examine these vernacular knowledges of animal behavior, I revive terms and attunements from early inquiries into elephant seal sociality—terms and attunements no longer present in the disciplinary vocabularies of biobehavioral studies of elephant seals. In particular, I dig into the pre-history of the term "harem" in behavioral research about elephant seals, and revive an alternative term, "pod," which doesn't carry the problems of "harem" of figuring in advance the kind of sociality encountered as hierarchical. Rather, I suggest how it provides openings to consider and cultivate curiosities about the gregarious sociality of female elephant seals encountered in the field. By noticing and drawing out my informants' vernacular knowledges with this descriptive attunement, I aim to put older traditions of descriptive methods in conversation with the descriptive attunements I cultivate in this dissertation—which include embodied interaction studies, combined with reflexive attention to recording and rendering through a feminist technoscience approach.

While my informants seek to undo the pod in order to draw out and produce the individual seals that are their research subjects, I contend that their skillful negotiations reveal vernacular knowledges of these corporeal arrangements. I thus highlight science's vernacular knowledges not only to draw attention to how scientific facts are produced, but also to draw attention to complexities that knowledge production erases. I note these erasures as a space from which questions can be asked, in both STS and in the scientific fields that STS critiques. This approach is aligned with the feminist tradition of envisioning "successor science projects," an approach in feminist standpoint epistemology developed by STS scholars including Sandra Harding in the 1980s

(Harding, 1986, 1987). As well, I introduce a tactic that I call, borrowing from Natasha Myers (2015), "amplification." By using this approach, I extend the earlier tradition of paying attention to how knowledge traditions are produced while asking how critique might alter their course. My contribution is to suggest methods for using STS critiques to amplify routes for doing scientific practice otherwise.

The chapter thus makes two contributions. First, it constitutes a review of feminist biology's critical engagements—as well as feminist STS critiques of biology—published in the 1980s and 1990s. Using critiques of the biobehavioral sciences' use of the term "harem," I examine both the content of these engagements, as well as the forms of response that emerge from them. Noting the feminist strategies of "interruption," "inversion," and "amplification," I then turn to earlier terms used to describe the social forms of elephant seals, and revive the term "pod" from 1960s behavioral science papers. In this way, I engage feminist biology and feminist critiques of biology in the spirit of not only conducting critique, but also asking what comes after it.[150] Second, I offer an empirical analysis of my informants' embodied practices with aggregates of elephant seals. In this analysis, I pay close attention to conversation, gesture, and how action is coordinated, in order to trace embodied vernacular knowledges and how they are made in practice. From the feminist projects and interventions in biology I review here, I seek a method for doing empirical analysis that responds to the conceptual absences brought to attention by discursive critique.

[150] A related problematic is outlined in Latour (2004b).

Conversely, I see discursive critique as key to highlighting what is implicitly foregrounded in empirical analyses, and I aim to provide suggestions for how we might direct our attunements differently.

The Procedure and Its Transformations

Figure 3.1: A seal "post-procedure," outfitted as "animal oceanographer." Image by Natalie Forssman. Año Nuevo, 2014.

The above image presents a female elephant seal that has just been outfitted as an "animal oceanographer," the end point of the on-shore rendering practices described in the previous chapter. A large device is glued to the top of her head with epoxy. This device, designed by the Sea Mammal Research Unit in Scotland can withstand the incredible pressure a mile under the ocean's surface. It measures temperature, salinity, and water depth, and relays its GPS coordinates to ARGOS satellites, which are part of a worldwide environmental data system. This device will begin to record and transmit a flood of data when she drags herself down to the tideline and dives under the surface of the ocean, beginning her long foraging migration. As described in the previous chapter, her body has been prodded and measured in repeating patterns from head to ankles, providing data that characterizes her as an individual physiological entity: with energy reserves that are modulated by inputs and outputs, and with movement trajectories that can be understood in terms of these energy reserves.

But this chapter draws attention away from the ocean depths this animal cyborg is now equipped to sample, away from the seal's physiological body, and away from the seal as an atomized individual. I investigate the moments that come prior to the measurements, attachments, and forms of vision described in Chapter 2, by following the body-work through which the "animal oceanographer"—who lies physically, socially, and epistemically apart from her conspecifics—is produced out of the gregarious aggregate of female elephant seals on shore. Traces in the sand attest to this work and the many movements that have transpired within the camera's wide curved frame.[151] These traces are clues to the labor required to turn this animal into an individualized ocean-going and data-gathering entity. The long lines scratched near the

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[151] This image, and the other photographs this chapter, are screen grabs from my own technology of capture, a GoPro HERO3 body-mounted camera. I leave in the artifacts of this capture, including the curvature produced by the wide-angle lens, in order to always draw attention to the mediations of my own representational and tracing technologies, which I discuss further, and place in conversation with my informants' tooling, in Chapter 4.

bottom right corner of the image are the transitory inscriptions left by flippers as seals move their amphibious bodies around the beach, traces of a graceful aquatic body that becomes bumbling and bulky on shore. The dappled footprints near the bottom left are marks left not by seal flippers dragging, but by many human feet stepping. The most obvious marks in the sand, though, are the large semi-circular indentation in front of the seal, an indentation left by her own body only minutes ago, right before she was rolled over into a large red polyester sheet, allowing us to hoist and weigh her. Around this marking is a pattern of small but deep depressions, traces left by scientists' knees and feet as they squatted and kneeled around her. Near this seal that has just been ascribed the epistemic job of "animal oceanographer," other female elephant seals lie, seeming to barely notice this transformation of their conspecific into an object of knowledge.[152] She is positioned apart from them, although within hours she will find her way back into this warm thermoregulating pile.

"The procedure" is my informants' term for the overall arc of their work with a four-digit numbered seal on the beach, the set of operations that turn her from a seal among thousands to a measured, sampled, and outfitted "animal oceanographer."[153] Largely, the procedure can be divided into two stages: before the animal is sedated, and after. The "after" stage involves the up-close tactile contact described and analyzed in

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[152] I use the term "objects of knowledge" in the sense of Charles Goodwin (1994), and others in STS, including Donna Haraway (1989). Goodwin shows through a variety of detailed examples how the object of knowledge emerges through an interplay between a "domain of scrutiny" and "discursive practices" that highlight and code that domain into relevant events.

[153] As discussed in Chapter 1, although my informants sometimes attach their devices to male elephant seals, the vast majority of their research subjects are adult females.

Chapter 2, while the "before" stage involves the scheming, planning and anticipating, and coordinated collaborative body-work required to approach her from afar, sedate her, and move seals away from the area around her body, separating her from her conspecifics and providing the temporary stable substrate upon which lab-like bodily interventions can be performed, the "physiology in the wild" described in Chapter 2. These "before" and "after" stages can be also understood as requiring work with two very different entities: in the second stage, researchers deal with an individual animal, and investigate her "body composition" through acts of measuring, prodding, imaging, and sampling at its surface. In the first stage, however, the researchers deal with the gregarious groupings and gatherings of female elephant seals in close contact with one another, bodies piled in such close contact that they need to be approached and interacted with not as individuals, but as an aggregate entity: a shifting, multi-headed hydra where vision, tactile contact, and kinesthetic movement are distributed in strange arrangements.

Researchers begin by selecting an animal ("the target animal") to draw out of the group, either to detach devices from ("a recovery") or attach devices to ("a deployment"). They decide whether and how to perform their intervention based upon where she lies with respect to her conspecifics ("if she's in a good position"). Then, they plan their approach towards the aggregation of seals in order to sedate their chosen candidate ("doing the initial"), based on embodied and vernacular knowledges of how the group will move and respond. After doing the "initial stick" with saline and sedative drugs, researchers retreat from the pod and closely observe their research subject, watching for signs that she is breathing well as she becomes sufficiently sedate. Then, they re-approach her, carrying the tools for gluing, clipping, measuring, weighing, sampling, and tagging her body. In order to create a stable platform for work on and around her, they “move” and “back up” surrounding seals, and then begin the physiologically focused interventions discussed in the chapter that precedes this one.

Through the work of this first stage of the procedure, an animal oceanographer is produced from the gregarious gathering of seals; an atomized body that can be delegated as a data-gathering entity is coaxed out of a shifting and amorphous formation of hundreds of bodies piled in close quarters. The procedure effects material transformations from group sociality to individualized body, as well as discursive transformations, evident in the language of my informants. Prior to the procedure, this seal is referred to as “the target animal,” displaying an association of “the procedure” with jargons of techno-militaristic strategizing and reconnaissance, where acts of control through techniques of surprise and capture are spatially and temporally coordinated. But, after the procedure, she is “our girl.” The intimacy of sedating her and performing painful interventions renders her vulnerable and subject to care, transforming her into a familiar. But even with this language of care and intimacy, these operations transform her into a knowledge delegate, asking her to perform a kind of bodily labor. She is now a “seal oceanographer,” a partner and collaborator in data gathering.

Disaggregating the Aggregate and Becoming-aggregate

Figure 3.2: Reading flipper tags with binoculars allows researchers to see the small numbers printed on the plastic tags. Image by Natalie Forssman. Año Nuevo, 2014.

Even the practice of reading flipper tags—arguably one of the simplest operations of apprehending female elephant seals as individuals—involves approaching them as an aggregation of closely packed bodies, and coaxing the individual out, turning her into the kind of entity representable in a spreadsheet cell. This practical work with aggregations of bodies, where vision and tactile contact are distributed across and between bodies, in turn involves distributed body-work on the part of the researchers, who work together by moving, crouching, waving arms, and gently irritating the seals in order to temporarily tease the aggregate entity apart.

On a fieldwork trip to Año Nuevo in early June 2014, during the molt, I observed Rachel and Julie, two old-timer researchers, working together to read the plastic flipper tag off a female elephant seal that was piled amidst five other female adult seals, all about the same size and length as her.[154] These seals were lying in the dense mats of seaweed that form spongy hills along the tideline on the south side of Point Año Nuevo. Because this was a gathering of only five animals, positioned somewhat apart from other similar clumps of bodies, it was possible for them to fully circle the group. The animals lay in an alternating formation, so that some hind flippers lay near heads of other animals, and vice-versa. Rachel and Julie worked together, placing themselves on opposite sides of the formation. Rachel worked by waving a hand near two heads, which instigated those necks to move, and the hind-flippers to flick back and twitch a little. This shifting of weight and body parts caused the head lying near that first animal's flippers to likewise move, reverberating motion back towards Rachel, along the body of the second seal, all the way back to her flipper, which repositioned their arrangement slightly, just enough so that the plastic tag pierced through left flipper, displaying four inky digits, worn by sand, salt, and time, to just barely and just for a moment become visible.

The improvisational choreography between these two researchers and five seals was impressive to watch. Well-attuned to the dynamics of how movements and disturbances travel among and between bodies, the two researchers coaxed this small formation of female elephant seals into the shape they required in order to extract needed data from them. Their work with the seals was a demonstration of skilled

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[154] I use the terms "old-timer" and "newcomer" from Lave and Wenger (1991), whose influential study of situated learning emphasizes the need to attend to diverse "biographies" of participation in communities of practice. The terms, they insist, point to richly diverse fields of actors and forms of participation that the "teacher/learner dyad" does not encompass. Unlike theirs, my study is not focused on these "biographies," yet I recognize the utility of these terms to point to learning as process.

knowledges of how seals move together as an aggregate entity, where sense and movement travel strangely—not through the nervous system of a single mammalian body, but along the edges between bodies closely packed together. The most effective way to instigate the movement of the flipper of one animal, these old-timer researchers know, might be to make the head of another shift its position. Rachel and Julie accomplished this by themselves embodying a fluid sociality, an intimate co-production of how they moved their bodies with one-another, and coordinated co-produced action. The dynamic of researchers working together, in this case to read a tag, is a process of coaxing the formation of seal bodies into a temporary shape that elicits data.

Definitional Engagements with the Aggregate: "Harems" and "Pods"

As the above vignette illustrates, the techniques used by my informants to approach and temporarily disaggregate gregarious groups of female elephant seals exceed an atomized ontology of individuals. In their vernacular and embodied knowledges of approaching these formations, researchers bring to their pragmatic tasks an understanding of how the edges between bodies are distributed, and change in interaction.[155] Yet, the behavioral ecological terminologies for naming groups of

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[155] In this chapter, I frame these attunements as an interest in *form*. In their discussion of the term "life form" from the German *Lebensform*, Helmreich and Roosth (2010), like other historians of science (Lenoir, 1980; Nyhart, 1995; Steigerwald & Fairbairn, 2000; Richards, 2010) trace interests in form and morphology to German romantic biology, and from the combined influences of Goethe and Humbolt find a dual interest in form as an aesthetic interest in nature's pure forms, and a manifestation of habit and habitation—the medium and material circumstances of growth and development (Helmreich & Roosth, 2010, p. 32-33). D'Arcy Wentworth Thompson's mathematic studies of growth and form are a different example of how an interest in form has been taken up in biology (Thompson, 1917). The move away from questions of form has often been framed as a move from "descriptive to mechanistic phases" in biology and ecology (Dayton & Sala, 2001, p. 201). However, Nyhart (1996) argues that dominant

elephant seals do not do justice to the nuance of their practices with aggregates of elephant seal bodies. The standard term used for these formations is “harem,” a name with a contentious history. In Chapter One, I bracketed some of the discursive critiques of the “harem” concept that have been articulated by feminist biologists since the 1970s (Lancaster, 1975; Callan, 1978; Haraway, 1978, 1981, 1989; Keller, 1982; Dagg, 1983). I pick up that thread here.

Feminist criticisms of the “harem” as a descriptive term for animal sociality were of course indebted to postcolonial criticisms of imperialism.[156] This criticism was not lost on feminist biologists and STS scholars during the 1970s and 1980ss, when this term’s use in primatology and other studies of animal behavior—including the study of seals—came to light. It became a central example in debates of the 1980s and 1990s about how the female is figured in biological theories and explanations. Feminist biologists and STS scholars framed the concept both as a problem for women, and a problem for science (Keller, 1982). Criticisms of the concept of the harem as a description for animal social formations were entangled, during that period, with efforts to unveil the covert strains of anthropomorphism, sexism, and colonialism in biobehavioral terminologies for sociality. In this section, I briefly touch upon key points

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historical narratives about the move from natural history to experimental biology—where morphology and natural history were cast as “merely descriptive and non-explanatory” (Nyhart, 1996, p. 432) at the end of the 19th century erases the ways that certain parts of what was formerly known as “natural history” were co-opted into the ‘new’ biology, including life history studies. While I cannot do justice to the complex histories of form, shape, and descriptive inquiry in biology, ecology, and natural history, this chapter does trace the disappearance of certain descriptive inquires, and aims to revive their attunements in my analysis of my empirical materials.

[156] For early postcolonial critiques, see Said (1978), Wolf (1982), Spivak (1988), and Stoler (1989).

in these controversies in order to situate this chapter's aim: to make an intervention into terminologies and attunements for describing the aggregate sociality of female elephant seals. The feminist biologist debates about the harem concept are important because they highlight the figurings of agency and action that underlie descriptions of sociality. They also matter because of the strategies and forms of engagement that emerged through these debates for change within biological research practice. Rather than only launching critiques of terms and methods, feminist projects in biology have forged diverse tools that push and enable the biobehavioral sciences to become more nuanced and reflexive by asking better empirical questions and interrogating taken-for-granted assumptions, including enlightenment visions of epistemology (Harding, 1986).

The Problems with "Harem"

The sociality of pinnipeds on shore is an interactional and spatial arrangement that has long intrigued sailors, sealers, and zoologists. As discussed in Chapter 1, Charles Darwin (1871) noted the extraordinary polygyny and behavioral and morphological differences between males and females in the marine Carnivora (seals, sea lions, and walruses), noting how starkly different these species' corporeal and social organization is from the terrestrial Carnivora (cats, dogs, bears, hyenas, weasels, badgers, and others). Chapter 1 examined behavioral ecological and historical ecological theories that situate the exceptional form of pinniped life on shore in the specificities of habitat or ecology. First, I discussed elephant seals' amphibious habit of living across the land-sea edge, and the behavioral ecological dependencies and constraints that dual habitat produces (Bartholomew, 1970). Then, I looked at the historical ecological evidence of their tendency, until recently, to haul-out on remote offshore islands (Rick et al., 2011). Finally, I considered the unique visual openness of the coastal landscape in which they conduct mating activities, which may afford particular forms of interspecies monitoring and control (Rowell, 1987). In marshaling these accounts and theories together, I sought to follow and build upon the important work of Thelma Rowell (1987; see also Despret, 2005, 2008b) in situating the specificities of both animal sociality and the kind of questions ask-able about particular organisms in the specific material and interactional features of site, landscape, and ecology. Situating knowledge production in the openings and constraints made available by particular "ecologies of practice," I argued there, is crucial in resisting the universalizing moves of a sociobiology that would see the social forms of nonhumans as models for interpreting or naturalizing certain modes of human social relation.

The concept of the harem has been critiqued by feminist biologists, who have seen it not as a natural fact, but as a discourse about the dynamics that govern social relations situated in Western traditions of scarcity economics, and entangled with racist and sexist discourses. These scholars have traced the historical co-constitution of observations of nonhuman sociality with orientalist fascinations and persistent cultural conceptions of females as passive and receptive to the schemes and rearrangements of males. Thus, the use of the concept of the "harem" in the natural and evolutionary sciences was not simply the appropriation of a sociopolitical term into the sciences. As Bharj and Hegarty (2015) point out, the concept has intertwined histories in colonial and evolutionary psychology discourse, and in sexist and racist projects. They historically situate the "whole portmanteau of *Arabian Nights* associations" in the "popular European conception of human harem polygyny that is likely to be in the back of the mind of the biologist" (Rowell, 1987, p. 650-51).[157] Bharj and Hegarty's analysis deftly teases out the complex entanglements of justifications of colonialism with western practices that sought to objectify women both as "hyper-sexual fantasies" and as damsels in distress in need of liberation by "white saviors":

> The harem was constructed by Western authors in two ways. First, it was stereotyped as a space of absolute oppression, in which women were entirely disempowered and objectified, to validate representations of the Middle East as less 'civilized' than the West and implicitly justify European colonial intervention. Second, the harem figured in hyper-sexualized fantasies, conjuring images of enslaved, scantily clad women who were readily available sexual objects for men … Stereotypic representations of the harem implied the rigid control of women by men, who in turn were subjected to the stereotype of Muslim Arab men as vulgar, oppressive, and savage 'Terrible Turks.' … The 'Terrible Turk' stereotype retained its association with violence, but this violence was directed purely at women, allowing for 'white savior' narratives to uphold colonial ventures as 'civilizing missions' and reconstruct Western men's sexual objectification of Muslim women as a mechanism of liberation. (Bharj & Hegarty, 2015, p. 259-60)

As Bharj and Hegarty note, it was the early and influential primatologist Solly Zuckerman (1932) that popularized the term "harem" for animal societies, though the 1833 account that describes the sailor's description of the male seal as "the jealous and despotic master of a Turkish harem," quoted at more length in Chapter 1, locates this association much earlier in natural historic and zoological discourses ("The proboscis-seal, or sea-elephant," 1833, p. 152). In *The Social Life of Monkeys and Apes* (1932),

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[157] The concept was critiqued as an invalid analogy with non-Western human political and economic institutions that were anyhow misunderstood, as I noted in Chapter 1 with reference to Thelma Rowell's (1987) discussion.

Zuckerman describes “the harem” as “a system in which every adult male attempts to secure for himself as many females as possible” (Zuckerman, 1932, p. 190-191, quoted in Bharj & Hegarty, 2015).

In the 1980s and 1990s, there was fierce debate among feminists, biologists, and feminist biologists about the metaphors and assumptions that ground sociobiological or behavioral ecological reasoning. The concept of the “harem” to describe groups of primates or other animals was frequently used as a particularly loaded example in these debates. Feminist biologists, many of them primatologists themselves, critiqued the concept of the harem for assuming female passivity in these arrangements, and in so-doing, pre-settling the question of how agency and sociality is distributed.[158] As Thelma Rowell succinctly puts it, the concept gives the “impression of helpless females of many species being won by heavily armed males” (Rowell, 1987, p. 649). This focus on aggression, dominance, and armament is what Donna Haraway, in her histories of early animal science, calls “a political physiology of dominance” (Haraway, 1978), where male dominance came to be a key explanatory term in animal science, naturalizing systems of economic or sexual dominance among humans. As Hoquet (2010) points out in a review article on the decades-long conversations and arguments between behavioral ecology and feminism, primatologist Sarah Hrdy’s *The Woman That Never Evolved*

[158] Bruno Latour’s work at this time aimed a similar critique at the discipline of sociology for assuming it already knew what “sociality” was, rather than making that the guiding question of the discipline. This argument is summarized in *Reassembling the Social* (2005). Latour was also part of the debates that circled around feminist critiques, primatology, and the science wars. With primatologist Shirley Strum (Latour & Strum, 1986; Strum & Latour, 1987), he authored articles about how primate behavior data challenges “existing ideas about the nature of society and the social link” (Strum & Latour, 1987, p. 783).

(1981) was a key text in these debates, for pointing out how the Darwinian theory of sexual selection—with its focus on male competition and female choice—has seen only male characteristics as having evolved. By focusing on the specialized armaments of males to fight each-other and win females, behavioral ecologists didn't take up female behavior and morphology as an explicit topic of interest. In addition, as Hoquet points out, feminists critiqued in a more expansive sense the "hyper-capitalistic conceptual framework [of behavioral ecology], where the biopolitics of reproduction is finally reduced to competition," and where "the very concept of 'resource' could thus be accused of bringing mating down to reproductive success" (Hoquet, 2010, p. 121).

Historian of biology Erika Milam provides a history of the theory of sexual selection in evolutionary biology. While the main thread of her (2010) argument is that changing conceptions of animals' minds—and the growing field of animal cognitive science—influenced the scientific community's receptiveness to sexual selection as a theory, she also tells the story of "female choice" as an emergent question in studies of animal behavior, a story that is tied up with feminist critiques of the life sciences, where females were depicted as "coy," and males as "aggressive" (Milam, 2012). The figuring of female animals as passive, a persistent Western cultural conception mapped onto animal sociality, goes even down to the issue of the difference in size between male and female reproductive cells (sperm and egg), where female cells are given the characteristics of being "conserving in energy, more passive, [and] vegetative," while male cells have "shorter life, greater activity, [and] smaller size" (Hoquet, 2010, in reference to Geddes & Thomson, 1889; for a critique see for example Tuana, 1988).

Feminist Strategies

The above section outlined the important critiques of the framing of the female in biology, which were brought to the fore in the 1980s and 1990s. This section examines feminist strategies of responding to critique or asking what comes after it. I aim to take from these critiques lessons about the form that critique can take. In particular, I draw out different strategies of feminist response: interruption, inversion, and amplification.

What have been some responses to this persistent assumption of female passivity within evolutionary biology? Several biologists oriented to feminist concerns have made it their project to look for interruptions within the concept, with varying levels of commitment to interrupting its core conceptual apparatus and assumptions. Despite varying levels of critical engagement, they share a project of *interrupting* some of the assumptions of the theory by searching for empirical contradictions. Sarah Mesnick, in her studies of the mating behavior of northern elephant seals (Mesnick & Le Boeuf, 1991; Mesnick, 1997), takes as assumption that male aggression constrains female mating behavior, and looks at how "female elephant seals behave in a number of ways that reduce their vulnerability to male aggression" (Mesnick, 1997, p. 234). She examines alliances that females form with "protective males" as a response to "sexual aggression," naming her hypothesis that these alliances are adaptive the "bodyguard hypothesis." She thus seeks evidence of and evolutionary explanations for female activity in an arrangement where they have been assumed passive. In closely following the dynamics of how the female coordinates her move to the shore by actively seeking the protection of particular males, this is a project of "documenting female counterstrategies" (Mesnick & Le Boeuf, 1991). In a similar vein, Cathleen Cox's work on sexual selection in elephant seals (Cox & Le Boeuf, 1977) looked at "female choice" in sexual selection, the mechanism in addition to "male competition" in Darwin's theory that many have pointed out has been understudied.[159] They state that, while "investigators have tended to emphasize positive responses of the female as an indication of choice, i.e. moving toward the male or soliciting him," their study looks at how female elephant seals "incite males to compete." While both of these studies seek to interrupt the assumptions of the "harem" concept and its concordant implications of female passivity by looking closely at females, their variables for following female agency or activity can still be seen as impoverished: Mesnick looks at how females solicit males to "protect" them, while Cox's metric is a quantification of the level to which females "protest copulatory attempts."

Zoologist Anne Innis Dagg, the first scientist to study giraffes in the wild, makes a stronger case against the harem concept in her bold-titled book, *Harems and Other Horrors: Sexual Bias in Behavioral Biology* (1983). She insists that, "it is as if a Martian came to this world and called a group of women and one man waiting at a bus stop a 'harem'" (Dagg, 1983, p. 20). Providing examples of how close observation of Ugandan antelope, red deer, Hooker's sea lions, and Steller sea lions have "shown [the word 'harem'] to be inaccurate in almost all the species in which it has been used," she

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[159] Cox and Le Boeuf (1977) cite Ghiselin (1974) for pointing out the dearth of studies on sexual selection. See Milam (2010) for a history of science analysis of why sexual selection was long given less attention than natural section. Her book is discussed briefly above.

pleads "that zoologists would apply it with extreme care" (Dagg, 1983, p. 24). Yet, she finds this to not be the case, and points out various cases in which "the propaganda continues" (Dagg, 1983, p. 26). In a similar bold rejection of the harem and its assumptions, primatologist Jane Lancaster experiments with a different apparatus for viewing what a single-male troop of animals could be interpreted as being, by performing an *inversion* of the taken-for-granted mapping of male as active and female as passive in the harem structure. Instead, she takes its opposite as assumption, drawing attention to how deeply underlying assumptions infiltrate descriptions:

> For a female, males are a resource in her environment which she may use to further the survival of herself and her offspring. If environmental conditions are such that the male role can be minimal, a one-male group is likely. Only one male is necessary for a group of females if his only role is to impregnate them. (Lancaster, 1975, quoted in Keller, 1982)

In a deceptively simple move, Lancaster fully switches the places of who is active and who is passive in her description, drawing attention to the forceful work implicit framings of agency do, while opening up the possibility of considering nonhuman mating systems under a very different arrangement of power and agency.[160] We can imagine Lancaster approaching the primates she studies with counter-assumption in mind, and seeing very different social dynamics than she would otherwise notice under the guiding frame of the harem.

I have drawn out the work that these descriptive terms for animal sociality do in order to suggest the importance of not only noticing terminologies in order to trace their

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[160] The technique of "inversion" can be compared to the feminist practices of "reading against the grain" and searching for "fractures" (Philip, 2004) or "reading athwart" (Hustak & Myers, 2013).

historical associations, but also as a forward-looking move—to ask what other kinds of inquiry are opened when terms are shifted or redone. In this sense, my inquiry in the remainder of the chapter is slightly different from what I have reviewed so far. While the response to the dominant framing of seal sociality as a “harem” has been to re-examine the interactions between males and females and characterize them otherwise, in this chapter I instead aim to examine interactions *among females*. Observers of elephant seal sociality are quick to note that females group in aggregations, but beyond asking what happens when females leave these groups and are subject to the “copulation attempts” of males, there has been a paucity of questions asked about what happens within these groups. There are a few notable exceptions. Christenson and Le Boeuf’s (1978) paper, “Aggression in the Female Northern Elephant Seal,” examines “the interfemale encounter,” but the unit of their inquiry is nevertheless largely constrained to the dyads of mother-pup pairs. In that article, Christenson and Le Boeuf corroborate and build upon many of the findings of Bartholomew and Collias (1962), another notable paper. In that paper on “The role of vocalization in the social behaviour of the northern elephant seal,” the authors used markings to identify female elephant seals, and then following their interactions and movements with respect to one-another over time. This paper, with only a few others, could be said to pass the popular “Bechdel test,” a criteria for evaluating works of fiction (mostly often applied to films) which "asks whether a work of fiction features at least two women or girls who talk to each other about something other than a man or a boy."[161]

Amplifying the "Pod"

In light of the deficiency of inquiries into elephant seal sociality among females and in aggregate, I would like to propose a final feminist strategy, one I work with for the remainder of this chapter: *amplification*. This is a strategy articulated in both Eduardo Kohn (2013) and Natasha Myers' (2015) recent ethnographic monographs, yet it also echoes earlier "successor science" projects (Harding, 1986, 1987). Myers flags her empirical accounts as non-neutral and "aspirational," with the explicit goal of "chang[ing] what we think science is and what it could become" (Myers, 2015, p. 8). She works by "amplifying a range of [tacit] practices that are otherwise muted, overlooked or even disavowed" (Myers, 2015, p. 8).[162] Kohn (2013) calls his approach, from Ghassan Hage (2012), an "alter-politics," which he defines as "a politics that grows not from opposition to or critique of our current systems but one that grows from attention to another way of being" (Kohn, 2013, p. 14).

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[161] Alison Bechdel credits the idea to a friend, Liz Wallace, and also to the writings of Virginia Woolf. ("Bechdel test," n.d.)

[162] A longer version of Myers approach to amplification and writing about science is as follows: "I am no neutral observer of science. … This is an aspirational account: in response to descriptions that tend to flatten both scientists' practices and the stuff of life, this ethnography attempts to render life and science in ways that might change what we think science is and what it could become. My intervention works by *amplifying* [emphasis added] a range of practices that are otherwise muted, overlooked or even disavowed. These are practices that remain tacit among scientists, or are otherwise not readily perceptible to observers of science…. [T]he aim is … shifting perceptions of scientific practice in a way that may change the questions we ask about life, matter, and forms of knowing" (Myers, 2015, p. 8).

Amplification, as a strategy for working with our empirical materials and doing scholarship, aims to respond to critique with propositions that imagine and describe otherwise.[163] I go about amplification in the remainder of this chapter by looking for alternative framings of female elephant seal sociality in the pre-history of the term "harem," or in instances of its use, that, despite using the term, don't necessarily focus on interactions between females and males, and reviving the term "pod." In one of the earliest papers published on northern elephant seals at Año Nuevo, there resides the modest potential for a different kind of inquiry into the sociality of the seal rookery, a path largely not taken in academic research on seal behavior and interaction to date. The paper that I use to guide my vocabulary and attunements is "A Note on Retrieval and Recognition of Young in the Elephant Seal, *Mirounga angustirostris*," by Peter H. Klopfer and Barrie K. Gilbert, published in the German journal of Animal Psychology in 1966. The declared goal of this paper is not to present a radically different way of looking at elephant seals. Rather, this paper is a small entry in studying the relations between adult females and pups, and how these relations might be a function of the observer.

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[163] On "propositions" and "articulations," see Latour (2000, 2004a) and Despret (2004, 2005, 2008a). In their conversations with animal breeders, Jocelyne Porcher and Vincianne Despret asked the breeders to help them construct their questions, by asking the question, "how do you think I should construct my question so that it has a chance of being understood and of being interesting?" (Despret, 2008a, p. 132). This is an approach to amplification that takes place *within* the fieldwork encounter, where the "interests" of the researchers are made explicit to those being questioned. Despret extends this approach to a method of asking animals more interesting questions as well (Despret, 2004, 2005). A shortcoming to my own approach to amplification is that my interest in "amplifying the pod" emerged after my fieldwork. In future ethnographic engagements, I hope to experiment more directly with Despret's technique.

While their stated focus is the mother-pup dyad, Klopfer and Gilbert's way of attending to adult females and their pups employs an analytic and set of attunements that considers much more than one-on-one interactions. They use the terms "clumps" and "pods" to describe aggregations of female elephant seals, rather than "harems."[164]

More than a difference in what the term technically encapsulates, I want to draw how Klopfer and Gilbert use the attunements provided by this term to draw attention to the spatial, temporal, and morphological dynamics of groups of female elephant seals on shore. The following description of the formations of female elephant seals on shore opens their paper, under the heading "Spatial Distribution":

> On any one beach the cows were distributed in clumps ("pods") … on the beaches. When first approached, some pods were composed of animals aligned in pairs that almost touched, while other pods had peripheral animals dispersed as much as 10 meters from one another. Pups appeared to be so located that an alien cow would not be able to touch them without moving a body length or so. In undisturbed groups there was relatively little movement. In contrast, the approach of an observer resulted in a compression of the pod. The peripheral cows with pups gradually moved closer to the centrum, and centrally placed cows also moved more closely together, so that they nearly touched one another. At this point, pups would lie as closely to alien [females] as to their own mothers. These changes in the distribution of animals persisted for hours even after the observers withdrew. (Klopfer & Gilbert, 1966, p. 758)

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[164] It is important to note that "pod" is a term these authors use for female-only aggregations of elephant seals, while "harem" is often used to describe the structure of relations *between* the sexes. However, this is not always the case, in later papers scientists often use "harem" to describe female-only aggregations as well. Le Bouef's (1972) article, "Sexual Behavior in the Northern Elephant Seal" is often cited as the paradigmatic paper on relations between the sexes in northern elephant seals. The three instances where Le Boeuf uses "pod" in that paper name female-only aggregations, and for the rest of the paper he uses "harem."

In the above description, Klopfer and Gilbert discuss the *form* of the pod, attending to how the pod is spatially and interactionally composed, the relations between bodies within the pod, and the alignment of mothers, pups, and females without pups with respect to one another. Rather than implying a haphazard arrangement of female elephant seals structured by the male dominance hierarchy, they notice the differences at its centre and edges, and how the overall entity responds to disturbance. They note where pups are located relative to adult females, whether bodies touched or were at a distance from one another, and the different spatial dynamics in the center versus the periphery of the pod.

They also discuss the pod as a *unit of behaviour*, with both internal and external dynamics. According to their observations, aggression between individuals within the pod is an emergent outcome of the size and density of the pod. Consistent with attending to the pod as an emergent form in its own right, they attend to *how action moves through the pod*:

> Threats and bites were most frequent following disturbance created by our activities. It appeared that chains of disturbances were often set off by cows backing into the pod and thereby coming closer to the pups of other cows. The latter cows responded quickly with vocal challenges. (Klopfer & Gilbert, 1966, p. 759)

They also discuss *heterogeneity within* the pod, so that individuals in the pod are not understood as identical 'subunits,' but rather as having different modalities of contributing to the overall form. They notice how aggression is distributed both spatially and according to whether cows are with or without pups:

> During an observation period of two hours and seven minutes, fifteen female-female agonistic [sic] interactions were recorded, thirteen of

> which involved threats or bites by a cow with pup towards a cow without a pup. This is an especially convincing difference if one considers the disparity in the number of cows with and without pups. … The cows without pups were very active in moving about the periphery of the pod, appearing to be making attempts to "break in." (Klopfer & Gilbert, 1966, p. 758)

While the question of Klopfer and Gilbert's article is the extent to which adult elephant seals can recognize and re-unite with their own pup, the descriptions above suggest that the scales of behavior that the researchers used to watch and analyze this activity are actively interested in the pod as an emergent social form. This stands in strong contrast to the contemporary paucity of peer-reviewed articles on elephant seal behavior interested in these dynamics.

Pod and harem are tools for attuning differently. Embedded in Klopfer and Gilbert's use of the term is an interest in describing the dynamics of female-only aggregations, and how they respond to external disturbance, both at the level of the individual and at the level of the aggregate social form. Furthermore, these terms have a *morphological* interest in these formations—an interest in *shape*. Attention to the spatial distributions, the gaps between individuals and how they expand and compress, the relations among individuals measured in body lengths, the differences between activities in the center of the pod and the periphery, and how chains of disturbances move and how long they persist, all display an attention to the *form* of interactions. While counting interactions is also part of their inquiry (such as noting the number of females with and without pups and their differentials in aggressive interactions), theirs is at heart a descriptive enterprise attendant to form.

Yet, this interest in the pod in terms of shape, form, and description is decreasingly present in later publications. The term slowly but surely drops out of use. Rasa (1971) uses “pod” in her study of social interaction and object manipulation in weaned pups, but then Le Boeuf (1972) uses the term “harem,” defining it from Laws (1956), a scientific report on southern elephant seal social and reproductive behavior that appears to be canonical in settling the issue of how to name and empirically approach groups of elephant seals on shore. Yet, perhaps ironically, even though Laws’ paper can be credited with inserting “harem” into the technical jargon of describing elephant seal natural history, some of the descriptive interest in shape that I have identified in the attunements of the pod persists in his study. This further emphasizes my point that rather than being merely a *term*, observing in terms of “pods” is a way of noticing, describing, and engaging the aggregate. In the images below, Laws traces the establishment of two rookeries over several weeks, using marked animals to follow how pods form, move, split, and merge.

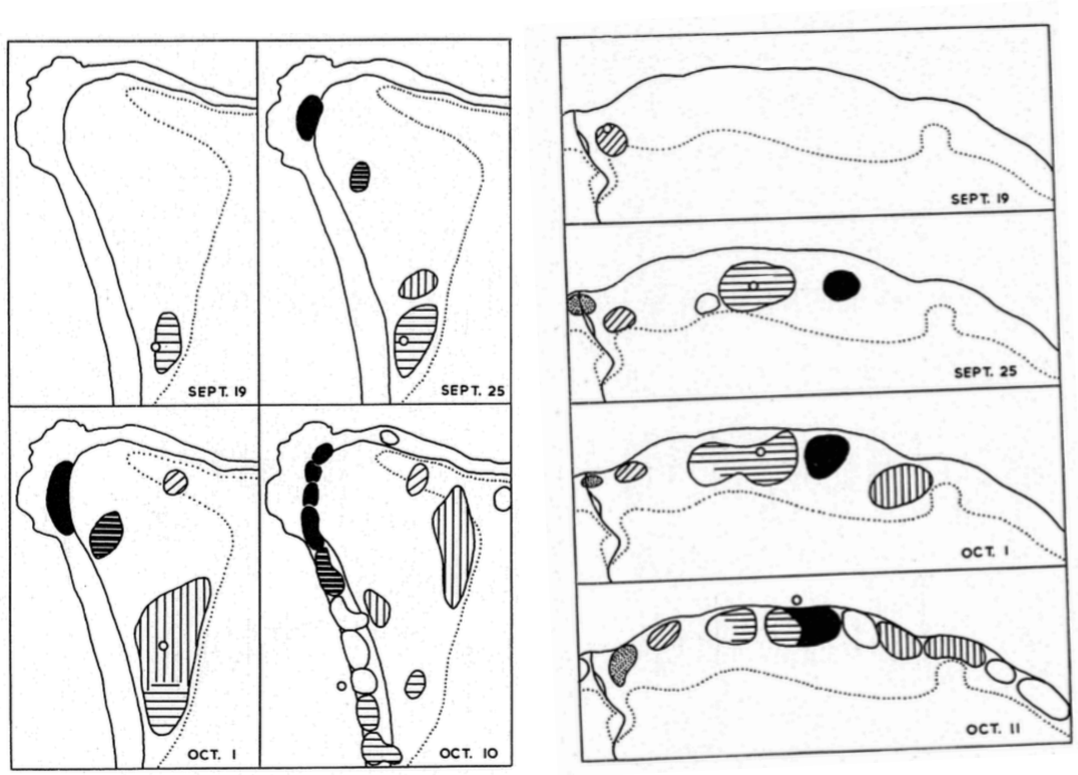

Figure 3.3: Diagrams which trace the temporal sequence of the establishments of two southern elephant seal rookeries in Cumberland East Bay, South Georgia in 1951 from Laws (1956). "The fifteen foot contour is shown as a doted line. The origin of the definitive harems was traced by means of marked cows and daily observations; the position of one marked bull is represented by a small circle" (Laws, 1956, p. 53-54). Images from Laws (1956).

Yet both the term pod—and the descriptive attunements to shape, distribution, and movement that come with it—rather quickly drop away, with "harem" becoming the dominant term. Aggregate female-female interactions are less and less analyzed, and descriptions of elephant seal sociality on shore quickly use the technical term "harem" in describing the natural history of seals before moving on to whatever the paper is actually about. Papers that are specifically about elephant seal sociality assume the individual, or at most the male-male, male-female, or mother-pup pair, as their unit of analysis, not asking how these interactions scale up through the tightly packed aggregation, producing emergent effects.

Thus Klopfer and Gilbert's qualitative descriptions of the form of the pod have been lost as an attunement used by northern elephant seal researchers to describe and explain the aggregate formations of female elephant seals on the beach in their research papers and conversations within their discipline. However, I insist that knowledges-of and attunements-to the pod, exist in vernacular, pragmatic, and embodied forms in the work of researchers that work to undo the pod in order to produce the animal oceanographer.

My quest in the remainder of this chapter is to work with the attunements of the pod. I do not claim that it is the term itself that fixes all the problems. Bartholomew and Collias (1962) bring similar attunements to bear on their descriptions of female elephant seals, where they employed methods of marking females and mapping locations and interactions. They look at the shape of the group, the changing placement of individual females, different degrees of sedentariness between females with and without pups, and individual differences between animals. They refer to the aggregates they examine as "groups (harems)" and sometimes as "herds." What is really at stake is not a term, but a certain way of noticing and describing—a set of attunements to the aggregate as a unit of behavior, to aggressions and other interactions as emergent outcomes of the aggregate, and to accounting for how the aggregate responds to external agitation, how action moves through it, and the forms of heterogeneous interactions that constitute it. Yet, looking at aggregations of female elephant seals under the attunements of the pod, I argue, brings attention and focus to different kinds of dynamics and different forms of agency. In particular, it allows a revival of engagements with *form*. How do my informants engage with the pod as an emergent and indeterminate form? I mean to track the ways they attend to shape, distribution, movement, response, heterogeneities, and how action moves.

Practically Engaging the Aggregate: The Procedure

Selecting or Locating the "Target Animal"

Figure 3.4: The pod as seen from a sand bluff. Image by Natalie Forssman. Año Nuevo, 2014.

Seen from a sandy bluff, a large group of female elephant seals gather together, away from the tideline and the rocky shelves of the intertidal zone, clumping near the sharp vertical cliffs of sand. In the center of the frame, the figures of three people are discernible. These researchers are looking for their "target animal." In this case, they are searching for a specific individual seal that satellite data tells them has just returned from the post-breeding season migration. Because these animals have returned ashore to molt off their pelage, researchers must locate a particular animal and remove the devices attached to her before she sheds them herself. They are examining the large pod of seals with binoculars, searching for telltale antenna protruding from the pile.

Researchers begin the procedure by locating their "target animal" within the formation of the pod. When locating a seal for a "deployment," selecting the target animal involves consulting spreadsheets that track the multi-year arrivals and departures to Año Nuevo of particular individuals, so as to ensure that the animal they choose is a reliable candidate for carrying the expensive devices, sure to follow a representative migration path and return next year with "site fidelity." But choosing an animal with a well-understood history in the database is only half of the puzzle. Researchers also need to ensure that this individual will soon be departing the beach, because to attach the GPS and TDR devices too early has its own risks: that the devices will come loose from the seal's terrestrial activities, rubbed loose by tactile contact with other animals in the closely packed pod.

They read this timing of departure in the post-breeding deployment by following the birth of the female's pup, timing their sense of when the adult female will depart the beach based upon multi-year monitoring: average length of nursing, and average post-weaning departure. In the post-molt deployment, the signs are different, and time is read not through the ballooning body of the pup but through the gradual regrowth of a new coat of short dense fur. Researchers use binoculars to peer at the growth of hair in the seals' "armpits," just under their flippers, and occasionally dash towards the seals to touch the top of their heads, to judge the length of the new coat of fur with the tactile senses of their fingers. Timing also matters for the welfare of the animals subject to the procedure. During the pupping and breeding haul-out, researchers don't want to overly strain the mother-pup bond by sedating the adult female too early in the nursing relationship, when her body is under significant physiological strain and her pup is small and relatively defenseless. During the molting haul-out, to attach the device too soon, when the new coat of fur is not yet long enough, could mean both a poor attaching surface and additional suffering to the animal from the heating two-part epoxy. These factors combine to make the selection of the "target animal" rather difficult, involving a negotiation of data from the lab and the pragmatic temporalities sensed and known in the field.

When locating a seal during "recovery," as in the above image, the "target animal" is pre-selected: she is the one with digital devices protruding from her back, head, and jaw that need to be snipped off from the plates they are glued to with wire cutters. In a recovery procedure, the trick is locating her.

Figure 3.5: Looking and listening for a satellite-tagged seal on Año Nuevo Island. Image by Natalie Forssman. Año Nuevo, 2014.

Finding the target animal during a recovery involves first listening for the ‘blip’ emitted by the GPS device attached to her body on a handheld antenna (see above image). This can be made more difficult in the portions of the coastline with a more intricate shape, especially on Año Nuevo Island, where signals bounce off the formations of rocks and coves, splashing the signal into a multidirectional and weak pointer. After her approximate position has been located with this listening, researchers seek to visually locate her within the pod, by looking for the protruding devices on her head and back.

Figure 3.6: "There she is!" - Two researchers spot their "target animal" in the group of seals. Image by Natalie Forssman. Año Nuevo, 2014.

A Good Position

Upon spotting or selecting the "target animal," and sometimes even before spotting her—sometimes even when driving up to Año Nuevo in the lab truck—my informants would be speculating, discussing, and planning what to do if or if she was not "in a good position." Attention to the position of the seal that will become their research subject was a topic of much concern prior to beginning a procedure. They spoke about "good positions" and "bad positions," and collaboratively planned the techniques required to "get her in a good position." The central question in all these discussions of "good" and "bad" positions were about how easy it would be to access and sedate this particular animal in a minimally invasive and safe manner. Whether or not a particular female elephant seal is in a "good position" involves negotiating tensions between the pod as an impediment to their work, and a tool in executing it.

The pod is an impediment to their work because of their goal to bring about minimal "disturbance." An animal deep within the piling bodies of the pod, densely packed among many, many tonnes of toothy flesh, is in a "bad position" because the researchers will need to disturb many other seals to get at her. "Disturbance" is difficult and skilled body-work: it is time-consuming but also risky, carrying the danger of being bitten, trampled, or snuck-up on from behind. Additionally, the scientists are sensitive to an imperative to make minimal possible disturbance, within the necessary disruptive interventions of conducting their work.[165] This is partially because their research with

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[165] Researchers carefully navigate this category of "disturbance" in their everyday work in a variety of ways that exceed their strategizing around "a good position." They used the term "disturbance" as a synonym for human effects, and carefully decided which situations they have responsibility over according to the degree to which they were anthropogenic—whether that meant caused by their own actions, or by human action more generally. This is different from the way the term "disturbance" is used in landscape ecology where it names temporary changes in environmental conditions that cause pronounced changes in ecosystems, changes that work against processes of "succession" (Johnson & Miyanishi, 2010). In landscape ecology, disturbances can be human or nonhuman in origin. My informants often resisted engaging in "disturbance" or "human effects" even if it involved helping animals, in order to maintain the sanctity of Año Nuevo as a "natural reserve." Cutting off pieces of fishing net caught around the necks of seals hauled ashore was allowed, because the cause was clearly anthropogenic. On the other hand, emaciated pups on the beach, which were likely to starve to death, were left alone because this was seen as a "natural" process in the population (and, the study of these population dynamics was a question only answerable in a "natural reserve" where such interventions were not performed). Since I began my fieldwork in 2013—and up until the time of this writing—an "Unusual Mortality Event" (UME) of California sea lion pups and yearlings has been declared by the National Oceans and Atmospheric Administration (NOAA) (see http://www.nmfs.noaa.gov/pr/health/mmume/, last accessed 30 March 2017; see also McClatchie et al., 2016). When emaciated, dehydrated, and underweight sea lion pups showed up at Año Nuevo, researchers begged them to "go somewhere else" so they could be helped by stranding organizations that rehabilitate pups that end up on other California beaches. Yet, when a weaned elephant seal pup was at risk of being trampled or harassed by an adult male elephant seal after we had captured and weighed it (without sedation) during the "weaner weighing," a researcher immediately intervened to "drive away" or "move" that male. Decisions about how and when to intervene are moments where the boundaries of the category of "disturbance" are negotiated in a natural reserve.

wild marine mammals is closely monitored by interest groups that do not want to see these animals pestered, and because Año Nuevo is a "Natural Reserve," with strict limitations on human impacts to keep it in a "natural" state. But this imperative to leave minimal unnecessary traces also grows out of their knowledge of the pod as a delicately articulated social form, particularly their concern to not disrupt the well-studied mother-pup bond.[166] This is apparent because of the extent to which undoing it through unnecessary disturbance was frowned upon in the field, and those researchers who could accomplish the work with a minimum of "disturbed" animals were seen as the most skillful.[167]

Yet, the pod is also a tool in their work because of its proclivity to "hold" the target animal.[168] Having to undo a whole pile in order to get to the "target animal" is not

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[166] Klopfer and Gilbert (1966), Rasa (1971), Le Boeuf, Whiting, and Gantt (1972), Riedman and Le Boeuf (1982), Insley (1992) and others have studied mother-pup relations in elephant seals, determining that they recognize individualized calls in order to reunite within the pod. My informants were especially concerned about disrupting the mother-pup bond when sedating a nursing female, and one of the "roles" on the many-membered field team during the breeding season deployment was to "pay attention to the pup," watching that the pup did not wander off and get separated from its mother. At other times, the effects of disruptions and disturbances were framed in mechanistic language, in terms of the "energy costs" to the seals of having to move and then return to their previous formations.

[167] In one of my very earliest trips into the field, I assisted in reading flipper tags and doing hair-dye marking with an old-timer who was training me in the field, and a researcher visiting from another lab. The old-timer asked me to do some of the "distracting" work, which involves getting the animal to turn towards you, while she used a wooden stick with a piece of flat wood at the end to mark large hair-dye digits on the seal's side. I wasn't very successful with the distracting, and a visitor to the lab showed me how to do it with a little more conviction. After previously spending time with researchers of California sea lions, who are a lot more skittish, I was somewhat surprised by how close he asked me to get to the animals. But later, the old-timer told me that the visitor's way of doing it wasn't really "how they'd like to teach me." The visitor was shouting a lot and trying to scare the seal when he was doing the distracting, but the old-timer told me we shouldn't do that to the 'girl.' She said it's more about waving the arms and getting close enough that they lunge slightly towards you, and then pulling back just a bit.

[168] In their experimental article that suggests "coordination" of multispecies temporalities as a way to follow more-than-human sociality—and diagramming as a method through which to do so—Gan and Tsing (n.d.) ask "how things hold," attending to "what happens when varied lifelines entangle with each

a "good position." But having her in the midst of a pod was in some ways much preferable to having her all alone on the beach. Some of the most difficult procedures, and the most dangerous to the animal, took place when we worked with an animal lying alone on the shore, away from others.[169] At first glance, this might seem a very "good position," because we don't have to disturb any animals beyond our research subject in order to reach her. But in fact, my informants repeatedly insisted that an animal that is already alone on the beach, sitting outside of the pod and thus already conducting herself as an individual, is much harder to approach and capture as a research subject. It turns out that it is easier to disentangle an aggregation of flesh than it is to chase a single seal down the beach, a difficult act that could end with her going into the water. The pod does crucial work of holding and immobilizing the seal in advance of its chemical sedation. Even working with a seal at the edge of the pod was judged more difficult, displaying a vernacular attention to the different proclivities of the pod's edges and center to hold, constrain, and prevent movement. How will our "target animal"—moving as an individual—respond to our disturbance, and where might she be most likely to flee? This is the question that the researchers must ask when working with an animal outside of, or at the edge of, the pile. How will activity and movement, instigated by our disturbance, make its way through this aggregate formation of the pod,

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other" (Gan & Tsing, n.d., p. 23). Their attention to how assemblages "gather" and "hold" provides an approach for asking about aggregates, what produces them, and what holds them together.

[169] This became particularly apparent in one instance where we had to recover the tag from an animal who had returned to the island, rather than the beach. The island is full of California sea lions, who are very skittish around people, much more so than elephant seals. The particular elephant seal that we were recovering the tag from was surrounded by sea lions, which all fled into the water as we approached. So in this case, we had to ourselves do the work of "holding" the animal, our five bodies surrounding hers.

and how will this affect our ability to reach the "target animal"? This is the question that researches must ask when working with an animal more fully embedded in the middle of the formation.

Thus, determining whether she's in a "good position" is a negotiation between "disturbing" the pod and depending upon it to "hold" the seal, a tension between the pod as an impediment and as a tool. But strategizing "good position" also involves coordinating spatial and temporal possibilities together. Judging, planning, and executing a "good position" involves anticipating where the seal will ultimately come to rest when the sedative drugs start to do their work. Elephant seal bodies are much too big and heavy to move once they have been rendered into objects. Working with such huge and heavy animals, the researchers have no hope of being able to move an elephant seal with physical force once their drugs have rendered it passive. The best they can hope for is to be able to roll it maybe a meter's distance. Thus, positioning involves techniques of appealing to those bodies as moving social interactants that can be affected. Strategizing about "a good position," and bringing it into being, thus requires simultaneous attention to a here-and-now social interactive body, and a future body as physical, recalcitrant material. The transformation of the first into the second must be carefully coordinated. Because of the lines of possible flight that researchers always keep in mind, ebbing or flooding tides were always an important factor in determining if a position was "good" or "bad." There is a great danger in sedating an animal too near the waterline on a rising tide, because we would risk causing that animal to drown. Thus researchers must both anticipate how the body will move and respond, but also endeavor to setup its spatial position when it can no longer move and respond, when it is sedated.

A great amount of responsibility comes with turning a moving body in a dynamic landscape into an object. It puts that body at risk in new ways. The researchers, as the ones that sedate it, acknowledge their responsibility for those risks. Sedative takes time to kick in, and during that time, the seal is still a moving subject, but about to be rendered in object-like ways. The tempo of movement of seal bodies deep within the pod and seal bodies on its outskirts are thus attended to in this planning of "position," as well as the way these temporalities articulate with the time between administering sedatives and those sedatives coursing through the seal's body and rendering her immobile. One informant explained that when an animal is more stressed or "disturbed," the drugs act more quickly on her body, causing her to be immobilized more quickly, even if she manages to travel a greater distance in that time. The researchers must coordinate temporalities and spatialities together, because determining and bringing into being a "good position" is not a matter of mapping a point within a stable field of spatial impediments. It also involves attention to the potential repercussions of movement and response, and hence requires a dynamic understanding of how elephant seal bodies relate to their environment and to one-another in their movements. Anticipating these responses suggests vernacular attention to the pod as an aggregate body composed of a diversity of forms of movement within.

Planning the Entry

Determining whether she's "in a good position" is inseparable from the coordinated work of planning the entry into the pod. This involves deciding which researchers will do which jobs, how they will move together, communicate, and respond to idiosyncrasies that arise, and what tools they will bring along as they approach the pod.

"Doing the initial" is the part of the procedure where the first dose of sedative, usually telesol but sometimes other drugs, is administered to their target animal, via a needle with saline attached to a long tube, poked deep into the muscle in the animal's long back. "Doing the initial" is a skilled practice performed by the researchers most experienced with elephant seal behavior ("old-timers").[170] It involves at least two researchers approaching the aggregation of seals. One person's job is to hold the needle, and at the right moment move quickly towards the backside of the seal when she isn't looking, inject the needle into the seal's lower back, and then quickly step back holding the saline tube for long enough for the drug to flow in. The other person's job is to distract the seal so that the first person can reach the back without being spotted by the animal. This involves waving hands, hitting or tapping the seal's head to draw its attention, and moving in such a way to draw it to face in a particular direction, away from the researcher holding the drugs.

[170] I never performed the procedure myself, but watched it many times, both from a distance and through video. I would ask the person "doing the initial" to wear my GoPro camera, thus giving me a chance to get a sense of the embodied coordinations involved from the position of particular human bodies. I use the word "position" rather than "perspective" because of my commitment to "reading at the surface." This is further elaborated in the Introduction, in Chapter 4, and in the Conclusion.

If the researcher holding the drugs was spotted, the seal would spin around and face them, which is incredibly risky for the one holding a sharp long needle loaded up with enough drugs to sedate a 500kg animal, within range of her charging distance. If the one holding the drugs were to fall on the needle and accidentally inject themselves, they would be at risk of serious bodily injury or even death. So, if the one holding the needle is spotted, the two researchers would back away and try to re-approach in a new configuration, always working with the element of surprise. Performing the initial could often take a very long time because of this tendency for false starts.

The following interaction involves three researchers planning their entry into a pod with "a lot of animals," to do the initial.[171]

> Julie: I don't want to do the initial. Do you have saline? Do you have drugs? Let's grab the tarp. There's a lot of animals. So she is…
>
> Paul: Oh, I can see her head in there.
>
> Julie: Yeah, so she's right there.
>
> Paul: All kind of…((wiggles hand))…going in as a group, and then …
>
> Julie: We'll just see what she does. Yeah that sounds good. C do you want to come with us? I'll give you the tarp. So we're going to all sort-of go as a group. Um. We might. I'll probably go first, and then Ps probably going to be behind me, because he might peel off. So we're just going to sort-of move in really slowly and just try to start moving animals out of the way, and then we're going to just see what she does.
>
> Megan: OK
>
> Julie: And we'll sort of adjust from there.

[171] I use pseudonyms for these snippets of talk.

> Paul: The general goal is to kind-of not go directly at her, but go a little bit to the right, there's less animals over there … it would be ((unintelligible)) if she got into that bigger group ((gesturing to the right))
>
> Julie: Yeah, and we might just come through here.

This planning conversation involves gathering the equipment "doing the initial" requires, and making an agreed upon plan that is responsive to the contingency they know they will likely encounter. First, they gather their necessary supplies: saline and drugs, for the injection, and a tarp because "there's a lot of animals." The tarp is a device for "moving" and "backing up" seals, which will be discussed in further detail in a section below. Its bright blue color and ability to be quickly unfolded is a powerful tool to draw the pod's attention in a particular direction. Then, they again locate the seal within the large group in front of them ("Oh I can see her head in there…" "Yeah she's right there…"). The conversation suggests that the two researchers have a slightly different sense of how much their approach can be planned.[172] Paul imagines a chain of movements and coordinations required ("…we'll go in as a group…the general goal is to…"). Julie, on the other hand, repeatedly emphasizes the contingency involved, the need to wait and see ("…we'll see what she does…we'll just sort-of adjust from there…we're just going to sort-of move in really slowly and just try to start moving animals out of the way, and then we're going to just see what she does.")

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[172] As Lucy Suchman discusses in her influential 1987 book, where she introduced the vocabulary of "plans and situated actions" to counter dominant artificial intelligence framings of what cognition is that were prevalent at the time. Plans, she insists are not blueprints for actions but rather resources for action, drawn upon but not "followed." I use the term "planning" in Suchman's sense here.

Figure 3.7: Hand gestures of planning the entry into the pod, and anticipating how the aggregate of seals might respond. Images by Natalie Forssman. Año Nuevo, 2014.

Key to planning the approach is to "kind-of not go directly at her," at the risk that she "got into that bigger group." Thus, the planning involves attention to the direction that researchers' actions will 'push' the "target animal," and the repercussions of that for her movement with respect to the rest of the pod. This involves both anticipating how the pod will respond to particular modes of approach, as well as planning among the researchers how best to respond to these likely movements. These modes of prediction involve anticipating how response moves through the pod, how the overall form will shift and fuse into different arrangements instigated by researchers' external disturbances. This echoes Klopfer and Gilbert's focus on how human disturbance increases compression as well as the frequency of aggression, changing the arrangement of the pod from diffuse to compressed: "chains of disturbances are set off by cows backing into the pod" (Klopfer & Gilbert, 1966, p. 759).

Redrawn Bodies and More-than-human Mimeses

Figure 3.8: Approaching the pod from a distance. Image by Natalie Forssman. Año Nuevo, 2014.

Klopfer and Gilbert discuss "compression" as a change in the morphology of the pod instigated by external human disturbance, but another clear change that goes along with this movement inward, this concentration and compression of bodies, is a change in the distribution of sense. As seal's bodies become more tightly packed together, their flexible spines also turn to orient their eyes towards the disturbance, so that hundreds of dark shiny eyes focus upon those who approach.

In the above image, three researchers have moved closer into the pod, beginning their approach, yet they still crouch at quite a distance from it. The effects of their disturbance are already apparent in the image, as many seal necks are already craned to look at them, as they climb on top of one another, compressing towards the pod's center.

Figure 3.9: Approaching the pod up close. Image by Natalie Forssman. Año Nuevo, 2014.

The above image shows increased compression and disturbance as the researcher wearing the camera approaches the "target animal" on the left ("3997"). The seal is attached with equipment on both her head and back. The disturbance to the pod is clear from how many of the seals on the perimeter of the pod have compressed inwards, climbing on top of the bodies of their conspecifics. Most heads are turned towards the one wearing the camera, most beady black eyes focused upon her. Patterns of wrinkles on their bodies repeat across the image, where many necks look backwards. Through their pragmatic efforts to approach the pod, get their research subject in a "good position" and administer the "initial stick," researchers build an understanding of how sense and affect is distributed across the aggregate formation, where these capacities do not reside "within" bodies, but are revealed across and between them, in shapes revealed not in advance, but through interaction.[173]

The morphology of the pod—its distribution of flesh and sense—thus shifts in interaction. It is not stable, but indeterminate and responsive. But these changes also instigate and require a remaking of the sociality of the researchers that approach the pod, compelling their action and sociality to become distributed as well. Not only the contours of seal bodies are re-drawn through these interactions, but also the contours of the bodies of researchers, who must work together to approach the large and many-headed hydra of the pod. The coordinations of researchers, in order to intervene in and respond to this sociality of the pod, becomes "distributed" as well. Both humans and seals in this dance become bodies with many sets of eyes, multiple avenues of sensing and reacting to their surroundings. There is a mimesis going on here in the way the human practitioners use their bodies to negotiate the aggregate. This vocabulary of "distributed" cognition or affect helps to track the action across ever-shifting boundaries between bodies or even within bodies—both human and seal. Re-drawing the contours of the body to encompass something different than the atomized individual is thus not only about fusion, but also about noticing new boundaries within the entities that were previously assumed unitary or hierarchically organized, with a single nervous system

[173] On distributed cognition, see Hutchins (1995a; 1995b). Few have taken up Hutchin's framework to empirically ask how affect, too, is distributed. On affect theory, see Gregg and Seigworth (2010).

controlled by a single set of eyes. When the researchers sneak towards the pod to administer drugs to an individual, they work to dis-aggregate an animal's head from the rest of her body through distraction techniques, so she won't notice the needle that injects her bloodstream with sedatives.

As described in the previous section—where three researchers planned their entry into the pod formation—"doing the initial" is a collaborative enterprise, involving more people than just the one holding the "initial stick."

Figure 3.10: Two researchers begin to approach the pod, one holding the drug-administering needle, and one holding the tools of "moving animals" or "backing up seals": a baseball cap, and a blue tarp. Image by Natalie Forssman. Año Nuevo, 2014.

In the above image, two researchers move very close the pod of seals, and seal heads can be seen in the top corners of the image. The researcher wearing the camera is the one doing the "initial stick." She holds the syringe loaded with saline and sedative drugs in one hand, and the needle in the other. The other researcher's job is to distract the "target animal" as well as "back up" others seals. She holds the tools of this work: a blue tarp in one hand, and a baseball cap in the other. Both can be waved in front of the faces of seals, inducing them to move away in distress. Both of these tools are extra-somatic appendages to the bodies of the researchers, who can use them to extend their reach and come closer to the seals, inducing them to back up without risking their own limbs being bit in the process. The tarp is often used folded up, but was also sometimes unfolded in order to create lines in the sand. The combination of the collaboration of working with other researchers, and the extra-somatic appendages of tarps and hats, extend and redraw the contours of the researchers bodies, giving them different affordances for sensing and responding than they would have otherwise. Part of the researchers' vernacular knowledge of podness—I argue—is in the transformations of their own bodies and socialities into forms that imitate it in order to work with it and undo it.[174] Nonhuman socialities are of interest not only for their strangeness and alienness from human ways of relating, but also for how attempts to relate with them instigate changes in human sociality.

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[174] This suggests that close examinations of *working with* nonhuman socialities are more likely to allow us to think the "more than human," in contrast to the move of examining scientific results *about* nonhumans. Their activities of undoing the pod by "imitating" it are worth close attention because they are in contrast to the one-on-one coordination that has been an implicit starting point of much of human-animal studies.

Moving and Backing-up Animals

Figure 3.11: "Backing up seals." The baseball cap held in one hand is a key tool of backing up seals. All newcomers in the field are instructed to wear one. Image by Natalie Forssman. Año Nuevo, 2014.

The above image involves a researcher "backing up" a seal. Individual seals would often need to be "moved" or "backed up" at various points in a procedure: to access the target animal if she was embedded within the pod, to move away an animal that was disrupting the researchers' ability to collaboratively sneak up on the target animal, and—after the initial stick was completed—to clear the area around the research subject in order to make space for many researcher bodies and research tools. The skills involved in "moving animals" suggest that the pod is not composed of identical units, which precisely scale to an emergent whole. Rather, within the pod exist heterogeneous modes of response, difference of individual seals respond to these aggressive "moving" and "backing up" actions by researchers, and how aggressive the seals are in turn.

Researchers referred to some seals, at the end of the long fast, as “skinny bitches,”[175] or to a persistently re-approaching animal as “the aggressive one.” During the entry into the pod, many animals need to be moved out of the way, and these differences became salient.

But different individual responses to attempts to “back them up” lead to repercussions for how to work with the pod as a whole entity.[176] In the following interaction, two researchers explicitly discuss differences of “moving animals” in the breeding season (January-February) versus the molting season (May-June).[177] An old-timer (Julie) discusses with a newcomer (Kate, a graduate student in her first field season) some of these differences.

> Julie: So you can see the molt is a little different than the breeding as far as moving animals
>
> Kate: Yeah, they’re not charging at you
>
> Julie: Yeah but… I almost don’t like it as much. Because during the breeding, they’re predictable. You can get them to do what you want for

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[175] This again displays the languages of gendered bodies that sometimes move between humans and seals in these practices. This is a topic I briefly touched upon in Chapter 2, and which I will take up again in the dissertation’s conclusion.

[176] In their study of “dominance relations among females,” Bartholomew and Collias (1962) attempted to “determine the constancy of dominance-subordination relationships between given females” (Bartholomew & Collias, 1962, p. 8). They found that dominance statuses between two cows were constant, that some marked females moved much farther than others, and these “mobile females” seemed to be “dominated by neighboring females” (Bartholomew & Collias, 1962, p. 8). They also observed that “vocal threats seem to have a generally exciting and contagious effect on the group. A squabble between two females tends to excite adjacent females, and so periods of general aggressive behavior within the group come in go in flurries alternating with periods of relative tranquility” (Bartholomew & Collias, 1962, p. 8). While these authors do not use the terminology of the pod, their ways of noticing the aggregate engages that mode of attunement.

[177] When I started the intensive period of my participant observation in January 2014, my informants noted happily that I was well-prepared for the breeding season because I’d done my preliminary volunteering in the field during the previous seasons’ molt (May 2013). They figured that I was ready for the more “chargey” interactions involved in doing procedures in the breeding season.

> the most part, you know. I find this…In some situations I find this more stressful, because you're backing up all these animals and they're all going to back up.
>
> Kate: They're not motivated to stay by anything
>
> Julie: Yeah, I mean, it's just trade-offs, right? If you've got a pup, that's really stressful
>
> Kate: They're definitely less chargey
>
> Julie: No, totally.

Julie opens the conversation with a statement that encourages Kate to see these differences ("So you can see…"). Kate responds that she can indeed see the differences, noting one of the more apparent ones: "…they're not charging at you," and later re-iterating, "They're definitely less chargey." While Julie agrees with this assessment ("Yeah," "Totally"), she also notes other differences, speaking about variation in how "predictable" they are.[178] Her observations at first sound a bit contradictory: "you're backing up all these animals and they're all going to back up." If the goal is to back up animals, why wouldn't you want them to all back up? It turns out the goal in "backing up animals" is actually more nuanced, and backing them all up is not actually desirable. As Klopfer and Gilbert put it, "chains of disturbances are set off by cows backing into the pod," resulting in "compression" of the pod. In order to reach their "target animal," the compression of the pod can actually act as an impediment to the researchers, causing the animals to pack closely together.

[178] This further highlights how forms of predictability, or the 'ease' with which elephant seals become research subjects, are situated in relation to the forms of questions being asked, as well as to much more than their biological sex. I discussed these issues in footnote 116mas they relate to male versus female elephant seals as "ideal research subjects." This example illuminates a further difference: that 'ease' is situated in relation to both predictability and the stakes of disturbance: females with pups, and without.

During the breeding season, with young pups at their side, she explains, the adult females are predictable in their movements to the extent that they don't want to flee and leave their pups behind. As Julie puts it, when "moving animals" during this time, "you can get them to do what you want for the most part." What she means by this is that the group of animals—as a whole—won't have the same tendency to back up in the breeding season, making it easier to move individual animals without backing up the whole pod. When "backing up animals" during the molt, however, the whole pod will move backwards, having no compelling reason to hold their ground. Julie's vernacular knowledge here is that the adult females in the breeding season are somehow 'stickier,' in that they are socially anchored to their less-mobile pups, and this has repercussions for how the whole pod responds to disturbance, and hence the ease of doing the initial. While Klopfer and Gilbert focus on the dynamics of the pod during the breeding haul-out—when females are with pups—my informants' negotiations with the pod in its different seasonal formations further elaborate on the complex aggregate morphology of this group. Because they must strategize and anticipate response by directly entering the pod, further knowledges of how it hangs together are manifest in their practices.

Researchers engage with aggregates of elephant seals in their work of doing the procedure. In selecting and locating the "target animal," planning and producing "a good position," coordinating the collaborations of entering the pod to "do the initial," and "moving" and "backing up" animals, they work with groups of elephants seals as what I have called "pods," units of aggregate behavior where action and movement is distributed across and between bodies, and where heterogeneous behaviors within—or instigated from outside—lead to effects that diffuse across and between seal and human bodies. While the term “harem” focuses on the activities of male elephant seals to “win” females as reproductive resources, my informants’ embodied, vernacular, and practical knowledges on the beach are much better understood through the attunements of the concept of the “pod,” an early descriptive term that was superseded by the behavioral ecological focus on mating structure that the interest in the “harem” is such a stark example of. Because male elephant seals don’t enter into my informants’ practical work on the beach except as nuisances that must be “moved” out of the way, the attunements to female-female interaction provided by the “pod” do a better job at describing and amplifying these practices.[179] In fact, my informants’ knowledges in some ways extend the analytic and empirical knowledges of the pod much further than Klopfer and Gilbert’s early article. By closely following these vernacular knowledges with video—noticing how researchers talk about, approach, interact with, and intervene in the pod—I have tried to suggest that the pod can become again an analytic to follow more-than-human sociality. My efforts are modest, and much work remains to be done.

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[179] Anne Fausto-Sterling makes a similar point in comparing the studies of red deer of Clutton-Brock et al. (1982) and Darling (1937): Darling was “concerned with reproduction, [but] he didn’t use it as his primary theoretical framing device” (Fausto-Sterling, 1997, p. 51). While Fausto-Sterling praises Clutton-Brock and colleagues’ study for their study of red deer as a population in “exquisite detail over a complete life cycle,” she points out that “focusing on reproductive structure also limits one’s vision” (Fausto-Sterling, 1997, p. 51).

Descriptive Methods as Successor Sciences

This chapter has staged an inquiry into the social worlds of female elephant seals, an endeavor to understand the formations these animals arrange themselves in on shore. I have brought together two different traditions of inquiry to this task. First, I have attended to the political imperative of feminist biologies to question the terminologies that guide our attunements to animal sociality, because "it matters what stories we tell to tell other stories with; it matters what concepts we think to think other concepts with" (Haraway, 2013). Guided by feminist debate about the problematics of the term "harem" to describe nonhuman social arrangements, I have traced influential feminist conversations about how agency and sociality are figured in behavioral ecological explanations, crucial debates to remember amidst renewed interest in biological materiality and the more-than-human in contemporary scholarship (for example: Wilson, 2004; Whatmore, 2006; Alaimo, 2010; Swanson, forthcoming). But I have paid attention not just to the content of these debates, but also their form*,* in particular to the various answers proposed of how to respond to these critiques within biological research practice, the calls for feminists to engage with and in biology directly and forge "successor sciences." From this, I have engaged in a strategy of "amplification," both historical and ethnographic. I have sought vocabularies for noticing social dynamics that exceed the structure of the "harem," and in so doing revived the term "pod" from Klopfer and Gilbert's (1966) work in my empirical descriptions. This brings me to the second broad tradition of inquiry that shapes this chapter: studies of embodied interaction. In endeavoring to continue the descriptive work of Klopfer and Gilbert through my own ethnography of research practices with seals, I have sought to recombine genealogies of descriptive methods for humans and animals, an interdisciplinary history discussed in more detail in Chapter 4. While Klopfer and Gilbert's short paper is interesting and provocative because it attends specifically to the effects of human disturbances on the phenomena studied, science studies has long attended to exactly those practices through which the objects of knowledge are shaped and even produced by the particular modes of questioning them (Latour & Woolgar, 1979; Knorr-Cetina, 1981; Hacking, 1983; Clarke & Fujimura, 1992). Thus, my use of the camera and the methodological conventions of interaction analysis to study the embodied dynamics of approaching and disturbing the pod allows me to build upon descriptive sciences of animal behavior that attend to form by using contemporary social science methods that are likewise committed to a detailed, non-reductive analysis of interaction and sociality.

The questions of this chapter run along lines similar to those articulated by Anna Tsing in her article, "More-than-human sociality: A call for critical description" (2013). She asks, "how can we study the social worlds of beings that can't talk to us?" and proposes a twofold method for the anthropologist or ethnographer of more-than-human sociality: attention to assemblages, and attention to form. Attention to assemblages involves noticing how arrangements are put together. For Tsing, the methods for attuning to arrangements and assemblages involve noticing how multispecies assemblages unfold through time, because in order to notice the "preferences" of nonhumans to gather in particular ways—the proclivities of these assemblages—a crucial method is to watch processes of "succession," the dynamics of living together that unfold over time as a landscape moves from pioneer newcomers that fill open spaces to shade-tolerant species that prefer a mature or climax forest.

The second mode of attention Tsing proposes is what she calls “observation of bodily form” as an expression of sociality:

> Humans don’t always think about bodily form as an expression of sociality because, like many animals, we have determinate body structures. We develop our basic form between conception and adolescence; afterwards, we can loose a limb or gain a layer of fat, but we don’t develop a different interface with the world. (Tsing, 2013, p. 32)

She contrasts this with how the social lives of many plants and fungi develop, because these organisms carry out forms of relation and sociality that shift as their indeterminate bodies grow or change modalities, change and responses instigated by the interactive situations that arise, and the emergent assemblages they become entangled in:

> They keep growing and changing throughout their lives. Even if they can’t pick up and move to another place, they can grow into new environments and social fields. Their form shows their biography; it is a history of social relations through which they have been shaped … social histories inscribed in form. (Tsing, 2013, p. 32)

Tsing’s call for “critical description” is important because it points out the methodologies of noticing and description that are at hand to describe nonhuman socialities, responding to the oft-repeated refrain of many social scientists that its methods are only suited to the study of the human, and therefore implying the study of the more-than-human is best left to the domain of the natural sciences. With her attention to plant and fungal relations, both of her proposals for tools for focusing attention are ways of attuning to the shapes or morphologies of material assemblages by reading the sedimentary traces of social relations in the contingencies of how these forms grow and emerge.

In this chapter, I have employed modes of attunement to *assemblage* and *form* in order to ask about the sociality of female elephant seals on shore, and the sociality of researchers with seals—a sociality of interspecies interaction. Tsing, in her methodological suggestions for a "more-than-human sociology," is rightly cautious of "animal sociology," which she declares she will "stay away from" because "[t]oo often, animals are brought into discussions of social worlds by showing that their consciousness and communication overlaps with that of humans. By human standards, then, they are at least sort of social." I recognize this easy slippage of efforts to understand animal sociality into humanist categories, and thus Tsing's inquiries into vegetal and fungal life inspire my approach in providing vocabularies and attunements not governed by the supposedly human capacities of intentionality and consciousness.[180]

Yet, I have endeavored to argue that the assemblages of female elephant seals on shore can also be attuned to through the methods of noticing assemblage and form. While the arrangements of female elephant seal bodies in the pod don't leave the same kind of sedimentary traces as dense mycological nets that attest to plant-fungi associations, they can still be read as preferences and proclivities to gather in particular

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[180] However, in experimenting with these vegetal and fungal attunements to describe animals, there is a danger of not giving these "bodies" the capacity for "mind." I do not intend to strip animals of these capacities, but rather experiment with frameworks that would see mammals—including humans—as engaging in forms of interaction that exceed a persistent mind vs. body orientation.

ways. The rearrangements of seal bodies in the pod instigated by the external disturbances of researchers do indeed—as Klopfer and Gilbert observed in their early article, by noticing compression of seals towards the centre and the increase in aggressive biting interactions—have repercussions that are visible long after the disturbances and interventions.

Furthermore, while Tsing insists that attention to bodily form is not a particularly useful method for following the sociality of nonhuman animals and humans, I have endeavored to trace how the bodily form of seals in the pod is indeed indeterminate, opening "a different interface with the world" (Tsing, 2013, p. 32). I have done this in several ways. First, I followed how human disturbance on the perimeters of the pod causes the compression that Klopfer and Gilbert discussed, which in turn pushes the pod into an aggregate body, where sense and movement are dispersed in unfamiliar arrangements. In response to this aggregate many-eyed form, I argued, researchers coordinate their bodies into new composite forms, working together to choreograph co-produced actions. Furthermore, their techniques for backing up and moving seals require them to rely on extra-somatic appendages—tarps and baseball caps—to extend the reach of their bodies and their ability to intervene in and reshape the pod. Thus, I have suggested that it is not only the assemblage and bodily form of the pod that is revealed and made in interaction, but also the assemblage and bodily form of humans, with one-another and with the pod. As Tsing points out, anthropology is:

> [T]he discipline that pays special attention to learning about the social by 'being there' … we learn other socialities by experiencing them, not through blueprints, but as ways of life … fieldwork 'immersion' works because we are forced to enter other ways of life—that is, to become

> social—before we have any idea what we are learning. (Tsing, 2013, p. 30)

Of course, while anthropologists have become practitioners who think reflexively about how sociality is learned through ‘being there,’ ethnography’s lesson is that all sociality is learned this way, through participation and interaction. In this chapter, I have shown that my informants—spatial ecologists interested in distant at-sea seal physiology—know much about seal sociality by ‘being there,’ and the form those vernacular knowledges take does not necessarily echo the individualistic competitive framework of behavioral ecology that is part of their disciplinary training, or the understanding of seals on shore in terms of the dominance hierarchy of the harem. Rather, their vernacular knowledges attend to the shifting morphologies of pods, a strange distributed sociality that they must know the contours of in order to intervene in. My aim has also been to amplify these knowledges and also describe how my informants own sociality, as humans, is remade in these interactions as well, through the ‘being there’ and ‘immersion’ their fieldwork requires. Neither “human sociality” nor “animal sociality” are stable categories, they are done in practices.[181] Furthermore, the moments where they are done together can tell us worthwhile things about both.

The attunements of the pod, I propose, are a viable “successor science” for inquires into the sociality of seals after the feminist critiques of the harem. The critiques

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[181] I thus insist that emerging anthropological inquires into “multispecies ethnography,” where anthropologists, including Tsing and others, take seriously the difficult task of using anthropology’s attentive, descriptive, and immersive methods in order to learn about the more-than-human through “arts of attentiveness” (van Dooren, Kirksey & Münster, 2016). These inquiries, I insist, must attend to practices *with* nonhumans, not relying, as some strains of the “new materialism” have been apt to, on the end-points of scientific research to make their interventions, as pointed out by Abrahamsson et al. (2015).

of the harem are important—situating the concept in its epistemic, cultural, and ecological specificities. Yet, it is equally important, as so many feminist projects in behavioral science and primatology have aimed to do, to find ways of noticing and describing otherwise.

Both studies of animal behavior, as well as social studies of scientific knowledge, have tendencies to render particular entities active and others passive in their analyses. Echoes of behavioral ecology's problematic tendency to see female animals as "passive resources like peanuts or water" (Fedigan, 1982, quoted in Haraway, 1989, p. 323), can be seen in early science studies' framing of nonhuman bodies and matter as having no more modes of capability available to them beyond simply "resisting" the schemes and interventions of scientific practice (see Pickering, 2010). In this chapter, I have taken issue with this double passivity, aiming to amplify the forms of practice and response of female elephant seals to the interventions of researchers as more than "resisting" the acts that aim to turn them into objects. Rather, I have asked whether science studies methods of following embodied interaction might be used to follow more than what human practices do, but also the finely articulated relations they undo.

Chapter Four: The Camera-Body in the Field

In my ethnographic research for this dissertation project, I followed scientists and seals to the edge of the sea, to study the coordinations through which elephant seals are transformed into "oceanographers." I brought along a camera, aiming to document the moment-to-moment embodied ecology of human-animal practices on the beach. In bringing a camera into the field I entered a rich and variegated ecology of devices. Researchers and I attached and detached location recorders, cameras, and accelerometers to seals, used ultrasound devices to prod their blubber, and embedded small scannable tags in their skin. Using databases accessed on smart phones, researchers tracked the arrivals and departures of some seals back to the year they were born. Radio-collar transmitters and readers made it possible to locate a specific animal among thousands. The researchers also carried cameras, using them (or the camera on their smartphones) to document things that happen in the field. Even the idiosyncratic did not escape capture: a tag not glued on right, a hair-dye mark mis-applied, or a dead stranded animal washed ashore. Cute pups, violent fights between male elephant seals, and striking coastal sunrises: all these were documented by researchers, the field volunteers, and myself. On the beach, we encountered researchers from other labs recording sounds and videos of animal behaviors. Those auditory and visual captures would be turned into data of a different sort from ours.

In a field so saturated in media and data-gathering technologies, my camera was not merely representing the action I witnessed. Rather, it entered this interactive ecology of sensing, tracking, and representing technologies as a participant in a field of practice. The use of the camera as a sensing tool in scientific knowledge acquisition has a long and varied history. The history of this usage has been widely reflected upon in visual anthropology and media studies. In this chapter, I re-enter my fieldwork to reflect on the place of the camera not only in the work of the researchers I studied, but also in my own practice as a participant observer.

The chapter charts the openings produced by entering the field with a specific camera: a GoPro HERO3. In charting these openings, and drawing out the moments of ethnographic insight they made possible, I intervene in discussions of method in both science and technology studies (STS) and multispecies ethnography.[182] Drawing on sources in visual anthropology and media studies, I aim to open a conversation in STS about the role that recording technologies play in STS methods. As an STS practitioner, I insist that our devices do more than chart "the real" of the laboratory and fieldwork conditions we observe. That is, they do much more than make our experiences in the field as ethnographers visible and tangible for later analysis. STS has cultivated adept attention to the agencies of nonhuman objects and technologies in the everyday practices of scientists. Yet, this attention has not been turned to the ethnographer of science's own tooling to the extent that it has been interrogated in anthropology and

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[182] There is a rich literature in anthropology on ethnographic methods and the practical social relations that enable participant-observation fieldwork. This chapter focuses specifically on methods in science and technology studies and in multispecies studies. In an influential paper, Marcus discusses "complicity" and "collaboration" in ethnographic methods in terms of the "conditions of the production of anthropological knowledge" (Marcus, 1997, p. 91), as well as "the collaborative ideal" alongside the colonialist histories of anthropology.

media studies scholarship. In studying fields immersed with recording and sensing devices, our own devices can draw out aspects of those media ecologies that might otherwise remain tacit.[183] Instead of focusing solely on the interactions my camera captured, I describe how I used my own visual and data-gathering device. In so doing, I draw situated ethnographic attention to the gaps, absences, and excesses of devices, to what they produce beyond "captures" of pre-existing realities.

The material instantiations of technology has been a popular topic of scholarly interest (Dourish & Mazmanian, 2011). The crossover area between science studies and visual studies, however, offers a long history of engagements with the material conditions of representation (Cartwright, 2014). McLuhan (1964) famously drew attention to the material components of so-called "immaterial" technologies. In her work on satellite technology, Lisa Parks (2005) has emphasized that although digital technologies are often characterized as "immaterial" (invisible airwaves, ephemeral networks), they operate through material forms (data sets, digital images, hardware, circuitry). These technologies are implicated broadly in the material world, where they appear as mundane hardware and software amidst other components of the built

[183] In theorizing how our research devices—our visual and mediational technologies—are folded within already existing technoscientific fields of interaction, there is a long tradition in film, visual, and media theory and practice that has focused specifically on the camera as an interactive and material participant in the worlds it aims to 'capture,' a device that, rather than representing the world, actively prods or enacts it. Lisa Cartwright (2014) argues that, while mainstream science studies was concerned with the topic of "objectivity" in the 1970s, film studies and visual studies were theorizing the body alongside technology. Bringing these traditions together opens media up to be seen not in terms of the veracity of their representative powers, but rather as devices that enact worlds in the novel relations they enact between the camera, the film-maker, the worlds drawn into the film, and the viewer. Coming from the observational tradition in ethnographic filmmaking, David MacDougall (1998) argues that ethnographic films are not devices that communicate anthropological knowledge, but they are rather activities of discovery.

environment, rather than pertaining only to the digital realm. Nicole Starosielski (2012) has studied global Internet infrastructure by focusing on neither software nor hardware, but rather the windswept coastal landscapes where deep undersea cables are routed ashore. She investigates these sites where infrastructure meets landscape, describing how digital technologies have all sorts of visible material excesses and effects.[184] Visual STS has many instances in which scholars have focused on the means of production in the laboratory, rather than on the use of images (Lynch & Woolgar, 1990; Coopmans, Vertesi, Lynch, & Woolgar, 2014). But few scholars have taken on the question of STS researchers' own usage of the camera, and the implications of camera usage for a phenomenology of sensory research. The resonance with sensory anthropology (Pink, 2009) is of high relevance here, yet even in this work the camera is engaged as a tool of sensory interaction and observation, and is not interrogated in light of the camera-body relationship this practice produces. Bridging STS and reflexive media archaeology, Lisa Cartwright and Andy Rice offer an account of viewfinderless cameras that focuses "first and foremost [on] the *process of the take* [emphasis added], and not the photograph." The photograph is regarded as "evidence or artifact of that process" (Cartwright & Rice, 2016).

Following from this tangle of traditions in STS, media studies, and sensory anthropology, this chapter delves into the work of cameras in tandem with bodies in the field. My device produced hours of video files of small and mundane practices in the

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[184] For the investigation of digital media as material infrastructure also see Blanchette on data storage (2011) and Parikka on smart phones (2013).

field.[185] Rather than analyze these representational outputs, I focus on activity with the device. Following from some of the works cited above, I propose that it is crucial to better understand the work of the camera with the body of the researcher (who in this case is myself) in the production of particular material relations in the field. Instead of using my camera to capture an interactive ecology of my informants' practices and devices, in this chapter I attend to both my device and my body, and the devices and bodies of my human and nonhuman informants, as parts of a shared ecology. Because my work was primarily with a GoPro camera, my focus will be on that particular device.

The GoPro HERO camera is a contemporary "action camera" designed for use in extreme sports, and its branding and material design embeds the heroic imaginaries and bodily practices of these activities. It is small and light, enveloped in a waterproof casing that muffles sound while allowing it to be thrown around in water, on sand, and on rocks. Its battery lasts for about two hours. In its original model, it lacks a viewfinder through which the photographer identifies, selects, and frames the view (Cartwright & Rice, 2016). While some models have made this feature as an optional add-on, in the design of the camera, viewfinding as an activity has been "unmoored from the body of the camera and made an optional side feature," done in apps from other devices. As visual culture scholars Lisa Cartwright and D. Andy Rice (2016) put it,

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[185] For a discussion of how I work with my video as data, see the Introduction to this dissertation project. Chapters 2 and 3 employ these "hours of files of small and mundane practices in the field" as their empirical materials.

viewfinderlessness produces “an aesthetic … featuring qualities such as uncentered composition, displacement, partialness, fragmentation, and blur.”

Figure 4.1a (top) GoPro Hero3 camera without case. Image: Laptopmag.
Figure 4.1b (bottom left): GoPro Hero3 camera case. Image: Alibaba.
Figure 4.1c (bottom right): GoPro Hero3 camera in case with head-mount strap. Image: Amazon.com

Yet, staying with this dissertation’s focus on material arrangements of corporeality and sociality, this chapter doesn’t attend to the representations I produced with this camera. Rather, I analyze the forms of embodiment that emerge around representational devices, and the social relations they engender. First, I discuss what Cartwright and Rice call “the camera body” (2016)—how this engenders a particular bodily comportment (Young, 1980) or habitus (Bourdieu, 1980/1990), and how the viewfinderless camera shifted attention in the field from eyes to hands: from the *scrutinizing gaze* that the conventional camera implies in this ecology of practices, to the *heroic bodies* that both the GoPro's branding discourse—and the culture of wildlife biology fieldwork—often imply. Then, I discuss the status of the camera in social science methods as a device of data collection, and how that particular casting of this technical artifact opened opportunities to consider the forms of interdisciplinarity and collaboration endogenous to my field site, and the opportunities for participation in them. I suggest that "thinking inside the infrastructure" (Helmreich, 2007) of the *repetitions* and *reciprocities* of fieldwork provides an opportunity to forge modest modes of "collaboration" with our research informants, which I characterize not as a radical practice of putting all assumptions at risk, but rather ambivalent relations of interest and disinterest. Finally, I consider how a practice of comparing the STS practitioner's devices with those of her informants can lead to productive *recursivities*, opening opportunities for "partial affinities" as provisional bodily achievements (Despret, 2013; Hustak & Myers, 2013): both across disciplines, and across species. I thus close the chapter with a discussion about what modest forms of affinity—between an ethnographer and her ecologist informants, between people and seals, and between people and technology—were constructed in the fieldwork encounters of this project's ethnographic research.

Scrutinizing Gaze

Many undergraduate volunteers help with the fieldwork at Año Nuevo, but with smartphones in their pockets, they are also a public relations liability for the lab. During my field research in 2013 and 2014, they were allowed to photograph the animals situated “naturalistically” within the landscape, but the field leaders always kept careful eyes upon them when they whipped devices out of their pockets, to make sure they didn’t reveal in their pictures any traces of the procedures that they were there to help orchestrate:

> Today on the field crew there was an undergraduate volunteer who had helped out in previous field seasons, Todd. With so many newbies helping out with the weaner weighing, Todd already had basic knowledge of how to do the weaner weighing, so Ben (who is in charge of the weaner weighing) said he was a welcome addition to the team. But Ben told me that Todd has a bit of a reputation amongst the researchers for taking inappropriate photos and posting them on Facebook. One of the other lab members is his friend on Facebook, and had seen the photos, and told him to remove them. They explained to him that it is ok to take photos of the animals, but not photos that show how close we are to them during the procedure, nor photos that show them “post-procedure.” It’s not ok, she emphasized, to take a selfie that shows yourself in the frame alongside the animals (Field note, Weaner weighing, March 2014)

These reactions to casual moments of visual documentation in the field highlight the attention my informants paid to the technologies and politics of witnessing. First, they display sensitivity towards issues of animal welfare and how it is represented in relation to this protected and charismatic species. Secondly, they follow a convention of nature filmmaking, where the apparatus upon which knowing and seeing is prefaced is removed from the frame, in favor of foregrounding wild and undisturbed nature.[186] This moment was just one of several situations in which scrutiny was directed upon how the interactions between seals and researchers are represented. It suggests that the

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[186] Gregg Mitman (1999) and Matthew Brower (2011)—historians of wildlife film and photography—write about wildlife and representation, and the technologies and politics of witnessing. They discuss these representational conventions at length: where wild and undisturbed nature is foregrounded, and the cameraperson’s work (such as efforts involved in taking multiple cuts) is backgrounded.

researchers have an everyday theory of media and a theory of science communication that they put into practice in these interactions, as well as rules about when images are allowed to be captured, and where they are allowed to travel.

This interest in managing what is allowed to fall within the camera's lens was mirrored in the ways researchers discussed the susceptibility of their research practices to scrutiny from "the public," and the steps they would take to mitigate the possible damages of this gaze. The field manager often spoke in terms of the "image" the lab projected to "the public." In performing fieldwork procedures in a state park with many visitors who come there to see wild animals in their habitat, he was constantly monitoring the relation of our work to the eyes of these strangers. He was tasked with carefully managing this relationship, considering these issues of how the research and the public should interact and relate in the Natural Reserve. He often used the word "sensitivity" when talking about the procedures being seen by the public.

One workaround was that research activities always took place in the very early hours of the morning, or sometimes in the late afternoon—times of day when the park was just opening or about to close, and therefore there would be no "tourists" on the viewing platform or trails that wind through the park. We usually finished the morning's work around ten, and, as we did the procedures, the field leaders constantly checked their watches, determining how much was left to do and how much time we had to do it. The decision of whether to do another procedure on a particular morning was most often constrained by the threat of the "tourists" moving towards the beach, as unstoppable as the flooding tide. Even with starting our work at sunrise, we were limited to one or two procedures before we had to head back to the lab. If we planned to do more than one procedure in the early hours of the morning, we'd aim to end with an animal relatively out of sight, to reduce the possibility of being spotted." But sometimes we would be seen. In these instances, one of the more experienced and trusted field researchers was sent to speak to the members of the public, to provide "context" and "interpretation" to the potentially violent practices they might have just seen.[187]

The attention with which researchers negotiate how the public perceives them relates to the special status of marine mammals, including their federal protection under the Marine Mammal Protection Act (MMPA), which is tied up with their cultural status as charismatic mega fauna. Given how strictly the MMPA defines the kinds of interactions that are allowable with marine mammals, the researchers viewed their job as partly one of emphasizing the reasons why they were harassing this federally protected species, that these activities were for some greater good, were highly regulated, controlled, and positive in an overall way. When an old-timer was sent off to provide "context" and "interpretation," as a delegate from science to the public, they included descriptions of the research project, its methods, its findings, and most crucially its potential applications to the protection and conservation of elephant seals. The mandate in these moments of "communicating science with the public" was a

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[187] In their classic historical study on the making of the experiment as a sanctified form of knowledge production, Shapin and Schaffer (1985) discuss the kinds of witnessing and virtual witnessing crucial to its success in the debates between Hobbes and Boyle, and the making of the experimental space as a well-defined space, in order to control the conditions of witnessing. Here we have a different kind of witnessing, not by members of the scientific community, but rather a control of how scientific practices of experimentation and intervention are witnessed by the public, which feeds into the economies and public perception of science.

careful management of context, and it was an act of re-presentation. More precisely, it involved a shifting of the context of what the visitor had just seen, from animal harassment to well-planned and justified scientific research.[188] My informants steered possible interpretations in directions that facilitated "public understanding of science," guiding the frame away from those interpretations that would be less flattering to the scientists and their work, or might question the sometimes-tenuous connections between disturbing individual animals and the conservation mandate. Given that northern elephant seals are a "thriving" population,[189] reasons for repeatedly disturbing them emphasized not only protection of the species that the work was for the greater good of knowledge, for conservation in general, for understanding climate change or human effects on ecosystems.[190]

The calculus of suffering in this knowledge production, the understanding that instrumentalizing some seals produced knowledge that protects the species as a whole,

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[188] For my informants, shifting the context has high stakes. In passing, they told me that they had received death threats from people who didn't like what they were doing to the animals. There is a specifically American anxiety about images and animal welfare, related to fear of litigation that can result from the circulation of videos of animal mistreatment by animal rights organizations. More specifically, Santa Cruz is a site where these issues have taken extreme form. In 2008, the home of a UCSC scientist who uses animals in his laboratory research was firebombed (see Ostrom, 2008).
[189] The "Threatened and Thriving" poster series for the 10th anniversary of the Monterey Bay National Marine Sanctuary highlights species whose populations "are either facing survival challenges, or are doing well." One poster features a northern elephant seal whose large head protrudes into the frame in the background while four Western snowy plovers dominate the foreground. The poster defamiliarizes the classic narrative of threatened megafauna, telling us that it is the "diminutive shorebird" that is one of the most endangered species in the United States. On the other hand, "Elephant seals, the largest pinnipeds in the northern hemisphere, were once hunted to near extinction. Now they are thriving in many parts of California." See: http://montereybay.noaa.gov/educate/tt/welcome.html#seal
[190] Researchers in the lab are also engaged with foundations like "Friends of the Elephant Seals" based in Piedras Blancas, and receive research funding from them. They are also involved in training docents in the park. Furthermore, "outreach" activities include educating docents and participating in giving tours at special outreach events in the park.

was a doctrine that everyone in the lab used to justify their work. This held consistently, even though many of them came to pinniped research out of a deep love for these animals—some even from the 'cuddly charisma' camp of marine mammal biology—and therefore were very aware of the bodily suffering they inflicted, and very keen to reduce it as much as possible. Yet one member of the lab referred in derogatory terms to "whale-huggers," casting certain members of the public as blinded by a new-age obsession with marine mammals that bordered on anti-science, and disparaging of the fact that these folks were unable to be convinced by the logical calculus of necessary harm for the purposes of knowledge production. This sometimes-pedantic relationship between "science and the public" always assumed that final moral high ground goes to those involved in the production of knowledge, and my informants didn't see moments of "interacting with the public" beyond the frame of an asymmetrical relationship of "educating."[191]

This control of scrutiny upon the more "sensitive" parts of the research practices extended also to visiting collaborators, who would often visit Año Nuevo to help out in a handful of procedures, either to collect their own data or to get a sense of the flow of the procedures and the natural history of the animals. Collaborators often brought cameras and other recording devices into the field, as part of their data collection. One visiting scientist brought his camera and tripod in order to film how male elephant seals move their bodies across the beach from a biomechanics perspective. His filming

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[191] I place the terms "tourists," "the public," "sensitivity," "context," and "interpretation" in quotes because these are words repeatedly used by my informants to gloss these issues and stakeholders.

practice consisted of jumping into the frame of his camera's view, holding a meter-long measuring stick close to a large male elephant seal. This moment of measuring allowed the images produced by his camera to become data for biomechanical and energetic analysis. Researchers from a lab next door brought expensive audio recording equipment to record and playback the vocalizations of male elephant seals during the breeding season, blasting loud recorded roars at unsuspecting seals with big and expensive-looking speakers.

But when media captures weren't explicitly in the service of data collection, they were treated with more suspicion.[192] On one trip to the field with long-time collaborators from another research-group, I was surprised when the visiting researcher was sternly told to put their camera away. We were doing a procedure and she was capturing with a handheld camera the key moments of it: where and how the measurements were taken, the position that the GPS transmitter was glued on, and many more everyday and mundane moments of the field procedure, which I have described in Chapters 2 and 3. But when it came to one of the more painful moments of the procedure for the elephant seals, the taking of a blubber core sample, she brought her camera in close, to take an image as the seal's flesh was perforated. The researcher taking the sample scolded her strongly, asking her to turn her camera off. Here, even in a mundane moment in the procedure, where everything was routine, still the person pointing the camera was chastised and told to put their camera away.

[192] As part of my own institutional permissions to do my research, I had to be "in the system" that gives permissions for research on the animals in Año Nuevo Natural Reserve. I discuss more on this status as 'fellow researcher' in a later section of this chapter, "Repetitions."

I have described three cases where the scrutiny of cameras upon researchers' interventions to the bodies and socialites of the seals are controlled and managed. First, the free labor of undergraduate field volunteers comes with the danger that the pictures they take will make their way onto social media platforms. Second, members of "the public" who visit the natural reserve for an authentic nature experience, and instead encounter what looks like the harassment of marine mammals, have the scene they witness carefully "interpreted" for them. Finally, research collaborators, who know and understand the contexts of the procedures, but are still asked not to capture their most sensitive moments on film.

In all of these instances, the camera is figured as "eye," enacting a scrutinizing gaze upon the setting. Embedded in these moments are two fears about what this "eye" does. In the first instance, there is a fear of free-floating images without interpretation, an embodiment of a particular theory of media and how representations travel, and an understanding that contexts need to be managed. The researchers endeavor to not let images travel without the context that *they* impose on them, and thus to restrict the taking of images that could be deemed "sensitive." Their everyday theory of media is therefore one where images travel, where images are volatile and apt to shift meanings as they move, a dynamic that they seek to wrangle control of.[193] Images that fall into the

[193] As sensory ethnographer Sarah Pink puts it: "The idea that images move has conventionally referred to the trajectories or biographies of images. Studies of photographs as material culture have recognized their mobility (e.g. Edwards 2003; Edwards, Gosden and Phillips 2006; Edwards and Bhaumik 2009; Pinney 2009). That the meanings of such moving images are contingent on what Arjun Appadurai has called 'the social life of things' (1988) as they move through different contexts is widely acknowledged. Thus

wrong hands are apt to be "misinterpreted," to fall into the wrong frames of analysis, for example under the worldview of "whale-huggers" rather than "scientists." Second, there is the sense that the camera imposes a judgmental gaze upon the scene at hand. Taking a camera out, and pointing it at something, is an act in itself: it is a particular way of looking and orienting to the action taking place that implies judgment, even if only implicitly, and even if only to the one that experiences the camera's gaze. And there is a fear of this judgment: both a fear that it is taking place in the moment that the camera is taken out of its case and held to capture the interaction, and a fear of a future judgment as the images travel. All of this is evidence of how my informants were keenly aware of the politics of their work and of representation, and the great lengths they go to so that they can carefully control the narrative.

It was with these considerations that I began my preliminary fieldwork, experimenting with both a tripod-mounted camera and a small handheld camera in Spring 2013. But pointing my camera at particular moments and interactions quickly tuned me into intersubjective dynamics, where the camera acts as an eye, and enacts a very particular kind of gaze. Decisions of where and when to film and not to film, when to take the camera out, and when to put it away, and when to change what it pointed at, can always be read as a gesture of scrutiny, judgment, or even critique, an embodied externalization of interest in the situation at hand, and a statement that it is worthy of capture and might be worthy of later viewing and critique. As discussed above, when

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images are in movement as material or digital 'things' that travel from one locality to another" (Pink, 2011, p. 6-7).

others pointed cameras upon particular moments or situations, it was not rare to be firmly told to put the camera away. In these already tense situations, with all eyes upon a difficult moment that involves an animal in some degree of pain or distress, the addition of the camera's eye to the eyes already watching simply carried too much judgment. The discomfort this generated, and what it told me about how my informants navigate visual representations of their fieldwork, led me to take a different approach when I began the long-term portion of my fieldwork in Winter 2014. The remainder of this chapter describes that approach, and discusses what emerged from it.

Heroic Bodies

I conducted the remainder of my filming in the field with a body-mounted camera, a GoPro HERO 3. I attached this camera to my own body, and asked the researchers that I accompanied into the field to wear it as well. Sometimes, I experimented with placing it in different positions in the landscape, such as the top of the sand cliffs that are set behind the beach, or on rocks that lie close to the animals.[194]

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[194] My experiments with these different spatial configurations between the camera, my own body, the bodies of my informants, and the landscape setting were shaped by the pragmatic constraints of my fieldwork, but also by the traditions of visual and sensory ethnography. The sensory ethnographic film *Leviathan* (2012, Castaing-Taylor & Paravel), which used footage from multiple small GoPro cameras to produce "eighty-seven minutes of jarring, decentering cinema" that "immerses viewers in the crashing sensorium of the New England fishery" (Battles, 2014), was released during my fieldwork at Año Nuevo, and inspired me to play with different placements of the camera. However, my way of filming was different than this sensory ethnographic tradition because of my orientation to my film as "data," a framing both inherited from my ethnomethodological training, and from my desire to "think from inside the infrastructure" of my informants own knowledge practices of attaching body-mounted data gathering technologies to their research subjects, the seals. However, the shortcoming of this way of working with the camera is the disorientation produced by the ever-moving frame, making it difficult to turn the videos into analytical objects in the ethnomethodological style, where videos are transformed into frame stills that show the moment-to-moment unfolding of gestures, gaze, and bodily movement, and how these bodily activities articulate with objects and talk.

Working with a body-mounted, rather than handheld or tripod-mounted camera, allowed me to shift my own bodily practice as ethnographer, away from the scrutiny of the camera as eye to a distributed and fragment gaze, a field of sensory activity, as Cartwright and Rice (2016) discuss in their media archaeology of viewfinderless cameras. In an essay that draws from visual studies, feminist science and technology studies, and performance studies, they argue that a body-mounted camera, in its coupling with the human body that wears it, does not function as an eye.[195] With the viewfinder removed, the orientation to the scene at hand is generated not by the gaze of the eyes, but by the movements of the whole body. Thus, the GoPro camera enacts an embodied engagement with the scene at hand, re-articulating the intersubjective tensions inherent in looking and documenting practices.[196]

According to Cartwright and Rice, the act of working with a camera with a viewfinder is an act of "projecting [the filmmaker's] desire for recordings to become cinematic objects to share later." The projection of this desire to generate "cinematic objects" names the exact tension that was palpable in moments of image capture in the field that I discussed in the previous section. My informants' worries about the everyday animal suffering generated by their research techniques led them to control precisely those moments where recordings might become cinematic objects. They

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[195] This echoes the formulation of Castaing-Taylor and Paravel, describing the making of *Leviathan*: "the body as eye" (Battles, 2014).
[196] Of course, all visual technologies engage their scenes in more-than-visual ways. Cartwright and Rice's media archeology of viewfinderless cameras shows that thinking with "viewfinderlessness" helps to rearticulate discussions in film and visual studies away from the lens, which "has been at the center of discussions about cameras and subjectivity, identification, and the indexical functions of camera vision." (Cartwright & Rice, 2016)

feared the travel of cinematic objects beyond the circumscribed interpretive contexts that they could manage with their interpretations. In contrast with the desire to produce "cinematic objects," Cartwright and Rice argue that viewfinderless cameras have embedded into their design a "technological design aesthetic of action and play," which produces a "distributed, fragmented, and intra-active gaze."

Cartwright and Rice's media archeology of viewfinderless cameras extends the concept of the "film body" from Vivian Sobchack (1992, 2004) in order to consider the "camera body," which they define as both the body of the camera, its physical configuration and morphology as a particular kind of object, as well as "the composite of the camera and human bodies in expressive configurations." The GoPro Hero line of action cameras is a predominant example, but they deal with more than this specific instance of viewfinderlessness in today's camera consumer goods. They tell a history that goes back to the beginning of the history of photography, aiming to situate the contemporary phenomenon of the "selfie," and inward-facing "aesthetics of narcissism," within a longer history of photography as material and intersubjective practice. The viewfinderless camera, they insist, must be understood in relation to its cultural meanings as an early 21st-century media device, embedded in the culture of the "selfie." Body-mounted cameras, in the logic of their design, implicitly frame the wearer's doings as heroic and extreme activities.

Asking my informants to wear a camera whose design and cultural currency cast them as "the figure of the hero," was a framing of their activities that they did not object to. In fact, it was one that they embraced. They didn't object to attaching the camera to their bodies, and the very idea of having their own movements and activities captured on film was appealing because it implicitly re-articulated these activities as heroic exploits rather than the mundane and repetitive everyday labor of data gathering. In this way, it inverted the assumed hierarchies of the research process, re-ascribing which activities are figured as active and passive in the work of gathering and interpreting data. In the economy of academic labor, fieldwork is often less rewarded than interpreting data back at the lab. While in some cases doing a significant amount of data collection for a particular research paper won my informants authorship (among several other names), in others it merely elicited a thanks in the "Acknowledgements" section of research papers. Interpreting data at the lab is thus the activity that provides rewards in the academic community, in the form of recognition and authorship. Yet, when fieldwork is figured as extreme outdoor heroism, as skillful on-the-ground knowledge of the organism of study—in contrast with disembodied data-crunching back at the lab—the fieldworker is re-articulated as active, in a bodily sense, while the one in the lab is figured as sedentary and perhaps slightly out of touch with the messy realities of the 'real world.' This is a way of figuring the differences between "the field" and "the study" that goes back to debates among natural historians from Humboldt to Darwin to Cuvier, "the field as a union of spatial metaphor and epistemological assumptions" (Outram, 1996, p. 259 quoted in Massey, 2003).[197]

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[197] Doreen Massey provides a conceptual history of "the field" relative to "the study." She locates habitual terminology of fieldwork within debates stretching back to the natural historian 'explorers,' including Alexander von Humboldt and Charles Darwin. "As Dorinda Outram writes: 'The concept of the field is a complex one, . . . the idea of "the field" is pivotal in its union of spatial metaphor and

The GoPro, as Cartwright and Rice detail, emerges from the "action culture of camera-body mobility." In particular, its history and genesis is in extreme sports, as it was originally designed in the surfer culture of California to allow surfers to "go pro." Its design for the capture of bodies in heroic and skillful configurations, often outdoors, is what gives this camera its "heroic" connotations. By orienting the body of the wearer within shots of extreme environments, such as wave tunnels, it "offers body orientation, and places the image on the cusp between a point of view shot and a 'selfie.'"

The extreme outdoorsy "selfie" was a familiar mode of bodily comportment to my informants. Wildlife biology fieldwork, as a form of outdoor adventurism, is entangled with the same "action culture" from which the technology of body-mounted cameras to document extreme sports emerged. In his ethnography of wildland firefighters in the US Forest Services Matthew Desmond calls this the "country-masculine *habitus,*" building on Bourdieu's *habitus* (1980/1990). The country-masculine *habitus*, he explains, "divides the world into two types of people: indoors people and outdoors people." The researchers I got to know best were the ones that spent the most time in the field, and thus had a self-defined 'outdoors people *habitus*' as well, which entangled their love of wildlife biology fieldwork with other activities that

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epistemological assumptions' (1996, p.259). The challenge thrown down by Cuvier to men such as Humboldt raised crucial questions which still reverberate: 'Where was their science located? Indoors or out? Were the systems of explanation created by the work of indoor anatomists superior to the intimate knowledge of living creatures in their habitats which was traditional field natural history?' (Outram, 1996, pp.251-2)." (Massey, 2003)
Closely reading Cuvier, Massey highlights how "the study" was figured as the site with "the possibility of comparison; nature as specimens; distance from the fullness of the field." In contrast, "the field" is thought of in terms of "specificity, nature in action, embeddedness within the field."

affirm the primacy of "getting outside," including hunting, hiking, fishing, and surfing.[198] Not unlike surfers on their way back from the shore, on trips to and from the field in the lab truck, researchers often swapped extreme and amusing stories of fieldwork adventures and mishaps.

On one drive, two of that lab's most experienced "seal wrangler" graduate students told me and the rest of the truck cab's captive audience about the previous weekend's work of capturing and tagging harbor seals in San Francisco Bay, for a private contract that monitors their presence along those busy and populated shores. They described a technique for capturing the seals, which involved driving their boats directly at them, stopping just short of them, and then jumping into the shallow water on top of the animals, at which point the seal would sometimes slip out from under them, as they described it, "like a greased pig." In sharing these anecdotes of heroic adventures, they spoke in tones of respect about old-timer "seal wranglers," mostly older men that had been doing this kind of work for government contracts for years, and thus weren't graduate students in a world-class academic research lab, but skilled and experienced field technicians. Yet, the know-how of these folks in the field, as judged by the tones with which they were praised by my informants, garnered them more respect than the members of the research group that spent most of their time at the lab,

[198] It is important to note the class differences between the "country-masculine *habitus*" described by Desmond and my informants. While Desmond worked with rural folks in northern Arizona, my fieldwork was in left-leaning Santa Cruz, and my informants came from a mix of urban and rural backgrounds, and I wouldn't describe them as working class. Many sociologists and historians have pointed out that concern for nature conservation as a class-based proposition; see Morrison and Dunlap (1986) and Bookchin (1987).

who were at a distance from affairs in the field and the practical constraints, as evidenced by their persistent habit of asking field researchers to gather this or that piece of extra data, oblivious to the toll these requests imposed upon the flows and rhythms of fieldwork.[199]

The outdoorsy *habitus* of biological fieldwork practiced and praised by my informants didn't only hold in high esteem practical skills like driving boats. It exists in feedback with the material culture and bodily comportment of hunting practices. In the Channel Islands, I worked with researchers who were conducting a "paternity study" of California sea lions in a small rocky pocket cove. The goal was to take genetic samples from all the dominant males in the cove, and then determine if their apparent dominance in the rookery correlated with the genetics of the following season's pups. In order to begin the study, the researchers needed to place uniquely identifying marks on all the adult males, so that they could record their activities as individuals in their spreadsheets. In order to mark them, two researchers outfitted themselves in head-to-toe camouflage gear, designed for hunting. I watched from the cliffs above as the researchers slowly

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[199] All members of the lab had participated in fieldwork, but some more regularly helped out in the field than others. Being in charge of the field season was one of the roles in the lab, so those people spent significantly more time in the field, and it was part of the expectation of their role in the research group. There were some researchers I only encountered at the lab, while there were others who I got to know well in the field. New graduate students spent a lot of time in the field, 'getting to know the animals.' Several of my informants spoke about the holistic organism they get from their organism of study from spending time in the field. One population biologist bemoaned the trend in wildlife biology towards using remote sensing technologies to monitor wildlife populations, insisting that crucial knowledge would be lost. A physiologist that studied the "energy budgets" of elephant seals at sea said that watching and interacting with elephant seals on the beach helped her realize that the super low-energy swimming tactic of elephant seals wasn't a mistake in her data, giving her the confidence to interpret what she saw. On the "feeling for the organism" (Keller, 1984) gained from being in the field, see Lorimer (2008) and Ellis (2011).

slithered on their stomachs to get within close enough range that they could shoot the males with paintball guns, which marked each seal on the back and rump with different combinations of colors of paint. One of the two researchers who did this work brought to it knowledge as a hunter of wild game, a set of bodily skills and tooling that crosses over into the domain of wildlife biology field practice. In the week that I spent with these researchers in a remote field station, we made several of our meals from a large cooler that contained chanterelle mushrooms gathered in the Pacific Northwest, and reindeer meat hunted in the Pribilof Islands.[200] In this ethnography of the "country-masculine *habitus,*" Desmond discusses "how the primary *habitus* of self-described 'country boys' transforms into the *specific habitus* of wildland firefighters." Socialization going back to childhood, he argues, can explain how young men become seasoned firefighters. For example, "the roads they navigated to find smoke in the summer were the same ones they drove to find deer in the winter — and most crewmembers had been going hunting with their fathers for as long as they can remember" (Desmond, 2006, p. 407). A similar already-existing masculine-outdoorsy *habitus* connects the practices of my informants who pursue wildlife biology out of

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[200] The Pribilof Islands are in Alaska, just north of the Aleutians, and include St. George and St. Paul Islands. Like California's Channel Islands and Año Nuevo, they are a locus of pinniped research, consisting of more than half of the world's northern fur seal population (*Callorhinus ursinus*), as well as some Steller sea lions (*Eumetopias jubatus*). Because northern fur seals are also found on the Channel Islands, there is a movement of researchers between these two locations. The reindeer meat we ate had been hunted by this informant (with a permit) while he was visiting the Pribilof Islands to do pinniped research. The Pribilof Islands were stocked with Russian reindeer after the Russian and American industrial seal hunt decimated the food source of the indigenous population.

their love for ‘being outside,’ connecting hunting, fishing, and outdoor sports culture with fieldwork practice.

These stories point to the entangled valuation of certain forms of action-culture masculinity, and highlight how bodily skill and heroism crossover between outdoor adventuring, hunting, and biological fieldwork. And, just as body-mounted cameras like the GoPro have pervaded the cultures of hunting and extreme sports, they have also made their way into wildlife field practice. Thus, my GoPro camera was not a foreign media device to them, and it was not unwelcome in the same way that the traditional camera’s scrutinizing eye was perceived to impose judgment. The always-on nature of body-mounted cameras, the way they blend, couple with, and follow the attentional gestures of their wearer, eased fears that I was unduly scrutinizing their practices in what might be the goal of animal rights advocates or “whale-huggers.” The GoPro camera, by virtue of the specific history and cultural connotations of its design, allowed for the emergence of different practices around media capture of fieldwork activities.

The GoPro, as part of this habitus of heroism, framed my camera not as a moralistic bystander, but rather as a device whose role was to foreground the skill of bodies. This affirmation of bodily skill is important to my informants. The researchers I most regularly accompanied in the field immersed themselves in this work, and built their identities, as scientists and also as people, from the intimate and holistic knowledge that they insist only regular fieldwork could provide. Given this, it is not surprising that they were eager to have their activities documented, and even to document themselves, offering to take the camera into the field for me when I wasn’t able to participate in fieldwork. Documentation of their fieldwork practices lends legitimacy to these sometimes under-appreciated practices, by tuning attention upon the skill and knowledge that daily fieldwork practice demands. Additionally, working with animals in the field always involves unpredictable unfolding of bodies and events, and sometimes unexpected events take place that are, in hindsight, worthy of capture just purely for the fun of watching exactly what took place. In this context, my role as their documentarian and a witness to their skilled bodily practice became something they embraced. By implicitly affirming that their skills in the field were worthy of visual capture, the camera gave legitimacy to those skills.

This also meant that my footage was of interest to my informants, and they wanted me to share it with them. I brought my hard drive to the lab to copy some footage onto their computers, and they reciprocated by providing footage of a procedure that I hadn't participated in.[201] By using a camera technology designed in a culture of narcissistic self-capture, a different relation between my camera, my informants, and myself emerged than would have been possible with a traditional handheld camera. In using my camera to notice the embodied skills of fieldwork—and the unexpected situations these skills respond to—I acknowledged the implicit skill and problem-solving of my informants, a facet of their research that is never discussed in scientific papers. In those papers, descriptions of methodology are outlined in ways that never acknowledge the idiosyncratic situations, and skilled multispecies coordinations,

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[201] This footage was from the recovery of the devices off a female elephant seal in the Channel Islands. The footage was gathered not on my own GoPro camera, but on the camera of one of the fieldworkers that helped them locally.

involved in making and executing those methods. Thus, because of its association with the culture of selfies and extreme sports, the GoPro camera drew out facets of my informants' practices in the field that are less connected to the making of the scientific self as a detached and objective observer, and more to do with biological fieldwork's historical and continued entanglement with a particular masculinity of heroic adventurism, of being in wild places with wild animals. Thus, the camera-body of this photographic technology allowed the capture of bodily practices that exceed the focus on knowledge production and the making of scientific objectivity, the traditional domain of early STS laboratory ethnographies.[202] This self-fashioning of the wild biologist as "explorer," was pervasive, for example in some of the researchers being funded by National Geographic's "young explorer" research grants.[203]

The affirmation of skilled practice, of "doing" rather than "thinking," extended to my own bodily comportment in the field as well.[204] The act of taking out a handheld

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[202] As Lisa Cartwright puts it in her historical sketch of the literature on visuality and representation in science studies: "Whereas objectivity and knowledge would emerge as dominant concerns in science studies work about visuality, subjectivity, situated knowledge and the phenomenology of experience were consistently a stronger presence in both feminist science studies and the sociology and anthropology of medicine. Feminist epistemology of science, though focused on knowledge, drew considerable attention to the matter of embodied standpoint and to subjugated knowledge. Writing in phenomenology, ontology, and historical materialism brought forward bodies—those of research subjects and patients as well as laboratory workers and scientists or clinicians—as crucial components of science studies research, and as features of the material apparatus" (Cartwright, 2014, pp. 244-5).

[203] This speaks to another form of 'witness,' the forms of witnessing involved in the discourses of conservation biology, where the biologist, through their encounters with and knowledge of often-threatened species, become 'spokespersons' for those organisms and their protection. Thus, in addition to the witnessing of skilled bodily practices that my camera enabled, it was also a witnessing of their conservation witnessing, their care for and knowledge of the animals. It thus has further 'heroic' connotations, in the form of the figure of the 'savior conservationist.'

[204] Historian of science Tanja Paulitz (2011) discusses gendering in 19th century engineering practice, the differing orientations to theory and practice along gendered lines: "the rational man" and "the man of action" respectively.

camera directs the gaze, but it also engages the hands. The one holding it shifts suddenly from ready-to-help in the collective projects of fieldwork to no-longer-engaged in the work. Holding a camera and taking video renders the ethnographer unable to help carry gear, distract an aggressive approaching seal, hold an empty syringe while another team member loads up saline solution, or write down tag numbers on the data sheet. It is a moment of not being available to help, of becoming a bystander, an observer rather than a participant.

Thus, using a hands-free camera made my own body available as a participant, freeing my hands from holding the camera, and my eyes from peering through a viewfinder. The camera made my own body available as participant. This allowed a very specific kind of entry into my field site. As I have discussed above, the culture of fieldwork is a culture that values ‘action’ and ‘doing’ more than ‘watching’ or ‘thinking,’ related to the ways the identity of the wildlife biology fieldworker is entangled with the identities of the explorer, the extreme athlete, and the hunter. The camera re-articulated my own fieldwork body in the geography of lab versus field, and the practices valued in each, as well. Rather than scribbling qualitative notes in my field notebook for my own social scientific research, my body was framed as “doing” rather than “thinking.” I, too, participated in the enactment of these “heroic” bodily configurations. Additionally, because of the constraint of Año Nuevo as a “natural reserve,” the number of researchers allowed to be present in the park at a time was limited to only ten. Within this regulatory structure, there wasn’t room to only be an “observer:” anyone who wanted to return to the field multiple times had to do so as a full participant in the work at hand. Thus, over the course of my fieldwork, I moved from the position of a complete novice to training others in the field.

In the *habitus* of fieldwork, action or doing is the primary modality of respect, not watching or thinking. The cultural status of the GoPro HERO camera facilitated a specific kind of ethnographic subjectivity, which allowed me to partially enter, or at least not directly offend, the heroic *habitus* of my informant. The place that the camera was able to occupy within the ecology of representational and mediational technologies provided particular kinds of openings, by virtue of the expressive bodily configurations it generated.

Repetitions

It was under the terms outlined in the above section that it was viable and even welcomed for me to engage in video ethnography in the field. This possibility was partially produced through the "camera body" of the GoPro—both its form as a technological artifact with a specific history, and the way it combines with the body of its wearer and acts as a "technology of intra-subjective action" (Cartwright & Rice, 2016). First, it brought an understanding that my eyes—and the eye of my camera—were not a scrutinizing or judgmental presence, but instead that my body followed and affirmed the heroic skilled bodily practices of fieldwork. By making my hands available to help, the camera also allowed me to cast myself in this same *habitus*, of the fieldworker as active do-er. The camera-body of the GoPro produced my eyes as non-judgmental, and my hands as helpful.

But working with a camera shaped my relationship with my informants in another way, casting us as fellow researchers doing fieldwork alongside one another, rather than the more familiar layout of the STS fieldwork arrangement, where the social scientist does fieldwork *on* the natural scientists. This relationship was framed around the assumption that what I was there to do was to collect data. Lorraine Daston and Peter Galison's historicization of "mechanical objectivity" helps shed light on why bringing a camera facilitated my identity with my informants as one of co-researcher. They chart the developments through which "one type of mechanical image, the photograph, became an emblem for all aspects of noninterventionist objectivity" (Daston & Galison, 2007, p. 187). By casting my filming as data gathering, I participated in this paradigm of film-as-scientific data that dates to the 19th century.[205]

I framed the representations my camera gathered as "data," because my social science methods training taught me to use video as means to track the flow of embodied actions in close detail.[206] Yet casting my own activities as "data collection" facilitated a

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[205] Scholars at the intersection of histories of science and histories of film have examined messy practices that crossed the boundaries between observational science and experimental film. The use of chronophotography—a method of taking photographs of a moving object at regularly spaced intervals in order to dissect movements that the human eye cannot perceive because of their speed— by French physiologist Etienne-Jules Marey is a well-known "origin story" in the history of film, and shows that film-as-data is one of the earliest uses of this medium. The analyses of Lisa Cartwright (1995) and Hannah Landecker (2006) on the history of physiological, microscopic, and X-ray cinema attest to an ongoing entanglement of scientists and film, "a distinct development of cinema as a scientific tool" (Landecker, 2006, p. 126).

[206] In the dissertation introduction, I discussed these methods in detail. In Chapters 2 and 3, I used stills from my camera footage to unpack the practices of my informants. Early in my fieldwork, I gave a presentation to my informants in one of their lab meetings, where I discussed the kinds of objects and practices that interested me in their fieldwork.

relationship with my informants and their fieldwork that allowed me to enter the rhythms and repetitions of everyday practice in particular ways.

Firstly, framing my work in the field as "data collection" allowed a division between "on" and "off" time. By enacting attention on some, but not all situations, explicit data-collection with a photographic device provides a chance to achieve that elusive ethnographic technique of "just hanging out." And, by allowing me to cast myself as 'just another researcher collect data,' the camera shifted the rhythms and temporalities within my visits to the field. Driving to and from the field in the lab truck, I was able to ask questions but also just hang out as a participant, because my camera wasn't on.

But "data collection" also framed my overall relation to the field. Much of my informants' work in the field consists of care and maintenance of research devices and the long-term data sets they gather. The rhythms of those activities are structured by the arrivals and departures of the animals, and the short windows of opportunity amidst these comings and goings to attach or detach devices, gather samples, and take measurements. The material needs of data-gathering devices thus offload themselves onto the bodily rhythms of those tasked with gathering the data, or setting up the conditions such that the devices can gather the data by attaching devices to the seals. Being stewards of data that aspires to "mechanical objectivity" structures the life of the one collecting it, in the image of an automaton. Fieldwork is thus repetitive and rhythmical, falling into patterns imposed by the needs of the devices, or the overall data set's requirement for an even and non-biased sample.[207] That data sets, as entities in their own right, elicit practices of care and maintenance is shown by the fact that the data being gathered by my informants in the 2014 field season, when I conducted my participant ethnography, was not even being marshaled towards any particular research question. No graduate students in the lab had active ownership over it, in the sense that the success or failure of certain portions of this data collection would determine the success or failure of their PhD projects.[208] Rather, "resights" and "recovery" and "deployment" procedures were undertaken many times a week for the continuity of the data set itself.[209] Repetitions maintain the possibility of asking questions in the future that rely on a continuous multi-year picture of the seals' migratory routes.[210] The data set becomes a kind of entity, recruiting and requiring care and maintenance.[211] The activities of data collection, through this offloading, become machinic and executed through nearly automatic scripts. As a device of data collection, my camera, too, was

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[207] In an article that expands Michael Lynch's discussion of "the place of science" (Lynch, 1991), Charles Goodwin (1995) pays attention to the orders of space that are "tied together" into what he calls "hybrid spaces" for ocean scientists that examine the ocean from a ship. He examines how representations are generated, but also how they are *inhabited*, how the sampling grid imposes rhythms that structure the lives of scientists, making the sampling grid much more than an "immutable mobile" (Latour, 1987). In the same way, the rhythms of my informants' fieldwork are generated by the structures required of their data.

[208] Most of the graduate students I worked with in the field were either just finishing or just beginning their PhD research. The ones that were just finishing had gathered their samples in previous field seasons. No PhD researcher would have what I am calling "ownership" over *all* of the data being collected, but rather some small part of it, such as the blubber samples, in order to ask a specific question that looked at the blubber samples in relation to the dive track data.

[209] "Resights" involve confirming that particular known animals have arrived on the beach. "Recoveries" involve removing the tags and devices from the "seal oceanographer" and gathering samples, while "deployments" involve attaching new devices.

[210] Ecologist Jim Estes (2016) discusses this continuous collection of data for long-term studies in his recent autobiography of his scientific career.

[211] For discussions of practices of maintenance in STS, see Denis. Mongili, and Pontille (2016) and Domínguez Rubio (2016).

imbued with concrete material needs, which were assumed to include repetition and consistent temporal patterning. Fellow researchers understand that data-collecting devices have needs.

This contrasts with another kind of relationship that my informants were accustomed to cultivating with outsiders interested in their fieldwork practice. Journalists and nature and science documentary film crews would sometimes be guests in the field, and initially I was accommodated to tag along in this mode, as someone helping with "outreach" and "communicating science to the public." As I discussed in the section "Scrutinizing Gaze," the researchers I followed were involved in various 'outreach activities' that often put them in positions where they found themselves explaining the methods of fieldwork with the animals to non-scientific audiences, in order to 'educate.' In my early research, I often felt like the researchers were giving me the public outreach version of their scientific practices. Yet, science and nature documentaries don't require the same rhythms and repetitions as data collection. As a fellow "collector of data," my need to show up repeatedly, doing the same tasks again and again, was understood to be in the service of the camera and the data *it* collects. After showing up enough times in this way, I was no longer viewed as a "member of the public" to which they had to "communicate the science," my role was able to shift and more interesting aspects of their research were revealed as I became a fellow researcher, and I gained a different, more emic kind of access. Furthermore, repeat visits lead to skilling, and hence being valued as a member of the team. At a certain point, I stopped having to ask to tag along, and was instead asked to help out with procedures, as I became one of the more available volunteers in that particular field season. Rather than being trained on how to do procedures, soon I was training others.[212]

Reciprocities

In being treated as a fellow researcher, collecting data, I was able to observe in a first-person sense the importance of facilitating the data-collection of others.[213] This helped me to see that fieldwork is in some ways a gift economy, where researchers help one-another out with their data collection with the expectation that they will return the favor. Collaborative multidisciplinary data-gathering is a modest form of collaboration and interdisciplinarity that takes place in the field, one that I managed to attune to, by "thinking from inside the infrastructure" (Helmreich, 2007) of my informants' own data-collection practices.

My informants know how to coordinate the data-collection needs of several projects at once. I entered these structures and was able to see them from the

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[212] This could be cast as what the anthropology methods literature often calls "immersion." But, following Stefan Helmreich, I find this spatial or topological metaphor for the ethnographic encounter "a poor tool for thinking about the structure of space, about the materiality of the media in which ethnographers as participant-observers … move" (Helmreich, 2007, p. 631). While Helmreich proposes "transduction" as an alternative tool for thinking ethnographic method, I instead to propose to mess up the geometries of 'insides' and 'outsides' assumed in "immersion," and to some extent assumed in Helmreich's (2007) article, where "*inside* the infrastructure [emphasis added]" (Helmreich, 2007, p. 633) is a possible site to be inhabited by the ethnographer. I elaborate in the footnote below.

[213] It is worth noting that I don't see becoming a 'fellow researcher' or 'co-participant' as equivalent to the anthropology cliché of "going native." I didn't aim to "become" my informants, but rather to make lines of partial affinity between our bodily practices. While discussions about "going native" are preoccupied with insider or outsider status, in this chapter—and this dissertation more broadly—I am making an argument for a different topological arrangement of the analyst with respect to her informants. This is made possible by the ideas of "partialness" from anthropology (Strathern, 1991/2004), and "surface reading" from ethnomethodology (see a description in Love, 2010). I elaborate on this in the introduction to the dissertation, the final section of this chapter titled "Embodied Empathies," and the conclusion of this dissertation.

perspective of a co-participant. With a single species as a research subject, and a tightly controlled state park as a research site, working together is always necessary, despite vast differences is research interests and expertise. Physiologists, oceanographers, and behavioral scientists constantly coordinate the data-collection needs of several different research projects at once. This means that they immediately recognize—in a pragmatic sense—what another researcher is, and what she needs. A typical trip to the field might consist of a team of four diverse researchers: a morphologist interested in the biomechanics of locomotion, an ecologist interested in mercury concentrations in deep sea fish, and a behavioral scientist interested in the social interactions among dominant male seals. Among such disparate concerns, a social scientist interested in scientific practice in anthropogenic landscapes is not such a strange addition. While I initially thought of myself as an outsider,[214] I learned that insider and outsider among these researchers might be the wrong topological metaphor for this field.

While there are vast differences in questions and approaches, being together in the field forces practical collaboration that doesn't necessarily aim towards convergence. This is not a strong "co-fabrication" (Whatmore, 2003) or "being at risk" (Stengers, 1997), with ones' own assumptions and approaches constantly called into question, as some STS scholars have discussed interdisciplinarity in idealized terms. In the field, differences among research paradigms and foci are negotiated not through

[214] The status of the STS researcher as an insider or outsider is discussed in many STS ethnographies. Latour's classic *Science in Action* (1987) exoticizes the scientists in the lab in order to make a point about the social and material life of laboratories being sites worthy of close examination as much as the classic anthropological subject of the non-western Other. On the other hand, many ethnographers of science have in fact been insiders (for example, Traweek, 1988).

conceptual discussion about which phenomena are worthy of focusing on, but through practical activities of facilitating one-another in ‘getting the data.’ This is a modest version of what Swanson, Bubandt, and Tsing (2015) call a “rubber boots approach.” Yet, Swanson and colleagues’ focus is on how shared curiosity in the field can lead to collaboration, the identity of being a fellow ‘collector of data’ facilitated simultaneous relations of interest *and disinterest*, the kinds of ambivalent affects discussed by Fitzgerald, Littlefield, Knudsen, Tonks, and Dietz (2014) in their analysis of the felt experiences of researchers involved in “a trans-disciplinary neuroscience encounter.” While my project obeyed a more traditional STS setup than either of the two mentioned above, practical enablement of the projects of others despite divergent knowledge traditions still has lessons for STS’s current moment that is concerned with collaborative possibilities with our informants.[215]

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[215] Matei Candea (2010) argues that approaches in recent animal, multispecies, and more-than-human studies share a commitment to “connections, relationships, and engagement” (Candea, 2010, p. 243). I would argue that the same characterization could be made of recent social science interest in “interdisciplinary” inquiries. For example, Mackenzie and Murphie (2008, cited in Hird, 2009) suggest “engagement” as a way STS practitioners might engage well with science. They describe “engagement” as between the poles of “critique” and “extraction.” And, they suggest that “engagement,” while inheriting the results of critique and extraction, tends towards “conversation, dialogue, or collaboration.” Candea’s intervention is to make space within the concept of “relationship” that can acknowledge “the broad spectrum that lies between complete lack of connection and, on the one hand, and actual ‘intersubjectivity’ on the other” (Candea, 2010, p. 244). For Candea, and in my project as well, this is an important intervention not just in thinking about methodologies and theoretical foundations for forging connection and empathy with nonhumans organisms and environments, but thinking about ethnographic method more generally. Candea is committed to examining how “engagement” and “detachment” are done in practice. Situating “engagement” and “detachment,” and pointing out their moral economy, continues Lorianne Daston and Peter Galison’s influential history of objectivity, which documents the pursuit of detachment as an ethical goal in the sciences (Daston & Galison, 2007). In the contemporary moment in critical scholarship concerned with “engagement,” historically and culturally situating the valuation of this form of relationship is important as well.

Inserting myself into their structures of practical collaboration allowed me to learn what co-fabrication might mean in their world, and to work towards achieving moments of shared interest and curiosity. In framing myself as collecting data with my camera, I found that I was able to open conversations differently. Being a co-practitioner, and fellow data-collector, makes opening technical and methodological discussions easy, which can sometimes be a difficult thing to ask a scientist when they view you as an "outsider." Too quickly, they will default to giving you a simplistic description of their research methods designed for a constructed image of a "public" that wants simple and charismatic story.

Casting myself as a fellow researcher meant that discussions could turn more easily towards matters of method, technique, and technology. It was in these sorts of discussions around data and method that shared interests and curiosity between researchers was most palpable; I found that this is where intellectual excitement is located in the work of the lab. This was especially evident in lab meetings, where we often read recent peer-reviewed publications or workshopped lab members' preliminary results. Often, there was interested inquisitiveness about the types of data being used. For example, in one meeting, we discussed a historical ecology paper (McClenachan & Cooper, 2008), which used sighting records by merchants and sealers of the extinct Caribbean monk seals to estimate past biomass, and therefore model the ecosystem-level effects of their extinction. In another meeting, we discussed a paper that included prey switching in models of species range change, grounding its analysis in museum specimens (Peers, Wehtje, Thornton, & Murray, 2014). In both instances, discussion turned to method: how interesting it was that these forms of data were being used, their validity, their limitations, and their possibilities for asking particular questions.

Even more vibrant conversation about method took place when a fellow lab member would present preliminary results. In one meeting, when workshopping new data presented by long-term collaborators, the excitement in the room—and the ever-multiplying possibilities for analyzing and expanding this data—was palpable. In this case, the new data came from the "jaw-mounted accelerometers,"[216] the data from which had recently undergone preliminary analysis. The presentation of the data generated excited and open-ended conversation about the new questions that might be ask-able with these devices. After the meeting, a senior graduate student told me that the meeting had been one of her favorites ever, because of the excitement and open-ended question asking, grounded in a new form of data it generated. While the pitch of excitement at the meetings was not always as high as this, these gatherings were often sites to become curious about small-scale data that closely tracked bodies, movements, and oceanographic conditions, and to ask how that data might be re-assembled to ask new and interesting questions.

When I first entered the field with camera in hand, my informants were curious about what I aimed to focus my own data-gathering upon, and what questions I hoped to answer. Part of this curiosity was because, as a social scientist, I was taking them as my research object, something that was confusing and made them slightly apprehensive. I

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[216] These devices log "prey-capture attempts," producing a digital trace every time the jaw to which the device was glued has snapped open and closed.

aimed to reduce this uneasiness by trying to convince them that my interests were not so different from their own. Framing my own methods to them as being concerned with the movements and coordinations between humans, animals, technologies, and landscapes in their everyday research allowed me to perform that I had an analogous set of "bottom-up" methods as their own, methods where the research object emerges through engagement with the minutiae of embodied movements and body-environment relations.[217] By removing some of the enigma of what I was there to investigate, possibilities of being curious together opened up. Beyond positioning me as a fellow researcher, my device opened up opportunities for them to be curious about my data, and to give input about how I might gather it.

Because the implicit relationship that emerged between myself and my research informants became that of fellow "researchers," and because working with recording technologies to characterize bodies moving over time was their research expertise, they sometimes had ideas and input to help me better think how to film and what to pay attention to. For example, I did several experiments with recording a group of a couple hundred animals that haul-out on the north end of the reserve from a bird's eye view. This group is fairly cut-off from other aggregations of animals at Año Nuevo and therefore cohesive as an entity. Nestling below sand cliffs, researchers would often view this group of animals from above in order to record the presence of particular animals

[217] In one of the early lab meetings I attended, I gave a presentation sharing what I was focusing on in my research. This had the function of informing them about what I was doing, but my project underwent some of the same workshopping that I observed in other lab meetings, where they gave me input, suggested possible directions of inquiry, and asked challenging questions, while at the same time being supportive and friendly as they were to one-another when sharing projects-in-progress.

that had been previously marked with hair-dye into their database. I sought to capture the movements and repositionings of this aggregate multispecies entity as the scientists worked to capture a single individual in order to attach tracking devices. I placed my camera upon a ledge above this scene, rather than attaching it to my body or an informants' body, and went back to the beach below in order to help with the work.

Noticing that I had worked with my camera in a way different from my usual practice of close-up filming prompted a conversation with the field leader about creative methods of viewing the animals "from above." He told me about an idea that he has to borrow a friend's photography drone, and fly it over the elephant seals on shore to do both population and "body condition" surveys. With a seemingly endless supply of undergraduate labor in a class he was teaching, he had tasked one student to investigate in her final project the precision of such "birds eye" measurements of body condition, to conduct a very early proof of concept for a speculative form of wildlife monitoring where students sitting on sand bluffs, notepads in hand and cultivating particular skills of noticing, may be replaced by drone flying and then sitting back at the lab analyzing photos. Thus, by experimenting with visual representational technology, I brought myself into a conversation with the researchers that I would not have otherwise entered, about their dreams and visions about methods that currently do not exist, and about future directions of research practices in their discipline. While my goal in placing my camera in this particular way had not been to improve population-level morphological and physiological measurements, but rather to track human "disturbance" of an aggregation of wild animals as a material and interactional phenomenon, my use of visual technology still opened a conversation. That is, despite our radically different research interests and approaches to asking questions, gathering together under the identity of fellow researchers, collecting data and doing fieldwork alongside one-another, opened conversations in unexpected directions. As a participant observer of their everyday practices, there were plenty of chances to learn about their present methods. But, as a fellow researcher with different, though related concerns, conversations lead into the realm of future speculations and the kinds of questions that really interested these researchers as evidenced by their excitement at the lab meetings: matters of method and data.

Framing my own activities as data gathering formed an unexpected opportunity to learn how my informants think about data, what Stefan Helmreich has called "thinking from inside the infrastructure" (Helmreich, 2007, p. 633). My camera, framed as a device for gathering data, facilitated a particular kind of entry to my field site, allowing me to "think from inside the infrastructure" of data collection, learning what data is to my informants. It allowed me to learn, in a first person and embodied sense, what data collection in the field feels like and is for these researchers, constructing a partial analogy and affinity between my own research practices and theirs. The camera, as a research device, framed my identity in the field for my informants. In gathering tangible data, my informants could easily see the analogy between what I was doing in the field and what they were doing in the field.

Recursivities

Positioning my work in the field as ‘gathering data,’ and noticing moments of shared curiosity about data that emerged in the field and lab, made it possible to cultivate comparisons and analogies between my own data-gathering practices and the data-gathering practices of my informants. Further, because the GoPro camera functioned as a data-gathering device attached to bodies in various configurations, I was able to put my own research device in experimental analogy or comparison with the devices of my informants’ research: the devices they attach to the seals. Asking my informants to engage in this playful recursive thinking had several results that provide insight to the questions of this project: about the kind of agency that the researchers interpose onto the body of the “seal oceanographer,” and about how they think about the labor of fieldwork. Constructing an analogy between my informants research practices and my own made possible methods for constructing affinities not just with the rhythms and repetitions of my informants’ research practices, but also with the seals, who perform the labor of carrying devices that gather data.

Figure 4.2: Attaching GoPro camera to an informant. Image by Natalie Forssman, Año Nuevo, 2014.

Figure 4.3: Detaching time-depth recorder from northern elephant seal. Image by Natalie Forssman, Año Nuevo, 2014.

The affinity between my research device and the devices they attach to the animals was not foreign to them. In fact, it was one that they themselves proposed. When I conducted preliminary participant observation research in Spring 2013, one researcher jokingly asked me if I was going to “track” them in the same way as they track the animals. This comment is what originally inspired me to think about working with a body-mounted tracking technology in the field, rather than a traditional camera, although this decision was also influenced by the constraints discussed in the above sections on visual scrutiny and heroic bodies, and the difficulty of filming in the ever shifting interactional arrangement of the beach environment. Another researcher, in an undergraduate class he taught on marine mammals, opened the course by asked his students to use location tracking apps on their phones, and then segment their movements into “foraging,” “resting,” and “transiting” components, in order to give them a sense of the interpretive work going into the following of seal’s activities from afar.

My informants seemed comfortable in a role as the conduit of someone else’s data-gathering project, and this revealed aspects about how they figure the labor of data gathering in their research. I found that they were quite willing to instrumentalize their own bodies, and I was surprised by how seamlessly my solicitation that they do so fit into the rhythms of fieldwork. It seems that there was something familiar about the relationship I asked of them, given what they ask of their seal oceanographers: to be the conduit of someone else’s data gathering was a role they understood. This was displayed through their offer to bring my camera into the field for me, on occasions where I was unable to participate myself. This was late in the course of my fieldwork with the lab, at a point in my research where I usually asked one of the old-timer researchers to wear the camera in the field, rather than wearing it myself, so that I could capture aspects of “procedures” that I was not a skilled practitioner of. Their offer to carry the camera for me in my absence suggested an epistemological orientation to data gathering as something that can be delegated onto the body of another. In this configuration, the device is the thing that collects the data, while the one that attaches it to the body of another merely sets up the conditions for that capture. This parallels with how they delegate agency onto the animal oceanographer: when they outfit a female elephant seal with sensing and tracking technologies, they send her off to do the work of data collection and view their own role in the field as simple acts of attachment and collection of devices and samples, and not the place where the epistemic labor is actually taking place.

This brought to light our differing perceptions of what ‘fieldwork’ is. The experimental comparison made possible by the device required me to confront my own preconceptions about ethnographic methods. First, it suggests that my informants viewed my presence in the field as sometimes the presence of one who collects data, and sometimes the presence of a different kind of character. In offering to bring the camera for me, they were implicitly assuming that the only part of the research that was relevant for me was the parts that I was gathering with the camera, and that the rest of the time, for example driving to and from the field in the truck, was “off” time. It thus suggests that they saw me as sometimes in a role of observing and gathering data about them, and sometimes in a role of just hanging out: swapping stories, chatting, and eating donuts. It also further illuminates where they think the 'work' of fieldwork is happening. With respect to their work on the seals, for them the beach isn't the site where 'data' happens; it is rather the site of the everyday mechanics that make data gathering possible. In their efforts to 'help me get the data,' they reveal how they figure the camera as the agent of the data collection, not the one who attaches it.

This offer that they carry the camera for me further reveals something about my own prejudices about what "fieldwork" means in *my* discipline. Trained in ethnographic methods, I wouldn't consider sending my camera into the field without also being present to observe the contexts around what it captures.[218] I was therefore uncomfortable with—and unwilling to—send my camera without tagging along as well, in order to interpret the images the camera captures within a broader field of interactions, practices, and meanings. Like my informants, I have an implicit theory of how images travel and what contexts they carry when they travel, as discussed in the first section of this chapter. I thus refused their offer to bring my camera into the field in my absence.

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[218] As Alač (2011) puts it in her laboratory study of multimodal semiotic interaction with digital screens, "video records … neither fully capture nor provide direct access to the meaningful activities in the laboratory. To understand the relevant patterns in the analyzed data as part of scientific practice, I interpreted … in light of the knowledge derived from my longstanding ethnographic work" (Alač, 2011, p. 12). What ethnomethodologists call "unique adequacy" requires that the researcher should be "a competent practitioner of the science, the profession, the occupation, the job, the skill, the discipline, that [she] seeks to bring under examination" (Garfinkel unpublished paper, cited in Wakefield, 2000). Garfinkel (1967) further "states that ethnomethodology is largely concerned with 'looking and telling': the person doing the telling, that is, the researcher, should be as skilled in knowing about the setting as the person being observed" (Wakefield, 2000).

To my work it matters who attaches the devices—the devices attached to the seals, and the attachment of the GoPro—and what is going on in that scene when they are attached. For me, not anyone can gather my data: it really matters who is connected to the device. To them, on the other hand, the ones who attach the device are interchangeable. Anyone can be taught to attach the GPS-recorders to the seals, and to take the samples. In fact, "human error" in performing these tasks was explicitly being studied, to make sure there *weren't* idiosyncrasies across the practices of different fieldworkers.

In hindsight, accepting their offer might have produced something interesting, and I could have viewed it as a further extension of my goal to playfully approximate their research practices with my own. Letting them carry the camera 'for me' would have allowed me to gather data similar to what the seals gather, outside the context of the attachment of the device. Outfitting them with my camera, and then sending them off to the "field" of *my* research (the beach) might have provided further insights about how they view field practices, and given me pause to consider the difficulties of interpreting body-mounted data gathered remotely—yet another analogy with their research practice.

But, even though I didn't take them up on this offer, the fact that they presented it, and my own reaction to it, still turns out to be a product research device. What this says is that the experimental comparison between their research devices and my own were productive in their incompleteness as a comparison, not in its completeness. The recursive comparison creates tensions because the comparison isn't quite right, it doesn't quite fit. In those tensions, features of both sets of practices— such as their practices around fieldwork, and my practices around fieldwork—are made salient.

But more than a comparison of our fieldwork practices, the recursivity of the device and the practices it engenders, and its looping similarities with their devices of research also allowed other kinds of relations to emerge. These were not empathies between my own data-gathering practices and theirs, but empathies between the bodies of those who find themselves tethered to a tracking technology: that is, empathies between the bodies of researchers (including myself) and the bodies of the seals. My GoPro camera thus allowed me to ask: How does the device make a difference to what seals do? In other words, how does the act of studying animals by attaching digital technologies to them affect their ways of living? How cumbersome are these devices, and how disruptive? By working with a technology that had small but still noticeable material effects on my informants, I had an opportunity to engage with the material effects of their technologies upon *their* informants—the seals.

Because they work with hot glue, needle-administered sedatives, and charismatic mega fauna, my informants have, from necessity, developed knee-jerk responses to questions about animal welfare that can quickly transform into accusations of animal cruelty, when they interpret them in the discursive frame of animal rights. Rather than trying to navigate the minefield of dangerous words to avoid what can sound like an accusation, a critical intervention with an object asks questions differently. Critical art and critical design interventions know this world-making capacity of objects and devices. Within the field of design anthropology, it is not wellcrafted arguments, but rather speculative objects that challenge assumptions about the roles objects play in everyday life (Dunne, 1999). Artists and designers work with the ways objects "do" to compose critique and engagement not with words, but with things. By constructing an analogy between my informant's body-mounted research devices and my own, I was able to engage their practices on the material effects of tracking technology.

Asking my informants to wear the device, or wearing it myself, created small discomforts and moments of disrupted bodily practice. These moments allowed me to tune into questions about the bodily discomfort that the researchers subject the seals to, in ways that would be difficult to ask directly. In asking my informants to wear a body-mounted camera, I engaged them in questioning how attaching head, body, and jaw-mounted devices to elephant seals might affect their movements and activities. And this mode of questioning was performed on a different register than their usual way of discussing this issue. In their scientific papers, they consider it in terms of physiological strain on the animal, or even in terms of survival outcomes, not allowing themselves to speculate about what it 'feels like' to be attached with the devices.[219] But asking the

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[219] Webb et al. (1998), as discussed in Chapter 2, used weights to study the relationship between buoyancy and diving behavior, and found that their research subjects adjusted their diving behavior in response to these changes. We can only suppose that elephant seals adjust their diving behavior in response to the additional weight and drag of the devices attached to their streamlined bodies. Researchers have examined the effect of ketamine immobilization on elephant seal physiology. Briggs, Henrickson, and Le Boeuf (1975) studied the effective dose for immobilization of elephant seals and concluded: "The effect on the cardiovascular and thermoregulatory systems appears to be minimal and recovery is rapid and uncomplicated…. With pinnipeds that are quiescent on the rookery such as elephant seals, ketamine hydrochloride serves both as a capturing and immobilizing agent. If the drug is injected swiftly and the seal is left undisturbed after injection, it will usually remain quiescent and not attempt to escape. This eliminates the need for physical restraint, with its attendant stress on the animal" (Briggs et

question in this way can be easily read as an accusation, casting the one who asks it as an unscientific "whale hugger." Questions about the feelings of animals are a thorny domain, easily subject to accusations of "anthropomorphism."[220] But in asking them to wear the camera, I was also not asking them what it "feels like" to wear it. The ethnomethodological and praxiographic imperative draws attention to "surface phenomenon" (Love, 2010), demanding that we follow *doings* rather than striving for *perspectives* (Mol, 2002).[221] Thus, I paid attention not to how my informants perceived the camera, but what it did, how it reshaped their practices.

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al., 1975, p. 547-48). In a more recent study, Champagne, Houser, Costa, and Crocker (2012) found that "the combination of anesthetic agents (Telazol, ketamine, and diazepam) …appeared to alleviate a cortisol stress response due to handling in the field without altering carbohydrate metabolism" (Champagne et al., 2012, p. 1). While these papers emphasize a lack of "stress," my informants vernacular knowledge in the field was that ketamine could cause what they referred to as "ket rage," an aggression (and sometimes rejection) of the mother towards her pup. They therefore carefully monitored the mother-pup relationship after the procedure, a form of care and maintenance similar to "watching her breath" as discussed in Chapter 2. In Chapter 3 (footnote 165), I discussed the situations in which my informants found "disturbance" to be justified, and this is certainly one of them, a place where they justify human intervention to intervene in human intervention gone awry.

[220] Eileen Crist (1996, 1999) critiques the grounding upon which accusations of anthropomorphism are made. She insists that that "mechanomorphism" is a common feature of explanations in contemporary animal science, yet it is rarely critiqued. In the case of Darwin's so-called anthropomorphism in *The Expression of the Emotions in Man and Animals* (1872), she argues that Darwin ties together "bodily expressiveness" and the "perception of mental modalities" through a relation of recognition (Crist, 1996, p. 48), and thus that his so-called anthropomorphic descriptions of animal behavior are compatible with his thesis of evolutionary continuity. Her study is historical and discourse-analytical, yet it is influenced by ethnomethodological inquiries in that it doesn't institute a discontinuity between cognitive and bodily practices, and rather sees bodily surfaces not as boundaries. Yet, in praise of Darwin's anthropomorphism, recognition here is still grounded in evolutionary relation, a grounding that I complicate at the end of this chapter, by asking about forms of empathy not grounded in pre-existing similarity. For more perspectives on anthropomorphism, see Daston and Mitman (2005), an edited volume that combines evolutionary biology, philosophy, history, and cultural studies perspectives.

[221] In this way, the attention to practices and everyday doings in closely observational social sciences, such as the post-ANT and ethnomethodological traditions, in some ways parallels the ways studies of animal behavior follow phenomenon, a shared set of "rendering practices." This echoes Hodgetts and Lorimer's (2015) call that multispecies ethnographers and geographers use ethnomethodological methods, rather than traditional interview or discourse analytic methods, to ask their questions.

The device created discomfort, and sometimes made it difficult for researchers to do their everyday work. I used a head-mounting strap with the GoPro, so that the direction of the camera's view would follow the gaze of its wearer.[222] This created a lot of very jumpy footage, because work in the field involves researchers constantly checking their surroundings, managing the 360 degree space around their bodies, and, when not being able to see behind themselves, asking others to "watch their back." Yet, the camera didn't only draw attention to, or make visible, aspects of the embodied practices of the researchers, but also disrupted them. And, those disruptions drew attention to aspects of their practices that lay outside the camera's frame. By being attached to the researcher's heads, the camera drew attention to particular aspects of their embodied practice, by unsettling them. What it drew attention to was the importance of baseball caps as bodily prostheses in the body-work of moving seals. These hats were required pieces of field equipment, as important as the bright blue t-shirts with yellow block letters that clearly advertised that we were researchers from the university.[223] Baseball caps are key tools in "distracting" and "moving" animals, as I described in Chapter 3. When moving into the gregarious pod of seals, a baseball cap is held on the head, ready to be grabbed by the hand and used to gently or not so gently hit an approaching seal on the nose, coaxing it to "back up." In this way, the hat works as

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[222] I considered using a chest-mount strap, however, lots of the time my informants were bent over as they snuck towards the seals. Thus, a chest mounted strap would provide a view of their feet, not the action with the animals. The head-mounted strap allowed me to follow the direction of my informants' gaze and their gestures with their hands.

[223] Researchers and volunteers weren't allowed to be the beach at Año Nuevo without one of these t-shirts on. On a trip to Año Nuevo Island in a small boat, we wore the cotton t-shirts over our wetsuits to clearly signal that we were permit-sanctioned researchers.

an extension of the researcher's arm, a prosthesis they can use to reconfigure the spatial arrangements of seal bodies on the beach without the risk of being bitten.

I learned about the key role played by this piece of equipment by asking my informants to wear my camera on their heads. The camera and its head-mounting strap took up the place reserved for the baseball cap, and thus disrupted their work. In one moment in my footage, Julie is moving towards the pod of seals to "do the initial"[224] when a female elephant seal lunges towards her. She reaches to the top of her head to whip off her baseball cap to hit the seal on the nose, in order to "back up the animal," but forgets that she had placed the hat in her pocket instead of on the top of her head, because she is wearing the camera. Her confusion and frustration in that moment suggests that the camera has interrupted an unconscious movement of her hand to the top of her head to grab her tool: "I don't have my hat… I got it…Went to grab my…[Ef-ing] GoPro." Julie is an old-timer "seal wrangler," skilled enough to encounter the encumbering presence of the camera, and know how to respond. However, in another instance, a less skilled researcher was learning to "do the initial" and I asked her to wear the camera. In this case, the head-mounting strap wasn't adjusted correctly, and the camera kept falling towards her face, obstructing her view. In the midst of the tensest moments of approaching the pod of seals, she tore the camera and its strap off of her head, throwing it onto a nearby rock mid-way through the procedure. While the old-timer can perform her competence with the camera attached to her head, for the

[224]"Doing the initial" is collaborative practice I analyzed in detail in Chapter 3.

newcomer the camera embarrassingly drew attention to their failure to perform those same competencies.

Figure 4.4: While approaching the pod of seals to do "the initial," a researcher pulls the camera off her head as it obstructs her ability to do the work. Images by Natalie Forssman, Año Nuevo, 2014.

As I discussed in "Scrutinizing gaze" and "Heroic bodies," the particular camera-body captured and brought into being by the GoPro—its orientation to heroic bodies rather than an enactment of a judgmental eye—allowed me to attune to the skillful bodily practices of my informants. Yet, these examples suggest that the camera has material effects on those performances of skill, and just as it captures them it disrupts them by being heavy, falling off their heads, or blocking their eyes. The camera thus both subjectified my informants, in affirming the competence and skill required to do the work they do in the field, while at the same time objectifying them, reducing them to merely a conduit for the camera, a means towards the end of *my* data collection.

This parallels the tension, discussed in Chapter 2, between the elephant seal's body agentive, skillfully navigating its pelagic environment, and the seal's body objectified as a cylinder of flesh, drifting passively through the water column. The agency interposed upon the body of the animal oceanographer requires the negotiation of both activity and passivity of that body. In a parallel sense, in asking my informants to carry out their skilled bodily practices on the beach wearing my camera, they had to negotiate a similar tension of how their own bodies are figured.[225]

Embodied Empathies

In the previous section, I discussed how posing my research activities in comparison to those of my informants—and my device as in comparison to the devices they attach to the seals—allowed particular ethnographic openings. To unpack these moments of similarity making, and the purchase they can have as methods in science

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[225] In addition to creating material discomforts, the camera undoubtedly created moments of slight psychological discomforts as well, the feelings of being watched. I sought to remediate these effects by turning off the camera as soon as the procedures were finished, or whenever asked, it nevertheless provides a chance to reflect on the affective and embodied feeling of being observed by an always-on camera. From the perspective of "surveillance studies," communications scholar Kelly Gates (2016) analyzes the work of wearing cameras by police, which is fast becoming standard law enforcement practice in the USA. These camera systems, argues Gates, enact police work into a form of "media labor." The cameras "invite viewers to occupy and identify with the police gaze," encouraging favorable interpretations of "the role of police power in society." Most relevant to my argument in this chapter is Gates' discussion of the intimate affective and embodied ways that body-worn cameras articulate with professional identities. She highlights that these cameras promise labor-saving in the form of no longer having to file written reports, alongside a form of self-protection for police in potential legal disputes, while at the same time providing the satisfaction that others' might see intimate glimpses of the job's everyday challenges (this calls back to the themes in "Heroic Bodies.") Also, "the active labor" of the camera is highlighted, because of the assumed superiority of video at capturing emotion. Together, says Gates, this makes some members of the police force "very much attached to their camera attachments." On the other hand, she asks how the presence of the camera itself might change the dynamics of the relationships enacted between police and those they encounter, an "unequivocally … profoundly asymmetrical power relationship," involving deliberate or not adjustments of performances "in recognition that those actions are being recorded."

studies and multispecies studies, I end this chapter by drawing on recent scholarship on empathy as an embodied and provisional practice. In critical theory, empathy has been defined and contextualized in various ways, some of which ground it in pre-existing forms of relation between bodies, such as shared cognitive capacities for "theory of mind."[226] Other approaches, however, see empathy as a practice, as a form of relation that needs to be actively produced, an achievement of provisional and partial affinity (Despret, 2013). In closing to this chapter, I insist that empirical work in both science studies and multispecies studies can benefit from a rethinking of empathy not as a capacity grounded in cognitive attributes, but rather as a bodily practice, an achievement, and an always-partial cultivation of bodily affinities.

Beyond using my camera to tentatively place my informants in relations of comparison with the seals around the material dimensions of body-mounted technologies, the device also served as a phenomenological tool for my imagination as a researcher. It opened opportunities to co-imagine with my eyes, my camera, and my body what it feels like to have a tracking and sensing device attached to my body. This is a co-imagining with the body of the animal that involves the construction of empathetic relations. Here, empathy is not the entering of the cognitive state of the other, but the construction of bodily affinities. This is not a "romantic empathy" that assumes that the perspective of the other—and the possibility of inhabiting it—is natural or pre-given. Rather, it is empathy as embodied labor or body-work, an empathy

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[226] See Gallese (2003) on the proposed connection between empathy and theory of mind. For a recent review of critical theory and biology theories of empathy, see Bubandt and Willerslev (2015).

that requires constant making and maintaining, work that highlights it as always partial and provisional.

Philosopher of psychology and ethology Vincianne Despret discusses empathy in these terms. In exploring the ways scientists engage their bodies when they interact with the animals they study in the field, she insists, "empathy is not experiencing with one's own body what the other experiences, but rather creating the possibilities of an embodied communication" (Despret, 2013, p. 71). Despret praises those close observers of animal lives that do not attempt to "inhabit" the perspectives of their animal subjects, but rather that they work to generate "bodily affinities" with them, which involves imitating the gestures, habits, and attentions of their research subjects as a way to understand their embodied worlds. She discusses the techniques of writer and biologist Farley Mowat to figure out the metabolism and foraging habits of wolves by eating what they eat, and of primatologist Shirley Strum to learn to pay attention to what matters to baboons by paying attention to what they pay attention to. Out of each of these, she draws out that these practices of mimicry do not strive to become the other, but rather to generate partial affinities. Rather than falling into to the longstanding cognitivist metaphysical debate of whether seeing—or sensing from—the perspective of another species is possible,[227] Despret casts empathy as what I have called in this dissertation a "surface phenomenon" (Streeck, 2009). For her, empathies are

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[227] Nagel (1974) is a classic philosophical articulation of the issue around the question of sense or "qualia." See von Uexküll (1940/2010) for an earlier discussion that postulates that each organism lives in an *Umwelt* or "world" composed of the parts of the world that have meaning to them. See also the work of Crist (1996, 1999) discussed in a previous footnote.

constructed affinities, and they are always "partial connections" (Strathern, 1991/2004).[228] Rather than an innate gift of cognitive capacity that pre-exists the encounter, empathies are always actively constructed in interaction.[229]

Historians and anthropologists of science Carla Hustak and Natasha Myers (2013) make a related conceptual shift around empathy in their playful re-reading of Charles Darwin's practices of investigating orchids. They focus upon Darwin's material interventions with orchids, particularly his experimental activities of simulating mimesis with insects that pollinate them, where he worked "by inserting himself into the kinesthetic and affective relations of insects and orchids." Rather than seeing these practices of mimesis as "a typical anthropomorphic restating that models the flower on the anatomy of man," they read Darwin as "conducting a 'body experiment'—an embodied twist on the well-known 'thought experiment'—that finds him exercising his kinesthetic dexterities" (Hustak & Myers, 2013, p. 92).[230]

Despret's re-casting of empathy as partial and provisional—and Hustak and Myers' focus on knowledge practices with other species as "body experiments"—

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[228] See also Haraway (1991, p. 113) and Mol (2002, p. 80)
[229] Theories of empathy that see it as an innate gift are instances of what Despret calls "romantic empathy," the sense that interactions exist within already-formed wholes, rather than the practice-oriented insistence that doings make wholes. Psychological theories of empathy ground it in the capacity for "theory of mind," which is the "ability to imagine how others see and experience the world" (Bubandt & Willerslev, 2015, p. 9). While these theories of empathy also take the "mimicry" of "senses and sensibilities" as central, they restrict empathy to higher mammals (for example, for primatologist Frans De Wall, intention-reading is part of a hierarchy of capacities biologically grounded in cognition), cutting off the radical potential of empathy as cultivated affinities that do not ground it in recognition of the other as in some sense the same as the self.
[230] Also see Alač (2009) and Vertesi (2012) for analyses of embodied practices that can also be understood as mimicry or a "partial" affinity with the body of another in relation to technology. Alač closely follows the work of designing the movements of social robots, while Vertesi follows the teams that work together to direct the movements of Mars Rovers.

provides methodological insights for both ethnographic science studies and multispecies ethnography. Both analyses suggest that mimesis, imitation, and the "cultivation of affections and sympathies for…experimental subjects through intimate encounters" (Hustak & Myers, 2013, p. 92) have potential as research methodologies that avoid the cognitivist reach to "inhabit" the perspective of the other, and instead demand attention to material experiments that go towards, but never quite reach.[231] In both of these accounts, the active and participative generation of partial affinities, the cultivation of sites and practices where we can move and be moved by our informants—both human and nonhuman—is the measure of good research.[232] In this chapter, I have read my work with the camera in the field as a version of this undertaking of the bodily labor of responsiveness. Imitating my informants in the repetitions and reciprocities of collecting data, "thinking inside the infrastructure" (Helmreich, 2007) of their everyday knowledge production, allowed recursivities between our methods and practices, experimental moments to generate partial affinities. While it might seem unconventional to compare attempts to think interdisciplinarity and collaboration with

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[231] Spivak (1988) is concerned with the problem of the "permission to narrate." In her question "Can the Subaltern Speak?" she asks what it means to narrate for those who cannot. "Speaking for" is a version of the same problematic of "inhabiting" that Despret discusses. Spivak states that "part of our 'unlearning' project is … measuring sciences, if necessary [as part of the] object of investigation" (Spivak, 1988, p. 612).

[232] Latour (2004a) and Despret (2004) discuss this in terms of "asking interesting questions." They insist that the measure of "good science" is asking questions that leave open the thing studied to provide opportunities to differ, to ask questions open enough that our study subjects can help us re-articulate the questions we ask of them. They talk about this in terms of maximizing the "recalcitrance" of the research subjects by giving them power to change the course of research. For example, when working with sociologist Jocelyn Porcher on an industrial pig farm, Despret and Porcher asked, "what is the best and most interesting way to ask a breeder a question … that will elicit an interesting and interested response?" (Despret, 2008a, p. 132).

natural scientists on the same term as trying to think about the possibilities of knowing animal lives in multispecies ethnography, both can be connected when empathy is thought of as the bodily labor of responsiveness. These more-than-human methods, created from the constraint of the difficulty of taking the "perspectives" of non-human others, can re-make methods for looking at humans as well. At the end of the day, this can be thought of as an argument for not using humanist methods on humans either. Rather than aiming to inhabit the perspectives of my (human) informants, to become and "insider" or "go native," bodily practices of mimicry allowed the generation of affinities that do not presume a geometry of "insides" and "outsides" of social worlds or epistemological standpoints. This is a lesson for both STS and anthropology, so interested now in "taking seriously."[233] In both, we need to let go of the hope of taking "perspectives" grounded in pre-existing similarity in our research methods, and work with the modest promise of cultivating affinities.

This also implies a way of thinking about the camera, and the kinds of knowledges *it* affords. I propose that we can aim towards cultivating partial affinities as a methodological stance not just with nonhumans, or with researchers with different epistemological commitments, but also with representational devices. If "partial affinity" need not be grounded in shared cognitive attributes, and if particular cameras, like particular organisms, have particular bodily forms that matter to how they see and do the world, can we also aim to attend not to the "perspective" of the camera, but

[233] This discussion in anthropology has been centered on the work of Eduardo Viveros de Castro. See de Castro (2011), and Candea (2011) for a response. See also Swanson's contribution in de la Cadena et al. (2015) for a discussion of how "taking seriously" might relate to cross-disciplinary conversations.

rather to cultivate partial embodied communication?[234] As Cartwright and Rice (2016) discuss in their media archeology of viewfinderless cameras, the camera's lens has taken a predominant place in the theory of film and photography. There, it is taken both "as synecdoche for the whole of the camera," as well as having "the power to serve as the extension of [the] eye." To re-word the quote from Hustak and Myers, discussing Darwin and his orchids, we could see this as "a typical anthropomorphic restating that models the [camera] on the anatomy of man." Or, as both Hustak and Myers do with Darwin and orchids, and Cartwright & Rice do with bodies and cameras, we could see this not as a practice of mis-directed anthropomorphism, but rather a provisional practice of cultivating bodily affinity. Further, though, as Cartwright and Rice note, "the lens has been at the center of discussions about … identification." In proposing to consider the condition of *viewfinderlessness*, they suggest that the theory of film and photography may be oriented to different parts of the camera-body, and thus different topics. Dwelling not on the lens, not on identification and "seeing-as" the camera, opens up other topics beyond identification or inhabiting of the subject position of the other. This allows video methods that don't assume that the camera 'sees as we do.'

In this chapter, I have proposed that bringing a small viewfinderless body-mounted camera into the field worked as a "body experiment," which generated

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[234] For a discussion of the methodological purchase of attention to bodily form in noticing "more-than-human sociality," see Tsing (2013). See also van Dooren and Rose (2016), who use the term "ethos" to designate "an embodied way of life," where clean divisions between morphology and behavior are harder to draw. They also discuss the problem of "recognition" of sociality in organisms that are not "like us," referencing Hird's (2009) study of bacteria and bacteriologists. These problems or "recognition" speak to the same problems of "empathy" I have discussed in this section.

moments to consider not just how devices see—the images and data they produce—but how they act, do, and make relations. More than a device for gathering data or images, or rather through its work of gathering these immaterial traces, the camera does other material work. In this chapter I have focused upon that work. The "camera body" (Cartwright & Rice, 2016) of the GoPro—"the composite of the camera and … bodies in expressive configurations"—acted as a "body experiment"—a way to attune to the agencies imbued to visual and data-gathering technologies in the field.

Entering my ethnographic field with a camera was something I did both seriously and playfully.[235] I did not initially conceive of it as a comparison-making practice. Yet, entering this particular field with a camera generated an almost-symmetry, a set of partial affinities, between my research practices and devices, and the research practices and devices of the scientists I followed. The researchers track the animals. They do it through devices that allow them to follow. I tracked the researchers tracking the animals, following *them* around. I also tracked the animals, in their encounters with the researchers. I used the camera, my eyes, my notes, and my body. While they gathered data by attaching devices to animal bodies, I followed activities and interactions by strapping a GoPro camera to my head, or asking my informants to do the same. Our research practices were both kinds of fieldwork, aimed towards 'getting the data.' These research devices were forms of both body-mounted

[235] On "serious play," see Haraway (1991).

technologies—technological devices that trace the movements of bodies through environments.

Conclusion

This dissertation set out to examine the staging of the "animal oceanographer" at the edge of the sea. My inquiry into the practices of this staging worked transversely to a framing of the animal oceanographer as an infrastructure or platform for long-distance vision. I aimed to open up the field site and practices where the seal oceanographer is outfitted by examining the coastal shore as an "ecology of practices" (Stengers, 2013) involving researchers, seals, and technologies, all situated within evolutionary, ecological, industrial, epistemic, and technological histories. At the center of the project's inquiry was the "body-work" (Myers, 2008, 2015) and "embodied coordinations" (Alač, 2011) involved in the everyday practices of fieldwork research—the corporeal negotiations involved in approaching, sedating, measuring, and instrumenting elephant seals before their long pelagic journeys.

Through four chapters, I moved between genres of descriptive methods for attuning to ecologies and technologies, and their entanglements with bodily practice. Chapters 1 and 3 focused on the *interactive landscape* of the beach and the somatic and social doings of northern elephant seals, while Chapters 2 and 4 centered on *technologies and their articulations with bodies* both human and nonhuman. In engaging landscapes, human and nonhuman bodies, and technologies together in this project, I developed an analytic lens to extended vocabularies of doings, practices, and behaviors across phenomena thought to be entirely distinct. Landscapes help us to grasp how knowledge about non-human others, and the concepts and technologies produced to generate it, are co-constituted by historically and materially situated encounters. At the edge of the sea, seal behaviors and biological rhythms intersect with those of human researchers and "thought collectives" (Fleck, 1935/1979), producing some kinds of knowledge and not others.

Several propositions emerged, reverberated, and unfolded across the chapters. Here in this conclusion I draw out—and further develop—several of them: first, an engagement with shape or form; second, a reflexive engagement with methods that separate and de-compose their phenomena; third, an inquiry into the pitfalls and possibilities of comparison; fourth, a development of agendas in studies of human-animal interaction; and fifth, a discussion of discourses of sex and gender, and femininities and masculinities. Within each of these thematic threads, I point to directions not taken in this project, and openings for further research. I end with a consideration of how this project could have developed in the hands of another, why I took the focus that I did, and where it allowed me to go. I end with some final thoughts on the ideal of inter-disciplinary collaboration across natural scientific, social scientific, and critical interpretive disciplines.

Propositions and Themes that Run Through

Shape and Form

By centering my inquiry on "edges"—the edge of the sea, edges between and within bodies, and edges among communities of knowledge practice—this project orbited around questions of shape, form, and morphology. I opened with a visible and consequential material edge—the edge between land and sea. I ended with edges between bodies and edges between disciplines. Edges are contoured shapes, requiring descriptive knowledges to characterize their non-reducible patternings. As stated in the Introduction, I began with the edge of the sea as the site and method of this project, contrasting my approach with a "frontier" perspective that emphasizes expansion, omniscience, and movements and flows *across*. Instead, I aimed to draw attention to coalescences and gatherings *at* the edge. In this move, I build on work that sees flows as taking form not through smoothness, but through oppositions, struggles, and entanglement.[236] I extended this approach to my inquires into other articulations of edges, aiming to grasp the edges between bodies and knowledges not as *boundaries* with insides and outsides, but rather as *sites* to be known via the cultivation of surface reading practices (Love, 2010) and experimental propositions of partial affinities (Despret, 2013).

In Chapter 1, I examined how the material features of the coastal edge have shaped the interactive repertoires of the elephant seals that make Año Nuevo their seasonal habitat. I re-read behavioral ecology and historical ecology findings as claims about *nonhuman practice*, and furthermore as claims that elaborate an *ecological* approach to practice, where practices are situated in the specificities of the settings that

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[236] Theorizations of water in the humanities have attended to water's connective and flowing material capacities, such as in discussions of "wet ontologies" (Steinberg & Peters, 2015). However, recent work questions this focus on connection and draws attention to disjuncture and friction (Tsing, 2011; Bear & Bull, 2011). This project builds on this tradition by not taking the edge of the sea as a site of flow and movement across, but rather as a site where particular human and nonhuman practices are encrusted, sedimented, and afforded.

afford and enable them. This chapter, in framing and opening the overall project, offers a contribution to re-thinking interaction by offering a historical, material, and behavioral perspective attuned to historical contingency to a focus on practice in STS that is often present-oriented in its orientation to enactment (see Asdal, 2012). In doing this, I amplify and extend the close attention to material specificity present in these ecological accounts, in order to situate and challenge narratives that would see this site, and the seals that aggregate there, as serendipitous found objects for knowing the deep ocean. In contrast, I attended to the way the material affordances and constraints of the coastal shore form not only the particularities of how seals relate to one-another, but also of how researchers interact-with, approach, and corral them. Thus I located the interactive repertoires of researchers on the shore within the same kinds of attention to specificities that historical and behavioral ecology demonstrate. This provides an opportunity to consider my informants' knowledge practices not in terms of a narrative of progress across the edge of the unknown—towards more and more encompassing vision—but rather as materially specific practices that reach for knowledge of the deep ocean in situated ways. The conditions of possibility of this scientific work are encrusted upon the material, sensory, and interactive affordances of the edge of the sea.

In Chapters 2 and 3, I moved to an examination of the edges between and within bodies, by looking closely at interactions between seals and scientists in the field to produce research subjects and data objects. While there is much work on the more-than-human in critical geography, multispecies anthropology, and STS (for example, Whatmore, 2006; Lorimer, 2010; Tsing, 2013), these chapters drew us back to the place of the human observer and researcher in practices of engagement with the more-than-human, and to the thus far under-considered intersubjective and affective dimensions of bioinformatics and environmental sciences practices. This is disciplinary edgework between more-than-human and new materialism and STS work on human-computer interaction and other practices of engagement with data forms (Suchman, 2007). Chapter 2 focused on bodily shape and the shapes of paths of movement—first, how the contours of the seal's body are characterized while she is sedated, and second, how the undulation of her path of continuous diving and surfacing are apprehended as data. I described how these two engagements with shape are coupled: how the measurements that separate the seal's body into fat and non-fat materials on shore allow the dive track to be read as a record of activities at sea.[237] Thus, this chapter examined my informants' explicit concerns with shape, and how they work with shapes as data objects. It is important to examine the work through which complex lively entities are turned into quantitative entities to understand the transformations that generate big-data about life-sciences phenomena, at a time when life and earth sciences data are garnering increasing attention with climate change and mass extinctions.

Researchers obtain "morphometrics" by taking more than sixty measurements of the seal's dimensions that are transformed through digital crunching and modeling into a decomposition of the seal's body. In an analogous set of practices that transform

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[237] While others in STS have looked at forms of coupling where at-a-distance and universalizing vision is grounded in embodied practices with data (see recent volumes edited by: Lynch et al., 2014; Carusi, Hoel, Wemboor, Woolgar, 2014), my contribution was to examine how the activities of nonhuman animals are figured through such practices, an important contribution amongst interest in the "more-than-human" and "new materialisms" that too often takes scientific findings about nonhumans at their word.

shapes into numbers and ratios, I looked at how these on-shore measurements are used to give meaning to my informants' methods of reading the seals' dive track data. Here, the shapes of dives are abstracted into "types," which in turn provide researchers with the seal's "activity budget"—where and when she is transiting from place to place, searching for and capturing prey, and resting or digesting. I discussed both of these practices using the term "rendering" in order to highlight how the taking apart of entities is part of acts of representation. Here, while my informants' inquiries appear at first blush to be concerned with shape and morphology, through their rendering work shape is transformed into numbers and ratios.

In Chapter 3, I took a different approach to shape and its everyday manifestations in the doings of research. Rather than following physiological and spatial data points, and other objects of explicit concern for my informants (as in Chapter 2), I sought to grasp the unruly more-than-human entities that my informants must engage to produce those objects of deliberate concern. I took as my focus the aggregate social forms of female elephant seals on shore, the tightly-packed assemblages of bodies that researchers approach and intervene upon in order to draw out and outfit an individual "animal oceanographer." Rather than inspecting and bemoaning the reductions of my informants research questions ("critique") or taking their research findings at their word ("extraction"),[238] in this chapter I pursue the possibility of inquiry beyond or in addition

[238] I borrow the terms "critique" and "extraction" from Mackenzie and Murphie's (2008, cited in Hird, 2009) typology of "three different stances towards Science and the sciences that thread through contemporary humanities/social sciences scholarship: critique, extraction, and engagement" (Mackenzie & Murphie, 2008, p. 88).

to their explicit research concerns, and propose to revive descriptive methods as potential “successor sciences” (Harding, 1986, 1987) that can do justice to shape and form. Just as in Chapter 2, my concern here was with how contingent disciplinary histories shape the curiosities and scope of present practices, delineating what becomes a question of research and what does not. But in Chapter 3, I engaged histories of disciplinary knowledge not only to highlight what knowledge practices erase, but also to highlight how that which is erased has previously been—and might again be made to be—an object of research. This is disciplinary edgework between ethnography and history and philosophy of science, an ethnography informed by and informing an older tradition of feminist epistemology. I followed in the tradition of early feminist projects in biology in order to ask how research questions might be asked differently, attuning to and amplifying different phenomena, sketching a way forward for both a science studies and an animal behavior research practice concerned with the aggregate shapes of nonhuman socialities, and interested in amplifying the doings of those entities that have too often been considered as passive or merely “resisting” the schemes imposed upon them. In Chapter 3, thus, I aimed to revive shape and form as an object of empirical concern, pursuable with descriptive “arts of noticing” (Tsing, 2013). Further, though, I engaged not only the *content* of early feminist biology critiques, but also the various *forms* of response to their provocations—the strategies of interruption, inversion, and amplification, which are *shapes* of engagement with the empirical phenomena at hand that reach beyond discursive critique. These shapes of engagement and response can challenge us to rethink how we might approach the edges between disciplinary knowledge, in order to cultivate methods and questions that dwell at these edges and construct partial affinities across knowledge communities.

In Chapter 4, I again approached morphological shape and bodily form by following how my camera not only captured and elucidated, but also reconfigured, mine and my informants' practices in the field. I engaged with the "bodily form" (Tsing, 2013) or "camera-body" (Cartwright & Rice, 2016) of the body-mounted camera—both its material capacities as a technical device, and how it articulates with and re-does the body of its wearer. I examined the repetitions, reciprocities, and recursivities produced by engaging my field site with this technical device, expanding on "tiny viewfinderless cameras as technologies of intra-subjective action" (Cartwright & Rice, 2016) by describing how this device participated in elucidating and shaping the topology of relation between an ethnographer and her informants and site. By using my fieldwork encounters as an opportunity to place this technical device in partial experimental analogy with the devices my informants use to follow the seals, I confronted the question of the shape of relations of affinity or empathy (Despret, 2013). This led to a reconsideration of "insides" and "outsides" as an appropriate topology for characterizing how engagements are cultivated between bodies, between species, between disciplines, and in ethnographic encounters. This contributes to a rethinking of the spatial metaphors used to characterize and describe ethnographic encounters—moving from an ideal of "immersion" or "insiderness," to an attention to the shapes of edges between forms of practice, and the partial affinities cultivated at these zones of interface. And, beyond contributing to the theory of ethnography, this also contributes to a theory of interaction and empathy, by insisting that intersubjective and interdisciplinary relations need not be grounded in pre-existing similarity, but rather in the cultivation of practices that *construct* connection.

Gathering these disparate threads from across the four chapters suggests a diversity of ways that form and shape are productive descriptive attunements and conceptual analytics: both needed (and often neglected) orientations to empirical encounters, and tools for noticing the topological metaphors of theoretical terms for describing them. 'Edges,' as an analytic, pushes this engagement with form. Yet, it deserves further attention and analysis beyond the scope of this dissertation project. Particularly, I neglected a fuller historical engagement with the biology of form (for example, in the German tradition of romantic biology), and a responsible and nuanced history of the eclipsing of natural historic descriptive practice with other forms of biological and ecological research (see Nyhart, 1995, 1996). While I have relied upon history of biology sources in this project, this dissertation is not a primary source historical study, and thus a deeper engagement with the nuance of the histories of knowledge at play in these practices is a direction for further inquiry, beyond the current scope.

Methods that De-compose

My engagements with shape in this dissertation project might be termed "holistic" or "romantic" (Kwa, 2002; Richards, 2010) in that I advocate for relational, descriptive, and experimental research methods that don't proceed by splicing edges, bodies, and interactions apart, but rather attend to their form and shape aided by materially descriptive attunements.[239] Yet, in my own methodological attunements coming from anthropology, communication and interaction studies, and science and technology studies, I have not aimed—and have not believed it possible—to escape separation and simplification as an analytical strategy. As discussed in the Introduction, issues of representation and rendering have been an explicit topic of inquiry in this project: both in considering my informants' research practices and the scientific discourses they participate in, as well as thinking about how the methodological toolkit of embodied interaction analysis itself imposes certain choices of rendering and representation, which might themselves be understood as violences to the material they analyze. These questions—of my own complicity in methods of separation—were confronted in particular in Chapters 2 and 3. Chapter 2 examined my informants' practices of rendering bodies as abstract shapes, and how these virtual de-compositions reference earlier industrial renderings of marine mammals. I thus called attention to the histories embedded in virtual rendering practices, which dictate modes of separation and splicing. Chapter 3, on the other hand, used my informants' practices of coaxing and pulling apart the aggregate formations of female elephant seals in order to amplify vernacular knowledges of the aggregate as a non-reducible entity. Thus, in Chapter 2 I

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[239] A sufficiently nuanced engagement with the forms and histories of holism is beyond the scope of this project. However, Chunglin Kwa offers an adept analysis of different concepts of wholes in the science, pointing out differences between a "romantic" conception of society as an organism, and a "baroque" conception of an organism as a society. While romantic holism trades in the terms "integration," "emergence," and "unity," "harmony, as it was practiced throughout the baroque era, is the art of counterpoint, bringing together different voices" (Kwa, 2002, p. 29). On this art of counterpoint as an analytic style, see also Tsing (2015) where she discusses "polyphonic" assemblages that don't strive towards unified rhythm and melody (Tsing, 2015, p. 23-24).

critiqued certain separations, and yet in Chapter 3 I suggested that my informants' separating practices as sources of knowledge that could reinvigorate descriptive studies of nonhuman social forms. In this way, Chapter 3 perhaps too quickly venerates practices of pulling the pod apart, suggesting the knowledge gleaned from these often-violent practices of separation is worth that violence. This unequal treatment of separations and their stakes begs the question of which kinds of violences and separations generate knowledge worthy of "amplification" (Kohn, 2013; Myers, 2015), and suggests that nuance is necessary for doing good 'disaggregating'—in the methods and analytics of ethnography as well as in those of the natural sciences we critique.[240]

I also aimed to directly engage with the violences of the video ethnography methods I employed in Chapters 2, 3, and 4, taking seriously the issue—articulated by Natasha Myers—that "video ethnography poses a challenge to [body-work] research. To make movies, or isolate snapshots … mid-gesture, is to cut into…a larger social and semiotic context for expression and meaning making" (Myers, 2015, p. 273). Myers worries that the methods of video ethnography don't allow the features she wants to amplify in biological research practice to be made salient. I took these questions of amplification seriously in this project. In Chapter 3, for example, I aimed to re-direct embodied interaction studies' methods for noticing co-produced action between humans

[240] In some ways, my advocating for the taking apart of the pod as a way to glean knowledge of seal aggregate sociality—a happy unintended consequence that can provide insights—recalls ecologist Jim Estes' discussion of the "serendipity" of his research career, the lucky break of finding in the Aleutian Island Landscapes he studies a case where ecologies denuded of their native fauna (sea otters from the Russian/American fur trade), provided a perfect "natural experiment" to study the relations between sea otters, kelp forests, and sea urchins. The complicities of such serendipities require careful attention and response-ability (Despret, 2004; Barad, 2007; Haraway, 2008).

and technologies to look at human-animal relationships. However, I also pushed back against some assumptions of this tradition, where humans are the focal actor, and—when studying scientific practice—that what is to be followed and therefore amplified are practices of reduction and simplification that researchers perform. Instead, I asked if the complex socialities erased (but still contended with) in my informants' practices could be made objects of investigation with the aid of this methodological tradition. I compared what my video footage makes salient with earlier descriptive inquiries into elephant seals, suggesting—if incompletely—video methods for noticing embodied interaction as a possible heir for earlier descriptive methods in biology.[241]

In Chapter 4, I again worked in a tradition of video ethnography, but in this case I took up visual anthropology, ethnographic film, and film studies' focus on the camera as an apparatus that produces relations, and aimed to bring that mode of attention into STS research practice. Yet, while influenced by the sensory ethnographic filmmaking tradition, I did not conduct my ethnography as a filmmaker, and no film resulted from this project. This dissertation thus begs closer engagement with filmmaking practice, as a next step in the development of the methodological direction I have sketched in nascent form towards video methods as a "successor" science for descriptive methodologies. This is a contribution to visual studies, visual anthropology, and the sensory ethnographic filmmaking tradition, disciplinary conversations that have engaged extensively with questions of if and how to represent and render encounters.

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[241] This makes such descriptive methods imperative in the Anthropocene, where co-produced human-nonhuman doings urgently require focal attention.

The Pitfalls and Possibilities of Comparison

Another thematic thread that emerged and developed across the chapters, chiefly in Chapters 1 and 4, was an inquiry into comparison and analogy-making.[242] In Chapter 1, my approach to closely examining the material conditions of knowledge production was closely influenced by Thelma Rowell's (1987) attention to material specificity in her career as a zoologist. In that chapter, I discussed the caution she prescribes about the applicability of the concept of the "harem" to describe animal sociality. She provides good reasons for close attention to material conditions both when proceeding from human economic institutions to animal social arrangements, and when making comparative moves between different forms of animal sociality situated in different ecological affordances.[243] In Chapter 1, I took seriously her assertion—which inspires Stengers' concept of "ecology of practices" (2013)—that practices must be understood as constituted through their ecologies, which makes comparative leaps across branches of the Linnaean taxonomy less well-advised than looking at particularities of ecology and how they structure forms of life, and asking how different "livabilities" (Tsing, 2015) are forged in specific and historically contingent environments. Rowell's careful attention to the work of comparison encourages a scholarly practice of closely attending

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[242] See Choy (2011) and Swanson (2013) for ethnographies of comparison. Anthropologists have thought through the pitfalls and possibilities of comparison with particular nuance (see Strathern, 1991/2004), and a complete engagement with that literature is beyond the scope of this project.

[243] Rowell critiqued both of these forms of comparison in an essay entitled "A Few Particular Primates" (2000), where she noted that North American primatology has been situated in anthropology departments, restricting its focus to the human-primate comparison, and not attending to other animals in the comparisons: the important differences both among primates, and also among primates and non-primate animals.

to the local conditions that shape human and nonhuman sociality, knowledge production, and bodily doings: economic, material, sensory, somatic and extra-somatic, and more.[244]

Yet, in Chapter 4, I took comparison and analogy-making in a very different analytic direction than this one suggested by Rowell and Stengers to always examine practices with respect to the ecologies which give rise to them, and to which they respond. In that chapter, I examined the camera with which I followed my informants' bodily coordinations in the field as an analogy-making device—a technique and technology of both documenting my informants' community of practice, and entering it as a partial participant. There, I re-thought comparisons as not statements of fact, but experimental, world-producing practices: material acts that, by bringing disparate phenomena into temporary relation, highlight sameness as well as tensions of divergence, and produce emergent effects. I used my recording device to draw attention to a shared history of visual recording technologies as data-gathering devices across biological and social science research practices. Further, I found in those constructed affinities (Despret, 2013) some inroads to modest moments of 'collaboration' with my informants.

I also examined the relations between acts of comparison and assumptions about the existence of *boundaries* or *edges*. So, in Chapter 1, I briefly discussed how the

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[244] In this sense, this project could benefit from a more comparative engagement with other sites where seal behaviors, biologies, and coastlines articulate with human practices and epistemic cultures. In particular, sites in Greenland, Alaska, or the Canadian arctic where scientific research and indigenous hunting exist in a shared landscape could be a fruitful next project or elaboration of this research.

ritualized mating contests between male elephant seals are understood by behavioral scientist as acts of comparing bodily armory, where the animals do not fight but rather ‘act out’ fighting in order to compare “fitness” and determine who is dominant in the mating hierarchy. On the other hand, I noted that it is harder to apply this comparative competitive logic to female elephant seals on shore, because there is no “resource” they compete for in this environment, and thus they pack their bodies very closely together, making it harder to practically and analytically resolve them into individuals. This highlights both that comparisons *enact* difference, and that there is an intimate relationship between understandings of comparisons and understandings of *boundaries* or *edges* between entities.[245]

So, first, I praised cautious comparison, saying it is imperative to always situate the practices of the phenomena studied, and of those studying it, in their ecologies. Then, I advocated for experimental comparison, suggesting that comparisons are performances and apparatuses for making connections. These seem in tension or even add odds with one-another. Yet, if we understand comparisons as devices or tools that shape the phenomena they examine—devices that we must be response-able to—these are actually compatible projects. Rowell’s attention to comparisons as non-neutral is in line with an active practice of constructing comparisons in order to draw out and make

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[245] Further thinking through these conceptual issues around comparison could benefit from a deeper engagement with work on comparison and connection by Marilyn Starthern (1991/2004), who insists on working against “units” in comparative projects, and attends to the ways “external differences connect to internal ones” (Strathern, 1991/2004, p. 35). Building upon Haraway’s (1991) work on the cyborg, she states that, “the relationships for forming totalities from parts are questioned, as are the relationships of domination and hierarchy promoted by the dualities of encompassment—such as self and other, public and private, or body and mind” (Strathern, 1991/2004, p. 37).

salient affinities and connections.[246] In the experimental comparisons I made in this project, I insist that the issue at stake is not only genealogies of connection between forms of knowledge, but also about situated practices that construct and make affinities. In this way, my approach has a conceptual affinity with Donna Haraway's argument against biological or genealogical kinship, and insistence on the cultivation of kinship across difference, where recognition need not be grounded in pre-existing similarity (Haraway, 2016).

Thus, part of my approach to investigating seal sociality in this project was explicitly *not* through schemes that see higher mammals as possessing cognitive and communicative capacities that overlap with those of humans, and therefore "almost human" (Strum, 1987). Rather than grounding my investigation in evolutionary or genealogical kinship between humans and other animals (and in the psychological and behavioral sciences), I used multispecies and more-than-human studies' rich engagements with plants, bacteria, fungi, and landscapes. These are forms of life on distant branches of the "tree of life" from humans, yet entangled with us through landscapes and mutualisms. Learning from these investigations how to look at animals, I insist, can refresh the questions we might ask about animals, too. Animals provide rich

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[246] Some comparisons I either critiqued or made in this dissertation include: comparisons between the social habits of humans and of nonhumans embedded in the concept of the "harem;" comparisons between human investigators of the ocean, and seals as "oceanographers;" comparison between the methods of embodied interaction analysis and the spatial ecological investigations of my informants; comparison between a seal glued with GPS, temperature, salinity, and depth measurement devices for half a year, and a researcher who is asked to wear a camera for half an hour; comparison between humans and seal bodies as decomposable into their component parts; comparison between the bodily comportments of wildlife biology field work and hunting and adventure sports; and comparison between 1960s descriptive engagements with the seal rookery's spatial distributions and contemporary social science interest in shape and description.

opportunities to consider and rethink the mammalian and the human, crucial junctures in the turn towards the “multispecies” that this project participates in developing.

Human-nonhuman Interaction, and Interventions in Studies of Animal Behavior

This dissertation project developed a particular mode for noticing and following human-animal interaction, grounded in close reading of behavioral ecology findings about elephant seals, alongside the micro-analytic traditions of ethnomethodology and micro-sociology—with attention to landscape and ecology on the one hand, and devices and technologies on the other. I engaged extensively with findings about elephant seal behavior, especially in Chapter 1 and Chapter 3, yet the researchers I followed were *not* chiefly behavioral scientists, but rather spatial and physiological ecologists.

This created certain openings, and different opportunities for amplification than following behavioral or psychological research on these animals might have led to. It allowed me to follow research practices less focused on “mind” and internal capacities and behaviors, and instead adopt an ecological and relational analytic from my informants. Furthermore, it allowed me to advance questions about ethology and animal behavior research practice from a sideways approach. By taking landscape and ecology seriously as part and parcel of behavior, I was able to ask the question of what an animal behavior research practice might look like that doesn’t prioritize monitoring and control as its necessary research requirements (Chapter 1). This provocation, inspired by the pioneering work of philosopher of ethology Vincianne Despret (2012/2016) that aims to expand the range of questions asked of animals, was thanks to the landscape perspective that I took in this project.

Another benefit of a landscape or anthropocenic perspective to questioning the terms and methods of animal behavior studies relates to my claim that human-animal studies and multispecies ethnography have overly focused on evolutionary and developmental “shared pidgins” (Kohn, 2013) between humans and other organisms. By looking at interactional repertoires between elephant seals and researchers, I investigated the uncanny interspecies repertoires of interactants that have only in the last half-century come into frequent and intimate contact. I insist that we need different tools for characterizing interaction and relation in what science journalist Elizabeth Kolbert calls the “New Pangaea” (Kolbert, 2014), those emerging ecologies where scripts of co-species interactions cobbled together over evolutionary time are reshuffled because of the unexpected movements and contingencies instigated by the landscape changes of the Anthropocene or “capitolocence.” In relation to this topic, a form of co-species interaction I left under-analyzed in this dissertation is interactions between researchers and male elephant seals. Male elephant seals are not focal research subjects for my informants, but must nevertheless sometimes be contended with in the field, making interactions with them particularly interesting. While these interactions have been characterized as the exchanging of “intentions” (Schusterman et al., 1992), I insist that an “ecology of practices” (Stengers, 2013) and “new Pangaea” (Kolbert, 2014) perspective demands a different analysis.

Sex and Gender, Femininities and Masculinities, and Economies of Bodies

Another thread that runs across the chapters is discourse of sex and gender—and femininities and masculinities—as they move between humans and animals. Female elephant seals are seen by my informants as better research subjects than males because of the focus upon reproduction that grounds population research, and because of the stability they are assumed to embody in reproductive relationships, where they are understood to make a higher "investment" in their young and therefore are more reliable research subjects in a scientific practice that demands site fidelity and year-to-year consistency. Yet, they are seen as behaviorally unstable—and difficult to work with in lab-based research—because they haven't developed the ritualized communicative repertoires that male elephant seals have through sexual selection. Thus, different kinds of "predictability" and "unpredictability" are assumed of male and female animals, grounded in the pragmatics of research. It is important to study these pragmatics to see how these orientations to biological sex color research questions and projects.[247]

Furthermore, framings of female bodies around reproductive predictability require gender critique because often in such framings, "the biopolitics of reproduction is finally reduced to competition," and the "the very concept of 'resource' could thus be accused of bringing mating down to reproductive success" (Hoquet, 2010, p. 121). In

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[247] Historians of science have pointed out gendered assumptions present in how biological research has been practiced, tracing how pervasive Western assumptions about sex and gender have shaped ways of asking questions about male and female animals in lab and field. Particular attention has been paid to scientific fields related to human health, where the implication of creating models of all human bodies based on male animal models are particularly dangerous and problematic. Neuroscientists Beery and Zucker (2010, 2011) undertook a quantitative analysis of this topic and concluded that, because of the estrous cycle of female rodents, which is erroneously assumed to be more difficult to work with in the lab, rat and mouse models using male animals still dominate studies of anxiety, depression, Graves' and Hashimoto's thyroiditis, multiple sclerosis, obesity, and pain—all diseases suffered by women in higher proportion (Zucker & Beery, 2010). Yet, female animals dominate studies of reproduction (Beery & Zucker, 2011, p. 567). Feminist historians of biology and primatologists have examined how male primates were long the focal subjects of behavioral research, and the Strum and Fedigan's (2000) edited volume investigates whether and how the entrance of woman primatologists into the field shifted the questions asked of primates.

Chapter 1 and Chapter 3, I pushed against the behavioral ecological framing that sees female bodies as "resources" for males, while at the same time investigating how seals have been enrolled as resources not only in this framing of the interaction between the sexes, but also in industrial sealing practices, and now in the scientific practices that prey upon the oceanic materialities seals haul ashore. This problematizing of "hyper-capitalistic conceptual framework [of behavioral ecology]" (Hoquet, 2010, p. 121) is a necessary project alongside my goal of "tolerat[ing] and explor[ing]…biological reductionism" (Wilson, 2004, p. 3), and I see a questioning of the political economic reductions of environments and bodies to resources as an issue within the orientation to gender studies carried through this dissertation.[248] This project thus contributes to science studies critiques of and engagements with the biobehavioral sciences, by paying close attention to *which* biological reductionisms can help us generate theories of life attendant to the critiques of gender framings and the reductions of biological process to economic logics.

Further, female elephant seals are referred to by my informants as "girls," "good moms," and "skinny bitches," all highly loaded gender terms, which sit beside their functional and mechanistic figuring as "target animals," "research subjects," and data-gathering "platforms." And, the methods of approaching and separating out a female elephant seal from the pod are perhaps mimetic of what the scientists understand the males to be doing when they control and structure the space of the beach in their

[248] Another political economic aspect of the project that could benefit from further development is histories of sealing, which I mention throughout the dissertation but did not engage in a complete primary-source fashion. See also footnote 244, above.

conceptualization of their sociality as organized as a “harem.” While I have attempted in this dissertation to amplify different parts of the practices of my informants than those that get captured in their scientific research, the doings I studied in close detail in Chapters 2 and 3 still involve instrumentalization and subjugation of female bodies, practices that deserve further analysis from a critical gender studies perspective. Chapter 4 has a different take on gender in this research, attuning to the masculinity of the adventurer bodily comportment of wildlife biology fieldwork. While these moments involving sex and gender, and the masculinities and femininities expected of both researchers and animals jump out from my ethnographic materials at key moments, these gender dynamics—as well as the scientific discourses that they are enrolled within—beg further interpretation than I have undertaken in this research.

Paths Not Taken and Final Thoughts

I now end by situating the analysis that emerged from this project’s empirical materials, and gesturing towards paths those materials might have taken in the hands of another scholar. I point out these directions in order to again re-iterate this dissertation’s unique contribution to the fields of communication and science studies, and to open up a final consideration of collaboration across the human and natural sciences.

As I insisted in the opening of this dissertation, and as became clear as the progression of chapters unfolded, there are many facets to the practices of my informants that this dissertation does not fully attend to or unpack. By turning to the coastal beach as the central site of my focus, and investigating the interspecies encounters between humans and seals as the analytic through which I approached my informants' research, this project did not investigate in close detail the sphere of laboratory practice, or other dimensions of research practice where data is integrated, interrogated, fed into models, and compiled in results and figures, before traveling as peer-reviewed papers and conference presentations. Only in the Introduction did I point to discourses in oceanographic science on knowledge as exploration and technological advance, which color and shape these my informants approaches—both in terms of their funding structures, and the comportment of the wildlife biologist as the figure of the outdoor adventurer. The financial structures that support this research include a complex and contradictory mix of grants that fund "young explorers," small donations from "Friends of the Elephant Seal," an organization committed to animal protection, and a diversity of research funding sources and institutional affiliations that hope for distant medical, fisheries, conservation, and military applications.[249]

Further, this project could be expanded to include a close inspection of these research practices' multifaceted connections with histories of marine mammal science and the special place cetaceans in particular gained in the public imagination of the 20th century (Burnett, 2012), or histories of wildlife tracking technologies, and the visions of a "wired wilderness" that tied together projects across the terrestrial-marine divide in

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[249] For example, medical applications include physiological and metabolic research, such as the physiology of fasting and its applicability to understanding diabetes. Fisheries applications include calculations of seals impact marine food chains, especially involving fish species of commercial interest. Conservation impacts include modeling how seals will respond to climate change, and how marine protected areas should be demarcated and managed. Military applications include training of sea lions and dolphins for mine-clearance and sentries. The navy research programs on marine mammals host postdocs for several researchers, and it is part of the funding and institutional structures through which researchers travel between academia, government work, and industry.

"the making of modern wildlife" (Benson, 2010, 2011). The historical studies referenced here, and many others, do important work of situating conceptions of wildlife within histories of knowledge about animals, and this project benefits from their findings.

Another path not taken in this research is an interrogation of how models of animal movement are conceptualized and produced—a very important component of this research—which involves more than the cataloging of raw data, but also the situating of many data forms within a diversity of models: of oceans, of animal behavior, and of the environmental cues and sensory and cognitive capacities that guide migration and navigation. These models matter because of the ways they imagine and enact the agency of animals, subsuming activities within optimizing economic models that likely don't capture the diversity of why and how creatures go where they do. Finally, this project could have gone in the direction of unpacking the embodied imagination work of "following" the seal's bodily movements at a distance, through dive track data.[250] In choosing to follow scientists and seals in the field rather than in the lab, though, other practices were also made periphery in this analysis: other organisms besides seals, a primary-source history of the site and its development as both a research site and lighthouse station, the practices of volunteer docents as natural history educators, the negotiation of State Park management with the day-to-day

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[250] This work could very well involve practices of reading and enacting data through complexes of digital screens, human bodies, and senses of space and movement, as other STS scholars have shown, for example in the research practices of social robotics (Alač, 2009, 2011) and remote sensing (Vertesi, 2012, 2015).

requirements of research, and the interaction of the public with elephant seals and research on them.[251]

Thus, the dual focus on science and the shore necessarily backgrounds aspects of both, but this is a cut that strengthens my contribution by allowing me to focus on a unique co-incidence of everyday scientific work and human-altered landscapes. The practices that this dissertation does highlight, while working athwart or askew of the whole breadth of my informants knowledge-work, aimed to make other aspects of knowledge practice salient: chiefly the embodied dynamics, material constraints, and ecological interactions involved in this research. I worked in this way in order to highlight ecological research as itself situated in complex ecologies—epistemic, historical, social, biological, and technological—and attend to these fields of practice using an ecological analytic.

Yet, despite my veneration of the ecological world-view, my attempts at collaboration and "co-infection" with my informants are limited, chiefly directions of provocation rather than sustained engagement with them on their own terms. While I attended lab meetings, and sometimes contributed to discussion in cases where I felt I could offer a perspective they might find worthwhile,[252] in most cases I embodied a

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[251] Furthermore, the contributions of this dissertation project to agendas of animal welfare and conservation are also incomplete, yet both are concerns important to my informants and central to the entanglement of topics considered here. Taking up these topics would have led this research on a different path, towards considering public "outreach" and engagement with science, rather than the doings of research practice.

[252] For example, an instance where we discussed a paper about historical ecology that highlighted, but didn't confront, uneven political economic histories of sealing around the world, and the discussion turned to the difficulty of "human effects" as a viable ecological variable.

more conservative role of the STS ethnographer, taking my role to be observational, rather than collaborative. This is partly to do with the setup of the project, where I solicited informants in order to "study" them, rather than sought collaborators on a co-constituted research question. Yet, in Chapter 3, I make explicit critiques of my informants' knowledge practices and explore directions not taken in the historical trajectories of elephant seal research. While these ideas were of course nascent in my fieldwork, they developed into full form only after it, in the process of writing and reading. Thus, I didn't fully engage a technique of "asking interesting questions (Despret, 2008a) and "amplification" (Myers, 2015) *during* my ethnographic encounters.

At the closing of this project, a driving question for me for further research is how, as STS practitioners, can our critiques become part of the way we do ethnography, engage our informants, and help to produce more interesting science? My perspective on my proper role as an STS ethnographer changed over the course of my fieldwork, and afterward. Since completing the ethnographic research for this dissertation project, I have been part of a collaborative project, Aarhus University Research on the Anthropocene (AURA), whose explicit goal is to stage an interdisciplinary collaboration between biologists and anthropologists around the thematic of "human-altered landscapes." This project has been a learning process about the potentials and difficulties of "engagement" (Mackenzie & Murphie, 2008), an attempt to not begin from the premises of incompatible theories of knowledge, but rather to start with with on-the-ground participation with shared phenomena of interest. I continue to insist that the history and anthropology of science perspectives are crucial in such projects, but this dissertation opens the question of what more may be required. The combination of this dissertation project and participation in AURA has taught me the diversity of things that one must consider with respect to interdisciplinary research, including assumed hierarchies of disciplines, different approaches to "data," divergent publishing timelines and requirements, and the need to co-construct questions, sites, and fields of literature. New and strange configurations of research and training might be needed for such projects, and this dissertation project brings them into relief for those in science and technology studies who seek to make headway on the increasingly recognized goal to forge them.

In this project, I have aimed to foster just such an inquiry at a juncture between natural and social sciences that share frameworks and methods for unpacking the co-articulations of bodies, ecologies, landscapes, and technologies. By following seals and seal scientists to the edge of the sea, I suggested that striking a balance between tolerating and exploring the reductionisms of the life sciences—between critique and engagement—can forge a method of learning from the natural sciences about how to understand the more-than-human, while at the same time aiming to push and alter the directions of life sciences research. As ethnographers of science and technology, we can bring histories of bodily configurations and knowledge practices into our chronicles of the present, allowing us to be both reflexive about knowledge making, and to have interests, stakes, and suggestions that contribute to the science.

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