Learning How to Fish:

Catch Shares and the Future of Fishery Conservation

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I.
INTRODUCTION

In a crowded meeting hall in Portsmouth, New Hampshire, the New England Fishery Management Council voted this

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January to recommend drastic new cuts to the catch limits for Atlantic codfish off the New England coast.[1] Over the strenuous objections of local communities and fishermen, the Council proposed 77% reductions in the allowable cod harvest for each of the next three years in the Gulf of Maine, and a 61% cut in next year's cod catch on Georges Bank.[2] The National Oceanographic and Atmospheric Administration approved the proposed catch limits and other "emergency" measures in May 2013.[3]

New England fishermen and other opponents of the plan fear that these restrictions will doom the centuries-old local fishing industry. As one lamented: "Right now what we've got is a plan that guarantees the fishermen's extinction and does nothing to ameliorate it."[4] Proponents of the plan, however, counter that these measures are the only way to save the rapidly collapsing Atlantic cod industry. As Council member John Bullard, regional administrator of the National Oceanic and Atmospheric Administration, observed, the problem is that there are fewer and fewer codfish in the sea. "It's midnight and getting darker when it comes to how many cod there are. There isn't enough cod for people to make a decent living."[5] The dire state of the fishery gave Council members little choice.[6]

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1. Katherine Q. Seelye & Jess Bidgood, *Officials Back Deep Cuts in Atlantic Cod Harvest to Save Industry*, N.Y. TIMES, Jan. 30, 2013, at A11, *available at* http://www.nytimes.com/2013/01/31/us/officials-back-deep-cuts-in-atlantic-cod-harvest-to-save-industry.html.

2. *Id.* ("The plan reduces the catch of cod in the Gulf of Maine down to 1,550 metric tons a year for the next three years; the limit was 8,000 metric tons a decade ago. The catch in Georges Bank would drop to 2,002 metric tons, down from 12,000 from a decade ago.").

3. *See* Magnuson-Stevens Fishery Conservation and Management Act Provisions; Fisheries of the Northeastern United States; Northeast Multispecies Fishery; Framework Adjustment 50, 78 Fed. Reg. 26172 (May 3, 2013); *see also* Matt Murphy, *New Rules Cut Georges Bank Cod 78 Percent*, CAPE COD TODAY, May 1, 2013, *available at* http://www.capecodtoday.com/article/2013/05/01/18492-new-rules-cut-georges-bank-cod-78-percent.

4. Seelye & Bidgood, *supra* note 1.

5. *Id.*

6. In September 2012, the Secretary of Commerce declared a "commercial fishery failure" in the fishery under Section 312(a) of the Magnuson-Stevens Act and Section 308(b) of the Interjursdictional Fisheries Act, thereby authorizing federal disaster assistance for the fishery. *See Secretary of Commerce Declares Disaster in Northeast Groundfish Fishery*, FISHERIES NEWSROOM, (NOAA

Unfortunately, even these severe new limits may not be enough to save the New England cod fishery. The Council's most recent steps follow on years of mismanagement, overly optimistic stock estimates, and misguided fishery policies that failed to align the economic interests of the fishing community with the long-term sustainability of the fishery. Reforms adopted for the 2010 season may have been too little too late.[7] As fishery researcher Ray Hilborn has explained, the incentives and policies governing the New England groundfish fishery for many years have made the fishery vulnerable to just this kind of collapse.[8] In the 1990s, for example, the fishery stock assessments indicated that short-term catch limits and fishing effort reductions could rebuild the fishery stock and ultimately lead to higher long-term yields. Nevertheless, local fishermen and their political representatives vehemently opposed any such reductions.[9]

FISHERIES), Sept.13, 2012, http://www.nmfs.noaa.gov/mediacenter/2012/09/13_secretary_of_commerce_declares_disaster_in_northeast_groundfish_fishery.html

7. *See* Eric Pooley, *How Behavioral Economics Could Save Both the Fishing Industry and the Oceans*, HBR BLOG NETWORK, (Jan. 24, 2013, 11:00 AM), http://blogs.hbr.org/cs/2013/01/how_behavioral_economics_could.html (noting initial benefits of reforms from 2009 to 2011). *See also* Jonathan M. Labaree, *Sector Management in New England's Groundfish Fishery: Dramatic Change Spurs Innovation*, GULF OF MAINE RESEARCH INST. (Aug. 2012), http://www.gmri.org/upload/files/Sector%20Review%20Report.pdf (describing voluntary sector management reforms implemented in 2010). The consequences of mismanagement were likely magnified by ocean warming, which appears to have caused fish stocks to migrate. *See* William W. L. Cheung, Reg Watson & Daniel Pauly, *Signature of Ocean Warming in Global Fisheries Catch*, 497 NATURE 365 (May 15, 2013).

8. Ray Hilborn, *Managing Fish is Managing People: What Has Been Learned?*, 8 FISH & FISHERIES 285, 288 (2007).

9. When a voluntary sector-based management system was adopted in 2010, many New England fishing groups, joined by local unions and politicians, filed suit to block the plan. *See* City of New Bedord v. Locke, 2011 WL 2636863 (D. Mass. Dec. 27, 2011), *aff'd,* Lovgren v. Locke, 701 F. 3d 5 (1st Cir. 2012) (rejecting legal challenges to fishery reforms). Among those filing briefs in support of the legal challenge were Massachusetts Representatives Barney Frank and John Tierney. A similar suit was promptly filed against the May 2013 catch reductions. *See* Jess Bidgood, *Massachusetts: State Sues Over Cod Limits*, N.Y. TIMES, May 31, 2013, at A13, *available at* http://www.nytimes.com/2013/05/31/us/massachusetts-state-sues-over-cod-limits.html.

It would be easy to attack New England fishermen for being short-sighted. To do so, however, would ignore the incentives they face—incentives created by the existing regulatory structure. Due to a large number of inactive trawling permits, incumbent fishermen have little incentive to agree to catch reductions, as they would be unlikely to capture the full value of the rebuilt stocks.[10] Even if catch reductions today would lead to higher catch limits in the future, a rebuilt stock could encourage inactive trawlers to resume fishing.[11] And although a variety of forces—some beyond human control—likely contributed to the fishery's present crisis, without proper incentives for the fishing community to preserve New England's stocks, overfishing and mismanagement continued, leaving one of North America's oldest fisheries increasingly vulnerable to collapse.

The hard choices being made in an effort to save the Atlantic cod fishery today are all too common, as policymakers continue to employ and rely upon failed conservation policies, leaving fisheries the world over poorly managed and under stress.[12] By some measures, a majority of exploited fisheries are depleted or in decline.[13] Even more troubling, new research suggests that those fisheries about which scientists know the least may be in the worst shape.[14] Yet all is not lost—perhaps not even for the great Atlantic cod. These same assessments conclude that, with proper management, fishery yields could double while remaining sustainable.[15] Proper fishery management can both conserve fisheries and maintain their value as a resource for human consumption.

One approach long recommended by economists has been the allocation or recognition of property rights in fisheries. This can be done in various ways, including recognizing rights in fishing

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10. Hilborn, *supra* note 8, at 288.

11. *Id.*

12. *See id.* at 286 ("There is general agreement that many U.S. and world fisheries are plagued by combinations of poor economic profitability, low stock abundance, discarding, bycatch and fishing impacts on marine ecosystems.").

13. *See* Ellen K. Pikitch, *The Risks of Overfishing*, 338 SCI. 474 (2012).

14. *Id.*; *see also* Christopher Costello et al., *Status and Solutions for the World's Unassessed Fisheries*, 338 SCI. 517 (2012).

15. *See* Costello, *supra* note 14.

territories or allocating portions of the catch among fishery participants. Once the subject of academic theory, ecologists, economists, and marine policy analysts have now had decades of experience with so-called "catch shares."[16] The ability of such methods to enhance economic efficiency is no longer a matter of academic speculation or economic theory. There is ample empirical evidence that such institutional reforms encourage more efficient fishery exploitation, reduce overcapitalization, and eliminate the dreaded "race to fish."[17] At the same time, there is increasing empirical evidence that property-based reforms produce social and ecological benefits as well, increasing safety for fishery participants and encouraging greater resource stewardship. The use of property-based management aligns fisher incentives with the underlying health of the resource and appears to reduce the adverse environmental effects of commercial fishing.

While the theoretical and empirical case for property-based fishery management has become ever more compelling, many policymakers have been slow to embrace property-based reforms. Some mainstream environmental groups have embraced the growing economic consensus that property-based systems are the key to fishery sustainability,[18] and both the Bush and Obama

16. According to the National Oceanic and Atmospheric Administration (NOAA):

> "Catch share" is a general term for several fishery management strategies that allocate a specific portion of the total allowable fishery catch to individuals, cooperatives, communities or other entities. Each recipient of a catch share is directly accountable to stop fishing when its exclusive allocation is reached.

See NOAA Catch Share Policy, 2010, *available at* http://www.nmfs.noaa.gov/sfa/domes_fish/catchshare/docs/noaa_cs_policy.pdf. As defined by NOAA, "catch shares" include individual transferable quotas (ITQs) as well as limited-access privilege policies and allocations created by territorial use rights fisheries (TURFs). *Id. See also* Christopher Costello, *Introduction to the Symposium on Rights-based Fisheries Management*, 6 REV. OF ENVTL. ECON. & POL'Y 212 (2012).

17. *See, e.g.*, Shannon Carroll, *Sector Allocation: A Misguided Solution*, 17 OCEAN & COASTAL L.J. 163, 164 (2011) ("The success of catch share programs is well documented.").

18. *See, e.g.*, *How Catch Shares Work: A Promising Solution*, ENVTL. DEF. FUND, http://www.edf.org/oceans/how-catch-shares-work-promising-solution (last visited Apr. 9, 2013); David Festa et al., *Sharing the Catch, Conserving the Fish*, ISSUES IN SCI. & TECH. (Winter 2008), http://www.issues.org/24.2/

Administrations supported the increased use of catch shares in domestic fisheries.[19] Yet some fishing interests and ostensibly market-oriented policymakers resist. In May 2012, a majority of Republicans in the U.S. House of Representatives voted to bar the adoption of new catch-share programs along the Atlantic Coast or in the Gulf of Mexico.[20] In the process, the alleged party of free enterprise and limited government turned its back on a proven market-based approach to a serious environmental problem.

This article reviews the theoretical and empirical evidence showing the superiority of property-based approaches to fishery management, stressing recent findings on the environmental effects of such reforms. The article traces the theory behind rights-based fishery management as it developed in the post-World War II period and documents how the theoretical claims initially made by fishery economists about the benefits of using property rights in the form of "catch shares" have been largely confirmed by empirical research. Recent academic studies now show that property rights systems, such as catch shares, are, in fact, superior to traditional management techniques and should be used more broadly.

Part II explains how marine fisheries represent the archetypal

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festa.html (last visited Apr. 9, 2013) (authors are part of Oceans Program at the Environmental Defense Fund); Carl Safina, *A Future for U.S. Fisheries*, ISSUES IN SCI. & TECH. (Summer 2009), http://www.issues.org/25.4/safina.html (last visited Apr. 9, 2013) (author is founder of Blue Ocean Institute).

19. *See* Alison Winter, *Obama Admin Proposes Major Spending for Fishery Cap-and-Trade Plan*, N.Y. TIMES, May 11, 2009, *available at* http://www.nytimes.com/gwire/2009/05/11/11greenwire-obama-admin-proposes-major-spending-for-fisher-12208.html. *See also* Juliet Eilperin, *Bush Aims for Market Approach to Fishing*, WASH. POST, SEPT. 20, 2005, *available at* http://www.washingtonpost.com/wp-dyn/content/article/2005/09/19/AR2005091901752.html.

20. *See Plenty More Fish In the Sea*, THE ECONOMIST, May 26, 2012, *available at* http://www.economist.com/node/21555960; Editorial, *The Grand Old Party and the Sea*, N.Y. TIMES, May 16, 2012, at A26, *available at* http://www.nytimes.com/2012/05/17/opinion/the-grand-old-party-and-the-sea.html. These limits were also supported by recreational fishing interests, such as the Recreational Fishing Alliance, and some New England Democrats such as Rep. Barney Frank (D-MA). *See* Jim Hutchinson, Jr., Letter to the Editor, *Protecting Fish Stocks*, N.Y. TIMES, May 27, 2012, at A16, *available at* http://www.nytimes.com/2012/05/28/opinion/protecting-fish-stocks.html.

"commons" problem famously (though not originally) described by Garrett Hardin. Part III summarizes how governments have tried—and largely failed—to address the problem of overfishing through various regulatory strategies. Such strategies are not the only potential approach to fishery conservation, however. Fishery economists have long recognized the potential for property rights to align the incentives of resource users and encourage sustainability. As Part IV documents, there is an extensive and longstanding academic literature making the theoretical case for the superiority of property-based management regimes over traditional regulatory controls. Economic theory may not always predict real-world consequences, but in the case of fishery management, the empirical evidence largely confirms the predictions made by economists. As Part V shows, a growing volume of empirical research demonstrates the economic and ecological benefits of property-based management systems, such as individual transferable quotas (ITQs) and other forms of catch shares. The adoption of such approaches in several different countries has improved fishery management, making commercial fishing more efficient, less dangerous, and more ecologically sound. As Part VI discusses, maximizing the ecological value of catch shares requires protecting the underlying property rights as actual property. The more security fishery participants have in their holdings, the stronger the incentive for sustainability. Secure property rights can also form the basis for private ordering among fishery participants.[21]

While ITQ-type catch-share programs are the most widespread, and the most studied, they are not a panacea. As noted in the conclusion, there is no single model of property-based fishery reform that is applicable everywhere. Depending on the specific conditions of a given fishery, other types of property-based reforms may be superior to ITQs. Other forms of property-based management, such as Territorial Use Rights in Fisheries (TURFs), should also be considered where appropriate. In still other cases, it may be desirable to encourage cooperative

21. *See generally* Jonathan H. Adler, *Legal Obstacles to Private Ordering in Marine Fisheries*, 8 ROGER WILLIAMS U. L. REV. 9 (2002).

management structures in lieu of ITQs. In all cases, however, moving toward a more property-oriented management approach is the most likely way to maximize the likelihood that a fishery will be managed in a productive and sustainable manner.

II.
THE TRAGEDY OF THE OCEAN COMMONS

For most of the twentieth century, the world's ocean fisheries provided a classic example of what Garrett Hardin famously called "the tragedy of the commons."[22] In his seminal essay, Hardin postulated an open access commons, specifically a grazing pasture owned by none, but available to all—though he could just as easily have written of a marine fishery.[23] As Hardin explained with the metaphorical pasture: With an open access resource each herdsman can capture the full benefit of adding an additional animal to his herd, while the cost to the pasture (overgrazing) is spread and shared among all of the users.[24] As a consequence, each individual herdsman lacks the incentive to exercise consumptive restraint, and this leads to overconsumption.[25] Thus, in an open access commons, the shared

22. Garrett Hardin, *The Tragedy of the Commons*, 162 SCI. 1243 (1968). While Hardin popularized the commons concept, he did not originate it. Indeed, as discussed *infra*, fishery economists were aware of this problem well before Hardin wrote his famous essay.

23. In fact, Hardin noted that "the oceans of the world continue to suffer from the survival of the philosophy of the commons." *Id.* at 1245.

24. Hardin was well aware he was not the first to observe the commons problem, and he was not making an historical claim about the fate of commons pastures. Rather, he was describing the fate that can be expected to befall common pool resources where there are no controls on access. Historically, many common pool resources, including pastures and some coastal fisheries, were protected by property rules, customary rules, and other constraints on access. *See, e.g.*, THE POLITICAL ECONOMY OF CUSTOMS AND CULTURE: INFORMAL SOLUTIONS TO THE COMMONS PROBLEM (Terry L. Anderson & Randy T. Simmons eds., 1993); ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION (James E. Alt & Douglas C. North eds., 1990); Susan Jane Buck Cox, *No Tragedy on the Commons,* 7 ENVTL. ETHICS 49 (1985).

25. *See* Thrainn Eggertsson, *Open Access versus Common Property*, *in* PROPERTY RIGHTS: COOPERATION, CONFLICT, AND LAW 76-77 (Terry L. Anderson & Fred S. McChesney eds., 2003) (describing the demand-and-supply effects of open access).

resource is overexploited and will eventually collapse. For this reason, Hardin explained, "freedom in a commons brings ruin to all."[26]

The incentives for fishermen to exploit the common fishery are much the same, if not worse, than with open access pastures.[27] Ocean fish have long been considered common property, "available to whoever dropped a hook or a net in the water."[28] But fish that are in the waters today, of course, may not be there tomorrow. This uncertainty creates the additional short-term incentive to catch as many fish today as possible, because every fish left in the ocean for tomorrow is one that got away: "The fish in the sea are valueless to the fishermen, because there is no assurance that they will be there for him tomorrow if they are left behind today."[29] Accordingly, there is little long-term individual or collective interest among fishermen to curb their daily catch. Just as Hardin theorized, "an additional fish caught is money in the individual's pocket, but the cost of one less fish available to breed or to be caught another day is spread among all fishermen."[30] Because each fisherman reaps the full benefit of his catch, he has every incentive to add boats, crew, and more efficient gear and equipment in order to intensify his effort and land more fish.[31] The costs to the fishery, however, are borne by

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26. Hardin, *supra* note 22, at 1244. A premise in Hardin's analysis is that demand for the resource in question is great enough to present a problem of overuse. *See also* Louis DeAlessi, *Gains from Private Property: The Empirical Evidence*, *in* PROPERTY RIGHTS, *supra* note 25, at 91 (noting there is no need to conserve a resource where the supply is great relative to demand).

27. *See* Martin D. Smith, *The New Fisheries Economics: Incentives Across Many Margins*, 4 ANN. REV. RESOURCE ECON. 379, 380 (2012) ("The story of fisheries economics could be distilled into diagnosing the commons problem and offering a solution to it.").

28. Donald Leal, *Saving Fisheries with Free Markets*, MILKEN INST. REV., 1st Quarter 2006, at 59.

29. H. Scott Gordon, *The Economic Theory of a Common Property Resource: The Fishery*, 62 J. POL. ECON. 124, 135 (1954).

30. Leal, *supra* note 28.

31. Lacking any secure claim in the fishery, the economically rational fisherman will invest in additional catch effort until the costs of additional effort exceed the expected value of the expected additional catch such effort will produce, without regard for the effect such efforts have on the sustainability of the fishery. *See* Terry L. Anderson & Fred S. McChesney, *Part II: Introduction*,

all, leading rather predictably to an overfished and exploited resource.

Hardin's theoretical "tragedy" has played out across the waters as many of the world's largest fisheries have drastically declined and others ultimately collapsed, despite substantial regulatory efforts.[32] In the United States, for example, fisheries were generally left unmanaged and in an "open-access free-for-all" until the mid-1970s when the U.S. and other nations asserted exclusive control over fisheries within their Exclusive Economic Zones (EEZs).[33] Until that time, most fisheries allowed foreign and domestic fishermen "free rein to catch as many fish as they wished."[34] Although the likely devastating consequences of such free-for-alls were theorized and predicted more than a half century ago, "evidence of global declines has only been seen quite recently" as biologists and researchers have developed more sophisticated and accurate methods for measuring fish stock.[35] That empirical evidence has largely confirmed economists' fears: Many of the world's fisheries are in danger from overexploitation and risk collapse.

The "tragedy of the commons" is not inevitable, however, a point Hardin himself recognized. By restraining consumption and controlling access to a common resource, the commons can be conserved. This can be accomplished, in Hardin's formulation,

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in PROPERTY RIGHTS, *supra* note 25, at 59-72 (discussing the incentives faced by participants in open access fishery).

32. *See infra* Part III.

33. *See* Dietmar Grimm et al., *Assessing Catch Shares' Effects Evidence from Federal United States and Associated British Columbian Fisheries*, 36 MARINE POL'Y 644, 646 (2012); Katrina M. Wyman, *The Property Rights Challenge in Marine Fisheries*, 50 ARIZ. L. REV. 511, 512 (2008).

34. Grimm et al., *supra* note 33, at 645 ("To maintain a competitive share in the fishery, U.S. public policy focused on expansion and exploitation, attempting to increase domestic capacity in the face of growing international encroachment. With incentives to grow the fleet and lack of incentives to sustain and build the resource, vessels steadily increased while landings did not change considerably. The U.S. fleet more than tripled in capacity from under 5000 vessels in 1935 to 17,000 vessels in 1975. . . . [T]he average vessel in 1975 caught only 34% as much biomass as it did in 1935, despite tremendous increases in fishing technologies.").

35. *See* Christopher Costello et al., *Can Catch Shares Prevent Fisheries Collapse?*, 321 SCI.1678 (2008).

either by private property or government regulation to restrict access and use of the underlying resource.[36] The tragedy, Hardin explains, "is averted by private property, or something formally like it."[37] Private property limits access to the commons, and tends to solve the commons tragedy because property owners have a substantial incentive to maximize the value of the resource they own.[38] As Harold Demsetz explained, "[t]he development of private rights permits the owner to economize on the use of those resources from which he has the right to exclude others."[39] Property owners tend to account for the value that others place on the resource and the value of sustaining the resource over time.[40] The benefits of property ownership do not necessarily depend on every owner acting solely, or even primarily, with a profit motive. Property rights also empower those with idiosyncratic preferences to protect and advance such values.[41]

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36. Hardin, *supra* note 22, at 1245; *see also* Armen A. Alchian & Harold Demsetz, *The Property Right Paradigm*, 33 J. ECON. HIST. 16, 23 (1973) ("The problem can be resolved either by converting the communal right to a private right, in which case there will be no overriding need to hunt the animals in order to establish a private claim, or the incentive to convert communal rights to private rights can be restrained through regulation.").

37. Hardin, *supra* note 22, at 1245.

38. *See* Steven F. Edwards, *Ownership of Renewable Ocean Resources*, 9 MARINE RES. ECON. 253, 255 (1994) ("Property rights both establish the potential capitalized value of an object and, with associated transaction costs and legal barriers, constrain choices.").

39. Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347, 356 (1967).

40. Conversely, as Anthony Scott observes, "No one will take the trouble to husband and maintain a resource unless he has a reasonable certainty of receiving some portion of the product of his management; that is, unless he has some property right in the yield." Anthony Scott, *The Fishery: The Objectives of Sole Ownership*, 63 J. POL. ECON. 116, 116 (1955). It may be an overstatement to claim that "no one" will act in such a manner, as there will be those with idiosyncratic preferences who will engage in conservation efforts even when not economically rational to do so, but the claim holds as a description of how people can be expected to behave.

41. Robert J. Smith, *Resolving the Tragedy of the Commons by Creating Private Property Rights in Wildlife*, 1 CATO J. 439, 456 (1981) ("[w]herever we have exclusive private ownership, whether it is organized around profit-seeking or nonprofit undertaking, there are incentives for the private owners to preserve the resource."). More broadly, nations with greater security of property rights

Private property rights are not always a viable option, however. They can be difficult to define and enforce. In some cases the costs associated with establishing and protecting those rights will be greater than the benefits.[42] In addition there may be political, cultural, or social conditions impeding a robust property rights regime.[43] It was long assumed that individual property rights in marine fisheries were unsuitable to the marine context due to the mobility and migration of fish, and the difficulty in monitoring property interests across the expanses of the open sea.[44] In many parts of the world, "[t]hese factors, among others, make it particularly costly to define and enforce property rights" in ocean fisheries.[45] Yet private property need not entail individuated ownership. It is possible to privatize resources "without dividing it into pieces."[46] Property rights in resources also need not be defined in spatial terms. Property law has long recognized interests that do not correspond with the physical metes and bounds of individual land holdings.

Throughout much of the world, fisheries have traditionally

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tend to have superior environmental performance across many measures, in addition to increasing economic growth. *See* Seth W. Norton, *Property Rights, the Environment, and Economic Well-Being*, *in* WHO OWNS THE ENVIRONMENT? 45, 51 (Peter J. Hill & Roger E. Meiners eds., 1998) ("[E]nvironmental quality and economic growth rates are greater in regimes where property rights are well defined than in regimes where property rights are poorly defined.").

42. *See* Terry L. Anderson & Peter J. Hill, *Privatizing the Commons: An Improvement?*, 50 S. ECON. J. 438, 438 (1985). Technology can play a role in reducing the costs of defining and enforcing property rights. *See generally*, Bruce Yandle & Andrew P. Morriss, *The Technologies of Property Rights: Choice among Alternative Solutions to Tragedies of the Commons*, 28 ECOLOGY L.Q. 123 (2001); *see also* THE TECHNOLOGY OF PROPERTY RIGHTS (Terry L. Anderson & Peter J. Hill eds., 2001).

43. *See, e.g.*, Barton H. Thompson, Jr., *Tragically Difficult: The Obstacles to Governing the Commons*, 30 ENVTL. L. 241, 255-65 (2000) (noting some of the obstacles to the creation of property rights in fisheries); *see also* Adler, *supra* note 21, at 13-14.

44. *See, e.g.*, GARY D. LIBECAP, CONTRACTING FOR PROPERTY RIGHTS 73-74 (1989).

45. Adler, *supra* note 21, at 14.

46. *See* Margaret McKean & Elinor Ostrom, *Common Property Regimes in the Forest: Just a Relic from the Past?* 46 UNASYLVA 3, 6 (1995). McKean and Ostrom note that what is often referred to as "common property" can be understood as "shared private property"; *see also* Adler, *supra* note 21, at 19-20.

been held in trust by the government for the common use of all, relying upon government regulation to conserve the commons and avert the tragedy of depletion and collapse. Yet as discussed in the next section, the traditional regulatory approach to fishery conservation has been a "spectacular failure."[47] While governmental regulation undoubtedly plays, and will continue to play, a critical role in fishery management, there is growing recognition of the need to move beyond conventional regulatory based strategies in favor of property-based management of marine resources.

III.
THE FAILURE OF FISHERY REGULATION

The traditional regulatory framework employed in fisheries around the world has been an abject failure. Conventional regulations have been unable to ensure sustainability and, often encourage economically wasteful and ecologically harmful fishing practices. In its 2010 assessment, the United Nations Food and Agriculture Organization (FAO) reported that approximately 85% of the world's fish stocks (for which assessment information is available) are either fully exploited (53%), overexploited (28%), depleted (3%), or recovering from depletion (1%).[48] Fully exploited fisheries are "at or close to their maximum sustainable productions, with no room for further expansion"; while overexploited, depleted, or recovering fisheries "yield[] less than their maximum potential production owing to excess fishing pressure," and need to rebuild.[49] Recent research suggests that the status of unassessed fisheries is even worse.[50] Thus, although annual fish production continues to rise—largely due to the expansion of aquaculture—fisheries the world over

47. Alison Rieser, *Property Rights and Ecosystem Management in U.S. Fisheries: Contracting for the Commons?*, 24 ECOLOGY L.Q. 813, 813 (1997).

48. U.N. Food & Agric. Org., *The State of World Fisheries and Aquaculture 2010*, 8 [hereinafter FAO Report 2010], *available at* http://www.fao.org/docrep/013/i1820e/i1820e.pdf.

49. *Id.*

50. *See* Pikitch, *supra* note 13; Costello et al., *supra* note 14, at 517.

are in trouble.[51]

Despite decades of regulation and government oversight, global fisheries continue to suffer "the dual crisis of overfishing and overcapacity," while also degrading aquatic habitats and ecosystems and depleting non-targeted species.[52] In economic terms, the losses due to failed fishery management could be as high as $50 billion annually.[53] In environmental terms, the costs of overfishing include the potential extinction of aquatic species and continued degradation of oceanic ecosystems, on top of the loss of an important source of food for many populations.[54]

The failure of fishery management "is entirely manmade," notes the University of Iceland's Ragnar Arnason. "It is the result of an inappropriate institutional framework" governing fishing.[55] For decades, government agencies adopted increasingly stringent control measures in an effort to limit overconsumption of fishery resources. These measures included time and area closures; limits on the types of gear and boats that could be used; and total caps on the amount of fish that could be caught in a given fishery in a season.[56] As these rules rarely worked, additional measures were tried to limit the intensity of fishing efforts and number of fishers in a given fishery, including limits

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51. *See* U. Thara Srinivasan et al., *Global Fisheries Losses at the Exclusive Economic Zone Level, 1950 to Present*, 36 MARINE POL'Y 544, 544 (2012). On the rise of aquaculture production, *see generally* James L. Anderson, *Aquaculture and the Future*, 17 MARINE RES. ECON. 133 (2002); MICHAEL DEALESSI, FISHING FOR SOLUTIONS 54-57 (1998).

52. J.R. Beddington et al., *Current Problems in the Management of Marine Fisheries*, 316 SCI. 1713, 1714 (2007).

53. *See* Srinivasan et al., *supra* note 51, at 544 (citing two studies reaching similar conclusions).

54. *See* Nicolas L. Gutierrez et al., *Leadership, Social Capital and Incentives Promote Successful Fisheries*, 470 NATURE 386, 386 (2011) ("[O]ne billion people depend on seafood as their primary source of protein and 25% of the world's total animal protein comes from fisheries.").

55. Ragnar Arnason, *Property Rights in Fisheries: How Much Can Individual Transferable Quotas Accomplish?*, 6 REV. ENVTL. ECON. & POL'Y 217, 217 (2012).

56. *See* Wyman, *supra* note 33, at 516-17 ("Most countries, including the United States, continue to regulate capture fisheries in their EEZs using conventional management techniques" including limits on total allowable catch, season length, and gear.); *see also* Ragnar Arnason, *Advances in Property Rights Based Fisheries Management: An Introduction*, 22 MARINE RESOURCE ECON. 335, 336 (2007).

on investment in fishing efforts, buyback schemes, and boat and license limits.[57]

Despite their good intentions, these measures routinely fail to ensure fishery sustainability. They are "primitive, simplistic," and, perhaps most importantly, "ineffectual."[58] License controls and other entry restrictions, for example, may limit the number of fishers, but they do not control the amount or intensity of fishing efforts.[59] Limits on the total catch and per-trip catch, even when combined with limits on the number of boats, did not prevent overfishing of the Gulf of Mexico reef fish fishery.[60] Restrictions on the types of equipment that may be used attempt to control total catch by forcing fishers to use less efficient means of catching fish, and thereby encourage fishers to increase their investment in additional vessels or gear to compensate for the efficiency losses. Likewise, severely shortened fishing seasons encourage fishers to increase their effort dramatically during the season, leading to some absurd results.[61] As Rod Fujita and Kate Bonzon of Environmental Defense have observed, the results of traditional regulatory approaches have been "shorter seasons, high-risk-fishing as fishermen go to sea in all kinds of weather, lost gear, sloppy fishing, high bycatch, discards, and habitat damage, as well as supply gluts, low prices, and financial ruin."[62]

The U.S. North Pacific Halibut Fishery is illustrative. Using traditional "top-down" regulatory strategies, the length of the fishing season was progressively shortened, dropping from sixty-

57. Arnason, *supra* note 56, at 336.

58. Safina, *supra* note 18 ("[T]he federal government's fisheries management remains primitive, simplistic, and, in important cases, ineffectual, despite a fund of knowledge and conceptual tools that could be applied.").

59. *See* Grimm et al., *supra* note 33, at 647-48 (2012) (noting the environmental, economic, and social harms that result under traditional management and the race for fish).

60. *See* Quinn Weninger & James R. Waters, *Economic Benefits of Management Reform in the Northern Gulf of Mexico Reef Fish Fishery*, 46 J. ENVTL. ECON, & MGMT. 207, 207 (2003) (noting such measures "failed to achieve key management objectives" and the fishery was "overfished").

61. *See generally* Kristin N. Carden, *The Legal Viability of Territorial Use Rights in Fisheries (TURFs) in California*, 38 ECOLOGY L.Q. 121, 123-24 (2011).

62. Rod Fujita & Kate Bonzon, *Rights-Based Fisheries Management: An Environmentalist Perspective*, 15 REV. IN FISH BIOLOGY & FISHERIES 309, 310 (2005).

five days in 1980 to only two in 1991.[63] Similarly, the Alaska crab fishery was eventually restricted to seasons as short as "three days of non-stop fishing" under traditional regulatory controls.[64] Faced with a shortened season, fishermen responded by increasing the number of boats, so more fish could be caught in less time.[65] Not only is this tremendously inefficient, it results in a lower quality and less valuable catch—as the entire year's halibut catch hits the market in a matter of days.

Shortening the fishing season, even in an effort to control the total catch, does not solve the commons problem. Instead it encourages rampant overcapitalization in fisheries and a destructive "derby" or "race to fish" in which each fisher races to catch as much as he can before the season closes. The resulting frenzy often leads to excessive catches and substantial impacts on non-target species.[66] This is true even when regulators respond with additional controls, such as trip limits.[67] Fishers respond to each new regulatory measure with innovations of their own.[68] As fishers scramble to catch as much as they can, discards and bycatch increase, and it becomes more difficult to

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63. *See* Festa et al., *supra* note 18; *see also* F. T. Christy, *The Death Rattle of Open Access and the Advent of Property Rights Regimes in Fisheries*, 11 MARINE RESOURCE ECON. 287, 293 (1996); Timothy J. Emery et al., *Are Input Controls Required in Individual Transferable Quota Fisheries to Address Ecosystem Based Fisheries Management Objectives?* 36 MARINE POL'Y 122, 122 (2012).

64. Grimm et al., *supra* note 33, at 647.

65. *See* Festa et al., *supra* note 18; Donald R. Leal, *Fueling the Race to the Fish*, *in* GOVERNMENT VERSUS ENVIRONMENT 48 (Donald Leal ed., 2002).

66. *See* SETH MACINKO & DAVID W. BROMLEY, WHO OWNS AMERICA'S FISHERIES? 15 (2002) (noting the difficulty of setting appropriate TAC levels particularly because in a compressed fishing season, "[t]he fleet can easily overrun the TAC before managers can prohibit further catches"); *see also* Grimm et al., *supra* note 33, at 647 (discussing increases in bycatch); David R. Griffith, *The Ecological Implications of Individual Fishing Quotas and Harvest Cooperatives*, 6 FRONTIERS IN ECOLOGY & ENV'T 191 (2008) (discussing impacts on habitat and non-target species).

67. Grimm et al., *supra* note 33, at 647.

68. Shi-Ling Hsu & James E. Wilen, *Ecosystem Management and the 1996 Sustainable Fisheries Act*, 24 ECOLOGY L.Q. 799, 806-07 (1997) ("The technological resourcefulness of fishermen has historically made a mockery of the most stringent and carefully crafted command and control regulations aimed at reducing fishing effort.").

determine remaining biomass levels.[69] Because of "the time pressures and poor conservation incentives" inherent in this derby-style fishing, fishery participants adopt "unselective fishing practices and fleet overcapacity."[70] The race to fish, of course, simply manifests the tragedy of the commons. Like all such manifestations, it takes its toll on fish populations and the environment. Thus, even in the regulated marine commons, "ruin is the destination toward which all men rush."[71]

The race to fish is not only bad for the fish, it can be bad for those fishing as well. In addition to the overcapitalization and economic waste, the derby-style race to fish has become particularly unsafe.[72] The "race to fish" in the Bering Sea crab fishery became so intense that hundreds of boats would line up for each season's opening day and crews would fish furiously, around the clock, until the fishery closed, usually only a week to ten days later. In a typical year, at least one boat and five crabbers would not make it back.[73] It was for this reason that the Discovery Channel used the Bering Sea crab fishery as the setting for its popular reality show, "The Deadliest Catch."[74]

Traditional regulatory approaches to fishery management might suffice to prevent overfishing if total catch limits were reliably set at appropriate levels and adequately enforced. Yet neither can be assured.[75] Because fishery participants have no

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69. Grimm et al., *supra* note 33, at 647 (noting increases in bycatch, underreporting, and biomass uncertainty in New England groundfish fishery).

70. *Id.*

71. Hardin, *supra* note 22, at 1244.

72. Griffith, *supra* note 66, at 191-92 (discussing safety implications of race to fish).

73. *See* Scott Campbell Jr., *Making 'the Deadliest Catch' Less Deadly*, WALL ST. J. (Nov. 14, 2011), http://online.wsj.com/article/SB10001424052970204224604577030061119546228.html; Jim Stone, *My Turn: Bering Sea Crab Catch Shares a Keeper*, JUNEAU EMPIRE (Apr. 26, 2010), http://juneauempire.co/stories/042610/opi_623749148.shtml.

74. *See* Campbell, *supra* note 73; Matt Jenkins, *The Most Cooked-Up Catch*, HIGH COUNTRY NEWS (July 7, 2009), http://www.hcn.org/issues/41.13/the-most-cooked-up-catch. Once ITQs were implemented in the fishery, however, it made for far less dramatic television, inducing the producers to contrive ways of encouraging more competitive behavior among the fish crews included on the show.

75. *See, e.g.*, Daniel W. Bromley, *Abdicating Responsibility: The Deceits of*

assurance they will be able to fish from one year to the next, and no direct stake in the fishery itself, they have little incentive to steward the resource. As a consequence, fishery participants pressure regulators to raise catch limits.[76] Further, the race to fish often results in exceeding the catch before the season can be closed.[77] The result is a "ratchet effect" that pushes fishing levels above sustainable levels.[78] Were that not enough, in many countries, other government policies, including subsidies to the fishing industry, further encourage overcapitalization and overfishing.[79]

As has become all too obvious to most, significant institutional reform is required to "prevent fishermen from engaging in destructive and ultimately self-defeating behavior."[80] Fortunately, the way forward—if not every twist and turn along the road—is clear. "There have been successes of fisheries management," several researchers noted in *Science* in 2007, "and there is an understanding of what is involved in successful fisheries management and of the requirements for its implementation."[81] Specifically, "[a] well-organized rights system alters the economic incentives of fishers . . . allow[ing] them to make rational economic choices about where and when they

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Fishery Policy, 34 FISHERIES 280, 284 (2009) (noting "the dreary record of fisheries management suggests that TACs are not taken seriously, nor rigorously enforced, in many fisheries"); Sebastian Villasante et al., *Overfishing and the Common Fisheries Policy: (Un)Successful Results from TAC Regulation?*, 12 FISH & FISHERIES 34 (2011) (reporting on an "alarming pattern of exploitation" of fisheries despite the existence of TACs); Weninger & Waters, *supra* note 60 (noting Gulf of Mexico commercial reef fish fishery "failed to achieve key management objectives" despite existence of TAC).

76. *See* A.A. Rosenberg et al., *Achieving Sustainable Use of Renewable Resources*, 262 SCI. 828, 829 (1993); *see also* Thompson, *supra* note 43, at 258-59; Villasante, *supra* note 75, at 46.

77. *See* Trevor A. Branch, *How Do Individual Transferable Quotas Affect Marine Ecosystems?*, 10 FISH & FISHERIES 39, 43 (2008) (noting "frequent and large TAC overruns during trip limit management").

78. Louis W. Botsford et al., *The Management of Fisheries and Marine Ecosystems*, 277 SCI. 509, 512 (1997); Donald Ludwig et al., *Uncertainty, Resource Exploitation, and Conservation: Lessons from History*, 260 SCI. 17, 17 (1993); Rosenberg et al., *supra note* 76, at 828-29.

79. *See* Leal, *supra* note 65, at 49-54.

80. Carden, *supra* note 61, at 125.

81. Beddington et al., *supra* note 52, at 1713.

catch fish."[82] This is the approach long advocated by economists as detailed in Part IV.

IV.
PROPERTY RIGHTS – THE ROAD NOT TAKEN

Garrett Hardin may have popularized the "tragedy of the commons," but he was not the first to uncover the fate of open access resources. Fishery economists, in particular, had been writing about the commons problem in the context of marine fisheries for well over a decade by the time Hardin's essay appeared in *Science*. Yet they were not even the first to observe that common ownership can affect the incentive to conserve resources. The basic insight goes back at least as far as Aristotle.[83]

In 1954, Scott Gordon published "The Economic Theory of a Common-Property Resource: The Fishery" in the *Journal of Political Economy*, and sparked the modern theory of fishery economics.[84] Gordon argued "that a firm in the fishery, an owner, or skipper, following the profit-maximization behavior described by price theory was not acting in a way that contributed to efficient trade, maximum rent, or optimal national utilization of resources."[85] He recognized that fisheries were "unusual in the fact of their common-property nature; but they are not unique, and similar problems are encountered in other cases of common-property resource industries such as petroleum production, hunting, and trapping, etc."[86] Accordingly, Gordon recognized that the fishing industry, with its "large numbers of fishermen permit[s] valid behavioristic generalization of their activities along the lines of standard economic theory of production," which allowed him "to demonstrate that the 'overfishing problem' has

82. *Id.* at 1714.

83. *See* ARISTOTLE, POLITICS § 1261b ("[T]hat which is common to the greatest number has the least care bestowed upon it.").

84. Gordon, *supra* note 29.

85. Anthony Scott, *The Pedigree of Fishery Economics*, 26 MARINE RESOURCE ECON. 75, 78 (2011).

86. Gordon, *supra* note 29, at 124.

its roots in the economic organization of the industry."[87] More than a decade before Hardin's famous essay, Gordon pointed out that in fisheries, "[w]ealth that is free for all is valued by none because he who is foolhardy enough to wait for its proper time of use will only find that it has been taken by another."[88] This seminal work ignited an important debate about the forms of ownership that would best manage ocean resources.

Gordon's analysis was joined the following year by Anthony Scott's "The Fishery: The Objectives of Sole Ownership,"[89] which stressed the importance of property rights for successful resource stewardship. Scott noted that, given the commons dynamic, fishery participants would be incentivized to invest more effort than necessary to maximize their returns and would have little incentive to restrain catch levels in the present so as to maximize the stock's present value.[90] Scott's contribution showed that "property rights were central to the fisheries problem."[91] As Gordon and Scott explained how the property interests and consequent incentives faced by fishers differed from those faced by other industries, more researchers began to focus on the role of property rights in resource conservation.[92]

Gordon and Scott's groundbreaking studies encouraged broader consideration of property-based approaches to marine conservation. The idea "that individual fishing rights might at least alleviate the fisheries problem" became the subject of active debate.[93] In 1970, for instance, Steven Cheung argued for extending private ownership in fisheries to lower the transaction costs of contracting over resources.[94] If the private sector is generally more efficient than the government, more efficient management could result from legal reforms that served to reduce transaction costs in private markets, and thereby reduce

87. *Id.* at 128.

88. *Id.* at 135.

89. Scott, *supra* note 40, at 116.

90. *Id.*; *see also* Scott, *supra* note 85, at 78.

91. Arnason, *supra* note 56, at 335.

92. Scott, *supra* note 85, at 83.

93. Arnason, *supra* note 56, at 336.

94. Steven N. S. Cheung, *The Structure of a Contract and the Theory of Non-exclusive Resource*, 13 J.L. & ECON. 49 (1970).

the costs of private ownership of resources. Conversely, Parzival Copes maintained that sole ownership in a fishery is not necessarily superior to government regulation from a social standpoint.[95] Others, such as Sigfried von Ciriacy-Wantrup and Richard Bishop, continued to argue for the collective ownership of common pool resources.[96]

One argument against applying property rights to marine fisheries was that it would be too difficult to apply the concept of private property to a mobile resource like fish, as opposed to something like land. It was hard enough to fence property lines and control cattle in the American West.[97] Policing boundaries and monitoring fish would be far more difficult, however, particularly in the case of migratory species. It is one thing to apply property rights to marine resources close to land, but quite another thing entirely to apply them miles from shore.[98]

In 1973, Francis Christy proposed what would become a ground-breaking solution to such concerns.[99] Specifically, Christy proposed allocating rights to portions of a given fishery or to a seasonal catch—a quota, or what would eventually become known as an ITQ—rather than to the fishery itself or a marine expanse. Other researchers quickly picked up and expanded on this idea. So in 1977, Ragnar Arnason argued tradable individual quotas would be "superior to taxation for generating efficiency in fisheries."[100] Others, such as D.G.

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95. Parzival Copes, *Factor Rents, Sole Ownership and the Optimum Level of Fisheries Exploitation*, 40 MANCHESTER SCH. ECON. 145 (1972).

96. S.V. Ciriacy-Wantrup & R.C. Bishop, *"Common Property" as a Concept in Natural Resources Policy*, 15 NAT. RESOURCES J. 713 (1975).

97. *See* Terry L. Anderson & P. J. Hill, *The Evolution of Property Rights: A Study of the American West*, 18 J.L. & ECON. 163, 176 (1975).

98. *See generally* James E. Wilen et al., *The Economics of Territorial Use Rights Fisheries, or TURFs*, 6 REV. ENVTL. ECON. & POL'Y 237, 240 (2012) (noting it has "generally been viewed as more problematic" to apply property rights management approaches "in nearshore and offshore marine environments because of the long-standing common belief that 'we can't fence the ocean'"); *see also* LIBECAP, *supra* note 44, at 73-74.

99. Francis Christy, *Fishermen's Quotas: A Tentative Suggestion for Domestic Management*, OCCASIONAL PAPER NO. 19, RHODE ISLAND: LAW OF THE SEA INSTITUTE (1973).

100. Ragnar Arnason, *The Fundamentals of Fisheries Economics*, 24 FJARMALATIDINDI 198 (1977).

Moloney and P.H. Pearse, proceeded to make an even more systematic case for individual quotas in fishery management.[101]

In the most basic form, an ITQ is a right to an assigned percentage or proportion of the total allowed annual catch in a given fishery.[102] So, for instance, the owner of a 5% quota would have the right to catch 5 tons in a season if the total allowable catch (TAC) were set at 100 tons, but would be able to catch 10 tons if the TAC were set at 200 tons. Under the typical ITQ regime, a government agency sets the TAC for a given season, and then allocates shares of the catch—the quota—to individuals, boats, or firms as a form of transferable right. In most such systems, shares or quota are initially allocated based on some sort of formula, such as the average volume caught over a set of prior years, or by an auction, but then continue from year to year. Insofar as the ITQ right continues into the future, ownership of a catch share provides the fisher with an incentive to ensure the fishery's sustainability over time.

As the academic debate percolated in the 1970s, some countries began to experiment with rights-based management techniques. In 1976, Holland and Iceland, two prominent fishing countries, introduced individual quotas in the North Sea flatfish fishery and the domestic herring fishery, respectively.[103] The economic literature on fisheries management also began to focus on how to design the optimal tax or quota policy, rather than on top-down regulatory controls of fishing activity.[104] As Anthony Scott would observe years later:

> As long as economists devoted themselves to advising governments on types of entry restriction and methods of controlling fishing technology, the world of fisheries was more or less indifferent to advice supported by economic theory. But when some economists, surveying the whole field, saw that the individual quota right might not only work to protect and enhance the fish stock but also increase economic efficiency, a

101. David G. Moloney and Peter H. Pearse, *Quantitative Rights as an Instrument for Regulating Commercial Fisheries*, 36 J. FISHERIES RES. BD. CAN. 859 (1979).

102. *See* Arnason, *supra* note 55, at 222.

103. *Id.* at 232.

104. Edwards, *supra* note 38, at 254; Scott, *supra* note 85, at 81.

workable alternative to common property was glimpsed.[105]

The problem of the fishery and the overexploitation of a common resource had caught the attention of economic theorists, and an extensive theoretical literature focusing on ownership, property rights, and traditional government regulation had quickly developed.[106]

Once Holland and Iceland had implemented the first catch-share protocols, other fishing countries began to adopt more widespread varieties of ITQ and other rights-based management regimes in the 1980s, giving economists and researchers "the opportunity to study actual working fisherman quota systems."[107] New Zealand introduced the first major catch-share program in 1986.[108] Since then rights-based management programs have been implemented in varying degrees in countries around the world, including Australia, Canada, Chile, Iceland, Namibia, the Netherlands, Norway, South Africa, and the United States.[109] At first, some of these systems were only intended "to patch up and strengthen older regulatory methods (such as license limitation)," but as they became more common, more accepted, and, ultimately, more effective, "they became secure, transferable, durable, and divisible, similar to familiar local systems of appropriative water rights or oil-drilling rights."[110]

Property-based fishery management regimes, ITQs in particular, have proliferated since the 1970s. As a consequence,

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105. Scott, *supra* note 85, at 81.

106. *See generally* Melvin Cross, *The Political Appropriation of an Open Access Resource*, in RESOURCE POLICY: INTERNATIONAL PERSPECTIVES, 165 (Peter Nemets ed., 1979); Peter H. Pearse, *Property Rights and the Regulation of Commercial Fisheries* 185 (1979)*;* Ronald N. Johnson & Gary D. Libecap, *Contracting Problems and Regulation: The Case of the Fishery*, 72 AMER. ECON. REV. 1005 (1982); Jonathan M. Karpoff, *Sub-optimal Controls in Common Resource Management: The Case of the Fishery*, 95 J. POL. ECON. 179 (1987); E.A. KEENE, OWNERSHIP AND PRODUCTIVITY OF MARINE FISHERY RESOURCES (1988).

107. Scott, *supra* note 85, at 81.

108. Christopher Costello et al., *Economic Incentives and Global Fisheries Sustatinability,* 2 ANNUAL REV. RESOURCE ECON. 299, 302 (2010).

109. Arnason, *supra* note 55, at 232.

110. Scott, *supra* note 85, at 81.

"there now exist hundreds of different management 'experiments' across many of the world's large marine ecosystems."[111] Nonetheless, so-called catch-share systems still only account for a fraction of global fisheries. According to a 2010 survey, catch-share systems cover only two percent or so of fish stocks around the world, but account for approximately twenty-five percent of the volume of fish caught annually worldwide.[112] Still, there has now been sufficient experience with such approaches to assess their economic and environmental effects. As discussed in the next section, the results have been quite reassuring and point the way toward the economic and ecological benefits of additional reliance on property-based fishery reforms.

V.
CATCH SHARES IN PRACTICE

Since the adoption of the first ITQ programs in the mid-1970s, hundreds of such programs have been adopted in over twenty countries. With so many catch-share programs in place, researchers have been able to study these programs, compile empirical data on their effects, and, to some extent, compare ITQ-managed fisheries against traditionally managed fisheries. The studies now provide such significant evidence that catch-share and rights-based management systems are having an overall positive effect on fisheries, just as economic theory had predicted. The question is no longer "whether catch shares work." Instead the focus is on "more nuanced questions of how to design a catch share system to best address the diverse goals, challenges, and needs of individual contexts."[113] No fishery management regime is perfect, but the evidence is accumulating that the more widespread adoption of ITQs and other forms of catch shares would represent a major step forward in fishery management.

111. *See* Costello et al., *supra* note 108, at 300.
112. *Id.*
113. *Id.* at 315.

A. *Economic Consequences of Catch Shares*

As noted above, the essential components of an ITQ program are the imposition of a limit on the TAC over a given time period, such as a fishing season, and the allocation of rights to harvest a certain portion of the catch. If these shares are transferable among fishery participants, quota shares will be reallocated to the most efficient fishery participants, thereby reducing the overcapitalization of the fishery.[114] If quota shares are perpetual, the market value of quota shares will represent the expected present value of the fishery.[115] As a consequence, ITQs will tend to maximize the economic value of the fishery.[116]

Empirical assessments have confirmed the economic benefits of adopting ITQ programs.[117] A 2012 study examining the performance of fifteen catch-share programs in the United States and British Columbia found that catch shares improve efficiency within the fishery, ending the "race for fish by creating incentives for economic efficiency and long-term stewardship."[118] Whereas the race to fish tends to shorten the fishing season, the rights-based security created by the catch-share regimes allowed fishers to "slow the pace of fishing by fishing when it is economically beneficial" and extending their fishing seasons on average from 63 to 245 days of the year.[119] At the same time, the adoption of catch shares enables fishers to "rationalize" their capital investment and "match their capitalization to their share of the catch."[120]

This same review found that the adoption of catch share in the

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114. *See* Richard G. Newell et al., *Fishing Quota Markets*, 49 J. ENVTL. ECON. & MGMT. 437, 438 (2005) ("For ITQs to deliver an efficient solution to the common pool problem in practice, it is critical that fisherman [sic] can buy and sell quotas in a competitive market and that quota markets convey appropriate price signals.").

115. *See* Arnason, *supra* note 55, at 224.

116. *Id.*

117. *See, e.g.*, R. Quentin Grafton et al., *Private Property and Economic Efficiency: A Study of a Common-Pool Resource*, 43 J.L. & ECON. 679 (2000); Newell et al., *supra* note 114, at 437.

118. Grimm et al., *supra* note 33, at 648.

119. *Id.*

120. *Id.*; *see also* Hilborn, *supra* note 8, at 289.

U.S. increased revenues for fishery participants Indeed, under catch-share management, revenues per vessel were found to almost double.[121] More efficient fishing methods, longer fishing seasons (which slow the frenetic "race to fish" and reduce fishing in hazardous and costly conditions), and lower discard rates in catch-share fisheries help raise total revenues. Slower, more deliberate fishing can produce higher yields, increase processing product recovery, and improve the quality (and thereby the value) of the catch.[122]

The economic benefits of ITQs were generally assumed and are not particularly contested. Even critics of property-based management regimes acknowledge that the allocation of quota, as through ITQs, can increase efficiency, prevent the "race to fish" and reduce overcapitalization.[123] Such critics have been less convinced of the environmental and social benefits of such property-based approaches, however.[124] Skeptics doubt catch shares are a necessary, or even sufficient, means of ensuring sustainable fishing, and they fear such approaches may facilitate the undue concentration of wealth within the industry and harm traditional fishing communities.[125]

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121. *See* Grimm et al., *supra* note 33, at 650.

122. *See id.*

123. *See*, Holly Doremus, *Why International Catch Shares Won't Save Ocean Biodiversity*, MICH. J. ENVTL. & ADMIN. L. (forthcoming 2013), at 13, *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2168556 ("most observers agree that catch shares have improved economic efficiency and reduced overcapitalization."); Seth Macinko & Daniel W. Bromley, *Property and Fisheries for the Twenty-First Century: Seeking Coherence from Legal and Economic Doctrine*, 28 VT. L. REV. 623, 625 n.12 (2004) (stating that individual quotas "work" in that they "can markedly reduce the pernicious racing between participants that afflicts many fisheries when individual catch is competitively determined"); *see also* Daniel W. Bromley, *Abdicating Responsibility: The Deceits of Fishery Policy*, 34 FISHERIES 280, 284 (2009).

124. *See,* Doremus, *supra* note 123, at 2 ("Catch shares have had positive economic effects in a range of domestic fisheries, but are not necessarily useful for addressing ecological problems."); Bonnie J. McCay, *Social and Ecological Implications of ITQs: An Overview*, 28 OCEAN & COASTAL MGMT. 3 (1995).

125. *See* McCay, *supra* note 124 (surveying such concerns); Evelyn Pinkerton & Danielle N. Edwards, *The Elephant in the Room: The Hidden Costs of Leasing Individual Transferable Quotas*, 33 MARINE POL'Y 707 (2009) (arguing the widespread leasing of ITQs can "reduce the economic benefits to society and to fishermen" of such reforms); B. Timothy Heinmiller, *The Politics of "Cap and*

B. *Catch Shares and Conservation*

Whereas the economic benefits of catch-share reforms are widely accepted, "the alleged ecological benefits of catch shares are more contentious."[126] In 2008, Christopher Costello, Steven D. Gaines, and John Lynham published "the first global empirical analysis linking sustainability to incentive-based fisheries management."[127] Their study found that implementing catch-share programs "halts, and even reverses, the global trend toward widespread [fisheries] collapse."[128] The Costello, Gaines, and Lynam (CGL) study took a broad view of fisheries worldwide, compiling a database of over 11,000 fisheries around the globe, "to test whether catch-share fishery reforms achieve [the] hypothetical benefits" long theorized by economists and whether the reforms prevent fisheries collapse.[129] The authors also revisited the issue two years later, releasing an expanded and updated analysis interpreting the results of the 2008 study in greater detail, and reviewing the subsequent academic literature.[130] Both the original research and follow-up "provide strong support for the hypothesis that exclusive access rights encourage stewardship and long-term sustainability of fisheries."[131]

For the initial paper, CGL identified 121 fisheries worldwide that installed ITQs between 1950 and 2003. Relying on the same metric of sustainability used by other researchers, the authors adopted a common definition of fishery collapse as being one in which a fishery is collapsed in a given year if the harvest in that year is less than 10% of the maximum recorded harvest up to that year.[132] This was a "conservative" metric that, if anything,

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Trade" Policies, 47 NAT. RESOURCES J. 445, 464 (2007) (raising concerns about potential increases in absentee ITQ ownership).

126. Costello et al., *supra* note 108, at 300.

127. *Id.*, at 301 (citing Costello et al., *supra* note 35, at 1678).

128. Costello et al., *supra* note 35, at 1678.

129. *Id.*.

130. Costello et al., *supra* note 108, at 301.

131. *Id.* at 310.

132. Costello et al., *supra* note 35, at 1679; *see also* Boris Worm et al., *Impacts of Biodiversity Loss on Ocean Ecosystem* Services, 314 SCI. 787 (2006).

would "overestimate the frequency of collapsed fisheries."[133]

The first ITQ programs were not implemented until the 1970s. Before their transition to catch-share management the "would-be ITQ fisheries were on trajectories toward collapse similar to non-ITQ fisheries."[134] Before 1980, for instance, there was essentially no projected difference in the collapse rates between ITQ and traditionally managed fisheries; but as some fisheries transitioned into ITQ management, those rate trajectories diverged as non-ITQ fisheries continued their rate of collapse while the collapse rate for ITQ fisheries slowed.[135] On this basis, CGL concluded that "well-designed catch shares may prevent fishery collapse across diverse taxa and ecosystems."[136]

In the follow-up paper, Costello, et al., acknowledged that "[p]roving rigorously that catch share management causes a reduction in fisheries collapse rates" is challenging, if not impossible.[137] Isolating the effect of implementing ITQ programs is complicated by several competing effects, namely: 1) the growing number of ITQ fisheries and the fact that "new ITQ fisheries are drawn from a global pool with an ever-increasing fraction of collapsed fisheries"; 2) a potentially biased selection of fisheries converted to ITQ management; and 3) potential "temporal benefits of an ITQ."[138] The authors adopted a number of strategies to account for these complications.[139] Their results

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133. Costello et al., *supra* note 35, at 1679 ("This collapse metric may overestimate the frequency of collapsed fisheries, which creates a conservative test for the benefits of catch shares.").

134. *Id.* at 1680.

135. *Id.* at 1679-80.

136. *Id.* at 1680. As noted in the follow-up paper, this conclusion was supported by "[a]ll model specifications and estimation techniques . . . ." Costello et al., *supra* note 108, at 310.

137. Costello et al., *supra* note 108, at 305.

138. Costello et al., *supra* note 35, at 1680.

139. *Id.*

> An initial regression of the data . . . suggests that implementing an ITQ reduces the probability of collapse by 13.7 percentage points. Because ITQs have been disproportionately implemented in a few global ecosystems such as Alaska, Iceland, New Zealand, and Australia, regional or taxonomic biases could generate misleading results. To account for potential selection bias, we used a variety of estimation strategies: (i) We restricted the sample to only those ecosystems or taxa that have experienced ITQ management. (ii) We used

did not change. The "picture that emerges from the results . . . is fairly clear: ITQ fisheries are less likely to collapse than non-ITQ fisheries, and the magnitude of this effect increases the longer a fishery is managed by an ITQ."[140] Not only do ITQ fisheries perform better than non-ITQ fisheries, but the encouraging results of Costello's fixed-effects analysis "suggest that ITQs not only halt the trend in global collapse, but they may actually reverse it."[141]

Skeptics of the CGL results questioned whether the study was actually measuring the beneficial effects of adopting TAC limits, rather than the effect of ITQ systems. Daniel Bromley, for example, charged CGL's conclusions were "comprehensively spurious because they failed to make the essential distinction between the effects of total allowable catch (TAC) as opposed to the effects of IFQs (catch shares)."[142] Yet as Costello, et al., noted in their follow-up paper, any claim "that there were no previous TAC limits" for the fisheries they examined is "incorrect."[143] Further, the data from their study indicates that, while "the benefit of switching to an ITQ is stronger when no TAC was in place prior to the ITQ . . . there is still a substantial benefit to switching to an ITQ in the presence of a TAC."[144] Further, "there

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> propensity score methods to match ITQ fisheries to appropriate control fisheries. (iii) We used fixed-effects estimation to identify the benefit of ITQs within each fishery.

Id. (footnotes omitted); *see also* Costello et al., *supra* note 108, at 305-10.

140. Costello et al., *supra* note 108, at 305. The specific details of that picture indicate that ITQ-managed fisheries are generally 6.9% to 7.1% "less likely to collapse than non-ITQ fisheries." *Id.* Furthermore, for "[e]ach additional year the fishery is in an ITQ reduces the probability of collapse by 0.1 to 0.49 percentage points." *Id.* at 306.

141. Costello et al., *supra* note 35, at 1680; *see also* Costello et al., *supra* note 108, at 310 ("[T]he findings presented in Costello et al. (2008) [CGL] and described in more detail here provide strong support for the hypothesis that exclusive access rights encourage stewardship and long-term sustainability of fisheries."). Other researchers characterized the study as presenting a "convincing and thorough analysis." *See* Geoffrey Hea1 & Wolfram Schlenker, *Sustainable Fisheries*, 455 NATURE 1044 (2008).

142. Bromley, *supra* note 75, at 284; *see also* Doremus, *supra* note 123 (noting "it might be that the imposition of a total catch limit is a more important driver in preventing collapse" than the allocation of quota shares).

143. Costello et al., *supra* note 108, at 312.

144. *Id.* at 313.

is a strong and statistically significant benefit to switching to an ITQ system regardless of whether there was an existing TAC in place."[145] One reason for this, as discussed below, could be that fishery participants have a greater incentive to maintain TAC compliance and facilitate TAC enforcement once they are guaranteed a right to a share of the catch.[146] As Bromley himself has acknowledged, fisheries subject to traditional regulatory management have a "dreary record" of TAC compliance.[147] Yet the adoption of catch shares appears to encourage greater support for enforcement among fishery participants and to enhance compliance.

The adoption of catch-share reforms may also encourage fishers to support lower and more sustainable TAC limits. This is significant because, as Bromley and other ITQ critics acknowledge, one key difficulty in fishery management is setting and enforcing an appropriate TAC. Under traditional regulatory management, fishery participants have no incentive to push for more precautionary catch limits, as they are not guaranteed the benefits of such stewardship. With perpetual catch shares, on the other hand, fishery participants have an economic incentive to support the setting and enforcement of TAC limits that will ensure the fishery's sustainability.[148] After New Zealand adopted ITQs for several fisheries, Philip Major of New Zealand's Ministry of Agriculture noted the effect on fisher behavior, commenting, "It's the first group of fishers I've ever encountered who turned down the chance to take more fish."[149]

Subsequent research reinforces the CGL findings on the environmental benefits of catch-share programs.[150] In 2012, for

145. *Id.*

146. *See* Arnason, *supra* note 55, at 225 (noting that catch-share programs tend to cause fishery participants to support more restrictive TACs).

147. Bromley, *supra* note 75, at 284. *See also infra* note 74, and sources cited therein.

148. *See* TAKING OWNERSHIP: PROPERTY RIGHTS AND FISHERY MANAGEMENT ON THE ATLANTIC COAST 4 (Brian L. Crowley ed., 1996).

149. *Quoted in* Michael DeAlessi, *Fishing for Solutions: The State of the World's Fisheries*, *in* EARTH REPORT 2000 99 (Ronald Bailey ed., 2000).

150. *See, e.g.*, Gutierrez et al., supra note 54, at 388 (reporting that catch shares "were a key management condition towards co-management success" and "[w]ell-designed and implemented catch shares have helped to prevent

instance, Grimm, et al., published an empirical study of "the environmental, economic, and social performance in the 15 major catch share fisheries of the United States and British Columbia."[151] This study explored the effects of transitioning from a traditionally managed fishery to "incentive-based catch shares," finding both environmental and economic benefits from adopting such programs.[152]

Grimm, et al., found that the adoption of catch-share management improved environmental performance in the covered fisheries by, among other things, lowering "discard" rates, reducing the frequency of TAC overages, and encouraging more accurate TAC estimates.[153] One common concern with and objection to catch shares has been the potential incentive to practice "high-grading" or discarding less desirable, cheaper grades of fish before landing in order to avoid having those less profitable fish count toward a fleet's share of the catch.[154] Significantly, then, Grimm, et al., found little evidence of high-grading under catch shares. In fact, the discards-to-retained-catch average in the studied fisheries actually fell 31% over five years and 66% over ten years, with almost all the fisheries reporting a lower discard rate under catch shares than under

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overfishing, promote stability, and ecological stewardship.").

151. Grimm et al., *supra* note 33, at 644.

The 15 fisheries, along with the year of catch shares implementation are: mid-Atlantic surf clam/ocean quahog (SCOQ 1990), British Columbia sablefish (1990), British Columbia halibut (1991), Alaska halibut (1995), Alaska sablefish (1995), Pacific whiting (1997), British Columbia groundfish trawl (1997), Alaska Pollock (1999), Bering Sea and Aleutian Island King and Tanner crab (Alaska crab, 2005), Gulf of Alaska rockfish (2007), Gulf of Mexico red snapper (2007), Atlantic sea scallop (2010), Gulf of Mexico grouper and tilefish (2010), mid-Atlantic tilefish (2010), Northeast multispecies groundfish (2010) The three BC fisheries are included in the analysis due to their interdependency and co-management with the Alaskan and Pacific coast catch share fisheries in the U.S.

Id.

152. *Id.*

153. *Id.* at 648-49. *See also* Sarika Cullis-Suzuki et al., *Red Snapper Discards in the Gulf of Mexico: Fishermen's Perceptions following the Implementation of Individual Fishing Quotas*, 36 MARINE POL'Y 583, 584 (2012) (reporting the red snapper IFQ program contributed to a decrease in discards in Gulf fisheries).

154. Grimm et al., *supra* note 33, at 648.

traditional management.[155] The study also compared discard rates in fisheries that have both catch shares and traditional management sectors and found similar results.[156] "In the Alaska groundfish fishery for example, the community development quota fishery managed with catch shares has a discard rate 40% lower than the traditionally managed sector," according to the research, while the Pacific whiting catch-share sector now boasts "a discard rate over 30% less than the traditionally managed mothership sector."[157] Instead of a potentially harmful increase in high-grading, which would increase the overall mortality rate and jeopardize the fishery, U.S. fisheries employing catch-share techniques are in fact reducing the discard rates as measured against traditional management programs.

Significantly, given questions of whether the CGL findings can be attributed to the adoption of catch shares or if they are simply the result of imposing TACs, Grimm, et al., found that catch shares have "improve[d] environmental management by reducing the size and frequency of significant TAC overages."[158] Overages occur when fleets exceed the TAC for a given season, a rather common occurrence given the relative difficulty in setting an accurate TAC. But according to Grimm, et al., overages were "nearly eliminated" in catch-share fisheries studied in the U.S.[159] "Of the TACs set in catch share fisheries since implementation, only five (6%) have been exceeded, and by an average of only 7%."[160] By comparison, 44% of TACs are exceeded by an average of 15% under traditional management programs.[161]

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155. *Id.*

> While the data show an increase in discards in the first full year of catch shares implementation, this is largely due to idiosyncratic and transitional factors. The fishery with the largest increase in discards is the Alaska Pollock fishery, where the discard rate nearly doubles to 3% during the first year of catch shares. However, this is due to abnormally low discards in the baseline year, when age class dynamics produced few fish below marketable size.

Id.

156. *Id.*
157. *Id.*
158. *Id.*
159. *Id.*
160. *Id.*
161. *Id.*

Setting a fishery's TAC is an inexact science "based on biological stock assessments that inherently contain a degree of uncertainty, as survey methods cannot directly capture the entire fishery,"[162] so it is not entirely surprising that they are often exceeded. But even here, catch shares have been shown to improve TAC estimates through increased industry participation, reporting, and financing. Grimm, et al., found that "in many of the [catch-share] fisheries . . . fisherman associations contribute major funds, data, and vessel participation to government scientific research so that TACs can be set more accurately and sustainably."[163] This phenomenon is consistent with the experiences of ITQ systems in other countries, such as New Zealand.[164] With a secure financial stake in the short- and long-term TAC, commercial fishers have a deeper vested interest in its accuracy, and therefore a stronger incentive to provide money and information for regulators setting the catch limit. In turn, "[t]hese improved information sources allow fishery managers to improve their modeling systems, gaining a better idea of the actual biomass of the fishery and reducing biomass estimate uncertainty."[165] By lowering discard rates, reducing the number of TAC overages, and making catch limit estimates more accurate, Grimm, et al., found that catch-share programs help create more management options for improving overall ecosystem health and rebuilding fish stock.[166]

Over time, the success of catch-share management has allowed some fisheries to increase their total catch limits. In the fisheries studied by Grimm, et al., "TACs increase an average of 13% five years after catch shares implementation, and 19% ten years after catch share implementation."[167] Of course, not all catch-share fisheries increase their TACs, and some have had to be lowered due to various environmental factors, but on average the compiled data suggests "that TACs can be adjusted upward

162. *Id.* at 649.
163. *Id.*
164. *Id.* at 646, 653.
165. *Id.* at 649.
166. *Id.* at 649-50.
167. *Id.* at 650.

due to increased biomass" in a number of catch-share fisheries.[168]

A survey of over 200 peer-reviewed papers on the environmental effects of ITQ programs by Trevor Branch provides further evidence of the role such programs can play in ensuring sustainability, and further undermines claims that the CGL study measured the benefits of setting TACs, as opposed to implementing catch-share programs.[169] Specifically, Branch found that it is relatively common for participants in catch-share fisheries to request lower TACs, and far more common than in fisheries subject to traditional regulatory management.[170] Equally significant, Branch found that the adoption of ITQ programs tends to reduce the rate of TAC exceedances. According to Branch, the "[e]vidence . . . is clear: when ITQs are enforced properly, catches are generally below the TAC."[171] For example, there were fewer overruns after ITQs were introduced to the surf clam fisheries in the eastern United States; overruns "virtually disappeared" from the British Columbia halibut longlining fishery after ITQs were implemented; the "gap between TAC and catch decreased for 6 of 7 species under ITQs" in the Australian South East Trawl; the Alaskan halibut and sablefish fisheries saw "TACs typically overcaught before ITQs and undercaught after ITQs"; and geoduck clam fisheries in British Columbia were subject to "massive overruns before ITQs, then 12 years of catches within 1% of TACs."[172] Furthermore, Branch cites the British Columbia groundfish trawl fishery as evidence of "how the frequent and large TAC overruns during [traditional] trip limit management were replaced by infrequent and small TAC overruns after ITQs were introduced."[173]

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168. *Id.*; *see also* Hilborn, *supra* note 8, at 290.

169. Trevor A. Branch, *How Do Individual Transferable Quotas Affect Marine Ecosystems?*, 10 FISH AND FISHERIES 39 (2008).

170. *See id.* at 42. Branch found such requests in fisheries in many different parts of the world, including "fisheries on New Zealand paua, offshore Nova Scotia scallop, New Zealand rock lobster, British Columbia sablefish, Tasmanian abalone and Icelandic herring." *Id.*

171. *Id.* at 43.

172. *Id.*

173. *Id.*

The setting of a TAC will not count for much if there is illegal fishing. ITQ programs must stringently monitor fleet or vessel catches in order to ensure against "quota busting." Preventing illegal fishing practices can be difficult and Branch found effective quota-enforcement varied among ITQ fisheries. In some, monitoring by both management and the fishers themselves was adequate and effective. In others, however, "quota busting" by fishery participants is a problem, particularly where "the stock is valuable, enforcement is difficult or poorly funded, and fines are small."[174] Yet on the whole, ITQ systems seem to have an easier time enforcing fishing limits. Among other things, ITQs require less at-sea monitoring than traditional regulations "because closed areas and seasons, banned gear types, and vessel restrictions are no longer required"; and ITQs tend to reduce "the number of participants, thus allowing more intensive monitoring of landings and discards and increasing the probability of detecting illegal fishing."[175] Of course, an ITQ program without adequate enforcement mechanisms will not prevent illegal fishing, nor will it yield positive ecological impacts in the absence of effective monitoring; but ITQs do change the incentives, types, and amount of monitoring required in many cases.

The setting of more conservative TACs and greater TAC compliance were not the only environmental benefits found by Branch. "Ghost fishing," or fish mortality caused by lost or abandoned gear, is a common problem in traditionally managed fisheries where the race for fish leads fishermen to drop and retrieve their gear as quickly as possible. "Inevitably," Branch reports, the derby-style race for fish "increases gear loss resulting in high rates of ghost fishing compared to fisheries managed under ITQs."[176] The Alaskan halibut fishery, for instance, saw gear losses fall from 554 tonnes in 1994 to 126 tonnes in 1995 after ITQs were implemented.[177]

As in the Grimm, et al., study, Branch found that ITQs affect

174. *Id.* at 47.
175. *Id.*
176. *Id.* at 44.
177. *Id.*

the practice of "high-grading," or discarding fish when trip or vessel catch limits are imposed and "there are price differences between grades of fish due to size, skin damage, colour, or disease."[178] Branch noted several fisheries in New Zealand and Canada in which high-grading historically has been a problem,[179] but he reports that high-grading cases were relatively uncommon and limited. One reason is that there is little incentive to high-grade in many fisheries because the difference in price between high-grade and low-grade fish is too small to encourage high-grading.[180] A second reason, according to Branch, is that high-grading is expensive, and any "[i]ncreased income from high-grading is often more than offset by higher fishing expenses" incurred in the time that it takes to release low-grade fish.[181] Branch also notes that although there may be a theoretical incentive for high-grading in some instances, the high-grading does not actually occur for a variety of reasons, including the selection of better gear designed to avoid smaller, low-grade fish; longer fishing seasons yielding more time to target fish selectively; and regulations specifically designed to reduce incidental mortality.[182] Thus, despite a theoretical incentive for high-grading, the overall practical effect of ITQ programs offsets this incentive, and high-grading remains relatively uncommon in rights-based fisheries.

ITQ management is still far from perfect, and Branch's survey confirms that the implementation of such programs remains important. For instance, catch quotas can create adverse incentives for discarding in multi-species fisheries.[183] In fisheries where multi-species discarding is permitted and does not count against a catch quota, it is not surprising that discard rates are high and negatively affect species stock.[184] But when compared

178. *Id.*

179. *See id.* at 44-45 (discussing the New Zealand snapper fishery, New Zealand oreo species, and Canada's Scotia-Fundy groundfish fishery).

180. *Id.* at 45.

181. *Id.*

182. *Id.*

183. *Id.*

184. *See id.* (discussing the Australian South East Trawl fishery, Canadian Atlantic herring fisheries, and a Canadian groundfish fishery).

with traditionally managed "derby fisheries," Branch found that "ITQs generally reduce discarding because fishers have more flexibility to alter their behavior."[185] Furthermore, ITQ programs can design specific quotas and other methods, such as quota leasing, or can "allow[] part of the quota to be shifted to or borrowed from the following year," for example, in order to reduce multi-species discards. Such flexibility makes rights-based programs generally more adept at lowering multi-species discard rates than race-for-fish managements systems.

Branch also reviewed the ITQ literature for two potential effects that catch-share programs may have on fish and fisheries outside the ITQ system. First, many initial allotments of catch quotas are based upon a fisher's recent "catch history," which may create an incentive for non-ITQ fishers to increase their catch totals in anticipation of a future transition to catch-share management. In theory, a pre-ITQ fishery may "slide to a worse state than the bioeconomic equilibrium . . . because of fishers' expectations of increasing their quota share when ITQs are implemented."[186] Branch found few practical examples of this phenomenon in the literature, however, "primarily because the catch history period is usually fixed to a period of years well before the initiation of ITQ discussions."[187] Branch also examined the "spillover effect," whereby fishers were found to target non-ITQ covered species or increase the fishing effort in non-ITQ fisheries. He found examples of such behavior quite limited, and concluded that the spillover effect can be managed

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185. *Id.* at 46.

> The classic examples are the North Pacific fisheries for sablefish and Pacific halibut: in British Columbia, discards of other species declined by 46%, while in Alaska, discards of other species decreased from 24% to 10% of the total catch. Side by side comparison of discards is possible for the Bering Sea fishery for walley Pollock, where the fleet fishing under community development quotas had discard rates less than half those in the open-access fleet. Finally, in the Alaskan groundfish fishery, the Japanese fleet greatly reduced bycatch of halibut, crab, herring and salmon by assigning individual bycatch quotas to these species.

Id.

186. *Id.* at 49.

187. *Id.* (noting that the Australian southern shark fishery saw fishers falsify their catch histories).

effectively "by limiting entry to those fisheries, or including them in ITQs."[188]

Not all potential environmental consequences of adopting catch-share programs are known. There is little research examining how the adoption of ITQ management affects the wider marine ecosystem. In principle, ending the race to fish and allowing for slower and more deliberate fishing should make it easier to accommodate area restrictions or other habitat-protection measures. However, Branch found no studies directly addressing the impact of ITQs on the wider ecosystem.[189] As a consequence, Branch concluded that questions related to the broader effects of ITQ systems on habitats and ecosystems remain open and largely unanswered. Yet even with this residual uncertainty about the effect of catch-share management on the broader marine ecosystem, there is now abundant evidence that adopting such approaches can produce substantial environmental gains.

A common theme found in the growing empirical literature on catch-share programs is the effect of institutional design on the incentives faced by fishery participants. This theme is significant because aligning the societal objectives with the incentives for fishermen is both possible and key for fishery sustainability. As Hilborn explains, "fishing fleets can be thought of as a rational economic entity that will, in aggregate, make decisions to maximize their well-being within the constraints of the legal and institutional incentives that are imposed on them."[190] Thus, Hilborn found that fishers in the New England groundfish fishery were behaving completely rationally in the 1990s when they fought greater catch limits.[191] Yet the adoption of catch shares in other fisheries encouraged fishers to accept catch reductions so as to rebuild stocks and allow for higher yields in the future.[192] Under a catch-share system, where quota shares are held for long periods of time—if not in perpetuity—fishers

188. *Id.* at 49-50, 52.
189. *Id.* at 50.
190. Hilborn, *supra* note 8, at 285.
191. *Id.* at 288.
192. *Id.*

"know exactly who will profit from any future increases in catch and reductions in fishing costs from higher catch per day."[193] Thus, the economic incentives of the fishermen become aligned with the long-term sustainability of the fishery. In the end, this may be the most important effect of moving toward property-based fishery management regime.

C. *Social and Economic Consequences of Catch Shares*

The most prominent objections to property-based fishery management are not ecological, but social and economic. Some fear the distributional consequences of recognizing transferable rights in a fishery or worry about the possible effect on local communities, particularly if the transferability of fishery shares results in consolidation, or if larger companies buy out the fishery shares.[194] Such concerns are legitimate, if exaggerated.

The adoption of ITQs inevitably produces some economic dislocation and may create winners and losers, as does any significant regulatory change. But the net economic benefits of such reforms have been substantial. Whereas derby fisheries have too many boats chasing too few fish, in ITQ fisheries, the fishing effort is rationalized because there is no advantage to putting extra boats in the water or racing to catch. Typically this phenomenon means that the number of vessels in a given fishery declines; but the seasons get longer, the income streams for fishery participants become more stable, and fishing becomes more profitable. Such changes will typically produce some consolidation as boats are retired to reduce the overcapitalization of the fleet. Yet some degree of consolidation is "a necessary outcome of reducing the overcapacity that is common in open access fisheries."[195]

While some may lose under ITQs, neither allowing fish stocks to collapse nor maintaining derby-style fishery rules benefits local fishing communities. If some identifiable groups will lose out from such changes, such concerns can be addressed directly,

193. *Id.*

194. *See, infra* note 126, and sources cited therein.

195. Costello et al., *supra* note 108, at 314.

such as through buy-out programs or other compensation measures. Allocating quota shares to fishery incumbents ensures that existing fishery participants are compensated should they leave the fishery.[196] If traditional fishery controls are used to restrict fishing, there is no such guarantee.

More importantly, concerns about the distributional effects of ITQs should not be an excuse for leaving unsustainable fishery management regimes in place. Given the extent of overcapitalization and wasted effort in most fisheries under traditional management, it should be possible to compensate potential losers from the gains generated by reform. Indeed, adopting catch shares tends to enhance government revenue by increasing the profitability of fishing vessels, thereby generating more tax revenue, and reducing net management costs.

Additionally, catch shares have affected some port communities by reducing the pressure for fishermen to land at the nearest port, and modestly consolidating ports.[197] This means that catch-share programs could reduce some of the economic consequences of and political opposition to implementing conservation zones, as there would be less pressure to fish in the most geographically convenient locations.

Grimm, et al., found evidence that transitioning from a traditional management system to catch shares affects landing patterns, and therefore fish processors. "Under race for fish conditions that result in short annual seasons, the processing industry (along with fisheries) can become overcapitalized to handle the glut of fish in short periods."[198] But catch-share management programs tend to lengthen and stabilize fishing seasons, allowing for more efficient processing capacity.[199] Such stabilization produces significant benefits for fishery participants and local communities by providing a more stable and predictable source of income. Overall, "there is evidence that

196. *Id.* (noting that with catch shares those who exit a fishery "are compensated by selling their quota rather than simply leaving because their business fails as the fishery declines in profitability.").

197. Grimm et al., *supra* note 33, at 650.

198. *Id.*

199. *Id.*

ITQs can provide a win-win outcome, leading to fisheries that are less likely to collapse and that provide fishermen with higher harvests."[200] And it should go without saying that if fisheries collapse, those who work in the fishery will face greater hardships than those imposed by the imposition of a new management regime.

Transitions to catch-share systems often require shifts in the fishery labor market. The longer fishing seasons may cause "a marked shift from shorter-term, part-time jobs in the years prior to catch shares to greater full-time employment after catch share implementation,"[201] and will often result in more stable positions with better working conditions, higher job quality, and higher pay.[202] It is thus not surprising that while fishery participants are often skeptical about the adoption of catch-share policies, they often report satisfaction with such reforms after they are adopted.[203]

Insofar as some catch-share skeptics are concerned about the effect of such reforms on fishing boat crews, rather than the owners, it should be significant that the adoption of catch-share programs, and the elimination of the "race to fish," appear to result in substantial safety improvements for fishery participants. The incentives generated by the race to fish in a derby-style fishery pressure boats and crews to cut corners so as to catch as much as possible as quickly as possible. By ending the race to fish, catch shares also remove "the incentive to sacrifice safety for speed."[204] In U.S. and B.C. fisheries, catch-share management has improved fishing safety by nearly 300% according to relevant safety data.[205] In Alaska's Bering Sea crab fishery, for example—the location of the Discovery Channel's "Deadliest Catch" reality television program—the adoption of catch shares resulted in a more orderly and far less deadly catch.

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200. Costello et al., *supra* note 108, at 311.

201. *Id.* at 651.

202. *Id.*

203. *See, e.g.*, Cullis-Suzuki et al., *supra* note 153, at 587 (reporting that the "overwhelming majority of fishermen interviewed had a good overall opinion of the red snapper IFQ program").

204. Grimm et al., *supra* note 33, at 650.

205. *Id.*

Once vessels no longer had to race to fish, there was far less incentive to cut corners or risk life and limb in pursuit of a larger haul. Mortality in the fishery has dropped from averaging five-plus deaths per year to only one death in five years.[206] Thus property-based management regimes can be just as good for fishery participants as they are for the fish.

VI.
THE IMPORTANCE OF PROPERTY RIGHTS

As discussed, catch-share and rights-based management systems have been successful to the point that researchers no longer ask "whether catch shares work," but have turned to "more nuanced questions of how to design a catch share system to best address the diverse goals, challenges, and needs of individual contexts."[207] Several recent catch-share studies have drawn significant conclusions for advancing fishery management and addressing these "nuanced questions" of design. These studies highlight areas where ITQ systems can be improved, while also identifying the inevitable limits of such approaches to fishery management.

Catch-share systems alter the incentives faced by fishery participants because they give fishers a stake in the fishery itself. The more secure a catch share or other fishing right is, the more the value of an ITQ or catch share is tied to the value of the fishery.[208] As a consequence, one key to maximizing the value of catch-share programs is to ensure that the rights allocated within the fishery are well-defined, broadly transferable, and quite secure.[209]

Corbett Grainger and Christopher Costello, for example, have examined the relationship between the property rights security

206. *See* Campbell, *supra* note 73.

207. Costello et al., *supra* note 108, at 315-16.

208. *See* Arnason, *supra* note 55, at 224 ("if the duration of the ITQ right is infinite in addition to being fully exclusive, secure, and transferable, then the current market value of quota shares will equal the expected present value of the fishery").

209. *Id.* (if ITQs "represent high-quality property rights" they "almost automatically guarantee efficient fishing").

in catch shares and their asset value. While observing the variation in ITQ system designs across fisheries and countries, they concluded that "property rights security has a significant effect on asset values in fisheries suggesting that property rights security may have a profound impact on economic behavior in (previously) common pool resources."[210] Grainger and Costello noted that a number of different ITQ design elements affect incentives and, ultimately, ITQ system performance. "Sunset clauses," for instance, "after which rights are revoked and redistributed will affect stewardship and value and assignment of rights to only a portion of the resource stock may erode conservation and investment incentives."[211] This phenomenon suggests that long-term security of fishing rights is essential to maximizing the incentives for maintaining fishery sustainability.[212]

For their analysis, Grainger and Costello examined annual average prices for quota sales and leases in hundreds of ITQ fisheries to "test the hypothesis that strong property rights lead to a lower dividend price ration in the context of renewable resources."[213] They identified differences in the ITQ system designs employed in New Zealand, Canada, and the United States. For instance, they observed that in New Zealand, "ITQs are viewed as perpetual rights to fish," and an owner may use the quota "as collateral in establishing credit with banks."[214] This contrasts with Canada and the United States, where ITQ rights are less secure because a quota share is deemed to be a "revocable privilege," and there is more uncertainty about whether ITQs will be recognized as property rights in the

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210. Corbett Grainger & Christopher Costello, *The Value of Secure Property Rights: Evidence From Global Fisheries* 4 (Nat'l Bureau Econ. Research Working Paper No. 17019, 2011), *available at* https://www.econ.iastate.edu/sites/default/files/announcements/grainger_costello_nov17.pdf.

211. *Id.* at 1-2.

212. *See* DeAlessi, *supra* note 26, at 109 ("Insecure property rights inhibit conservation."); *see also id.* at 109-10 (discussing effect of property insecurity on ITQs in New Zealand).

213. Grainger & Costello, *supra* note 210, at 10.

214. *Id.* at 2-3.

future.[215] Such differences in the nature of the rights allowed Grainger and Costello to assess the effects of securing catch-share rights.[216]

Grainger and Costello's analysis confirmed the economic prediction that greater security would increase the value of the rights. Specifically, the authors found that "stronger property rights lead to higher asset values and lower dividend price ratios . . . in ITQ fisheries."[217] Although Canada and the United States have each adopted ITQ systems in certain fisheries, Grainger and Costello report that "the governments have very different legal definitions of the quota share held by individuals; these imply palpable differences in property rights security."[218] In the United States, federal law requires

> that quota shares "shall be considered a permit;" "may be revoked, limited, or modified at any time;" "shall not confer any right of compensation to the holder . . . if it is revoked, limited, or modified;" "shall not create or be construed to create, any right, title, or interest in or to any fish before the fish is harvested by the holder;" and "shall be considered a grant of permission to the holder of the quota share to engage in activities permitted by such . . . quota share."[219]

Although federal courts have concluded that quota shares are "property" for purposes of the Due Process Clause of the Fifth Amendment, this conclusion only guarantees that the rights will not be taken without providing sufficient process and an opportunity to be heard.[220] The courts' conclusion does not ultimately protect the right against revocation, nor does it ensure that quota owners would be entitled to compensation under the Fifth Amendment's takings clause if quota shares were taken for some public purpose.

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215. *Id.*

216. *Id.* at 3.

217. *Id.* at 20.

218. *Id.* at 4.

219. *Id.* at 5.

220. *See, e.g.*, Foss v. Nat'l Marine Fisheries Serv., 161 F.3d 584 (9th Cir. 1998) (holding that fishery participants had judicially cognizable property interest in right to fishery permit for purposes of the Fifth Amendment's Due Process clause).

Given the somewhat precarious legal status of share rights in the United States, Grainger and Costello found that "there is uncertainty about the future of the program, and holders of quota shares are generally unable to use their holding as collateral at banks."[221] They corroborated their findings anecdotally with interviews of fishermen. For example, one fisherman in the Red Snapper fishery in the Gulf of Mexico told them "we don't really own anything. In the legal language, it's a privilege. There's always a danger that the government can change its fishery policy down the road, and then the quota would be worthless."[222]

Similarly, Canadian law views ITQ shares as a revocable privilege. But in 2008, Canada's Supreme Court held that even though fish are "Property of the Crown," "fishing quotas are 'property' for the purposes of the federal Banking and Insolvency Act."[223] Nevertheless, Grainger and Costello found that "restrictions on trading [quotas] were cited as a constraint on potential efficiency gains in the [British Columbia] halibut fishery. That is, 'substantial long-run gains in efficiency can be jeopardized by preexisting regulations and the bundling of the property right to the capital stock.'"[224]

By contrast, New Zealand recognizes "explicit property rights" in ITQs, and "over the past 25 years nearly all commercial fisheries have shifted to ITQ management."[225] Whereas Canadian and American regimes limit ownership rights and treat catch shares as a kind of revocable privilege, New Zealand affords more robust legal protection and assurances. For example, "the right to a share of the catch is held in perpetuity, and when a program is discontinued, or where the allocation is changed by the regulator, fishers are entitled to financial compensation."[226] New Zealand provided Grainger and Costello more "empirical evidence that the security of property rights

221. Grainger & Costello, *supra* note 210, at 5.
222. *Id.*
223. *Id.* at 6.
224. *Id.* at 5-6.
225. *Id.*
226. *Id.*

affects quota asset value," and although "other factors are clearly important, such as market interest rates and the volatility of revenues for that fishery, factors that strengthen or attenuate the security of property rights affect quota asset values."[227] Thus, the authors' research found "strong evidence of a pecuniary effect of property rights strength, which suggests that the design of these institutions plays a critical role,"[228] and concluded that "stronger property rights lead to greater quota asset values."[229]

Similar research of ITQ design and implementation has focused on tenure rights in quota shares as governments—despite recognizing the advantages of property rights regimes—have remained "reluctant to relinquish complete control over public trust resources, and instead often grant to resource appropriators various forms of limited tenure with the possibility of renewal."[230] In a separate paper, Christopher Costello and Daniel Kaffine concluded that "limited tenure contracts with the possibility of renewal can be structured to induce economically desirable, even fully efficient, extractive behavior."[231] But they also caution that such "limited tenure contracts must be secure enough to provide sufficient incentive for an appropriator to not mine the resource."[232] Their research "identif[ied] a tipping point in the design of successful concessions contracts that falls between the completely insecure world of open access and the completely secure world of complete property rights," and they found that "through careful design and attention to private economic incentives, sufficient property right security can be granted to induce socially desirable outcomes."[233] For example, Costello and Kaffine's study indicates that "there exists a minimum length of tenure that is required to induce the infinite path, and this minimum tenure is a decreasing function of the

227. *Id.* at 18-19.

228. *Id.* at 18-20.

229. *Id.* at 21.

230. Christopher Costello & Daniel Kaffine, *Natural Resource Use with Limited-Tenure Property Rights*, 55 J. ENVTL. ECON. & MGMT. 20, 20 (2008).

231. *Id.* at 32.

232. *Id.*

233. *Id.*

renewal probability and growth rate."[234] And finally, Costello and Kaffine demonstrate that "the tenure length granted to slow growing species such as abalone may be insufficient to induce good stewardship, which may account for the poor performance of concessionary regimes for abalone as opposed to the faster growing spiny lobster."[235] Such evidence provides significant guidance for managers and legislatures as they design legal constructs and management techniques to align economic and ecological incentives in fisheries.

VII.
CONCLUSION

Although most of the empirical research on catch-share programs to date has focused on ITQs, they are not a one-size-fits-all solution to fishery management. The experience with various forms of fishery management has increasingly shown that "the most successful [fishery] management approaches are likely to combine rights-based systems—creating incentives for fishers to operate efficiently and with long-term sustainability in mind—with a strong legal structure. Such a legal structure should require the development of pre-agreed-to harvest strategies and decision rules that are triggered and adhered to as reference points are passed."[236] Whereas ITQs work well for marine fisheries, location-based property systems, such as TURFs, may be more appropriate for managing more localized populations.[237] In other cases, there may be value in creating fishery cooperatives to coordinate fishing efforts.[238] Yet any of these approaches are likely to be superior to traditional regulatory management. As one recent review concluded, "[c]atch shares, both by individual or community quotas and by

234. *Id.* at 31.

235. *Id.*

236. Beddington et al., *supra* note 52, at 1714.

237. *See* Wilen et al., *supra* note 98; Carden, *supra* note 61.

238. *See* Robert T. Deacon, *Fishery Management by Harvester Cooperatives*, 6 REV. OF ENVTL. ECON & POL'Y 258 (2012); Daniel A. Ovnado et al., *Conservation Incentives and Collective Action Choices in Cooperative Fisheries*, 37 MARINE POL'Y 132 (2013).

TURFs, were a key management condition towards co-management success. Well-designed and implemented catch shares have helped prevent overfishing, promote stability, and promote ecological stewardship."[239]

Strengthening property rights in quotas; enhancing tenure contracts to induce long-term stewardship; and improving the working relationships between fishers and managers should all be part of the ongoing resource management effort. As lawmakers, researchers, and resource managers digest the scientific data and develop strategies for managing fisheries' "complex social-ecological systems," they would do well to recognize the importance of aligning social, economic, and ecological incentives, and to acknowledge the growing body of empirical research demonstrating the significant role of stronger, longer-tenure property rights and rights-based incentives for improving fishery performance. Although catch shares, like any management regime, have their drawbacks, the world has less to fear from the expansion of property rights in marine resources than from the failure to utilize property rights for marine conservation.

239. Gutierrez et al., *supra* note 54, at 388.