Title

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies

Authors

Bowen, Kelly R

Kurle, Carolyn M

Publication Date

2024

DOI

10.1111/mms.13221

Received: 27 June 2024 | Accepted: 27 October 2024

DOI: 10.1111/mms.13221

NOTE

Marine Mammal Science

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies

Kelly R. Bowen | **Carolyn M. Kurle**

School of Biological Sciences, Department of Ecology, Behavior, and Evolution, University of California San Diego, La Jolla, California, USA

Correspondence
Kelly R. Bowen, School of Biological Sciences, Department of Ecology, Behavior, and Evolution, University of California San Diego, 9500 Gilman Dr., La Jolla, CA 92093-0116, USA.
Email: flandersrae@gmail.com

Funding information
University of California, San Diego

KEYWORDS: bony fishes, cartilaginous fishes, cetaceans, North Pacific, pinnipeds, sharks, squid, stable isotope analysis, stable isotope review, trophic ecology

Trophic ecology research provides insight into ecosystem form and function through an understanding of predator–prey dynamics (Boecklen et al., 2011). Analyses of the stable carbon ($^{13}C/^{12}C$; $\delta^{13}C$) and nitrogen ($^{15}N/^{14}N$; $\delta^{15}N$) isotope values from predator and prey tissues are a useful method by which to study foraging relationships. Stable isotope values increase with each trophic level due to consumer metabolism and the differential assimilation of heavier and lighter isotopes from prey into predator tissues (DeNiro & Epstein, 1978; Deniro & Epstein, 1981; Hobson, 1999). The differences in the stable isotope values between prey and predator tissues due to fractionation can be predictable and is measured as the trophic discrimination factor (TDF). TDFs are dependent upon several variables, including taxonomy (e.g., fish or mammal, etc.), consumer type (e.g., carnivore or herbivore), consumer sex (e.g., male or female), diet source (e.g., marine or terrestrial), and tissue type (e.g., blood or skin, etc.; Kurle, 2009; Kurle et al., 2014; Stephens et al., 2023).

Although TDFs would ideally be specific to the system being studied, controlled feeding experiments over months to identify TDFs are often prohibitively difficult. Generalized TDFs have been recognized (+1‰ for the $\delta^{13}C$ values and + 3.4‰ for the $\delta^{15}N$ values; Post, 2002) as a substitute when experimentally-derived TDFs are unavailable, but, when possible, it remains important to compare similar predator and prey tissues to control for the tissue-dependency of TDFs. Stable isotope values can be measured for soft tissues such as skin, blubber, and muscle, as well as hard tissues such as dentin and bone. The isotopic turnover, the rate at which stable isotopes in a tissue are replaced with those metabolized from the diet, varies by tissue type (Kurle, 2009). Blood has a relatively high turnover rate of weeks compared with

the slow turnover rate of bone over years (Aurioles-Gamboa et al., 2013; Buchheister & Latour, 2010; Riofrío-Lazo & Aurioles-Gamboa, 2013). Therefore, similar tissues should be compared between predator and prey when possible.

Despite the challenges in standardizing isotope values and TDFs across taxa and tissue types, stable isotope analyses have been used to study trophic ecology at multiple temporal and spatial scales in the Pacific Ocean (among other marine and terrestrial environments). For example, Misarti et al. (2009) examined stable isotope values of bone collagen from fish and marine mammals in the Pacific Ocean over 4500 years, and Arnoldi et al. (2023) investigated stable isotope values from invertebrates and fish across the majority of the North Pacific Ocean basin. These studies demonstrate the utility of a multitaxa approach for understanding food webs and trophic dynamics.

To facilitate food web studies of diverse organisms within the North Pacific Ocean, we curated a database of stable isotope values from consumer species in six broad taxonomic groups: Cetacea (dolphins, porpoises, and whales), Pinnipedia (seals, sea lions, and walruses), Mustelidae (sea otters), Osteichthyes (bony fishes), Chondrichthyes (cartilaginous fishes), and Cephalopoda (squids and octopus). Our database (Table 1) is a comprehensive, but not exhaustive, overview of many ecologically important species of interest.

Our first goal was to capture the range of stable isotope values that could represent a species, given measurements from different time periods, regions, life stages, sexes, and tissues. We compiled 254 $\delta^{13}C$ and $\delta^{15}N$ values (with standard deviations, SD, or standard errors, SE) from 89 taxa across 74 published studies. Our second goal was twofold: to first condense the multitude of stable isotope values across studies into one representative range for that species (i.e., calculate one mean $\delta^{13}C$ and $\delta^{15}N$ value ± SD from values reported across multiple studies) and further condense the stable isotope values from multiple species into a representative range for that taxonomic group (i.e., calculate one mean $\delta^{13}C$ and $\delta^{15}N$ value ± SD to represent 'pinnipeds' from multiple species). Some studies could require the fine-scale data shown in Table 1, such as the $\delta^{13}C$ and $\delta^{15}N$ values for juvenile male Northern fur seals (*Callorhinus ursinus*), but others may aim to examine a broad taxonomic group, such as the $\delta^{13}C$ and $\delta^{15}N$ values for pinnipeds in the North Pacific.

To compute a single $\delta^{13}C$ and $\delta^{15}N$ value (± SD) from multiple studies and species (Table 2), we followed methodology in Carlisle et al. (2015). For example, we computed a single $\delta^{13}C$ value (± SD) for the pantropical spotted dolphin (*Stenella attenuata*) by resampling 2000 values from a normal distribution with the parameters of Study 1 (mean $\delta^{13}C$ value of −16.82‰ ± 0.69‰; Kanaji et al., 2017) and the parameters of Study 2 (mean $\delta^{13}C$ value of −17.3‰ ± 0.3‰; Endo et al., 2010), then combining them into a cumulative distribution, and finally evaluating the mean $\delta^{13}C$ and SD of the cumulative distribution (in this case, our reported $\delta^{13}C$ value for pantropical spotted dolphins is −17.1‰ ± 0.6‰). We also resampled 2000 values from the $\delta^{13}C$ and $\delta^{15}N$ values ± SD of species with only one representative study to generate a distribution that incorporates the reported variation and remains consistent with our methodology for these generated $\delta^{13}C$ and $\delta^{15}N$ values.

We applied several filters and corrections to our compilation analysis of Table 1 to identify the single $\delta^{13}C$ and $\delta^{15}N$ values in Table 2. First, we excluded samples if they were collected from the Gulf of California due to bias from elevated $\delta^{15}N$ values in this region (Altabet et al., 1999). Second, we aimed to compile the $\delta^{13}C$ and $\delta^{15}N$ values that were representative of soft tissues overall, with muscle specifically targeted when possible. We found muscle was the most frequently sampled tissue, allowing for greater consistency when compiling studies among a species. Soft tissues are also more likely to be useful for dietary analyses, as soft tissues are typically consumed by a predator and bones, teeth, or whiskers may be discarded. To this end, we chose muscle samples in cases of measurements from paired tissues in Table 1. We also corrected bone or teeth measurements to resemble muscle with the equation: $\delta^{13}C_{muscle} = \delta^{13}C_{bone/tooth} - 2‰$ (see supplementary material of Kim et al., 2012), except for sea otters (*Enhydra lutris*). The studies we report for sea otters sampled bone and whiskers, and the correction factor does not apply to whiskers. For consistency, we complied the hard tissue measurements (whiskers and bone) for sea otters as they were reported. Finally, if a study provided SE rather than SD, we converted SE to SD when calculating our study or species distributions (Table 1 reports the original SE values in such cases). We report single condensed stable isotope values (± SD) for each species in Table 2, and single condensed stable isotope values (± SD) for broad taxonomic groups in Table 3. All computations were conducted in R v. 4.2.1 (R Core Team 2022) using base functions.

TABLE 1 The mean $\delta^{13}C$ and $\delta^{15}N$ values (± SD, or SE where noted) for six major taxonomic groups are compiled from published literature.

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Cetacea (dolphins, porpoises, whales)									
Balaena mysticetus	Muscle (Non LE)	1983–2001	−20.65	0.82	13.28	0.62	110	Alaska, Arctic Ocean	Dehn et al. (2006)
Balaena mysticetus	Muscle (Non LE)	Fall 1997	−21.1	0.2	13.3	0.3	21	Alaska, Artic Ocean	Hoekstra et al. (2002)
Balaena mysticetus[a]	Muscle (Non LE)	1997–2006	−20.63	0.85	13.29	0.76	134	Alaska, Arctic Ocean; Skin/muscle pair A	Horstmann-Dehn et al. (2012)
Balaena mysticetus	Skin (LE carbon, Non LE nitrogen)	1997–2006	−20.49	0.68	13.63	0.94	99, 133	Alaska, Arctic Ocean; Skin/muscle pair B	Horstmann-Dehn et al. (2012)
Balaena mysticetus[b]	Bone collagen	Meta	−15.9	0.6	14.5	0.8	3	Bering Sea, Alaska	Newsome, Etnier, et al. (2009)
Balaenoptera acutorostrata	Red muscle (LE)	2000–2006	−18.4	0.7	12.0	1.7	13	Market meat in Japan; J-stock	Endo et al. (2012)
Balaenoptera acutorostrata	Red muscle (LE)	2000–2006	−18.6	0.8	11.4	0.7	12	Market meat in Japan; O-stock	Endo et al. (2012)
Balaenoptera borealis	Red muscle (LE)	2000–2006	−19.5	1.6	8.3	1.3	10	Market meat in Japan	Endo et al. (2012)
Balaenoptera brydei	Red muscle (LE)	2000–2006	−16.9	0.6	10	1.2	11	Market meat in Japan	Endo et al. (2012)
Balaenoptera brydei[c]	Skin (LE)	1995, 1996	−18.1	1.5	15.8	0.6	2	Near Gulf of California	Gendron et al. (2023)
Balaenoptera musculus	Skin (LE)	1996–2015	−16.9	0.0	13.3	0.1	222	California Current Ecosystem; Bayesian ANOVA means	Busquets-Vass et al. (2021)
Balaenoptera musculus[c]	Skin (LE)	1995, 1996	−18.2	0.6	12.9	0.3	2	Near Gulf of California	Gendron et al. (2023)
Balaenoptera musculus[c]	Skin (LE)	1996–2015	−16.7	0.0	14.8	0.1	196	Gulf of California; Bayesian ANOVA means	Busquets-Vass et al. (2021)

(Continues)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Balaenoptera musculus[c]	Skin	1999–2007	−16.8	0.7	14	1.0	109	Central-south Gulf of California	Busquets Vass (2008)
Balaenoptera physalus	Skin (LE)	2001–2010	−18.3	0.68	12.5	1.19	9	Shumagin Islands, Alaska	Witteveen and Wynne (2016)
Balaenoptera physalus	Skin (LE)	2004–2014	−18.6	0.95	12.5	0.84	6	Kodiak, Alaska	Witteveen and Wynne (2016)
Balaenoptera physalus[c]	Skin (LE)	1995, 1996	−16.0	0.6	15.4	1.1	2	Near Gulf of California	Gendron et al. (2023)
Balaenoptera physalus[c]	Unspecified tissue	2001–2002	−17.3	0.5	15.3	0.8	29	Southwest Gulf of California	Jaume-Schinkel (2004)
Berardius bairdii	Red muscle (LE)	2000–2004	−17.8	0.6	16.3	0.8	19	Market meat in Japan	Endo et al. (2010)
Delphinapterus leucas	Muscle (Non LE)	1992–1999	−18.41	0.62	16.74	0.56	49	Alaska, Arctic Ocean	Dehn et al. (2006)
Delphinus capensis[c]	Unspecified tissue	2005	−16.7	0.5	18.4	0.4	39	Along Gulf of California	Diaz-Gamboa (2009)
Delphinus delphis	Skin (LE)	1993–2015	−17.8	0.34	11.37	0.59	33	Coast of Japan	Kanaji et al. (2017)
Delphinus delphis[c]	Tooth/bone (Non LE)	1988–1998	−15.3	1.2	18.1	0.6	12	Along Gulf of California	Aurioles-Gamboa et al. (2013)
Eschrichtius robustus[a]	Muscle (Non LE)	2001	−17.32	1.03	12.03	0.86	17	Subsistance harvested in Russia; Skin/muscle pair A	Horstmann-Dehn et al. (2012)
Eschrichtius robustus	Skin (LE carbon, Non LE nitrogen)	2001	−17.62	1.32	13.21	1.13	25	Subsistance harvested in Russia; Skin/muscle pair B	Horstmann-Dehn et al. (2012)
Eschrichtius robustus	Muscle (Non LE)	2001	−17.32	1.03	12.04	0.86	17	Coast of Russia	Dehn et al. (2006)
Eschrichtius robustus[a]	Muscle (Non LE)	1999–2000	−16.58	0.89	12.93	1.01	11	Stranded in California; Skin/muscle pair A	Horstmann-Dehn et al. (2012)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Eschrichtius robustus	Skin (LE carbon, Non LE nitrogen)	1999–2000	−16.06	0.92	13.51	0.8	14, 18	Stranded in California; Skin/muscle pair B	Horstmann-Dehn et al. (2012)
Eschrichtius robustus	Skin (LE carbon, Non LE nitrogen)	2000–2011	−16.09	0.88	13.15	0.74	15	Eastern subpopulation; 9 M, 5 F, 1 U; Primary basale layer of epidermis	Lian et al. (2020)
Eschrichtius robustus	Skin (Non LE)	2002–2013	−16.52	0.74	12.2	0.77	10	Western subpopulation; Primary basale layer of epidermis	Lian et al. (2020)
Eschrichtius robustus[b]	Bone collagen	1960s/70s	−13.7	0.2	14.2	0.2	14	Carbon Suess effect corrected	Alter et al. (2012)
Eschrichtius robustus[b]	Bone collagen	Ancient	−13.1	0.1	14.7	0.2	16	150–2690 years before present; Carbon Suess effect corrected	Alter et al. (2012)
Eschrichtius robustus[b]	Bone collagen	Meta	−13.1	0.8	14.2	0.7	13	California and Alaska	Newsome, Etnier, et al. (2009)
Globicephala macrorhynchus	Red muscle (LE)	2000–2004	−16.9	0.5	12.2	0.7	18	Market meat in Japan; Southern form	Endo et al. (2010)
Globicephala macrorhynchus[c]	Unspecified tissue	2005	−15.6	0.5	18.3	1.1	33	Central-south Gulf of California	Diaz-Gamboa (2009)
Grampus griseus	Red muscle (LE)	2000–2004	−16.7	0.3	13.1	0.5	8	Market meat in Japan	Endo et al. (2010)
Megaptera novaeangliae	Skin (LE)	2005	−17.3	0.2	12.1	0.3	20	Karaginsky Gulf, Bering Sea, Russia	Filatova et al. (2013)
Megaptera novaeangliae	Skin (LE corr)	2011	−18.6	0.1	10.8	0.3	16	Commander Islands, Russia	Filatova et al. (2013)

(Continues)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Megaptera novaeangliae	Skin (LE)	2001–2010	−18.3	0.66	13.2	0.74	86	Shumagin Islands, Alaska	Witteveen and Wynne (2016)
Megaptera novaeangliae[a]	Skin (LE)	2004–2005	−17.6	0.0	13.2	0.0	1105, 1104	North Pacific basin (10 regions); M and F; SE reported	Witteveen, Worthy, Wynne, and Roth (2009)
Megaptera novaeangliae	Skin (LE)	2004–2005	−16.4	0.04	14.6	0.07	181	British Columbia through California; M and F; SE reported; Subset A from above	Witteveen, Worthy, Wynne, and Roth (2009)
Megaptera novaeangliae	Skin (LE)	2004–2005	−18.4	0.04	12.5	0.07	282	Gulf of Alaska and Bering Sea; M and F; SE reported; Subset B	Witteveen, Worthy, Wynne, and Roth (2009)
Megaptera novaeangliae	Skin (LE)	2004–2005	−17.8	0.1	12.2	0.19	81	Russia and West Aleutian Islands; M and F; SE reported, Subset C	Witteveen, Worthy, Wynne, and Roth (2009)
Megaptera novaeangliae	Skin (LE)	2004–2006	−17.2	0.09	13.3	0.13	117	Mexico; SE reported	Witteveen, Worthy, and Roth (2009)
Megaptera novaeangliae	Skin (LE)	2004–2014	−17.9	0.64	13.4	0.91	145	Kodiak, Alaska	Witteveen and Wynne (2016)
Orcinus orca[b]	Teeth	1855–2021	−12.63	1.0	19.32	1.6	42	North Pacific Ocean; Transient ecotype; Suess effect corrected to 1850; Multiple dentin annuli	Personal communication (Bowen)
Orcinus orca[b]	Teeth	1864–2006	−11.9	0.5	17.7	0.5	23	North Pacific Ocean; Offshore ecotype; Suess effect corrected to 1850; Multiple dentin annuli	Personal communication (Bowen)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Orcinus orca[b]	Teeth	1898–2015	−12.9	0.8	16.7	0.9	12	North Pacific Ocean; Resident ecotype; Suess effect corrected to 1850; Multiple dentin annuli	Personal communication (Bowen)
Orcinus orca	Blubber (LE)	2001–2003	−16.8	0.3	17.2	0.6	3	Alaska; Offshore ecotype	Herman et al. (2005)
Orcinus orca	Blubber (LE)	2001–2003	−16.8	1.1	16.7	1.2	11	Eastern Aleutian Islands, Alaska; Resident ecotype	Herman et al. (2005)
Orcinus orca	Blubber (LE)	2001–2003	−16.2	0.6	17.9	0.5	9	Eastern Aleutian Islands, Alaska; Transient ecotype	Herman et al. (2005)
Orcinus orca	Blubber (LE)	2001–2003	−17.5	0.8	15.6	1.5	11	Central Aleutian Islands, Alaska; Resident ecotype	Herman et al. (2005)
Orcinus orca	Blubber (LE)	2001–2003	−15.4	0.5	17.2	0.8	8	Gulf of Alaska; Resident ecotype	Herman et al. (2005)
Orcinus orca	Blubber (LE)	2001–2003	−16.0	0.2	16.9	0.6	4	West coast; Southern resident ecotype	Herman et al. (2005)
Phocoena phocoena[a]	Muscle (LE)	1997–2000	−16.2	0.5	15.2	0.8	29	Central California; Muscle/bone/skin pair A	Toperoff (2002)
Phocoena phocoena	Bone collagen	1997–2000	−13.4	0.5	15.7	0.7	29	Central California; Muscle/bone/skin pair B	Toperoff (2002)
Phocoena phocoena	Skin (LE)	1997–2000	−16.2	0.6	16.0	0.7	29	Central California; Muscle/bone/skin pair C	Toperoff (2002)

(Continues)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Phocoenoides dalli	Muscle (Non LE)	1987	−20.3	0.5	10.8	0.7	5	Eastern North Pacific	Ohizumi and Miyazaki (2010)
Phocoenoides dalli	Muscle (Non LE)	1997	−19.1	0.3	11.6	0.5	10	Western North Pacific	Ohizumi and Miyazaki (2010)
Phocoenoides dalli	Muscle (Non LE)	1985; 1996	−19.9	0.5	11.8	1.1	5	Bering Sea, Alaska	Ohizumi and Miyazaki (2010)
Phocoenoides dalli	Muscle (Non LE)	1987; 1994	−20.2	0.6	11.1	1.0	5	Western-central North Pacific	Ohizumi and Miyazaki (2010)
Phocoenoides dalli	Red muscle (LE)	2000–2004	−18.8	0.2	13.2	0.3	8	Market meat in Japan	Endo et al. (2010)
Physeter macrocephalus	Skin (LE carbon, Non LE nitrogen)	2003–2017	−17.2	0.6	16.9	0.8	33	Gulf of Alaska; M; Individuals depredating fish lines	Wild et al. (2020)
Physeter macrocephalus[c]	Skin (LE)	1996–1999	−13.8	0.4	19.6	0.5	35	Central-south Gulf of California	Ruiz-Cooley et al. (2004)
Physeter macrocephalus[b]	Tooth dentin	Meta	−13.3	0.5	17.5	0.5	24	Oregon	Newsome, Etnier, et al. (2009)
Pseudorca crassidens	Red muscle (LE)	2000–2004	−16.2	0.6	12.8	0.6	5	Market meat in Japan	Endo et al. (2010)
Stenella attenuata	Skin (LE)	1993–2015	−16.82	0.69	12.39	0.8	32	Coast of Japan	Kanaji et al. (2017)
Stenella attenuata	Red muscle (LE)	2000–2004	−17.3	0.3	12.1	0.8	4	Market meat in Japan	Endo et al. (2010)
Stenella coeruleoalba	Skin (LE)	1993–2015	−17.28	0.63	12.27	0.64	140	Coast of Japan	Kanaji et al. (2017)
Steno bredanensis	Red muscle (LE)	2000–2004	−16.9	0.5	11.6	0.5	6	Market meat in Japan	Endo et al. (2010)
Tursiops truncatus	Skin (LE)	1993–2015	−16.28	0.79	13.04	0.66	40	Coast of Japan	Kanaji et al. (2017)
Tursiops truncatus	Red muscle (LE)	2000–2004	−17.2	0.3	13.1	0.6	10	Market meat in Japan	Endo et al. (2010)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)									
Taxa	**Tissue**	**Year(s)**	**$\delta^{13}C$ (‰)**	**SD/SE**	**$\delta^{15}N$ (‰)**	**SD/SE**	**N**	**Metadata**	**Source**
Tursiops truncatus[c]	Unspecified tissue	2005	−16.0	0.4	19.1	0.4	57	Central-south Gulf of California	Diaz-Gamboa (2009)
Pinnipedia (seals, sea lions, walrus)									
Callorhinus ursinus	Skeletal muscle (LE)	1992	−18.9	0.4	16.6	0.5	7	Alaska; pups; M and F	Hobson et al. (1997)
Callorhinus ursinus	Skin (LE)	1997	−16.0	0.0	17.3	0.1	50, 46	St. George Island, Alaska; F; SE reported	Kurle and Worthy (2001)
Callorhinus ursinus	Skin (LE)	1997	−16.1	0.1	18.1	0.2	15	St. Paul Island, Alaska; F; SE reported	Kurle and Worthy (2001)
Callorhinus ursinus	Skin (LE)	1997	−17.4	0.1	16.7	0.1	27, 28	St. George Island, Alaska; juvenile M; SE reported	Kurle and Worthy (2001)
Callorhinus ursinus	Skin (LE)	1997	−17.5	0.1	16.5	0.2	20	St. Paul Island, Alaska; juvenile M; SE reported	Kurle and Worthy (2001)
Callorhinus ursinus	Muscle (LE)	1997	−18.0	0.1	15.6	0.2	30	St. George Island, Alaska; juvenile M; SE reported	Kurle and Worthy (2002)
Callorhinus ursinus	Blubber (LE)	1997	−19.7	0.4	17.1	0.1	30	St. George Island, Alaska; juvenile M; SE reported	Kurle and Worthy (2002)
Callorhinus ursinus	Muscle (LE)	1997	−18.1	0.1	15.1	0.2	37, 38	St. Paul Island, Alaska; juvenile M; SE reported	Kurle and Worthy (2002)
Callorhinus ursinus	Blubber (LE)	1997	−18.1	0.2	17.1	0.1	36	St. Paul Island, Alaska; juvenile M; SE reported	Kurle and Worthy (2002)

(Continues)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Callorhinus ursinus	Vibrissal roots (LE)	2007, 2008	−18.05	0.58	14.26	1.07	95	Adult F and pups live and dead, 1 adult M, 1 U; Least-square means reported	Waite et al. (2012)
Callorhinus ursinus[b]	Bone collagen	1952–1995	−14.4	1.1	17.2	1.5	13	Gulf of Alaska and Bering Sea	Hirons et al. (2001)
Callorhinus ursinus[b]	Bone collagen/tooth dentin	Meta	−15.5	0.6	15.7	1.2	230	Bering Sea, Alaska	Newsome, Etnier, et al. (2009)
Callorhinus ursinus[b]	Bone collagen	Most 1970+	−14.8	0.7	16.6	1.4	10	Alaska; F	Burton and Koch (1999)
Callorhinus ursinus[b]	Bone collagen	Most 1970+	−15.4	0.9	17.4	2.1	9	Alaska; M	Burton and Koch (1999)
Eumetopias jubatus	Skeletal muscle (LE)	1990–1993	−18.2	0.2	17.5	0.2	13	Alaska; M and F	Hobson et al. (1997)
Eumetopias jubatus	Muscle (LE)	2003, 2004	−15.1	0.2	17.6	0.5	4	British Columbia	Todd et al. (2009)
Eumetopias jubatus	Vibrissal roots (LE)	2007, 2008	−17.12	0.56	16.57	1.03	63	Russia; 6 live adult F, 11 dead pups; Least-square means reported	Waite et al. (2012)
Eumetopias jubatus[b]	Tooth dentin (Not decalcified)	1958–1994	−12.16	1.79	17.97	1.13	18	Gulf of Alaska and Bering Sea; M; Means manually calculated for present study	Hobson and Sease (1998)
Eumetopias jubatus[b]	Bone collagen	1961–1997	−14.3	1.0	18.5	1.4	31	Gulf of Alaska and Bering Sea	Hirons et al. (2001)
Mirounga angustirostris	Bone collagen	Most 1970+	−13.6	1.1	18.2	0.7	10	California; M	Burton and Koch (1999)
Mirounga angustirostris[b]	Bone collagen	Most 1970+	−14.4	0.8	18.1	1.3	14	Central California; F	Burton and Koch (1999)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Odobenus rosmarus	Muscle (Non LE)	1981–2010	−17.0	0.8	13.0	0.9	154	Bering Sea and Chukchi Sea, Alaska; Carbon Suess effect corrected	Seymour et al. (2014)
Odobenus rosmarus[a]	Muscle (LE carbon, Non LE nitrogen)	2014–2016	−16.8	0.2	12.6	0.5	30	St. Lawrence Island, Alaska; M and F; Muscle/bone pair A	Clark et al. (2019)
Odobenus rosmarus	Bone collagen	2014–2016	−14.8	0.3	12.2	0.7	30	St. Lawrence Island, Alaska; M and F; Muscle/bone pair B	Clark et al. (2019)
Phoca vitulina	Skeletal muscle (LE)	1992	−17.1	0.3	16.4	0.2	5	Washington; M and F	Hobson et al. (1997)
Phoca vitulina	Skeletal muscle (LE)	1990–1993	−17.6	0.2	18.6	0.3	9	Alaska; pups; M and F	Hobson et al. (1997)
Phoca vitulina[b]	Bone collagen	1951–1996	−13.7	0.9	17.4	1.8	37	Gulf of Alaska and Bering Sea	Newsome, Etnier, et al. (2009)
Phoca vitulina[b]	Bone collagen	Most 1970+	−13.7	0.9	18.0	1.2	20	Alaksa; M	Burton and Koch (1999)
Phoca vitulina[b]	Bone collagen	Most 1970+	−12.4	0.6	18.9	1.1	13	Central California; M	Burton and Koch (1999)
Phoca vitulina[b]	Bone collagen	Most 1970+	−13.7	1.0	16.7	2.1	17	Alaska, F	Burton and Koch (1999)
Phoca vitulina[b]	Bone collagen	Most 1970+	−12.4	0.9	18.3	0.6	5	Central CA; F	Burton and Koch (1999)
Zalophus californianus	Muscle (LE)	2003, 2004	−15.4	0.2	17.2	0.4	5	British Columbia	Todd et al. (2009)
Zalophus californianus	Red blood cells	2006–2007	−14.9	0.0	18.4	0.1	39	California; Pup; SE reported	Orr et al. (2009)

(Continues)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Zalophus californianus	Red blood cells	2006–2007	−15.3	0.1	17.0	0.1	3	California; Yearling; SE reported	Orr et al. (2009)
Zalophus californianus	Red blood cells	2006–2007	−15.3	0.0	16.7	0.0	9	California; Juvenile; SE reported	Orr et al. (2009)
Zalophus californianus	Red blood cells	2006–2007	−15.2	0.1	16.5	0.1	7	California; Adult; SE reported	Orr et al. (2009)
Zalophus californianus[c]	Tooth/bone (Non LE)	1975–2006	−12.5	0.4	21	0.9	87	Gulf of California	Aurioles-Gamboa et al. (2013)
Zalophus californianus[c]	Tooth dentin	Meta	−12.5	0.6	20.5	1.6	34	Gulf of California	Newsome, Etnier, et al. (2009)
Zalophus californianus[b]	Bone collagen	Most 1970+	−13.7	0.7	18.7	1.0	11	California; M	Burton and Koch (1999)
Zalophus californianus[b]	Bone collagen	Most 1970+	−13.9	1.1	18.4	0.9	4	California; F	Burton and Koch (1999)
Mustelidae (sea otters)									
Enhydra lutris	Vibrissae (Non LE)	1996–2003	−14.07	0.78	11.9	0.9	16	Southcentral Alaska; adult M and F; Means manually calculated for present study	Mandi (2002)
Enhydra lutris	Vibrissae (Non LE)	1996–2003	−13.07	0.83	14.11	1.76	8	Southwest Alaska; adult M and F; Means manually calculated for present study	Mandi (2002)
Enhydra lutris	Vibrissae (Non LE)	1998–2006	−12.2	0.9	15.4	1.0	16	Monterey Bay, California; F	Newsome, Tinker, et al. (2009)
Enhydra lutris	Vibrissae (Non LE)	1998–2006	−11.8	0.8	14.9	0.6	15	Monterey Bay, California; M	Newsome, Tinker, et al. (2009)
Enhydra lutris	Bone collagen	Meta	−13.3	1.3	11.7	1.2	97	Central Aleutian Islands, Alaska	Newsome, Etnier, et al. (2009)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)									
Taxa	**Tissue**	**Year(s)**	**$\delta^{13}C$ (‰)**	**SD/SE**	**$\delta^{15}N$ (‰)**	**SD/SE**	**N**	**Metadata**	**Source**
Enhydra lutris	Bone collagen	Meta	−12.2	0.5	12.6	0.6	95	Prince William Sound, Alaska	Newsome, Etnier, et al. (2009)
Osteichthyes (bony fishes)									
Ammodytes hexapterus	Anterior dorsal muscle	2000, 2002	−17.5	1.2	11.6	0.6	34	California Current	Miller et al. (2013)
Ammodytidae	Whole animal (LE)	1997	−18.6	0.1	9.0	0.0	10	Bering Sea, Alaskal; Large size class (mean length 24.19 cm); SE reported	Kurle and Worthy (2001)
Ammodytidae	Muscle (LE carbon, Non LE nitrogen)	2014	−20.8	0.9	12.8	0.5	5	Bering Sea, Alaska; Medium size class (mean length 7.7 cm)	Liu (2017)
Ammodytidae	Muscle (LE carbon, Non LE nitrogen)	2016	−21.4	1.0	10.2	0.6	12	Bering Sea, Alaska; Small size class (mean length 5.8 cm)	Liu (2017)
Anoplopoma fimbria	Anterior dorsal muscle (LE corr carbon)	2000, 2002	−18.0	NA	13.5	NA	14	California Current; Juveniles	Miller et al. (2013)
Anoplopoma fimbria	Muscle (LE carbon, Non LE nitrogen)	2014, 2016	−19.9	0.8	14.0	0.4	10	Bering Sea, Alaska	Liu (2017)
Atheresthes stomas	Muscle and whole body (LE/corr carbon)	2000, 2005	−17.8	0.1	14.7	0.2	17	Alaska	Carlisle et al. (2015)
Atheresthes stomas	Muscle (LE corr)	2013, 2014	−15.9	0.6	15.5	0.9	42	Aleutian Islands, Alaska	Doll et al. (2018)
Clupea pallasii	Muscle and whole body (LE/corr carbon)	Meta	−19.2	0.2	13.0	0.2	393	Alaska	Carlisle et al. (2015)
Engraulis mordax	Muscle (LE)	1997–2000	−17.2	1.0	13.6	0.5	27	Monterey Bay, California	Becker et al. (2007)

(Continues)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Engraulis mordax	Anterior dorsal muscle	2007, 2009	−18.3	0.5	13.8	0.4	60	California Current	Miller et al. (2013)
Engraulis mordax	Muscle (LE)	NA	−16.9	0.8	13.7	0.9	5	Monterey Bay, California	Toperoff (2002)
Engraulis mordax	Lateral muscle (LE)	NA	−16.8	0.4	13.9	0.8	4	Gulf of Farallones, California	Sydeman et al. (1997)
Gadus macrocephalus	Muscle (LE corr)	2013, 2014	−16.3	0.7	16.6	0.8	52	Aleutian Islands, Alaska	Doll et al. (2018)
Gadus macrocephalus	Muscle (LE/corr carbon)	Meta	−17.7	0.3	14.6	0.3	31	Alaska	Carlisle et al. (2015)
Genyonemus lineatus	Muscle (LE)	1996–2002	−15.3	0.2	15.1	0.3	10	Monterey Bay, California	Becker et al. (2007)
Hippoglossus stenolepis	Anterior muscle	2002–2011	−17.99	1.4	14.88	1.46	693	Alaska; M and F; Less than 20 lbs. up to 40.9 kg	Bentzen et al. (2016)
Hippoglossus stenolepis	White muscle (Non LE)	2012, 2013	−16.76	0.95	15.87	1.26	370	Alaska; F; 5 to 16 years old	Wolf et al. (2019)
Hippoglossus stenolepis	White muscle (Non LE)	2012, 2013	−17.36	0.79	14.95	1.02	161	Alaska; M; 5 to 18 years old	Wolf et al. (2019)
Hypomesus pretiosus	Muscle (LE)	NA	−18.6	0.6	13.4	0.1	2	Monterey Bay, California	Toperoff (2002)
Lampris guttatus	White muscle (LE corr)	2007–2010	−18.26	0.55	14.57	0.69	4	California Current	Madigan et al. (2012)
Lampris guttatus	White muscle (LE corr)	2009–2011	−17.5	0.5	12.1	1.0	24	North Pacific Subtropical Gyre; 1000 ± 123 mm mean length	Choy et al. (2015)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Lampris guttatus	Muscle (LE carbon, Non LE nitrogen)	2014–2017	−19.1	0.78	12.2	2.12	2	San Diego, California; Means manually calculated for present study	Fauvelle and Somerville (2021)
Mallotus villosus	Muscle (LE carbon, Non LE nitrogen)	2016	−19.2	0.8	15.4	0.6	6	Bering Sea, Alaska	Liu (2017)
Merluccius productus	Anterior dorsal muscle	2007, 2009	−17.6	0.4	13.5	0.6	67	California Current	Miller et al. (2013)
Mola mola[d]	White dorsal muscle (LE corr)	2010	−20.48	0.87	6.93	1.73	17	Otsuchi Bay, Japan; Means manually caluclated for present study	Nakamura and Sato (2014)
Oncorhynchus gorbuscha	Muscle (LE corr)	1997	−21.89	0.43	10.79	0.41	22	Southeast Alaska; Adults	Satterfield and Finney (2002)
Oncorhynchus gorbuscha	Unspecified tissue	2004–2013	−20.8	0.2	11.4	0.2	14	Okhotsk Sea; Adults	Gorbatenko et al. (2015)
Oncorhynchus gorbuscha	Meta (LE corr)	Meta	−21.16	0.63	11.03	0.7	130	Alaska and Washington	Johnson and Schindler (2009)
Oncorhynchus gorbuscha	Muscle (LE/corr carbon)	Meta	−21.4	0.4	11.4	0.4	78	Alaska	Carlisle et al. (2015)
Oncorhynchus keta	Muscle (LE corr)	1997	−21.28	0.72	11.01	1.21	25	Southeast Alaska; Adults	Satterfield and Finney (2002)
Oncorhynchus keta	Muscle	2004	−17.2	0.8	15.0	0.5	30	Washington; from Figure 1 in reference; ± 2 SD	Warlick et al. (2020)
Oncorhynchus keta	Unspecified tissue	2004–2013	−20.4	0.3	11.4	0.3	15	Okhotsk Sea; Adults	Gorbatenko et al. (2015)
Oncorhynchus keta	Muscle (LE carbon, Non LE nitrogen)	2014, 2016	−21.4	0.7	11.9	1.3	10	Bering Sea, Alaska	Liu (2017)

(Continues)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Oncorhynchus keta	Meta (LE corr)	Meta	−21.27	0.96	11.1	0.43	113	Alaska and Washington	Johnson and Schindler (2009)
Oncorhynchus keta	Muscle (LE/corr carbon)	Meta	−20.9	0.3	11.2	0.4	55	Alaska	Carlisle et al. (2015)
Oncorhynchus keta	Muscle (LE/corr carbon)	Meta	−19.5	0.3	12.6	0.6	2	California	Carlisle et al. (2015)
Oncorhynchus kisutch	Muscle (LE corr)	1997	−20.02	0.37	13.81	0.49	12	Southeast Alaska; Adults	Satterfield and Finney (2002)
Oncorhynchus kisutch	Muscle	2000, 2003	−15.6	0.6	16.8	1.0	40	Washington; from Figure 1 in reference; ± 2 SD	Warlick et al. (2020)
Oncorhynchus kisutch	Unspecified tissue	2004–2013	−19.9	0.2	13.4	0.2	12	Okhotsk Sea; Adults	Gorbatenko et al. (2015)
Oncorhynchus kisutch	Meta (LE corr)	Meta	−20.18	0.48	12.67	0.92	107	Alaska and Washington	Johnson and Schindler (2009)
Oncorhynchus kisutch	Muscle and whole body (LE/corr carbon)	Meta	−19.6	0.2	13.6	0.2	68	Alaska	Carlisle et al. (2015)
Oncorhynchus nerka	Muscle	2004	−18.8	0.4	13.2	0.5	30	Washington; from Figure 1 in reference; ± 2 SD	Warlick et al. (2020)
Oncorhynchus nerka	Muscle (LE corr)	1990s	−21.35	0.49	11.24	0.56	47	Alaska; Adults	Satterfield and Finney (2002)
Oncorhynchus nerka	Unspecified tissue	2004–2013	−20.7	NA	11.8	NA	1	Okhotsk Sea; Adults	Gorbatenko et al. (2015)
Oncorhynchus nerka	Muscle (LE carbon, Non LE nitrogen)	2014, 2016	−20.0	1.5	14.0	1.5	17	Bering Sea, Alaska	Liu (2017)
Oncorhynchus nerka	Meta (LE corr)	Meta	−20.74	0.61	11.29	0.13	123	Alaska and Washington	Johnson and Schindler (2009)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Oncorhynchus nerka	Muscle (LE/corr carbon)	Meta	−21.3	0.3	11.1	0.3	95	Alaska	Carlisle et al. (2015)
Oncorhynchus tshawytscha	Muscle (LE corr)	1997	−17.85	0.65	15.23	0.34	15	Southeast Alaska; Adults	Satterfield and Finney (2002)
Oncorhynchus tshawytscha	Dorsal muscle	2011	−23	0.8	11.7	0.3	5	Washington; Subyearling; SE reported	Litz et al. (2017)
Oncorhynchus tshawytscha	Dorsal muscle	2011	−19.8	0.8	13.0	0.3	5	Washington; Subyearling; SE reported	Litz et al. (2017)
Oncorhynchus tshawytscha	Anterior dorsal muscle (LE corr carbon)	2000, 2002	−18.8	1.6	13.7	0.7	7	California Current; Subyearling	Miller et al. (2013)
Oncorhynchus tshawytscha	Anterior dorsal muscle	2000, 2002	−17.5	2.2	14.3	0.9	76	California Current; Yearling	Miller et al. (2013)
Oncorhynchus tshawytscha	Muscle	2000, 2004, 2009	−15.3	0.6	17.9	0.5	111	Washington; from Figure 1 in reference; ± 2 SD	Warlick et al. (2020)
Oncorhynchus tshawytscha	Unspecified tissue	2004–2013	−20.0	NA	13.7	NA	1	Okhotsk Sea; Adult	Gorbatenko et al. (2015)
Oncorhynchus tshawytscha	Muscle (LE carbon, Non LE nitrogen)	2014, 2016	−19.9	0.2	13.9	1.0	4	Bering Sea, Alaska	Liu (2017)
Oncorhynchus tshawytscha	Meta (LE corr)	Meta	−19.06	1.34	14.21	0.84	51	Alaska and Washington	Johnson and Schindler (2009)
Oncorhynchus tshawytscha	Muscle and whole body (LE/corr carbon)	Meta	−18.5	0.2	14.8	0.2	43	Alaska	Carlisle et al. (2015)
Oncorhynchus tshawytscha	Muscle (LE/corr carbon)	Meta	−16.8	0.3	14.0	0.2	159	California	Carlisle et al. (2015)

(Continues)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Ophiodon elongatus	White muscle (Non LE)	2016–2017	−16.98	0.7	16.51	0.6	519	US west coast; adult and juvenile M and F	Brown (2021)
Ophiodon elongatus	Lateral muscle (LE)	NA	−18.3	0.5	12.5	0.3	6	Gulf of Farallones, California; Juveniles	Sydeman et al. (1997)
Pleurogrammus monopterygius	Muscle (LE corr)	2013, 2014	−17.2	0.8	13.0	1.5	59	Aleutian Islands, Alaska	Doll et al. (2018)
Pleurogrammus monopterygius	Muscle (LE/corr carbon)	Meta	−19.8	0.2	11.6	0.1	40	Alaska	Carlisle et al. (2015)
Sarda chiliensis	White muscle (LE corr)	2007–2010	−17.68	0.32	16.16	0.18	12	California Current	Madigan et al. (2012)
Sardinops sagax	Anterior dorsal muscle	2000, 2002	−19.1	0.8	12.6	0.6	66	California Current	Miller et al. (2013)
Sardinops sagax	White muscle (LE corr)	2007–2010	−19.79	0.21	13.59	0.57	18	California Current	Madigan et al. (2012)
Sardinops sagax	Muscle (LE)	NA	−17.7	0.5	13.2	0.4	4	Monterey Bay, California	Toperoff (2002)
Sardinops sagax	Lateral muscle (LE)	NA	−17	0.3	12.9	0.1	3	Gulf of Farallones; Juveniles	Sydeman et al. (1997)
Scomber japonicus	Muscle (LE/corr carbon)	Meta	−18.1	0.4	14.3	0.3	23	California	Carlisle et al. (2015)
Sebastes jordani	Muscle (LE)	1996–2002	−17.1	0.3	11.6	0.6	10	Monterey Bay, California	Becker et al. (2007)
Sebastes spp.	Muscle (LE/corr carbon)	Meta	−17.9	0.3	14.4	0.6	162	Alaska	Carlisle et al. (2015)
Seriola lalandi	White muscle (LE corr)	2007–2010	−17.26	0.57	15.9	0.62	34	California Current	Madigan et al. (2012)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Thunnus alalunga	Muscle (LE/corr carbon)	2001–2015	−17.19	1.09	12.92	1.9	874	Global dataset; Manually calculated means for this study from Pacific Ocean	Bodin et al. (2020)
Thunnus alalunga	Anterior dorsal muscle (LE corr carbon)	2007, 2009	−19.9	0.5	13.5	1.0	40	California Current	Miller et al. (2013)
Thunnus albacares	Muscle (LE/corr carbon)	2001–2015	−15.67	1.1	12.15	2.98	978	Global dataset; Manually calculated means for this study from Pacific Ocean	Bodin et al. (2020)
Thunnus obesus	Muscle (LE/corr carbon)	2001–2015	−16.04	1.14	14.01	2.91	642	Global dataset; Manually calculated means for this study from Pacific Ocean	Bodin et al. (2020)
Thunnus orientalis	White muscle (LE)	2005–2015	−17.74	0.42	15.4	0.84	30	Sea of Japan; Migrant; >100 cm fork length; Means manually calculated for present study	Tawa et al. (2017)
Thunnus orientalis	White muscle (LE)	2005–2015	−18.41	0.33	12.6	0.63	125	Sea of Japan; Resident; >100 cm fork length; Means manually calculated for present study	Tawa et al. (2017)
Xiphias gladius	White muscle (LE corr)	2007–2010	−17.36	1.17	15.74	0.8	21	California Current	Madigan et al. (2012)
Xiphias gladius	White muscle (LE corr)	2009–2011	−17.0	0.7	13.4	1.9	13	North Pacific Subtropical Gyre; 1329 ± 372 mm mean length	Choy et al. (2015)

(Continues)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Chondrichthyes (cartilaginous fishes)									
Alopias superciliosus	Muscle	2011	−17.11	0.44	17.02	1.21	7	Mideast Pacific Ocean	Li et al. (2014)
Carcharhinus falciformis	Muscle	2011	−17.08	0.35	15.45	0.99	19	Mideast Pacific Ocean	Li et al. (2014)
Carcharhinus longimanus	Muscle	2011	−18.79	0.17	14.93	0.84	5	Mideast Pacific Ocean	Li et al. (2014)
Carcharodon carcharias	Dermis (LE)	2006–2009	−12.8	0.5	19.2	0.9	48	California; 32 M, 6 F, 10 U; Muscle/dermis pair A	Carlisle et al. (2012)
Carcharodon carcharias[a]	Muscle (LE)	2006–2009	−15.5	0.5	18.4	1.0	21	California; 14 M, 2 F, 5 U; Muscle/dermis pair B	Carlisle et al. (2012)
Carcharodon carcharias[e]	Dermis (LE)	2007, 2010	−14.4	0.5	19.1	0.7	28	Guadalupe Island, Mexico; 10 M and 6F, 13 adults, 1 subadult, 3–4 ft. in length	Jaime-Rivera et al. (2014)
Carcharodon carcharias[b]	Bone (Decalcified)	1957–2000	−12.9	0.985	18.35	1.21	15	California; Carbon Suess effect corrected; Means manually calculated for present study	Kim et al. (2012)
Isurus oxyrinchus	White muscle (LE corr)	2007–2010	−18.21	0.24	16.36	0.8	10	California Current	Madigan et al. (2012)
Lamna ditropis[b]	Bone (Decalcified)	2007, 2009	−16.0	0.7	13.6	1.3	20	Prince William Sound, Alaska; Summer; Mostly F; Manually calculated from multiple annuli	Carlisle et al. (2015)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Prionace glauca	Muscle	2011	−18.31	0.54	15.77	1.07	18	Mideast Pacific Ocean	Li et al. (2014)
Prionace glauca	White muscle (LE corr)	2007–2010	−19.01	0.57	15.19	0.64	9	California Current	Madigan et al. (2012)
Prionace glauca	Lateral white muscle (LE)	2010–2015	−18.5	0.6	12.1	0.8	120	Northwest Pacific Ocean	Fujinami et al. (2018)
Prionace glauca	Muscle	NA	−17.6	0.6	16.8	0.8	20	Pelagic Pacific Ocean; Unpublished data within reference	Carlisle et al. (2012)
Somniosus pacificus	Muscle (LE corr)	2006	−19.5	0.3	14.8	0.2	4	Northern Southeast Alaska; Summer; SE reported	Courtney and Foy (2012)
Somniosus pacificus	Muscle (LE corr)	2007	−21.1	0.0	13.7	0.1	54	Northwestern eastern Bering Sea; Summer; SE reported	Courtney and Foy (2012)
Somniosus pacificus	Muscle (LE corr)	2007	−21.1	0.0	13.7	0.2	41	Southeastern eastern Bering Sea; Summer; SE reported	Courtney and Foy (2012)
Somniosus pacificus	Muscle (LE corr)	2007	−21.1	0.1	12.7	0.1	50	Southeastern eastern Bering Sea; Winter; SE reported	Courtney and Foy (2012)
Somniosus pacificus	Muscle (LE corr)	2007	−20.0	0.2	15.3	0.5	11	Gulf of Alaska; Summer; SE reported	Courtney and Foy (2012)
Sphyrna lewini	Muscle	2011	−16.7	0.17	15.05	1.05	8	Mideast Pacific Ocean	Li et al. (2014)
Squalus acanthias	Muscle (LE)	2004, 2005	−15.03	0.38	14.76	0.53	20	Monterey Bay, California; M	Bigman (2013)
Squalus acanthias	Muscle (LE)	2004, 2005	−15.24	0.47	14.50	0.47	23	Monterey Bay, California; F	Bigman (2013)

(Continues)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Cephalopoda (squids and octopus)									
Abraliopsis felis	Mantle muscle (LE corr carbon)	2007, 2009	−18.9	0.5	14.5	0.7	4	California Current	Miller et al. (2013)
Abraliopsis spp.	White muscle (LE corr)	2007–2010	−18.95	0.49	15.18	0.36	4	California Current	Madigan et al. (2012)
Berryteuthis magister	Whole animal (LE)	1997	−18.3	0.2	11.4	0.2	9	Bering Sea, Alaska; Medium size class (mean length 10.0 cm); SE reported	Kurle and Worthy (2001)
Berryteuthis magister	Whole animal (LE)	1997	−18.1	0.2	11.4	0.2	3	Bering Sea, Alaska; Small size class (mean length 5.4 cm); SE reported	Kurle and Worthy (2001)
Berryteuthis magister	Mantle muscle (Non LE)	2004, 2007	−20.05	0.48	12.32	0.93	100	Eastern Bering Sea, Alaska	Hunsicker et al. (2010)
Berryteuthis magister	Muscle (LE corr)	2013, 2014	−17.6	0.8	14.5	0.9	40	Aleutian Islands, Alaska	Doll et al. (2018)
Berryteuthis magister	Mantle muscle (LE carbon, Non LE nitrogen)	2016–2017	−18.8	0.8	12.1	1.1	45	Gulf of Alaska	Wild et al. (2020)
Berryteuthis magister	Muscle and whole body (LE/corr carbon)	Meta	−19.2	0.2	13.1	0.4	230	Alaska	Carlisle et al. (2015)
Dosidicus gigas	White muscle (LE corr)	2007–2010	−18.42	0.23	15.4	0.52	17	California Current	Madigan et al. (2012)
Dosidicus gigas	Mantle tissue	2007, 2009	−19.1	0.2	13.9	0.5	76	California Current	Miller et al. (2013)
Dosidicus gigas	Muscle (LE/corr carbon)	Meta	−17.2	0.2	15.0	0.3	41	California	Carlisle et al. (2015)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Dosidicus gigas[c]	Muscle (LE)	1996, 1997	−14.9	0.6	16.9	0.7	10	Gulf of California; Large size class (mean length 60.2 ± 15.2 cm)	Ruiz-Cooley et al. (2006)
Enteroctopus dofleini	Animal tissue	2019	−18.0	0.5	9.7	1.0	9	Korean peninsula, Mukho coast	Kang et al. (2021)
Enteroctopus dofleini	Animal tissue	2019	−16.4	0.3	9.9	0.5	4	Korean peninsula, Pohang coast	Kang et al. (2021)
Enteroctopus dofleini	Muscle (LE corr)	2013, 2014	−16.4	0.5	14.7	0.9	19	Aleutian Islands, Alaska	Doll et al. (2018)
Eucleoteuthis luminosa	Mantle muscle (LE)	1990–1998	−17.77	0.25	11.23	1.1	3	Mid-North Pacific Ocean; M; Means manually calculated for present study	Takai et al. (2000)
Gonatopsis borealis	Whole animal (LE)	1997	−18.4	0.5	11.1	0.2	3	Bering Sea, Alaska; Small size class (mean length 7.7 cm); SE reported	Kurle and Worthy (2001)
Gonatopsis borealis	Mantle muscle (LE)	2000	−20.2	0.4	10.3	0.3	2	Bering Sea, Alaska; Small size class (mean length 9.5 cm); SE reported	Kurle et al. (2011)
Gonatopsis borealis	Mantle muscle (LE)	2000	−20.4	0.2	9.7	0.4	9	Bering Sea, Alaska; Medium size class (mean length 12.0 cm); SE reported	Kurle et al. (2011)

(Continues)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	$\delta^{13}C$ (‰)	SD/SE	$\delta^{15}N$ (‰)	SD/SE	N	Metadata	Source
Gonatopsis borealis	Mantle muscle (LE)	1990–1998	−17.76	0.22	13.14	0.21	5	Eastern North Pacific; M; Means manually calculated for present study	Takai et al. (2000)
Gonatopsis borealis	Unspecified tissue	2004–2013	−20.3	0.5	12.2	0.3	4	Okhotsk Sea	Gorbatenko et al. (2015)
Gonatopsis spp.	White muscle (LE corr)	2007–2010	−19.46	0.29	13.61	1.25	7	California Current	Madigan et al. (2012)
Gonatus berryi	Lateral white muscle (LE)	2014–2015	−17.8	0.05	11.4	0.15	2	Northwest Pacific Ocean; Manually calculated SD	Fujinami et al. (2018)
Gonatus madokai	Unspecified tissue	2004–2013	−20.7	NA	13.0	NA	1	Okhotsk Sea	Gorbatenko et al. (2015)
Gonatus onyx	Animal tissue (LE corr)	2001	−19.3	0.3	12.7	0.3	6	Oregon; Values derived from Miller et al. (2013)	Bosley et al. (2004)
Loligo opalescens	White muscle (LE corr)	2007–2010	−17.99	0.65	15.29	0.5	21	California	Madigan et al. (2012)
Loligo opalescens	Mantle muscle (LE)	NA	−17.2	0.5	13.3	0.7	10	Monterey Bay, California	Toperoff (2002)
Ommastrephes bartramii	Remains in bird digestive tract (LE)	1990–1991	−18.4	0.2	11.7	0.4	44	From birds in North Pacific Ocean; ± 2 SE	Gould et al. (1997)
Onychoteuthis borealijaponica	Mantle muscle	2007, 2009	−20.1	0.4	13.2	0.6	14	California Current	Miller et al. (2013)
Onychoteuthis spp.	White muscle (LE corr)	2007–2010	−18.52	0.15	14.41	0.34	6	California	Madigan et al. (2012)
Onykia robusta	Mantle muscle (LE carbon, Non LE nitrogen)	2014–2017	−18.8	0.6	16.7	0.8	10	Gulf of Alaska	Wild et al. (2020)

TABLE 1 (Continued)

Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. Bowen and Kurle (2024)

Taxa	Tissue	Year(s)	δ^{13}C (‰)	SD/SE	δ^{15}N (‰)	SD/SE	N	Metadata	Source
Stenouteuthis oualaniensis	Mantle muscle (LE)	1990–1998	−16.2	0.31	10	1.51	5	Coast of Japan; 3 M, 2 F; Means manually calculated for present study	Takai et al. (2000)
Stenouteuthis oualaniensis	Muscle (Non LE)	1998–2001	−18.7	0.5	8.1	1.1	14, 156	Hawaii; Non-paralarval	Parry (2008)
Stenouteuthis oualaniensis	Muscle	NA	−17.8	0.3	12.8	1.0	11	Hawaii; Unpublished data within reference	Carlisle et al. (2012)

Note: In the "Tissue" column, "LE" indicates the samples were lipid-extracted to remove fats that are depleted in their δ^{13}C values and create a source of bias. A note of "LE corr" indicates that the values reported by the original study were mathematically (and not experimentally) corrected for the presence of lipids. "LE/corr" means that the samples were a mixture of experimentally and mathematically corrected values. The "Year(s)" column reports the general timeframe in which the samples in the study were collected, although some samples do not have a known collection date or it was not reported ("NA"). "Meta" in the "Tissue" or "Year(s)" columns indicates that the measurements reported were part of a meta-analysis consolidating multiple studies. In the sample number column ("N"), two values separated by a comma indicate that the δ^{13}C and δ^{15}N measurements, respectively, had different sample sizes. In the "Metadata" column, we note location of sample collection, sex, size, life stage, or other relevant information provided in the study (M: Males, F: Females, U: Unknown sex, SE: Standard error).

[a]Indicates which sample was used in compilation analysis between replicates.

[b]Bone collagen was converted to resemble muscle (−2‰) in compilation analysis.

[c]Gulf of California specimens, excluded from compilation analysis.

[d]Excluded from compilation analysis due to outlier δ^{15}N value.

[e]Original source provided muscle correction, which was used for compilation analysis.

TABLE 2 Summary of single $\delta^{13}C$ and $\delta^{15}N$ values (± SD) for each species, excluding samples from the Gulf of California due to elevated $\delta^{15}N$ values for animals collected in that region.

Taxa	$\delta^{13}C$ (‰)	SD	$\delta^{15}N$ (‰)	SD	*N*
Cetacea (dolphins, porpoises, whales)					
Balaena mysticetus	−20.1	1.5	13.6	0.9	268
Balaenoptera acutorostrata	−18.5	0.8	11.7	1.4	25
Balaenoptera borealis	−19.6	1.6	8.3	1.3	10
Balaenoptera brydei	−16.9	0.6	10.0	1.2	11
Balaenoptera musculus	−16.9	0.0	13.3	0.1	222
Balaenoptera physalus	−18.4	0.8	12.5	1.0	15
Berardius bairdii	−17.8	0.6	16.3	0.8	19
Delphinapterus leucas	−18.4	0.6	16.7	0.6	49
Delphinus capensis	−16.7	0.5	18.4	0.4	39
Delphinus delphis	−17.8	0.3	11.4	0.6	33
Eschrichtius robustus	−16.2	1.1	13.1	1.3	113
Globicephala macrorhynchus	−16.9	0.5	12.2	0.7	18
Grampus griseus	−16.7	0.3	13.1	0.5	8
Megaptera novaeangliae	−17.8	0.8	12.7	1.2	1489, 1488
Orcinus orca	−15.9	1.4	17.2	1.4	123
Phocoena phocoena	−16.2	0.5	15.2	0.8	29
Phocoenoides dalli	−19.7	0.8	11.7	1.1	33
Physeter macrocephalus	−16.3	1.1	17.2	0.7	57
Pseudorca crassidens	−16.2	0.6	12.8	0.6	5
Stenella attenuata	−17.1	0.6	13.6	0.4	36
Stenella coeruleoalba	−17.3	0.6	12.3	0.6	140
Steno bredanensis	−16.9	0.5	12.3	0.6	6
Tursiops truncatus	−16.7	0.8	13.1	0.6	50
Pinnipedia (seals, sea lions, walrus)					
Callorhinus ursinus	−17.6	1.3	16.5	1.5	609, 607
Eumetopias jubatus	−16.2	1.7	17.6	1.2	129
Mirounga angustirostris	−16.0	1.0	18.2	1.1	24
Odobenus rosmarus	−16.9	0.6	12.8	0.8	184
Phoca vitulina	−15.8	1.4	17.7	1.5	106
Zalophus californianus	−15.4	0.5	17.6	1.1	78
Mustelidae (sea otters)					
Enhydra lutris	−13.4	1.5	13.4	1.8	247
Osteichthyes (bony fishes)					
Ammodytes hexapterus	−17.5	1.2	11.6	0.6	34
Ammodytidae	−20.3	1.5	11.5	1.2	27
Anoplopoma fimbria	−18.9	1.1	13.7	0.4	24
Atheresthes stomas	−16.8	1.1	15.1	0.8	59
Clupea pallasii	−19.2	0.2	13.0	0.2	393
Engraulis mordax	−17.3	0.9	13.8	0.6	96

TABLE 2 (Continued)

Taxa	$\delta^{13}C$ (‰)	SD	$\delta^{15}N$ (‰)	SD	*N*
Gadus macrocephalus	−17.0	0.9	15.6	1.2	83
Genyonemus lineatus	−15.3	0.2	15.1	0.3	10
Hippoglossus stenolepis	−17.4	1.2	15.3	1.4	1224
Hypomesus pretiosus	−18.6	0.6	13.4	0.1	2
Lampris guttatus	−18.3	0.9	12.1	1.7	30
Mallotus villosus	−19.2	0.8	15.4	0.6	6
Merluccius productus	−17.6	0.4	13.5	0.6	67
Mola mola	−20.5	0.9	7.0	1.8	17
Oncorhynchus gorbuscha	−21.3	0.6	11.3	0.5	244
Oncorhynchus keta	−20.7	0.9	11.7	0.9	195
Oncorhynchus kisutch	−19.1	1.8	14.1	1.6	239
Oncorhynchus nerka	−20.5	1.1	12.1	1.3	313
Oncorhynchus tshawytscha	−18.8	2.2	14.2	1.6	477
Ophiodon elongatus	−17.6	0.9	14.5	2.1	525
Pleurogrammus monopterygius	−18.5	1.4	12.3	1.3	99
Sarda chiliensis	−17.7	0.3	16.2	0.2	12
Sardinops sagax	−18.4	1.3	13.1	0.6	91
Scomber japonicus	−18.1	0.4	14.3	0.3	23
Sebastes spp.	−17.5	0.5	13.0	1.5	172
Seriola lalandi	−17.2	0.6	15.9	0.6	34
Thunnus alalunga	−18.5	1.6	13.2	1.6	914
Thunnus albacares	−15.7	1.1	12.2	3.0	978
Thunnus obesus	−16.0	1.2	14.0	2.9	642
Thunnus orientalis	−18.1	0.5	13.4	1.6	155
Xiphias gladius	−17.2	1.0	14.6	1.8	34
Chondrichthyes (cartilaginous fishes)					
Alopias superciliosus	−17.1	0.4	17.0	1.2	7
Carcharhinus falciformis	−17.1	0.4	15.5	1.0	19
Carcharhinus longimanus	−18.8	0.2	14.9	0.8	5
Carcharodon carcharias	−15.7	1.0	19.3	1.6	64
Isurus oxyrinchus	−18.2	0.2	16.4	0.8	10
Lamna ditropis	−18.0	0.7	13.6	1.3	20
Prionace glauca	−18.4	0.8	15.0	1.9	167
Somniosus pacificus	−20.6	0.7	14.0	1.0	160
Sphyrna lewini	−16.1	0.2	15.1	1.1	8
Squalus acanthias	−15.1	0.4	14.6	0.5	43
Cephalopoda (squids and octopus)					
Abraliopsis felis	−18.9	0.5	14.5	0.7	4
Abraliopsis spp.	−19.0	0.5	15.2	0.7	4
Berryteuthis magister	−18.7	1.0	12.5	1.3	427
Dosidicus gigas	−18.2	0.8	14.8	0.8	134

(Continues)

TABLE 2 (Continued)

Taxa	$\delta^{13}C$ (‰)	SD	$\delta^{15}N$ (‰)	SD	*N*
Enteroctopus dofleini	−16.9	0.9	11.4	2.4	32
Eucleoteuthis luminosa	−17.8	0.3	11.2	1.1	3
Gonatopsis borealis	−19.4	1.3	11.2	1.4	23
Gonatopsis spp.	−19.4	0.3	13.6	1.2	7
Gonatus berryi	−17.8	0.1	11.4	0.2	2
Gonatus madokai	−20.7	0.0	13.0	0.0	1
Gonatus onyx	−19.3	0.3	12.7	0.3	6
Loligo opalescens	−17.6	0.7	14.3	1.2	31
Ommastrephes bartramii	−18.4	0.7	11.8	1.3	44
Onychoteuthis borealijaponica	−20.1	0.4	13.2	0.6	14
Onychoteuthis spp.	−18.5	0.2	14.4	0.4	6
Onykia robusta	−18.8	0.6	16.7	0.8	10
Stenouteuthis oualaniensis	−17.6	1.1	10.3	2.3	30, 172

Note: In the event of paired samples (Table 1) from a study, the values for muscle tissue were used. Additionally, for studies that utilized bone collagen, we converted the values to resemble those from muscle. In the sample number column ("N"), if two values are present, the first indicates the $\delta^{13}C$ sample size and the second indicates the $\delta^{15}N$ sample size. See main text and Carlisle et al. (2015) for methodology.

TABLE 3 Summary of single $\delta^{13}C$ and $\delta^{15}N$ values (± SD) for broad taxonomic groups in the North Pacific Ocean.

Taxa	$\delta^{13}C$ (‰)	SD	$\delta^{15}N$ (‰)	SD
Cetacea	−17.5	1.4	13.1	2.4
Pinnipedia	−16.3	1.4	16.7	2.2
Mustelidae	−13.5	1.5	13.5	1.8
Osteichthyes	−18.1	1.7	12.6	5.5
Chondrichthyes	−17.5	1.6	15.6	2.0
Cephalopoda	−18.7	1.2	13.1	2.1

Note: Values represent primarily soft tissues, except for Mustelidae (sea otters) which are represented by whiskers and bone collagen. See main text and Carlisle et al. (2015) for methodology.

Our reference database is informative for future researchers aiming to study trophic relationships within the North Pacific, variation in isotope values within species that may be due to differential life history traits, variation in isotope values across time, and the potential for differences in the trophic discrimination factors among multiple tissues from a species. It is worth emphasizing that we report the original data here to maximize adaptability, but studies that reference this database may consider accounting for or further examining tissue corrections, the Suess effect (Baxter & Walton, 1970), geographic variation (i.e., changes in the $\delta^{13}C$ values with latitude or the elevated $\delta^{15}N$ values of the Gulf of California; Ruiz-Cooley et al., 2012), or other appropriate measures for the context of their work.

AUTHOR CONTRIBUTIONS

Kelly R. Bowen: Conceptualization; data curation; formal analysis; investigation; methodology; writing – original draft; writing – review and editing. **Carolyn M. Kurle:** Conceptualization; resources; supervision; writing – review and editing.

ACKNOWLEDGMENTS

Funding and support for K.R.B. and C.M.K. were provided by the University of California San Diego (UCSD).

ORCID

Kelly R. Bowen https://orcid.org/0000-0001-7718-4504

REFERENCES

Altabet, M. A., Pilskaln, C., Thunell, R., Pride, C., Sigman, D., Chavez, F., & Francois, R. (1999). The nitrogen isotope biogeochemistry of sinking particles from the margin of the eastern North Pacific. *Deep Sea Research Part I: Oceanographic Research Papers*, *46*(4), 655–679. https://doi.org/10.1016/S0967-0637(98)00084-3

Alter, S. E., Newsome, S. D., & Palumbi, S. R. (2012). Pre-whaling genetic diversity and population ecology in eastern pacific gray whales: Insights from ancient DNA and stable isotopes. *PLoS One*, *7*(5), e35039. https://doi.org/10.1371/journal.pone.0035039

Arnoldi, N. S., Litvin, S. Y., Madigan, D. J., Micheli, F., & Carlisle, A. (2023). Multi-taxa marine isoscapes provide insight into large-scale trophic dynamics in the North Pacific. *Progress in Oceanography*, *213*, 103005. https://doi.org/10.1016/j.pocean.2023.103005

Aurioles-Gamboa, D., Rodríguez-Pérez, M., Sánchez-Velasco, L., & Lavín, M. (2013). Habitat, trophic level, and residence of marine mammals in the Gulf of California assessed by stable isotope analysis. *Marine Ecology Progress Series*, *488*, 275–290. https://doi.org/10.3354/meps10369

Baxter, J. M., & Walton, A. (1970). A theoretical approach to the Suess effect. *Proceedings of the Royal Society of London. Proceedings of the Royal Society of London. A. Mathematical and Physical Sciences*, *318*(1533), 213–230. https://doi.org/10.1098/rspa.1970.0141

Becker, B., Peery, M., & Beissinger, S. (2007). Ocean climate and prey availability affect the trophic level and reproductive success of the marbled murrelet, an endangered seabird. *Marine Ecology Progress Series*, *329*, 267–279. https://doi.org/10.3354/meps329267

Bentzen, R., Castellini, J. M., Gerlach, R., Dykstra, C., & O'Hara, T. (2016). Mercury concentrations in Alaska Pacific halibut muscle relative to stable isotopes of C and N and other biological variables. *Marine Pollution Bulletin*, *113*(1–2), 110–116. https://doi.org/10.1016/j.marpolbul.2016.08.068

Bigman, J. S. (2013). *Trophic ecology of the North Pacific spiny dogfish, Squalus suckleyi, off central California* (Master of Science). California State University Monterey Bay. https://scholarworks.calstate.edu/downloads/dn39x628v

Bodin, N., Pethybridge, H., Duffy, L. M., Lorrain, A., Allain, V., Logan, J. M., … Young, J. W. (2020). Global data set for nitrogen and carbon stable isotopes of tunas. *Ecology*, *102*(3), e03265. https://doi.org/10.1002/ecy.3265

Boecklen, W. J., Yarnes, C. T., Cook, B. A., & James, A. C. (2011). On the use of stable isotopes in trophic ecology. *Annual Review of Ecology, Evolution, and Systematics*, *42*(1), 411–440. https://doi.org/10.1146/annurev-ecolsys-102209-144726

Bosley, K. L., Lavelle, J. W., Brodeur, R. D., Wakefield, W. W., Emmett, R. L., Baker, E. T., & Rehmke, K. M. (2004). Biological and physical processes in and around Astoria submarine canyon, Oregon, USA. *Journal of Marine Systems*, *50*(1–2), 21–37. https://doi.org/10.1016/j.jmarsys.2003.06.006

Bowen, K. R., & Kurle, C. M. (2024). Effects of pre-treatment, historical age, and sample characteristics on the stable isotope analyses of killer whale (Orcinus orca) bone. *Rapid Communications in Mass Spectrometry*, *38*(19). https://doi.org/10.1002/rcm.9874

Brown, B. (2021). *Geographic and ontogenetic variation in the trophic ecology of lingcod (Ophiodon elongatus) along the U.S. West Coast* (Master of Science). San Jose State University. https://doi.org/10.31979/etd.5s93-muc8

Buchheister, A., & Latour, R. J. (2010). Turnover and fractionation of carbon and nitrogen stable isotopes in tissues of a migratory coastal predator, summer flounder (*Paralichthys dentatus*). *Canadian Journal of Fisheries and Aquatic Sciences*, *67*(3), 445–461. https://doi.org/10.1139/F09-196

Burton, R., & Koch, P. L. (1999). Isotopic tracking of foraging and long-distance migration in northeastern pacific pinnipeds. *Oecologia*, *119*(4), 578–585.

Busquets Vass, G. R. (2008). *Variability of stable isotopes of nitrogen and carbon in blue whale (Balaenoptera musculus) skin* (Master's Thesis). National Polytechnic Institute. Interdisciplinary Center for Marine Sciences. https://www.repositoriodigital.ipn.mx/handle/123456789/13664

Busquets-Vass, G., Newsome, S. D., Pardo, M. A., Calambokidis, J., Aguíñiga-García, S., Páez-Rosas, D., … Gendron, D. (2021). Isotope-based inferences of the seasonal foraging and migratory strategies of blue whales in the eastern Pacific Ocean. *Marine Environmental Research*, *163*, 105201. https://doi.org/10.1016/j.marenvres.2020.105201

Carlisle, A. B., Goldman, K. J., Litvin, S. Y., Madigan, D. J., Bigman, J. S., Swithenbank, A. M., … Block, B. A. (2015). Stable isotope analysis of vertebrae reveals ontogenetic changes in habitat in an endothermic pelagic shark. *Proceedings of the Royal Society B: Biological Sciences*, *282*(1799), 20141446. https://doi.org/10.1098/rspb.2014.1446

Carlisle, A. B., Kim, S. L., Semmens, B. X., Madigan, D. J., Jorgensen, S. J., Perle, C. R., … Block, B. A. (2012). Using stable isotope analysis to understand the migration and trophic ecology of northeastern Pacific white sharks (*Carcharodon carcharias*). *PLoS One*, *7*(2), e30492. https://doi.org/10.1371/journal.pone.0030492

Choy, C. A., Popp, B. N., Hannides, C. C. S., & Drazen, J. C. (2015). Trophic structure and food resources of epipelagic and mesopelagic fishes in the North Pacific Subtropical Gyre ecosystem inferred from nitrogen isotopic compositions. *Limnology and Oceanography*, *60*(4), 1156–1171. https://doi.org/10.1002/lno.10085

Clark, C. T., Horstmann, L., & Misarti, N. (2019). Lipid normalization and stable isotope discrimination in Pacific walrus tissues. *Scientific Reports*, *9*(1), 5843. https://doi.org/10.1038/s41598-019-42095-z

Courtney, D. L., & Foy, R. (2012). Pacific sleeper shark *Somniosus pacificus* trophic ecology in the eastern North Pacific Ocean inferred from nitrogen and carbon stable-isotope ratios and diet. *Journal of Fish Biology*, *80*(5), 1508–1545. https://doi.org/10.1111/j.1095-8649.2012.03261.x

Dehn, L.-A., Follmann, E. H., Rosa, C., Duffy, L. K., Thomas, D. L., Bratton, G. R., … O'Hara, T. M. (2006). Stable isotope and trace element status of subsistence-hunted bowhead and beluga whales in Alaska and gray whales in Chukotka. *Marine Pollution Bulletin*, *52*(3), 301–319. https://doi.org/10.1016/j.marpolbul.2005.09.001

DeNiro, M. J., & Epstein, S. (1978). Influence of diet on the distribution of carbon isotopes in animals. *Geochimica et Cosmochimica Acta*, *42*(5), 495–506. https://doi.org/10.1016/0016-7037(78)90199-0

Deniro, M. J., & Epstein, S. (1981). Influence of diet on the distribution of nitrogen isotopes in animals. *Geochimica et Cosmochimica Acta*, *45*(3), 341–351. https://doi.org/10.1016/0016-7037(81)90244-1

Diaz-Gamboa, R. E. (2009). *Trophic relationships of teutophagous cetaceans with the Giant Squid Dosidicus gigas in the Gulf of California* (Doctorate in Marine Sciences). National Polytechnic Institute. Interdisciplinary Center for Marine Sciences. http://repositoriodigital.ipn.mx/handle/123456789/14199

Doll, A. C., Taras, B. D., Stricker, C. A., Rea, L. D., O'Hara, T. M., Cyr, A. P., … Wunder, M. B. (2018). Temporal records of diet diversity dynamics in individual adult female Steller sea lion (*Eumetopias jubatus*) vibrissae. *Oecologia*, *188*(1), 263–275. https://doi.org/10.1007/s00442-018-4173-8

Endo, T., Hisamichi, Y., Kimura, O., Haraguchi, K., Lavery, S., Dalebout, M. L., … Baker, C. S. (2010). Stable isotope ratios of carbon and nitrogen and mercury concentrations in 13 toothed whale species taken from the Western Pacific Ocean off Japan. *Environmental Science & Technology*, *44*(7), 2675–2681. https://doi.org/10.1021/es903534r

Endo, T., Hotta, Y., Hisamichi, Y., Kimura, O., Sato, R., Haraguchi, K., … Baker, C. S. (2012). Stable isotope ratios and mercury levels in red meat products from baleen whales sold in Japanese markets. *Ecotoxicology and Environmental Safety*, *79*, 35–41. https://doi.org/10.1016/j.ecoenv.2012.01.020

Fauvelle, M., & Somerville, A. D. (2021). Surf and turf: A dataset of stable isotope values of plants and animals from southern California. *Data in Brief*, *38*, 107380. https://doi.org/10.1016/j.dib.2021.107380

Filatova, O. A., Witteveen, B. H., Goncharov, A. A., Tiunov, A. V., Goncharova, M. I., Burdin, A. M., & Hoyt, E. (2013). The diets of humpback whales (*Megaptera novaeangliae*) on the shelf and oceanic feeding grounds in the western North Pacific inferred from stable isotope analysis. *Marine Mammal Science*, *29*(3), 253–265. https://doi.org/10.1111/j.1748-7692.2012.00617.x

Fujinami, Y., Nakatsuka, S., & Ohshimo, S. (2018). Feeding habits of the blue shark (*Prionace glauca*) in the northwestern Pacific based on stomach contents and stable isotope ratios. *Pacific Science*, *72*(1), 21–39. https://doi.org/10.2984/72.1.2

Gendron, D., Aguiniga, S., & Carriquiry, J. (2023). δ^{15}N and δ^{13}C in skin biopsy samples: A note on their applicability for examining the relative trophic level in three rorqual species. *Journal of Cetacean Research and Management*, *3*(1), 41–44. https://doi.org/10.47536/jcrm.v3i1.898

Gorbatenko, K. M., Kiyashko, S. I., Lazhentsev, A. E., Emelin, P. O., & Grishan, R. P. (2015). Bentho-pelagic relations in the deep-water part of the Okhotsk Sea by the data of stable isotopes C and N analysis. *Izvestiya TINRO*, *183*(4), 200–216. https://doi.org/10.26428/1606-9919-2015-183-200-216

Gould, P., Ostrom, P., & Walker, W. (1997). Trophic relationships of albatrosses associated with squid and large-mesh driftnet fisheries in the North Pacific Ocean. *Canadian Journal of Zoology*, *75*(4), 549–562. https://doi.org/10.1139/z97-068

Herman, D., Burrows, D., Wade, P., Durban, J., Matkin, C., LeDuc, R., … Krahn, M. (2005). Feeding ecology of eastern North Pacific killer whales *Orcinus orca* from fatty acid, stable isotope, and organochlorine analyses of blubber biopsies. *Marine Ecology Progress Series*, *302*, 275–291. https://doi.org/10.3354/meps302275

Hirons, A. C., Schell, D. M., & Finney, B. P. (2001). Temporal records of δ^{13}C and δ^{15}N in North Pacific pinnipeds: Inferences regarding environmental change and diet. *Oecologia*, *129*(4), 591–601. https://doi.org/10.1007/s004420100756

Hobson, K. A. (1999). Tracing origins and migration of wildlife using stable isotopes: A review. *Oecologia*, *120*(3), 314–326. https://doi.org/10.1007/s004420050865

Hobson, K. A., & Sease, J. L. (1998). Stable isotope analyses of tooth annuli reveal temporal dietary records: An example using Stellar Sea lions. *Marine Mammal Science*, *14*(1), 116–129. https://doi.org/10.1111/j.1748-7692.1998.tb00694.x

Hobson, K. A., Sease, J. L., Merrick, R. L., & Piatt, J. F. (1997). Investigating trophic relationships of pinnipeds in Alaska and Washington using stable isotope ratios of nitrogen and carbon. *Marine Mammal Science*, *13*(1), 114–132. https://doi.org/10.1111/j.1748-7692.1997.tb00615.x

Hoekstra, P. F., Dehn, L. A., George, J. C., Solomon, K. R., Muir, D. C., & O'Hara, T. M. (2002). Trophic ecology of bowhead whales (*Balaena mysticetus*) compared with that of other arctic marine biota as interpreted from carbon-, nitrogen-, and sulfur-isotope signatures. *Canadian Journal of Zoology*, *80*(2), 223–231. https://doi.org/10.1139/z01-229

Horstmann-Dehn, L., Follmann, E. H., Rosa, C., Zelensky, G., & George, C. (2012). Stable carbon and nitrogen isotope ratios in muscle and epidermis of arctic whales. *Marine Mammal Science*, *28*(2), 173–190. https://doi.org/10.1111/j.1748-7692.2011.00503.x

Hunsicker, M., Essington, T., Aydin, K., & Ishida, B. (2010). Predatory role of the commander squid Berryteuthis magister in the eastern Bering Sea: Insights from stable isotopes and food habits. *Marine Ecology Progress Series*, *415*, 91–108. https://doi.org/10.3354/meps08750

Jaime-Rivera, M., Caraveo-Patiño, J., Hoyos-Padilla, M., & Galván-Magaña, F. (2014). Feeding and migration habits of white shark Carcharodon carcharias (Lamniformes: Lamnidae) from Isla Guadalupe inferred by analysis of stable isotopes δ^{15}N and δ^{13}C. *Revista De Biologia Tropical*, *62*(2), 637–647.

Jaume-Schinkel, M. S. (2004). *Food habits of the fin whale Balaenoptera physalus in the Gulf of California using stable isotopes of nitrogen and carbon* (Master's Thesis). National Polytechnic Institute. Interdisciplinary Center for Marine Sciences. http://repositoriodigital.ipn.mx/handle/123456789/14439

Johnson, S. P., & Schindler, D. E. (2009). Trophic ecology of Pacific salmon (*Oncorhynchus* spp.) in the ocean: A synthesis of stable isotope research. *Ecological Research*, *24*(4), 855–863. https://doi.org/10.1007/s11284-008-0559-0

Kanaji, Y., Yoshida, H., & Okazaki, M. (2017). Spatiotemporal variations in habitat utilization patterns of four Delphinidae species in the western North Pacific, inferred from carbon and nitrogen stable isotope ratios. *Marine Biology*, *164*(4), 65. https://doi.org/10.1007/s00227-017-3107-z

Kang, H. Y., Lee, Y.-J., Kim, C., Kim, D., Kim, D.-H., Kim, J.-H., … Kang, C.-K. (2021). Food web trophic structure at marine ranch sites off the east coast of Korea. *Frontiers in Marine Science*, *8*, 653281. https://doi.org/10.3389/fmars.2021.653281

Kim, S. L., Tinker, M. T., Estes, J. A., & Koch, P. L. (2012). Ontogenetic and among-individual variation in foraging strategies of Northeast Pacific white sharks based on stable isotope analysis. *PLoS One*, *7*(9), e45068. https://doi.org/10.1371/journal.pone.0045068

Kurle, C., & Worthy, G. (2002). Stable nitrogen and carbon isotope ratios in multiple tissues of the northern fur seal *Callorhinus ursinus*: Implications for dietary and migratory reconstructions. *Marine Ecology Progress Series*, *236*, 289–300. https://doi.org/10.3354/meps236289

Kurle, C. M. (2009). Interpreting temporal variation in omnivore foraging ecology via stable isotope modelling. *Functional Ecology*, *23*(4), 733–744. https://doi.org/10.1111/j.1365-2435.2009.01553.x

Kurle, C. M., Koch, P. L., Tershy, B. R., & Croll, D. A. (2014). The effects of sex, tissue type, and dietary components on stable isotope discrimination factors (Δ^{13}C and Δ^{15}N) in mammalian omnivores. *Isotopes in Environmental and Health Studies*, *50*(3), 307–321. https://doi.org/10.1080/10256016.2014.908872

Kurle, C. M., Sinclair, E. H., Edwards, A. E., & Gudmundson, C. J. (2011). Temporal and spatial variation in the δ^{15}N and δ^{13}C values of fish and squid from Alaskan waters. *Marine Biology*, *158*(11), 2389–2404. https://doi.org/10.1007/s00227-011-1741-4

Kurle, C. M., & Worthy, G. A. J. (2001). Stable isotope assessment of temporal and geographic differences in feeding ecology of northern fur seals (*Callorhinus ursinus*) and their prey. *Oecologia*, *126*(2), 254–265. https://doi.org/10.1007/s004420000518

Li, Y., Gong, Y., Chen, X., Dai, X., & Zhu, J. (2014). Trophic ecology of sharks in the mid-east Pacific ocean inferred from stable isotopes. *Journal of Ocean University of China*, *13*(2), 278–282. https://doi.org/10.1007/s11802-014-2071-1

Lian, M., Castellini, J. M., Miller, D., Griff, B., Vertyankin, V. V., Dupont, J., … O'Hara, T. M. (2020). Assessing δ^{13}C, δ^{15}N and total mercury measures in epidermal biopsies from gray whales. *Frontiers in Marine Science*, *7*, 133. https://doi.org/10.3389/fmars.2020.00133

Litz, M. N. C., Miller, J. A., Copeman, L. A., Teel, D. J., Weitkamp, L. A., Daly, E. A., & Claiborne, A. M. (2017). Ontogenetic shifts in the diets of juvenile Chinook Salmon: New insight from stable isotopes and fatty acids. *Environmental Biology of Fishes*, *100*(4), 337–360. https://doi.org/10.1007/s10641-016-0542-5

Liu, A. K. (2017). *Temporal variability in the stable carbon and nitrogen isotope values from common midtrophic level species in the Bering Sea* (Master's Thesis). UC San Diego. https://escholarship.org/uc/item/3x09n333

Madigan, D. J., Carlisle, A. B., Dewar, H., Snodgrass, O. E., Litvin, S. Y., Micheli, F., & Block, B. A. (2012). Stable isotope analysis challenges wasp-waist food web assumptions in an upwelling pelagic ecosystem. *Scientific Reports*, *2*(1), 654. https://doi.org/10.1038/srep00654

Mandi, D. A. (2002). *Trophic ecology of Northern Sea otter (Enhydra lutris) in southcentral and Southwest Alaska utilizing stable isotope ratios* (Nova southeastern university). https://nsuworks.nova.edu/hcas_etd_all/7

Miller, T., Bosley, K., Shibata, J., Brodeur, R., Omori, K., & Emmett, R. (2013). Contribution of prey to Humboldt squid *Dosidicus gigas* in the northern California current, revealed by stable isotope analyses. *Marine Ecology Progress Series*, *477*, 123–134. https://doi.org/10.3354/meps10133

Misarti, N., Finney, B., Maschner, H., & Wooller, M. J. (2009). Changes in northeast Pacific marine ecosystems over the last 4500 years: Evidence from stable isotope analysis of bone collagen from archeological middens. *The Holocene*, *19*(8), 1139–1151. https://doi.org/10.1177/0959683609345075

Nakamura, I., & Sato, K. (2014). Ontogenetic shift in foraging habit of ocean sunfish *Mola mola* from dietary and behavioral studies. *Marine Biology*, *161*(6), 1263–1273. https://doi.org/10.1007/s00227-014-2416-8

Newsome, S., Etnier, M., Monson, D., & Fogel, M. (2009). Retrospective characterization of ontogenetic shifts in killer whale diets via $\delta^{13}C$ and $\delta^{15}N$ analysis of teeth. *Marine Ecology Progress Series*, *374*, 229–242. https://doi.org/10.3354/meps07747

Newsome, S. D., Tinker, M. T., Monson, D. H., Oftedal, O. T., Ralls, K., Staedler, M. M., … Estes, J. A. (2009). Using stable isotopes to investigate individual diet specialization in California sea otters (*Enhydra lutris nereis*). *Ecology*, *90*(4), 961–974. https://doi.org/10.1890/07-1812.1

Ohizumi, H., & Miyazaki, N. (2010). Differences in stable isotope ratios of Dall's porpoises (*Phocoenoides dalli*) between coastal and oceanic areas of the North Pacific. *Fisheries Oceanography*, *19*(4), 257–261. https://doi.org/10.1111/j.1365-2419.2010.00547.x

Orr, A. J., Newsome, S. D., & DeLong, R. (2009). Variation in stable carbon and nitrogen isotope values from multiple tissues of california sea lions (*Zalophus californianus*). In C. C. Damiani & D. K. Garcelon (Eds.), *Proceedings of 121 the 7th California Islands symposium*, (pp. 121–129). Institute for Wildlife Studies. https://sbbotanicgarden.org/wp-content/uploads/2022/08/Orr-et-al-2009-CA-sea-lion-isotopes.pdf

Parry, M. (2008). Trophic variation with length in two ommastrephid squids, *Ommastrephes bartramii* and *Sthenoteuthis oualaniensis*. *Marine Biology*, *153*(3), 249–256. https://doi.org/10.1007/s00227-007-0800-3

Post, D. M. (2002). Using stable isotopes to estimate trophic position: Models, methods, and assumptions. *Ecology*, *83*(3), 703–718. https://doi.org/10.1890/0012-9658(2002)083[0703:USITET]2.0.CO;2

R Core Team (2022). R: A Language and Environment for Statistical Computing. *R Foundation for Statistical Computing*, Vienna.

Riofrío-Lazo, M., & Aurioles-Gamboa, D. (2013). Timing of isotopic integration in marine mammal skull: Comparative study between calcified tissues. *Rapid Communications in Mass Spectrometry*, *27*(9), 1076–1082. https://doi.org/10.1002/rcm.6556

Ruiz-Cooley, R., Gendron, D., Aguíñiga, S., Mesnick, S., & Carriquiry, J. (2004). Trophic relationships between sperm whales and jumbo squid using stable isotopes of C and N. *Marine Ecology Progress Series*, *277*, 275–283. https://doi.org/10.3354/meps277275

Ruiz-Cooley, R. I., Engelhaupt, D. T., & Ortega-Ortiz, J. G. (2012). Contrasting C and N isotope ratios from sperm whale skin and squid between the Gulf of Mexico and gulf of California: Effect of habitat. *Marine Biology*, *159*(1), 151–164. https://doi.org/10.1007/s00227-011-1795-3

Ruiz-Cooley, R. I., Markaida, U., Gendron, D., & Aguíñiga, S. (2006). Stable isotopes in jumbo squid (*Dosidicus gigas*) beaks to estimate its trophic position: Comparison between stomach contents and stable isotopes. *Journal of the Marine Biological Association of the United Kingdom*, *86*(2), 437–445. https://doi.org/10.1017/S0025315406013324

Satterfield, F. R., & Finney, B. P. (2002). Stable isotope analysis of Pacific salmon: Insight into trophic status and oceanographic conditions over the last 30 years. *Progress in Oceanography*, *53*(2–4), 231–246. https://doi.org/10.1016/S0079-6611(02)00032-0

Seymour, J., Horstmann-Dehn, L., & Wooller, M. J. (2014). Inter-annual variability in the proportional contribution of higher trophic levels to the diet of Pacific walruses. *Polar Biology*, *37*(5), 597–609. https://doi.org/10.1007/s00300-014-1460-7

Stephens, R. B., Shipley, O. N., & Moll, R. J. (2023). Meta-analysis and critical review of trophic discrimination factors ($\Delta^{13}C$ and $\Delta^{15}N$): Importance of tissue, trophic level and diet source. *Functional Ecology*, *37*(9), 2535–2548. https://doi.org/10.1111/1365-2435.14403

Sydeman, W. J., Hobson, K. A., Pyle, P., & McLaren, E. B. (1997). Trophic relationships among seabirds in Central California: Combined stable isotope and conventional dietary approach. *The Condor*, *99*(2), 327–336. https://doi.org/10.2307/1369938

Takai, N., Onaka, S., Ikeda, Y., Yatsu, A., Kidokoro, H., & Sakamoto, W. (2000). Geographical variations in carbon and nitrogen stable isotope ratios in squid. *Journal of the Marine Biological Association of the United Kingdom*, *80*(4), 675–684. https://doi.org/10.1017/S0025315400002502

Tawa, A., Ishihara, T., Uematsu, Y., Ono, T., & Ohshimo, S. (2017). Evidence of westward transoceanic migration of Pacific bluefin tuna in the sea of Japan based on stable isotope analysis. *Marine Biology*, *164*(4), 94. https://doi.org/10.1007/s00227-017-3127-8

Todd, S. K., Holm, B., Rosen, D. A. S., & Tollit, D. J. (2009). Stable isotope signal homogeneity and differences between and within pinniped muscle and skin. *Marine Mammal Science*, *26*(1), 176–185. https://doi.org/10.1111/j.1748-7692.2009.00345.x

Toperoff, A. (2002). *Examination of diet of harbor porpoise (Phocoena phocoena) from central California using stomach content and stable isotope analysis from multiple tissues* (Master's Thesis, San Jose State University). https://scholarworks.calstate.edu/concern/theses/pc289p704

Waite, J. N., Trumble, S. J., Burkanov, V. N., & Andrews, R. D. (2012). Resource partitioning by sympatric Steller sea lions and northern fur seals as revealed by biochemical dietary analyses and satellite telemetry. *Journal of Experimental Marine Biology and Ecology*, *416–417*, 41–54. https://doi.org/10.1016/j.jembe.2012.02.009

Warlick, A., Ylitalo, G., O'Neill, S., Hanson, M., Emmons, C., & Ward, E. (2020). Using Bayesian stable isotope mixing models and generalized additive models to resolve diet changes for fish-eating killer whales *Orcinus orca*. *Marine Ecology Progress Series*, *649*, 189–200. https://doi.org/10.3354/meps13452

Wild, L. A., Mueter, F., Witteveen, B., & Straley, J. M. (2020). Exploring variability in the diet of depredating sperm whales in the Gulf of Alaska through stable isotope analysis. *Royal Society Open Science*, *7*(3), 191110. https://doi.org/10.1098/rsos.191110

Witteveen, B., Worthy, G., & Roth, J. (2009). Tracing migratory movements of breeding North Pacific humpback whales using stable isotope analysis. *Marine Ecology Progress Series*, *393*, 173–183. https://doi.org/10.3354/meps08231

Witteveen, B., Worthy, G., Wynne, K., & Roth, J. (2009). Population structure of North Pacific humpback whales on their feeding grounds revealed by stable carbon and nitrogen isotope ratios. *Marine Ecology Progress Series*, *379*, 299–310. https://doi.org/10.3354/meps07900

Witteveen, B. H., & Wynne, K. M. (2016). Trophic niche partitioning and diet composition of sympatric fin (*Balaenoptera physalus*) and humpback whales (*Megaptera novaeangliae*) in the Gulf of Alaska revealed through stable isotope analysis. *Marine Mammal Science*, *32*(4), 1319–1339. https://doi.org/10.1111/mms.12333

Wolf, N., Webster, S. R., Welker, J. M., & Harris, B. P. (2019). Assessing the relationship between diet and size-at-age in Pacific halibut (*Hippoglossus stenolepis*) using $\delta^{13}C$ and $\delta^{15}N$ analysis. *Canadian Journal of Fisheries and Aquatic Sciences*, *76*(12), 2326–2331. https://doi.org/10.1139/cjfas-2018-0380

How to cite this article: Bowen, K. R., & Kurle, C. M. (2024). Stable isotope values from organisms in the North Pacific Ocean: A reference for trophic ecology studies. *Marine Mammal Science*, e13221. https://doi.org/10.1111/mms.13221