

# THE PROPERTY RIGHTS CHALLENGE IN MARINE FISHERIES

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*This Article argues that fisheries policymakers currently face a multifaceted challenge. Wild fish stocks are declining, aquaculture is growing, and there are many possible policy responses to these developments. Drawing on economic analysis of property rights, the Article frames the challenge facing policymakers as an optimization problem in which the objective should be to design property rights in fisheries that will produce the greatest net benefits. Complicating matters, the Article suggests that there is no single property arrangement that is optimal for fisheries in general and that policymakers will need to design many different property rights regimes to reflect local conditions.*

## INTRODUCTION

One of the great property stories of the twentieth and twenty-first centuries is the enclosure of the oceans and fisheries within them.<sup>1</sup> Early in the twentieth century, most of the oceans were open to all, with nation states controlling only the three nautical mile area close to their shores known as the territorial sea.<sup>2</sup> Since World War II, coastal countries have claimed ever larger expanses of the oceans and their resources.<sup>3</sup> The landmark 1982 United Nations Convention on the Law of the Sea (the “Law of the Sea Convention”)<sup>4</sup> codified many countries’ marine claims and provided a legal framework for making new

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1. See, e.g., RÖGNVALDUR HANNESSON, *THE PRIVATIZATION OF THE OCEANS* 1–3 (2004) (emphasizing the significance of the evolution of property rights in marine fisheries).

2. *Id.* at 31.

3. *Id.* at 31–34, 113–16.

4. United Nations Convention on the Law of the Seas, Dec. 10, 1982, 21 I.L.M. 1261 (1982).

ones.<sup>5</sup> One result: the countries racing to claim the riches of the Arctic seabed are framing their claims in light of the rules established by the Law of the Sea Convention.<sup>6</sup>

Economists have played a little noticed supporting role in the enclosure of the oceans and their resources in the past several decades. More than we often recognize, economists have provided an intellectual justification for the enclosure movement. Going back to the late 1960s and early 1970s when the Law of the Sea Convention was being negotiated some economists advocated enclosing the oceans and marine fisheries within national Exclusive Economic Zones (“EEZs”) as the first step in establishing individual property rights in these resources.<sup>7</sup> For economists, EEZs represented a means of achieving the desired endpoint of individual property rights. Once nations had claimed most of the oceans, economists assumed, nations would be well-positioned to allocate individual rights, giving fishers the proper incentives to conserve fisheries.

Consistent with the economists’ prescriptions, individual rights in ocean fisheries have emerged in the wake of the enclosure of the oceans within EEZs. Individuals and communities are acquiring private property-like rights in wild fisheries<sup>8</sup> through the establishment of individual transferable quotas (“ITQs”), community quotas, territorial use rights, and other instruments.<sup>9</sup> Enclosure through EEZs also has coincided with the dramatic growth in aquaculture, a development that economists generally did not predict. Like agriculture, aquaculture is premised on property rights in the stock being grown and the area used to grow it such as the water bottom or water column.<sup>10</sup> Indeed, aquaculture has become such an

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5. HANNESSON, *supra* note 1, at 34–39. The Law of the Sea Convention, which the U.S. still has not ratified, came into force in 1994. *Id.* at 38.

6. See, e.g., *The Arctic: Drawing Lines in Melting Ice*, ECONOMIST, Aug. 18, 2007, at 51 (arguing that Canada, Denmark, and Russia are claiming parts of the Arctic as extensions of their continental shelf because of provisions in the Law of the Sea Convention and that the three countries are rushing to establish their claims because the Convention requires that countries make claims within a decade of ratification).

7. See, e.g., ROSS D. ECKERT, THE ENCLOSURE OF OCEAN RESOURCES 16, 120, 147 (1979); Donald McRae & Gordon Munro, *Coastal State “Rights” Within the 200-Mile Exclusive Economic Zone*, in RIGHTS BASED FISHING 97, 98 (Philip A. Neher et al. eds., 1989).

8. I use the terms “wild” and “capture” synonymously to refer to fish that are caught in the wild rather than farmed by aquaculture operations.

9. See, e.g., HANNESSON, *supra* note 1, at 52 (EEZs have facilitated “rights-based fisheries management”); Steffen Hentrich & Markus Salomon, *Flexible Management of Fishing Rights and a Sustainable Fisheries Industry in Europe*, 30 MARINE POL’Y 712, 715 (2006) (referring to use of individual transferable quotas in New Zealand, Iceland, Canada, Australia, Chile, Namibia, and the United States). Of course, there were some individual property rights in fisheries close to the shore even before EEZs were established. HANNESSON, *supra* note 1, at 69. *But see* GARY D. LIBECAP, CONTRACTING FOR PROPERTY RIGHTS 79–80 (1989) (discussing historical reluctance in the United States to recognize private property rights in fisheries).

10. M. Richard DeVoe & Andrew S. Mount, *An Analysis of Ten State Aquaculture Leasing Systems: Issues and Strategies*, 8 J. SHELLFISH RES. 233, 233 (1989) (“[M]any aquaculture methods . . . require some degree of ‘exclusivity of use’ of the water column and/or submerged lands.”).

important source of food for humans that fish farming in freshwater and marine waters shortly could supplant wild fisheries as the main source of fish for human consumption, much as farming long ago replaced hunting as the source of much of the meat that humans eat.<sup>11</sup>

Amid the movement toward individual rights in marine fisheries, however, there is a growing chorus of calls from scientists and environmental non-governmental organizations (ENGOS) to import into marine fisheries another form of property arrangement widely used on land: no-take areas in which extractive uses are prohibited or severely curtailed.<sup>12</sup> On land, vast areas of private property are surrounded by state-owned protected areas such as wilderness areas where extractive uses are limited.<sup>13</sup> As private property rights increase in marine resources, there is pressure to replicate our experience on land and to establish the oceanic equivalent of wilderness areas, usually called marine reserves.<sup>14</sup> Protected

11. See, e.g., James L. Anderson, *Aquaculture and the Future: Why Fisheries Economists Should Care*, 17 MARINE RESOURCE ECON. 133, 148 (2002) (“Aquaculture or ranching is becoming, or has already become, the dominant factor in fish supply.”); *The Promise of a Blue Revolution*, ECONOMIST, Aug. 9, 2003, at 19, 20 (“Some people believe that, by 2030, aquaculture will supply most of the fish people eat.”); Carlos M. Duarte et al., *Rapid Domestication of Marine Species*, 316 SCIENCE 382, 383 (2007) (“The development of aquaculture is bound to replace fisheries as animal husbandry replaced hunting on land.”). On the rise of factory farming, see, e.g., MICHAEL POLLAN, *THE OMNIVORE’S DILEMMA: A NATURAL HISTORY OF FOUR MEALS* 65–84 (2006) (describing Concentrated Animal Feeding Operations (“CAFOs”)).

12. See *infra* note 118. On the participation of scientists and environmentalists in calls for marine reserves, see, e.g., Ray Hilborn, *Defining Success in Fisheries and Conflicts in Objectives*, 31 MARINE POL’Y 153, 155 (2007) (describing marine protected areas (“MPAs”) as “a specific management action broadly supported by the preservationist community” and indicating that “[a]ll of the signatures on the ‘consensus statements’ on MPAs and ecosystem-based fisheries management are from academics, the majority of whom are ecologists”). On the distinction between MPAs and marine reserves, see *infra* note 14.

13. On wilderness areas under the Wilderness Act, see, e.g., JAMES RASBAND ET AL., *NATURAL RESOURCES LAW AND POLICY* 609–33 (2004). Marine reserves might also be compared with wildlife refuges. On national wildlife refuges in the U.S., see, e.g., Robert L. Fischman, *The Significance of National Wildlife Refuges in the Development of U.S. Conservation Policy*, 21 J. LAND USE & ENVTL. L. 1, 3 (2005) (discussing the “tangle of some 550” national wildlife refuges, which “all share a general purpose of animal conservation”). Some refuges, such as the Arctic National Wildlife Refuge in Alaska, include wilderness areas within them. *Id.* at 6.

14. Marine reserves should not be confused with MPAs. MPAs usually accommodate a much wider array of uses than reserves, often including fishing. See, e.g., Robin Kundis Craig, *Coral Reefs, Fishing, and Tourism: Tensions in U.S. Ocean Law and Policy Reform*, 27 STANFORD ENVTL. L.J. 3, 12–13 (2008) (“MPAs are location-based legal protections for marine ecosystems—the ocean equivalent of terrestrial national and state parks. The most protective MPAs are marine reserves, which generally prohibit all extractive uses of the marine ecosystem, including fishing.”); Callum M. Roberts, *Marine Protected Areas and Biodiversity Conservation*, in *MARINE CONSERVATION BIOLOGY: THE SCIENCE OF MAINTAINING THE SEA’S BIODIVERSITY* 265, 267 (Elliott A. Norse & Larry B. Crowder eds., 2005) (referring to fishing allowed in U.S. National Marine Sanctuaries and California’s Marine Protected Areas).

parks cover approximately four percent of land around the world, while marine reserves encompass under one percent of the oceans.<sup>15</sup> The pattern is similar in the United States where “4.6 percent of the land area . . . is protected as wilderness” while marine reserves represent less than one percent of the oceans under national control.<sup>16</sup>

In this Article I argue that many of the economists who advocate for individual property rights in wild fisheries, and the scientists and ENGOs arguing for marine reserves, focus on an overly narrow slice of the issues confronting fisheries policymakers today. Lost amid the concern with the depletion of wild fisheries is the historic rise of farmed fish and the parallel diminishing significance of wild fish as a source of human food.<sup>17</sup> Moreover, in focusing on wild fisheries, fisheries experts tend to advocate rather single-mindedly for particular types of property instruments, such as marine reserves or individual transferable quotas.<sup>18</sup>

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15. STEPHEN R. PALUMBI, *MARINE RESERVES: A TOOL FOR ECOSYSTEM MANAGEMENT AND CONSERVATION* 2 (2002); Roberts, *supra* note 14, at 267 (“[A]t a global scale it is estimated that as little as one hundredth of 1 percent of the sea is protected from all fishing.”); see also Alexander Gillespie, *Obligations, Gaps, and Priorities Within the International Regime for Protected Areas*, 19 *Geo. Int’l Env’tl. L. Rev.* 1, 17 (2006) (under one percent of Earth’s marine area is in protected areas while approximately eleven percent of Earth’s land surface is in protected areas).

16. PEW OCEANS COMM’N, *AMERICA’S LIVING OCEANS: CHARTING A COURSE FOR SEA CHANGE* 31 (2003); see also NAT’L RESEARCH COUNCIL, *MARINE PROTECTED AREAS: TOOLS FOR SUSTAINING OCEAN ECOSYSTEMS* 6 (2001) (under one percent of “U.S. territorial waters” in “reserves”).

In 2006, however, President Bush established a marine reserve which is the largest nature reserve in the world, exercising his authority under the Antiquities Act to declare the Northwestern Hawaiian Islands a national monument. Christopher Pala, *A Long Struggle to Preserve a Hawaiian Archipelago and Its Varied Wildlife*, *N.Y. TIMES*, Dec. 19, 2006, at F3; Andrew C. Revkin, *Bush Plans Vast Protected Sea Area in Hawaii*, *N.Y. TIMES*, June 15, 2006, at A14. In 2007 the reserve was renamed the Papahānaumokuākea Marine National Monument. See Papahānaumokuākea Marine National Monument, <http://hawaiiireef.noaa.gov/management/welcome.html> (last visited Apr. 1, 2008).

17. See, e.g., Anderson, *supra* note 11, at 133 (arguing that “fisheries managers and/or economists” have not paid much attention to aquaculture). For example, Røgnvaldur Hannesson’s otherwise excellent recent book on the creation of property rights since World War II focuses largely on the rise of rights in wild fisheries, neglecting the dramatic growth in aquaculture, which is not mentioned in the index. HANNESSON, *supra* note 1. I also neglected the growth of aquaculture in my previous works on the evolution of property rights in fisheries. Katrina Miriam Wyman, *Why Regulators Turn to Tradeable Permits: A Canadian Case Study*, 52 *U. TORONTO L.J.* 419 (2002); Katrina Miriam Wyman, *From Fur to Fish: Reconsidering the Evolution of Private Property*, 80 *N.Y.U. L. REV.* 117 (2005). There is, though, a “small but growing rapidly” “literature on the economics of aquaculture.” Porter Hoagland et al., *The Optimal Allocation of Ocean Space: Aquaculture and Wild-Harvest Fisheries*, 18 *MARINE RESOURCE ECON.* 129, 132 (2004) (surveying literature). A very interesting economically-oriented article on aquaculture is Josh Eagle et al., *Why Farm Salmon Outcompete Fishery Salmon*, 28 *MARINE POL’Y* 259, 259 (2004).

18. See *infra* notes 107 (listing sources in which economists argue for property rights such as individual transferable quotas in wild fisheries) and 118 (identifying calls for marine reserves).

In short, much of the debate about fisheries policy takes place within pigeon-holes that ignore the breadth of the challenge facing policymakers.

Returning to the basic premise behind economic approaches to property rights, I argue that the key challenge confronting fisheries policymakers is the broad one of identifying and implementing the economically optimal arrangement of property rights for marine fisheries overall, considering farmed and wild fisheries together and the many potential varieties of property rights in fisheries of both types. The economically optimal arrangement will be the one that generates the greatest net benefits from a societal perspective. Our experience combining different types of property rights on land suggests that that arrangement likely will be a mix of individual and communal property rights and state-governed protected areas where extractive uses are prohibited—neither only marine reserves nor private property rights. Furthermore, the elements of the optimal mix of property rights arrangements likely will differ across fisheries depending on many context-specific factors, including the level of the demand for the resource, externalities caused by fishing, prospects for economies of scale, and administrative costs. My overall point is that the property rights challenge in fisheries is much greater than conventionally conceived: we must design property rights for aquaculture and wild fisheries, recognizing that the optimal arrangements will likely be context-specific combinations of different kinds of property rights.<sup>19</sup>

## I. BACKGROUND: THE CURRENT GOVERNANCE AND STATUS OF MARINE FISHERIES

I start my argument for reorienting fisheries policy discussions with a brief overview of the current regulatory regime for marine fisheries and the status of marine fish stocks.

### A. Current governance regime

Most commercial fisheries are under national jurisdiction because they are within national EEZs.<sup>20</sup> In many countries, the national or federal government regulates marine fisheries in the EEZ.<sup>21</sup> In contrast, the U.S. regime for regulating EEZ fisheries is heavily regionalized. States regulate wild and farmed fisheries up to and including three nautical miles from the shore.<sup>22</sup> Federal wild fisheries, which are 3–200 miles from the shore, are regulated primarily by regional fishery management councils. Established under the Magnuson–Stevens Fishery Conservation and Management Act,<sup>23</sup> the councils include substantial representation of state interests since many of the councils' voting members are

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19. For other arguments to approach aquaculture and fisheries together, see Hoagland et al., *supra* note 17, at 131 (referring to sources arguing for integrated management of aquaculture and fisheries).

20. See *infra* notes 48 (most wild fish caught within EEZs) and 65 (most marine aquaculture in areas under national jurisdiction) and accompanying text.

21. See, e.g., HANNESSON, *supra* note 1, at 85–87 (discussing fisheries policies established by national governments in Chile, New Zealand, and Norway, and by the federal government in Canada).

22. 43 U.S.C. § 1312 (2000).

23. 16 U.S.C. §§ 1801–1884 (2000).

selected by the federal Secretary of Commerce from nominees submitted by state governors.<sup>24</sup> Furthermore, the councils are overseen by a federal agency, the National Marine Fisheries Service (“NMFS”), that itself is heavily regionalized, with offices throughout the country.<sup>25</sup> There is currently no regime governing aquaculture in federal waters. The lack of a regulatory infrastructure impedes the development of fish farming in these waters.<sup>26</sup>

An old practice, aquaculture is a rights-based approach to fishing.<sup>27</sup> Aquaculture operations own the stocks they are growing and require exclusive rights to portions of the water bottom and/or the water column.<sup>28</sup> In general, regulators with jurisdiction over aquaculture provide these rights through leases, permits, or licenses.<sup>29</sup> Aquaculture operations also may have to comply with other environmental laws, such as the Clean Water Act<sup>30</sup> in the United States.<sup>31</sup>

Most countries, including the United States, continue to regulate capture fisheries in their EEZs using conventional management techniques. These include overall catch limits (often called total allowable catches), restrictions on the length

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24. JOSH EAGLE ET AL., TAKING STOCK OF THE REGIONAL FISHERY MANAGEMENT COUNCILS 12 (2003) (discussing composition of councils).

25. See NOAA Fisheries: Organization Chart, [http://www.nmfs.noaa.gov/org\\_chart.htm](http://www.nmfs.noaa.gov/org_chart.htm) (last visited Apr. 19, 2008).

26. See *infra* note 87 and accompanying text (referring to lack of regulatory infrastructure).

27. See, e.g., TERRY L. ANDERSON & DONALD R. LEAL, FREE MARKET ENVIRONMENTALISM 107–21 (rev. ed. 2001) (advocating property rights in fisheries, including individual transferable quotas and fuller property rights such as territorial use rights and ranching of salmon and other fish); Anderson, *supra* note 11, at 134 (offering a framework for categorizing rights-based approaches to fisheries, and including aquaculture as a rights-based approach); Hope M. Babcock, *Grotius, Ocean Fish Ranching, and the Public Trust Doctrine: Ride ‘Em Charlie Tuna*, 26 STANFORD ENVTL. L.J. 3, 36–37 (2007) (describing individual fishing quotas and fish farming as “type[s] of privatization of” fisheries).

28. See MARINE AQUACULTURE TASK FORCE, SUSTAINABLE MARINE AQUACULTURE: FULFILLING THE PROMISE; MANAGING THE RISKS 20 (2007), available at [http://www.who.edu/cms/files/jmcdowell/2007/1/Sustainable\\_Marine\\_Aquaculture\\_final\\_1\\_02\\_07\\_17244\\_17263.pdf](http://www.who.edu/cms/files/jmcdowell/2007/1/Sustainable_Marine_Aquaculture_final_1_02_07_17244_17263.pdf) (discussing techniques for farming mollusks such as oysters, and for farming salmon).

29. On the legal infrastructure for marine aquaculture in the U.S., see, e.g., DeVoe & Mount, *supra* note 10, at 233–34 (aquaculture requires conveying property rights to culturists, which states have done by leasing submerged lands and sometimes the water column). On the legal infrastructure in other countries, see, e.g., Jeremy Firestone et al., *Regulating Offshore Wind Power and Aquaculture: Messages From Land and Sea*, 14 CORNELL J.L. & PUB. POL’Y 71, 101 (2004) (stating that nations such as “Japan, Norway, Ireland, the United Kingdom (Scotland), Chile, New Zealand, and Australia . . . [f]or the most part . . . require both a lease for an area of ocean and a license to operate an aquaculture facility”); Dag Standal & Ingrid Bouwer Utne, *Can Cod Farming Affect Cod Fishing? A System Evaluation of Sustainability*, 31 MARINE POL’Y 527, 528 (2007) (referring to “more than 300 licences” Norwegian Directorate of Fisheries allocated “for commercial farming” by 2005).

30. 33 U.S.C. §§ 1251–1387 (2000).

31. MARINE AQUACULTURE TASK FORCE, *supra* note 28, at 6; Firestone et al., *supra* note 29, at 84–85.

of the fishing season and the gear fishers are allowed to use, closed areas, and sometimes limits on the numbers of fishers allowed to fish.<sup>32</sup>

Some countries, however, have also established property rights in wild fisheries.<sup>33</sup> For instance, in some countries inshore fisheries in the territorial sea are the subject of territorial use rights (“TURFs”), which give fishers ownership of the stock of the fish in designated areas. Fish covered by TURFs generally are sedentary species that do not migrate much because these fish can be allocated territorially.<sup>34</sup> An increasing number of countries, including the United States, are establishing ITQs.<sup>35</sup> These are individual rights-based instruments which allocate fishers shares of the allowable catch that they can buy and sell.<sup>36</sup> Migratory fisheries are amenable to individual transferable quotas because, unlike TURFs, ITQs provide exclusive rights to shares of the flow of fish, not to fish in geographically determined areas of the sea.<sup>37</sup>

Many countries also have long-established communally-run fisheries in which community norms often substitute for state regulation.<sup>38</sup> For instance, in

32. See, e.g., RASBAND ET AL., *supra* note 13, at 449 (“The traditional approach to overfishing has been to restrict the activities of fishers, whether through the size of catch, length of season, areas that may be fished, or gear used.”); Mark T. Gibbs, *Lesser-known Consequences of Managing Marine Fisheries Using Individual Transferable Quotas*, 31 MARINE POL’Y 112, 112 (2007) (describing “input controls” such as “net mesh size, fishing day restrictions, vessel size restrictions, etc.” as “[t]he preferred policy and regulatory instruments in fisheries management over the last 50 years”); Hentrich & Salomon, *supra* note 9, at 712–14 (describing current approach for managing fisheries in European Union).

33. See HANNESSON, *supra* note 1, at 55 (describing three types of exclusive use rights in fisheries: “(i) rights to catch a certain quantity of fish, (ii) rights to own and to operate fishing vessels, and (iii) territorial use rights”).

34. *Id.* at 75. The oyster beds that coastal states lease to private fishers are a famous example of a TURF fishery popularized by free-market economists. These beds are more productive and generate higher prices and incomes than oyster beds under common property regimes. See, e.g., Richard J. Agnello & Lawrence P. Donnelly, *Prices and Property Rights in the Fisheries*, 42 S. ECON. J. 253, 261 (1975) (common property rights in oysters lead to lower oyster price levels and incomes than private property rights); Richard J. Agnello & Lawrence P. Donnelly, *Property Rights and Efficiency in the Oyster Industry*, 18 J.L. & ECON. 521, 522 (1975) (private property rights in oyster beds have positive impacts on labor productivity compared with common property rights); Garrett Power, *More About Oysters Than You Wanted to Know*, 30 MD. L. REV. 199, 200 (1970) (attributing decline of oyster harvest in Maryland to most oyster grounds in the state being under common property rather than private property).

TURFs resemble aquaculture in that the holders of TURFs may take steps to actually grow species such as oysters. See, e.g., Anderson, *supra* note 11, at 134 (emphasizing similarities between aquaculture and other property rights approaches to fisheries); MARINE AQUACULTURE TASK FORCE, *supra* note 28, at 16 (discussing oyster farming as aquaculture).

35. See, e.g., HANNESSON, *supra* note 1, at 85 (discussing “development of exclusive fishing rights in . . . four countries”).

36. *Id.* at 56–57.

37. Hentrich & Salomon, *supra* note 9, at 715.

38. See ELINOR OSTROM, *GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION* 19–21 (1990) (referring to studies of productive common-property arrangements in inshore fisheries).

Japan, fishing cooperatives—not individuals—have TURF rights to fish in “specific territories extending as far as five and a half miles seaward.”<sup>39</sup> The premier example of a communal property regime in United States fisheries, the lobster gangs of Maine, may be slowly giving way to a formal regulatory apparatus established by the state of Maine.<sup>40</sup> Interestingly, there are recent efforts in the U.S. and elsewhere to create new communal regimes to manage fisheries, sometimes from above by government regulators and sometimes from below by fishers. For instance, in Alaska, the Pacific, and New England, fisheries regulators have allocated shares of the total allowable catch of certain species to groups of fishers.<sup>41</sup> Some of these groups have formed cooperatives that in turn allocate the group share among their members, establishing by contract or by custom an individual quota program.<sup>42</sup> Other groups—such as the Native American communities holding community development quotas in Alaska—lease their shares of the total allowable catch to other fishing interests.<sup>43</sup>

Several categories of fisheries remain outside the control of a single state: fisheries that cross the EEZs of more than one country (transboundary fisheries), fisheries that straddle the EEZs of one or more countries and the high seas outside of areas of national jurisdiction (straddling or highly migratory species), and fisheries exclusively on the high seas (discrete high seas fisheries).<sup>44</sup> Many of these fisheries are regulated by regional fisheries management organizations (“RFMOs”) established by conventions and dominated by nation states.<sup>45</sup> Currently, 16 RFMOs are authorized “to establish conservation and management

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39. ANDERSON & LEAL, *supra* note 27, at 116; *see also* HANNESSON, *supra* note 1, at 24–25 (“The lords of feudal Japan gave exclusive fishing rights to designated villages. . . . [T]hese feudal rights have evolved into exclusive rights now held by fishermen’s cooperatives in the inshore fisheries of Japan.”).

40. James M. Acheson & Jennifer F. Brewer, *Changes in the Territorial System of the Maine Lobster Industry*, in THE COMMONS IN THE NEW MILLENNIUM: CHALLENGES AND ADAPTATION 37 (Nives Dolšak & Elinor Ostrom eds. 2003).

41. *See, e.g.*, HANNESSON, *supra* note 1, at 151–58 (discussing whiting cooperative off Oregon and Washington, and pollock cooperatives in Alaska); André Verani, *Community-Based Management of Atlantic Cod by the Georges Bank Hook Sector: Is It a Model Fishery?*, 20 TUL. ENVTL. L.J. 359 (2007) (analyzing Georges Bank Cod Hook Sector).

42. HANNESSON, *supra* note 1, at 152 (stating that the Pacific whiting “cooperative essentially amounts to an ITQ management system”); *id.* at 153 (referring to Alaska cooperatives as “ITQs through the Back Door”); *see generally* Robert T. Deacon et al., *Improving Efficiency by Assigning Harvest Rights to Fishery Cooperatives: Evidence From the Chignik Salmon Co-op*, 50 ARIZ. L. REV. 479 (2008); Hentrich & Salomon, *supra* note 9, at 716 (suggesting that allocation of national catch quotas to producer organizations in Germany, Great Britain, and Netherlands has permitted creation of individual shares in catch quotas).

43. *See generally* HANNESSON, *supra* note 1, at 82, 148–49; RASBAND ET AL., *supra* note 13, at 454–55.

44. U.N. FOOD & AGRIC. ORG., FISHERIES & AQUACULTURE DEP’T, THE STATE OF WORLD FISHERIES AND AQUACULTURE 2006 120–21 (2007) [hereinafter FAO] (defining transboundary, straddling, highly migratory, and discrete high seas fisheries).

45. *See id.* at 52–53.



measures.”<sup>46</sup> Notably, 75% of the high seas are not regulated by any RFMO.<sup>47</sup> The gap in regulation reflects the fact that the high seas account for a relatively small share of world fish catches. Estimates vary, but perhaps 90% of fisheries are in national EEZs, meaning that the high seas account for perhaps only 10% of fisheries.<sup>48</sup>

RFMOs generally are weak and ineffective regulators.<sup>49</sup> RFMOs are governed by commissions comprised of representatives of the countries whose vessels fish the species that the RFMOs regulate.<sup>50</sup> RFMOs tend to operate by setting total allowable catches and then allocating these among their member states in the form of country quotas.<sup>51</sup> Some RFMOs also establish gear and other kinds of restrictions.<sup>52</sup> No RFMO seems to have established individual transferable quotas.<sup>53</sup> RFMOs depend on their member states to enforce their regulations.<sup>54</sup> Nation states may fail to do so, however, because enforcement is too costly, for example because of political pressures from domestic fishing industries to allow higher catch levels.<sup>55</sup> An RFMO also may be hobbled by the refusal of some

46. HIGH SEAS TASK FORCE, CLOSING THE NET: STOPPING ILLEGAL FISHING ON THE HIGH SEAS (FINAL REPORT OF THE MINISTERIALLY-LED TASK FORCE ON IUU FISHING ON THE HIGH SEAS) 46 (2006), available at <http://www.high-seas.org/>.

Most of the 16 RFMOs regulate transboundary, straddling, and highly migratory fisheries. Kristina M. Gjerde, High Seas MPAs and Deep-Sea Fishing 26 (Feb. 9, 2007) (unpublished manuscript, <http://www.cbd.int/doc/meetings/mar/ewsebm-01/other/ewsebm-01-gjerde-en.pdf>) (indicating that only 5 RFMOs regulate discrete high seas fisheries); cf. HIGH SEAS TASK FORCE, *supra*, at 46–47 (listing 11 regional fisheries management organizations with “a significant level of competence over high seas areas”).

47. Gjerde, *supra* note 46, at 24–25.

48. Babcock, *supra* note 27, at 11 (“[O]ver 90% of the fish are within 200 nautical miles of the U.S. coastline and ‘distant’ or high seas fishers contribute only 5% to total marine landings.” (citation omitted)); Ussif Rashid Sumaila et al., *As We See It: Potential Costs and Benefits of Marine Reserves in the High Seas*, 345 MARINE ECOLOGY PROGRESS SERIES 305, 307 (2007) (“Although the high seas . . . make up about 56% of the world’s ocean areas, they account for only 9% of the current marine fisheries catch.”). *But see* FAO, *supra* note 44, at 121 (“FAO estimates that as much as one-third of global marine capture fishery harvests may be based on” transboundary, straddling and highly migratory, and discrete high seas “stocks”).

49. Gjerde, *supra* note 46, at 2; *see also* A. WILLOCK & M. LACK, FOLLOW THE LEADER: LEARNING FROM EXPERIENCE AND BEST PRACTICE IN REGIONAL FISHERIES MANAGEMENT ORGANIZATIONS (2006); FAO, *supra* note 44, at 52–57.

50. WILLOCK & LACK, *supra* note 49, at 6.

51. *Id.* at 26 (discussing allocation of fisheries).

52. *Id.* at 19 (discussing the regulation of bottom trawling by some RFMOs).

53. *See* J. R. Beddington et al., *Current Problems in the Management of Marine Fisheries*, 316 SCIENCE 1713, 1715 (2007) (“To our knowledge, none of the [Regional Fisheries Management Organizations] currently allocate rights to individual fishers, and only a few have defined and tested effective harvest strategies.”).

54. *See* Kevern L. Cochrane & David J. Doullman, *The Rising Tide of Fisheries Instruments and the Struggle to Keep Afloat*, 360 PHIL. TRANSACTIONS ROYAL SOC’Y LONDON, SERIES B. 77, 84 (2005).

55. Levels of enforcement of fisheries laws vary significantly among countries. In general, developed countries do a better job enforcing domestic and international fisheries regulations than developing countries. *See, e.g.*, HIGH SEAS TASK FORCE, *supra*

countries to join even though the countries' vessels are harvesting fisheries the RFMO regulates. Historically there has been an incentive not to join an RFMO because vessels flying the flags of nonparty states are not bound by the RFMO's regulations.<sup>56</sup>

In sum, over two decades after the negotiation of the Law of the Sea Convention, countries have developed a range of approaches for regulating fisheries within and outside of their EEZs. But wild fisheries are declining notwithstanding the governance regimes established in the wake of the Law of the Sea Convention. To date, the regulatory infrastructure countries have built has yet to yield much improvement in the status of fish stocks.<sup>57</sup>

### ***B. Current status of marine fisheries***

Look closely at the offerings of fish markets and restaurants and you will see evidence of the leveling off of wild fisheries and the rise of aquaculture. The

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note 46, at 19 (“For Sub-Saharan Africa as a whole, the cost of illegal fishing is estimated at about USD 0.9 billion (about 19 per cent of current landed value.”); Diane Erceg, *Deterring IUU Fishing Through State Control Over Nations*, 30 *MARINE POL’Y* 173, 176 (2006) (“Developing countries experience greater difficulties achieving effective enforcement of measures to control IUU [illegal, unreported and unregulated] fishing due to their limited resources.”). The weakness of management regimes in developing countries is important because they harvest a large share of the world’s fish. Andy Thorpe et al., *When Fisheries Influence National Policy-making: An Analysis of the National Development Strategies of Major Fish-producing Nations in the Developing World*, 29 *MARINE POL’Y* 211, 212 (2005) (In 2000, developing countries harvested 75.8% of capture fisheries and aquaculture combined.).

56. G. BRUCE KNECHT, *HOOKED: PIRATES, POACHING, AND THE PERFECT FISH* 265 (2006) (stating that Commission for the Conservation of Antarctic Marine Living Resources (“CCAMLR”) “regulations are essentially voluntary: they apply only to vessels that are flagged to countries that choose to be CCAMLR members.”).

The 1995 UN Fish Stocks Agreement attempted to create incentives to overcome this free-rider problem and to encourage countries to join the RFMOs managing the fisheries their vessels fish, or at least to ensure that their vessels comply with RFMO regulations. Specifically, “the Fish Stocks Agreement seeks to limit access to fishing in areas covered by an RFMO to only those states which are members of the RFMO or similar arrangements, or which agree to apply its conservation and management measures (Fish Stocks Agreement art. 8.3).” Gjerde, *supra* note 46, at 25.

57. The decline of wild fisheries in spite of the coming into force of the Law of the Sea Convention raises many interesting questions. For example, is the current declining state of fisheries attributable to the Law of the Sea Convention? If so, why did the effort to create property rights in fisheries through the Law of the Sea Convention fail? Alternatively, has the Law of the Sea Convention actually been a positive development for marine fisheries because it created a legal framework that countries such as New Zealand and increasingly the U.S. are using to establish individual property rights in fisheries?

salmon being sold is increasingly farmed Atlantic salmon.<sup>58</sup> Sometimes the cod is farmed too.<sup>59</sup>

Consider a few data points on the current status of marine fisheries by way of background:

- On a global basis, the Food and Agriculture Organization (“FAO”) reports that the production of capture fisheries has remained relatively constant for the last decade as demand for fish for food has increased.<sup>60</sup> Aquaculture has surged to fill the void. According to the FAO, “[a]quaculture continues to grow more rapidly than all other animal food-producing sectors, with an average annual growth rate for the world of 8.8 percent per year since 1970, compared with only 1.2 percent for capture fisheries and 2.8 percent for terrestrial farmed meat production systems.”<sup>61</sup> In 2004, capture fisheries supplied 57% of the fish used for food around the world.<sup>62</sup> Aquaculture supplied the remaining 43% of fish used for food.<sup>63</sup>

Most aquaculture is conducted in freshwater onshore, but aquaculture also occurs in marine waters, and interest in this brand of aquaculture is growing.<sup>64</sup> Marine aquaculture generally is conducted within national EEZs, not on the high seas.<sup>65</sup>

58. See Anderson, *supra* note 11, at 134 (“During the past five years, the fastest-growing seafood imports into the US are farmed Atlantic salmon, farmed mussels, and farmed tilapia.”).

59. See Standal & Utne, *supra* note 29, at 528 (“[C]od farming is an emerging industry” in Norway “that may seriously threaten the traditional [Norwegian cod] fisheries.”). In a recent development, this past spring, “the aquaculture company HQ Sustainable Maritime Industries created what it calls ‘sea-flavored’ tilapia, the first farmed fish manipulated to taste like wild fish,” to meet the “flavor” needs of the fast-food industry. Charlie Foster, *Fish-Flavored Fish*, N.Y. TIMES, Dec. 9, 2007, (Magazine) at 70.

60. See FAO, *supra* note 44, at 4–5, 29, 36.

61. *Id.* at 5. However, the FAO suggests that the rate of increase in aquaculture “may be moderating.” *Id.* at 17.

62. See *id.* at 3 (by implication).

63. *Id.* Approximately 75% of “estimated world fish production was used for direct human consumption” in 2004. *Id.* at 34. Aquaculture’s share of worldwide “food fish supply” is heavily attributable to the large volume of fish farmed for food in China. *Id.* at 17.

64. *Id.* at 6 (“Freshwater culture continued to dominate [in 2004.]”); MARINE AQUACULTURE TASK FORCE, *supra* note 28, at 14 (“Based on 2003 data, [worldwide] freshwater fish, mainly carps, comprised more than 85 percent of farmed fish production by weight.”).

China, which reportedly produces 70% of the world’s farmed fish, harvests farmed fish “mostly on land, and in lakes, ponds, rivers and reservoirs, or in huge rectangular fish ponds dug into the earth.” David Barboza, *China’s Seafood Industry: Dirty Water, Dangerous Fish*, N.Y. TIMES, Dec. 15, 2007, at A1, A12. In the United States, only 20% of farmed fish are “marine species.” U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Aquaculture Program: Aquaculture in the United States, <http://aquaculture.noaa.gov/us/welcome.html> (last visited Mar. 25, 2008).

The historic rise of farmed salmon supplies illustrates the rapid shift from wild to farmed fish in recent decades. Twenty-seven years ago over “99 percent of salmon consumed worldwide” was caught in the wild.<sup>66</sup> “Today, only about 40 percent of the world’s salmon is” wild-caught.<sup>67</sup> “The rest originates in net-pen farms installed along the coasts of Norway, Scotland, Chile, Canada, and other countries.”<sup>68</sup>

- Farmed fish are not only a substitute for wild fish, but they also depend to some extent on the existence of wild fish. Farmed fish come in different varieties: some are omnivores and herbivores while others are carnivores.<sup>69</sup> The carnivorous species, such as salmon, consume fishmeal and fish oil made from wild fish, such as small pelagic species. The need to feed carnivorous species wild fish means that there may be limits on the extent to which aquaculture can replace wild fisheries.<sup>70</sup> But these limits should not be exaggerated.<sup>71</sup> Currently, carnivorous species such as salmon account for just under 25% of farmed fish worldwide<sup>72</sup> and consume “12 percent of the world’s [wild] catch.”<sup>73</sup> Moreover, since the late 1990s, aquaculture has made some progress in reducing its use of fishmeal and fish oil.<sup>74</sup> The dependence of aquaculture on wild fish may loom particularly large in the minds of North Americans and Western Europeans because carnivorous species account “for approximately three-

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On the growing interest in marine aquaculture, see, e.g., MARINE AQUACULTURE TASK FORCE, *supra* note 28, at 1 (“[M]any experts see open ocean waters as the most likely venue for any major expansion of U.S. marine aquaculture.”); Robert R. Stickney et al., *Toward Sustainable Open Ocean Aquaculture in the United States*, 31 FISHERIES 607, 608 (2006) (referring to “open ocean aquaculture facilities” in different countries).

65. See FAO, *supra* note 44, at 8.

66. Eagle et al., *supra* note 17, at 259.

67. *Id.*

68. *Id.* Eagle et al. note that about 20% of salmon caught in the wild are hatchery fish, meaning they “spend the first part of their existence in incubators and concrete runways” although they “spend their adult lives in the ocean.” *Id.* at 259 n.1; see also *id.* at 260; Anderson, *supra* note 11, at 143 (stating that in 2000, “43% of the total salmon harvest [in Alaska, where aquaculture is forbidden,] was from hatcheries”).

69. See Roger S.V. Pullin & U. Rashid Sumaila, *Aquaculture*, in FISH FOR LIFE: INTERACTIVE GOVERNANCE FOR FISHERIES 93, 99 (Jan Kooiman et al. eds., 2004).

70. Dadi Kristofersson & James L. Anderson, *Is There a Relationship Between Fisheries and Farming? Interdependence of Fisheries, Animal Production and Aquaculture*, 30 MARINE POL’Y 721, 721 (2006).

71. See *id.* at 723.

72. *Id.* tbl.3 (World Aquaculture Production of Finfish and Shrimp, World Fishmeal Production and Use in Aquafeed).

73. *National Offshore Aquaculture Act of 2007: Hearing on H.R. 2010 Before the H. Subcomm. on Fisheries, Wildlife & Oceans, H. Comm. on Natural Res.*, 110th Cong. 4 (2007) (testimony of Tim Eichenberg, Pacific Regional Director, Ocean Conservancy), available at [http://resourcescommittee.house.gov/images/Documents/20070712b/testimony\\_eichenberg.pdf](http://resourcescommittee.house.gov/images/Documents/20070712b/testimony_eichenberg.pdf) [hereinafter Eichenberg Testimony].

74. See MARINE AQUACULTURE TASK FORCE, *supra* note 28, at 6–7.

quarters of finfish culture production in developed countries.”<sup>75</sup> In developing countries, however, where most aquaculture takes place and is growing more rapidly,<sup>76</sup> “[w]ith the exception of marine shrimp, the bulk of aquaculture production . . . in 2004 comprised omnivorous/herbivorous fish or filter-feeding species.”<sup>77</sup>

But the overall impact of fish farming on wild fish stocks and the environment in general should not be underestimated.<sup>78</sup> Farmed fish may escape from fish farms and interbreed with wild fish to the detriment of the latter.<sup>79</sup> Wild fish also may die from parasites that they contract from infested farmed salmon.<sup>80</sup> Like concentrated animal feeding operations on land, fish farms also discharge pollutants that contaminate the marine environment.<sup>81</sup> In fact, the environmental harms from fish farming are now prominent blips on the political radar in many countries around the world.<sup>82</sup>

- In the United States, aquaculture represents a rapidly growing source of fish for food, although most farmed fish consumed here is imported.

75. FAO, *supra* note 44, at 6; *see also* Pullin & Sumaila, *supra* note 69, at 99 (aquaculture in developed countries was “73.8% carnivores”). The FAO reports that “55.6 percent of the world’s farmed salmonids come from Western Europe, mainly the northern part of the continent.” FAO, *supra* note 44, at 17.

76. *See* FAO, *supra* note 44, at 21–22. “Of the world total, China is reported to account for 69.6 percent of the total quantity and 51.2 percent of the total value of aquaculture production.” *Id.* at 16.

77. *Id.* at 6; *see also* Pullin & Sumaila, *supra* note 69, at 99 (aquaculture in developing countries was “27.2% filter feeds, . . . 65.7% omnivores/herbivores”). On a less optimistic note, Naylor et al. indicate that the use of fishmeal and fish oil is increasing in Asia. Rosamond L. Naylor et al., *Effect of Aquaculture on World Fish Supplies*, 405 NATURE 1017, 1021 (2000).

78. *See* FAO, *supra* note 44, at 77 (listing many ways aquaculture may harm ecosystems); Naylor et al., *supra* note 77.

79. *See, e.g.*, MARINE AQUACULTURE TASK FORCE, *supra* note 28, at 3 (“[T]here is growing evidence that escaped farmed salmon are interbreeding with wild Atlantic salmon, spreading their genes within dwindling wild stocks of Atlantic salmon and potentially confounding the recovery of this species.”).

80. *See, e.g.*, Martin Krkošek et al., *Declining Wild Salmon Populations in Relation to Parasites from Farm Salmon*, 318 SCIENCE 1772, 1772 (2007) (estimating that mortality of pink salmon from lice infesting farmed salmon “commonly” exceeds 80%).

81. *See, e.g.*, MARINE AQUACULTURE TASK FORCE, *supra* note 28, at 6 (“Marine aquaculture facilities produce a variety of wastes that are potentially harmful to the environment and which are discharged untreated into coastal and ocean waters.”). On the pollution from concentrated animal feeding operations, *see, e.g.*, POLLAN, *supra* note 11, at 67 (referring to “polluted water and air, toxic wastes, novel and deadly pathogens” as examples of “environmental and health problems” attributable to concentrated animal feeding operations).

82. *See, e.g.*, Barboza, *supra* note 64 (reporting concerns about aquaculture in China, including water pollution from fish farms); Monte Reel, *Salmon Farms Roil Chilean Waters: The Patagonian Purity That Lured Aquaculture May Not Be What It Once Was*, MIAMI HERALD, December 17, 2007, at G8 (reporting environmental concerns with salmon farming in Chile, a major exporter of farmed salmon to the U.S.).

According to NMFS, “[t]he U.S. imports over 70 percent of the seafood that Americans eat, and at least 40 percent is farmed overseas.”<sup>83</sup> The United States does not farm much fish domestically by world standards.<sup>84</sup> Moreover, only 20% of the relatively small amount of U.S. domestic farmed fish are marine species.<sup>85</sup> Most marine aquaculture in the United States takes place in the three mile area close to shore regulated by the states.<sup>86</sup> The growth of aquaculture in the area between 3 and 200 miles from United States shores currently is hindered because there is “no way to obtain a permit for aquaculture in federal waters under existing U.S. laws and regulations.”<sup>87</sup> Although the Bush Administration has proposed legislation to facilitate establishing fish farms in federal waters, the legislation is opposed by environmentalists and wild fishing interests, among others.<sup>88</sup>

- Turning to wild fisheries, from a global perspective, the FAO estimates that as of 2005: about 25% “of . . . [wild] stock groups . . . were underexploited or moderately exploited and could perhaps produce more,”<sup>89</sup> approximately “half . . . were fully exploited and therefore producing catches that were at, or close to, their maximum sustainable limits, with no room for further expansion;”<sup>90</sup> and “the remaining [25% of] stocks were either overexploited, depleted or recovering from depletion and thus were yielding less than their maximum potential owing to excess fishing pressure.”<sup>91</sup> The percentage of overexploited stocks has

83. Press Release, Nat’l Oceanic & Atmospheric Admin., U.S. Dep’t of Commerce, Bush Administration Releases National Offshore Aquaculture Bill (June 7, 2005), available at [http://ocean.ceq.gov/announcements/05\\_070\\_Aquaculture.pdf](http://ocean.ceq.gov/announcements/05_070_Aquaculture.pdf).

84. The U.S. “produces less than one percent of worldwide aquaculture output.” MARINE AQUACULTURE TASK FORCE, *supra* note 28, at 10.

85. U.S. Department of Commerce, *supra* note 64.

86. Firestone et al., *supra* note 29, at 75 (“In the United States, almost all the efforts to develop marine aquaculture have focused on state jurisdictional waters—those generally within three miles of the shore.”); see also U.S. COMM’N ON OCEAN POL’Y, AN OCEAN BLUEPRINT FOR THE 21ST CENTURY 332 (2004) [hereinafter USCOP].

Some states have prohibited marine aquaculture in their state waters, most prominently Alaska. ALASKA STAT. § 16.40.210 (2003).

87. U.S. Department of Commerce, *supra* note 64; see also USCOP, *supra* note 86, at 101, 332–33; Stickney et al., *supra* note 64, at 609 (referring to “frustration” with lack of federal regulatory framework and permitting process).

88. See Press Release, *supra* note 83; U.S. Department of Commerce, National Oceanic and Atmospheric Administration, The National Offshore Aquaculture Act of 2007, <http://aquaculture.noaa.gov/us/2007.html> (last visited Mar. 25, 2008); National Offshore Aquaculture Act, H.R. 2010, S. 1609, 110th Cong. (2007). On the opposition to the legislation, see, e.g., Eichenberg Testimony, *supra* note 73, at 6–7 & 12 n.38.

In October 2007, NOAA released a ten-year plan to promote marine aquaculture in the United States. U.S. DEP’T OF COMMERCE, NAT’L OCEANIC & ATMOSPHERIC ADMIN., NOAA 10-YEAR PLAN FOR MARINE AQUACULTURE 7 (2007), available at <http://aquaculture.noaa.gov/pdf/finalnoaa10yrweb.pdf> [hereinafter NOAA].

89. FAO, *supra* note 44, at 7.

90. *Id.*

91. *Id.*

remained roughly the same for “10–15 years” after greatly increasing in the 1970s and 1980s.<sup>92</sup>

A widely publicized—but controversial—recent study “projects the global collapse of all [wild] taxa currently fished by the mid-21st century.”<sup>93</sup> The study extrapolates from FAO data about fish catches between 1950 and 2003 in areas of the oceans accounting for “83% of global fisheries yields over the past 50 years.”<sup>94</sup>

High seas fisheries are especially vulnerable to over-exploitation, partly because many are long-lived species that reproduce for limited periods of time.<sup>95</sup> Some predict that “given current management practices, most if not all deep-sea fisheries will be commercially extinct within 10–20 years.”<sup>96</sup>

- The status of wild fisheries is not universally bleak. Some developed countries have established strong regimes for regulating fisheries in their national EEZs that seem to be maintaining or restoring biologically healthy fisheries.<sup>97</sup>

The U.S. regime for managing fisheries, in particular, deserves some praise. Currently, 25% of stocks in federal waters (3–200 nautical miles

92. *Id.*

93. Boris Worm et al., *Impacts of Biodiversity Loss on Ocean Ecosystem Services*, 314 *SCIENCE* 787, 790 (2006) [hereinafter Worm et al., *Impacts of Biodiversity Loss*]. On the controversy, see, for example, Letters and Technical Comment Abstracts, 316 *SCIENCE* 1281, 1281–85 (2007); Franz Hölker et al., *Comment on “Impacts of Biodiversity Loss on Ocean Ecosystem Services,”* 316 *SCIENCE* 1285 (2007); John Jaenike, *Comment on “Impacts on Biodiversity Loss on Ocean Ecosystem Services,”* 316 *SCIENCE* 1285 (2007); Michael J. Wilberg & Thomas J. Miller, *Comment on “Impacts of Biodiversity Loss on Ocean Ecosystem Services,”* 316 *SCIENCE* 1285 (2007); Boris Worm et al., *Response to Comments on “Impacts of Biodiversity Loss on Ocean Ecosystem Services,”* 316 *SCIENCE* 1285 (2007) [hereinafter Worm et al., *Response to Comment*].

94. Worm et al., *Impacts of Biodiversity Loss*, *supra* note 93, at 788.

95. FAO, *supra* note 44, at 7; *id.* at 33 (discussing the “more critical” situation facing “some highly migratory, straddling and other fishery resources that are exploited solely or partially in the high seas”).

96. Gjerde, *supra* note 46, at 22 (citing Adrian G. Glover & Craig R. Smith, *The Deep-sea Floor Ecosystem: Current Status and Prospects of Anthropogenic Change by the Year 2025*, 30 *ENVTL. CONSERVATION* 219 (2003)). *But see* Sumaila et al., *supra* note 48, at 305 (unlike many inshore and EEZ fisheries, high seas fisheries are not yet in a crisis situation).

97. Gibbs, *supra* note 32, at 113 (arguing that New Zealand’s rights-based approach to fisheries management “has been particularly successful in halting, and in some cases reversing declines in the abundance of [fish] stocks through capping yields”); Ray W. Hilborn, Letter, 316 *SCIENCE* 1281 (2007) (criticizing Worm et al., *Impacts of Biodiversity Loss*, *supra* note 93, for failing “to recognize that jurisdictions such as the United States, New Zealand, Iceland, and Australia have good fisheries management systems where the proportion of stocks that are overfished is declining”); *see also* FAO, *supra* note 44, at 5, 9–10, 32 (discussing differences in conditions of fish stocks in different areas of the oceans).

from the shore) are overfished, while 75% are not.<sup>98</sup> And wild fish stocks in the United States EEZ may have better prospects than fish stocks in the EEZs of many other countries.<sup>99</sup> In 2006, Congress reauthorized the main federal statute governing the regulation of fisheries between 3–200 miles with several new provisions intended to prevent fish stocks from becoming overfished and to rebuild existing overfished stocks.<sup>100</sup> For example, the statute requires the establishment of total allowable catches for all fisheries.<sup>101</sup> The reauthorization also paves the way for establishing ITQs (which the statute calls limited access privileges) in more fisheries,<sup>102</sup> something that growing numbers of regional fishery management councils are moving toward.<sup>103</sup> Indeed, the Bush administration has pledged to double the number of federal fisheries with dedicated access privileges, including ITQs, by 2010.<sup>104</sup>

## II. THE RANGE OF POSSIBLE PROPERTY RIGHTS ARRANGEMENTS IN MARINE FISHERIES

The rise of aquaculture and the depletion of many wild fisheries under the governance regime created by the Law of the Sea Convention have given rise to several policy debates that are unfortunately largely isolated from each other.

One debate concerns the framework for regulating marine aquaculture. Where to establish marine aquaculture facilities and how to regulate aquaculture

98. NOAA FISHERIES, OFFICE OF SUSTAINABLE FISHERIES, REPORT ON THE STATUS OF U.S. FISHERIES FOR 2006 5 (2006), *available at* [http://www.nmfs.noaa.gov/sfa/domes\\_fish/StatusoFisheries/2006/2006RTCFinal\\_Report.pdf](http://www.nmfs.noaa.gov/sfa/domes_fish/StatusoFisheries/2006/2006RTCFinal_Report.pdf). “A stock that is overfished has a biomass level below a biological threshold specified in its fishery management plan.” *Id.* The statistics mentioned in the text concern fish stocks whose status is known; there are many fish stocks whose status remains unknown. *Id.* at 1, 5.

99. *But see* Andrew A. Rosenberg et al., *Rebuilding U.S. Fisheries: Progress and Problems*, 4 FRONTIERS IN ECOLOGY & ENV'T 1, 1 (2006) (arguing that federal fisheries legislation provides “a very strong statutory mandate to end overfishing and rebuild depleted fishery resources” but that rebuilding programs have produced disappointing results).

100. Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, Pub. L. No. 109-479, 120 Stat. 3575.

101. 16 U.S.C. § 1852(h)(6) (2006).

102. *Id.* § 1853a.

103. *See, e.g.*, South Atlantic Fishery Management Council, Limited Access Privilege (LAP) Program for the South Atlantic Snapper Grouper Fishery?, <http://www.safmc.net/SocioEconomic/LimitedAccessPrivileges/tabid/486/Default.aspx> (last visited Mar. 25, 2008) (listing fisheries where limited access privileges are being considered).

104. COMM. ON OCEAN POL'Y, U.S. OCEAN ACTION PLAN IMPLEMENTATION UPDATE 22 (2007), *available at* [http://ocean.ceq.gov/oap\\_update012207.pdf](http://ocean.ceq.gov/oap_update012207.pdf) (Department of Commerce pledging to “double the number of [dedicated access privilege programs, which include ITQs] by 2010,” which translates into “bring[ing] eight new fisheries under market-based management programs”); *see also* COUNCIL ON ENVTL. QUALITY, COMM. ON OCEAN POL'Y, U.S. OCEAN ACTION PLAN, THE BUSH ADMINISTRATION'S RESPONSE TO THE U.S. COMMISSION ON OCEAN POLICY 18–19 (2004), *available at* <http://ocean.ceq.gov/actionplan.pdf>.



operations are pressing issues in many parts of the developed and developing world.<sup>105</sup> These questions have typically been addressed by scientists and others, but relatively rarely by economists.<sup>106</sup>

Economists have engaged much more in debates about the proper framework for regulating wild fisheries. They have tended to prescribe private property rights for wild fisheries, such as territorial use rights, or proxies for private rights, such as cooperatives or ITQs.<sup>107</sup> Economists generally attribute the problems in wild fisheries to the fact that fishers usually do not have property rights in wild fish before they are harvested from the sea.<sup>108</sup> According to economists, this lack of property rights encourages fishers to race for the fish in the sea, to over-invest in labor and capital to do better in the race, and to press regulators for higher total allowable catches to increase returns from the race.<sup>109</sup> Economists argue that granting fishers private property rights transforms fishers' incentives. Under this analysis, property rights should reduce the need fishers currently have to race for the fish, reduce the excess capacity that currently plagues many wild fisheries, and increase the efficiency of harvesting.<sup>110</sup> Fishers with property rights such as territorial use rights or individual transferable quotas also might become more focused on conserving fish stocks and less likely to pressure regulators to increase total allowable catches because fishers will internalize the benefits of improved stewardship.<sup>111</sup> Proposals for property rights such as TURFs

105. See, e.g., MARINE AQUACULTURE TASK FORCE, *supra* note 28, at 22 (discussing issues raised by rise of aquaculture).

106. See, e.g., Anderson, *supra* note 11, at 133 (arguing that “fisheries managers and/or economists have not paid much attention to aquaculture”).

107. See, e.g., HANNESSON, *supra* note 1, at 56 (referring to individual transferable quotas as “[t]he form of exclusive use rights that appears most promising for achieving an efficient exploitation of fish stocks”); ANDERSON & LEAL, *supra* note 27, at 112–20 (advocating individual transferable quotas and full property rights); LIBECAP, *supra* note 9, at 85 (discussing benefits of individual transferable quotas); R. Quentin Grafton et al., *Incentive-based Approaches to Sustainable Fisheries*, 63 CANADIAN J. FISHERIES & AQUATIC SCI. 699, 701 (2006) (advocating “more secure harvesting or territorial rights to fish.”); Hilborn, *supra* note 12, at 155 (“Economists have long advocated ITQs as one mechanism to provide for economically profitable fisheries.”).

108. See, e.g., HANNESSON, *supra* note 1, at 43 (“Open access to fisheries leads to what has come to be known as the tragedy of the commons.”).

109. Over-capacity is a significant problem in fisheries today. See, e.g., Serge M. Garcia & Richard J.R. Grainger, *Gloom and Doom? The Future of Marine Capture Fisheries*, 360 PHIL. TRANSACTIONS ROYAL SOC'Y LONDON, SERIES B. 21, 23 (2005) (“There is . . . broad agreement that the present global fishing capacity is in excess of that needed to extract potential sustainable catches.”); Hentrich & Salomon, *supra* note 9, at 714 (The “EU estimates that fishing capacity in the EU fleet is around 40% too high” given existing stocks and “[t]his figure is likely to have risen due to the further deterioration in fish stocks.”).

110. See, e.g., HANNESSON, *supra* note 1, at 56–57 (describing individual transferable quotas as a means of addressing excess harvesting capacity in fisheries).

111. See, e.g., *id.* at 60 (arguing that individual transferable quota holders “will have a collective interest in promoting good management” because the resultant rents “will be capitalized into the value of” their quotas); Grafton et al., *supra* note 107, at 702 (“[S]ustainability is promoted by fisher participation in combination with more secure harvesting rights.”).

or individual transferable quotas generally envision them being implemented by countries in their EEZs. But there also have been some proposals for “fishing rights or privileges” on the high seas, even though many RFMOs are probably too weak to manage the allocation and the enforcement of individual property rights.<sup>112</sup>

As discussed earlier, the economic arguments for private property rights have gained more traction since the creation of EEZs, and countries increasingly parcel out individual rights to marine fisheries.<sup>113</sup> Experience implementing ITQs suggests that they often produce the benefits that economists anticipate.<sup>114</sup> But individual property rights have not been greeted with universal acclaim. Not everyone gains from the introduction of individual property rights such as ITQs. The excess labor and capital that individual property rights squeeze out of fisheries has real faces: people who work in the fisheries whose jobs are eliminated.<sup>115</sup> The forced exit of these people leaves the fisheries in the hands of a smaller number of better-paid players.<sup>116</sup> Some observers, concerned about the distributional consequences of individual property rights, argue for communal property rights instead. They hope that allocating property rights to communities will generate some of the benefits of ITQs without consolidating fisheries in the hands of a small number of people.<sup>117</sup>

Some scientists and environmental organizations advocate an approach to wild fisheries very different from individual and communal property rights. Arguing that wild fisheries may be doomed unless drastic measures are taken soon, these scientists and ENGOs advocate creating marine reserves where fishing is prohibited.<sup>118</sup> Marine reserves, scientists often suggest, “would provide some

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112. Gjerde, *supra* note 46, at 29; *see also, e.g.*, Torbjorn Trondsen et al., *Towards a Market-oriented Management Model For Straddling Fish Stocks*, 30 MARINE POL’Y 199 (2006) (recommending market mechanism for managing stocks crossing national EEZs and international boundaries).

113. *See supra* note 9 and accompanying text.

114. *See, e.g.*, ENVTL. DEFENSE, SUSTAINING AMERICA’S FISHERIES AND FISHING COMMUNITIES: AN EVALUATION OF INCENTIVE-BASED MANAGEMENT (2007), available at [http://www.environmentaldefense.org/documents/6119\\_sustainingfisheries.pdf](http://www.environmentaldefense.org/documents/6119_sustainingfisheries.pdf). This is a highly favorable assessment of the impacts of ITQs from an ENGO that supports the use of ITQs.

115. *See id.* at 20 (reporting “employment opportunities fell by over half” in limited access privilege fisheries analyzed).

116. *Id.* (explaining that “work becomes more stable, safer, more year-round and more profitable” in fisheries with limited access privileges).

117. *See, e.g.*, Hilborn, *supra* note 12, at 155; Alison Rieser, *Prescriptions for the Commons: Environmental Scholarship and the Fishing Quotas Debate*, 23 HARV. ENVTL. L. REV. 393 (1999); *see also* HANNESSON, *supra* note 1, at 82 (suggesting that the “large and growing body of literature on common property” is “penned mainly by anthropologists and social scientists other than economists” and expressing skepticism about the practicality and normative desirability of “communal access rights”).

118. *See, e.g.*, KNECHT, *supra* note 56, at 207–08 (2006) (fisheries scientist Daniel Pauly recommends “that at least 20 percent of the oceans be designated as ‘marine protection areas’ where fishing is permanently banned”); NAT’L RESEARCH COUNCIL, *supra* note 16, at 1 (“Declining yields in many fisheries and the decay of treasured marine habitats . . . have heightened interest in establishing a comprehensive system of marine protected

insurance against management errors within fished areas.”<sup>119</sup> Currently, very small shares of the oceans are protected from fishing. As mentioned above, marine reserves comprise under one percent of the oceans worldwide and of the U.S. EEZ.<sup>120</sup> There are no reserves on the high seas.<sup>121</sup> Proponents have urged the reservation of large segments of the oceans, perhaps 20%, although some estimate that it might be necessary to close over 50% of the oceans to fishing.<sup>122</sup> Reserves are proposed for areas within national EEZs and, more recently, for portions of the high seas.<sup>123</sup> The growing popularity of the idea of reserving areas of the oceans as protected spaces recalls the move in late nineteenth and early twentieth century America to preserve some of the country’s most spectacular scenery for future generations after many public lands had been privatized.<sup>124</sup>

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areas (MPAs) in the United States.”); NAT’L CENTER FOR ECOLOGICAL ANALYSIS & SYNTHESIS, SCIENTIFIC CONSENSUS STATEMENT ON MARINE RESERVES AND MARINE PROTECTED AREAS I (2001), *available at* <http://www.nceas.ucsb.edu/Consensus/consensus.pdf> (“The declining state of the oceans and the collapse of many fisheries have created a critical need for new and more effective management of marine biodiversity, populations of exploited species and overall health of the oceans. Marine reserves are a highly effective but under-appreciated and under-utilized tool that can help alleviate many of these problems.”); PEW OCEANS COMM’N, *supra* note 16, at 34 (“Congress should enact legislation mandating the establishment of a national system of marine reserves . . . .”); Robin Kundis Craig, *Protecting International Marine Biodiversity: International Treaties and National Systems of Marine Protected Areas*, 20 J. LAND USE & ENVTL. L. 333, 360 (2005) (“[S]cientists increasingly recommend marine protected areas (MPAs), marine reserves, and national systems of MPAs and marine reserves as the best means of preserving and restoring marine biodiversity.”); Peter J.S. Jones, *Collective Action Problems Posed by No-take Zones*, 30 MARINE POL’Y 143, 143–44 (2006) (reviewing calls for no-take zones and criticisms of the idea); J. M. Pandolfi et al., *Are U.S. Coral Reefs on the Slippery Slope to Slime?*, 307 SCIENCE 1725, 1726 (2005) (advocating “immediate increase of cumulative no-take areas of all U.S. reefs to >30% [and] reduc[ing] fishing efforts in adjacent areas”); Callum M. Roberts et al., *The Role of Marine Reserves in Achieving Sustainable Fisheries*, 360 PHIL. TRANSACTIONS ROYAL SOC’Y LONDON, SERIES B. 123, 128–30 (2005); Sumaila et al., *supra* note 48, at 306 (urging establishment of marine reserves on high seas); Worm et al., *Impacts of Biodiversity Loss*, *supra* note 93, at 790 (urging creation of marine reserves to avoid predicted collapse of marine fisheries although recognizing other management measures are needed).

119. Sumaila et al., *supra* note 48, at 306 (advocating marine reserves on the high seas).

120. *See supra* note 16 and accompanying text.

121. Sumaila et al., *supra* note 48, at 306.

122. *See, e.g.*, NAT’L RESEARCH COUNCIL, *supra* note 16, at 6 (referring to “[p]roposals to designate 20% of the ocean as marine reserves” and discussing origin of 20% figure); Andrew Balmford et al., *The Worldwide Costs of Marine Protected Areas*, 101 PROCEEDINGS NAT’L ACADEMY SCI. 9694, 9696 (2004) (referring to recent estimates ranging from “10% to >50%” coalescing “around a modal value of ~30%” of share of ocean that would need to be protected (citation omitted)); Sumaila et al., *supra* note 48, at 306 (“In the general context of ecosystem considerations, there are suggestions that at least 20% of a given fishing area or habitat type should be fully protected . . . .”).

123. Sumaila et al., *supra* note 48, at 306; Gjerd, *supra* note 46.

124. *See* James R. Rasband & Megan E. Garrett, *A New Era in Public Land Policy? The Shift Toward Reacquisition of Land and Natural Resources*, 53 ROCKY

One way of understanding the current debate about how to manage wild fisheries is that it is a debate over what policy approach to emphasize going forward—creating marine reserves or individual or communal property rights. Economists, scientists, and community-oriented observers essentially agree that the current framework, under which wild fish are state or common property until they are harvested, has contributed to the decline of wild fish stocks. While each camp campaigns for its favored prescription, thoughtful members of each group recognize that their favored policy prescriptions will not by themselves solve the problems in wild fisheries.<sup>125</sup>

Before turning to the overarching property rights challenge confronting fisheries policymakers in Part III, it is useful to attempt to identify more precisely than the policy debates have to date the range of possible property rights regimes in marine fisheries.

The place to start is with the many different types of property arrangements that property scholarship has identified, usually taking land as the paradigmatic form of property. In addition to the classical triptych of commons, state property, and private property, we have the anti-commons, liberal commons, semicommons, religious property, inherently public property, *res nullius*, *res universitatis*, and open-access, to name just a few.<sup>126</sup> In practice, most property—including land—is held in a mix of ways.<sup>127</sup> While vast amounts of land in the

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MOUNTAIN MIN. L. INST. 11-1 (2007) (describing shift toward retention of federal public lands).

125. See, e.g., Boris Worm et al., *Response to "Biodiversity Loss in the Ocean: How Bad Is It?"*, 316 SCIENCE 1282, 1284 (2007) (emphasizing that they "are not advocating the establishment of MPAs [marine protected areas] as the sole policy solution to resolving the problems of fisheries management"); Beddington et al., *supra* note 53, at 1715 (emphasizing the importance of rights-based instruments for fisheries but arguing that marine protected areas could play a useful role although "they are not a universal solution because . . . protected areas will simply displace [fishing] elsewhere").

126. See, e.g., DANIEL H. COLE, POLLUTION & PROPERTY: COMPARING OWNERSHIP INSTITUTIONS FOR ENVIRONMENTAL PROTECTION 8–14 (2002) (critiquing conventional four-fold typology of "private, common, state and nonproperty (or open access)"); Michael A. Heller, *Three Faces of Private Property*, 79 OR. L. REV. 417, 417 (2000) (critiquing "trilogy of private, commons, and state forms" of property); *id.* at 423–29 (discussing anti-commons and liberal commons); Carol M. Rose, *Left Brain, Right Brain and History in the New Law and Economics of Property*, 79 OR. L. REV. 479, 479–84 (2000) (discussing different categorizations of property, offering a new categorization, and commenting on Heller, *supra* and Peter H. Huang, *Reasons Within Passions: Emotions and Intentions in Property Rights Bargaining*, 79 OR. L. REV. 435 (2000)) [hereinafter Rose, *Left Brain*]; Carol M. Rose, *Romans, Roads, and Romantic Creators: Traditions of Public Property in the Information Age*, 66 LAW & CONTEMP. PROBS. 89 (2003) (discussing *res nullius*, *res communes*, *res publicae*, *res universitatis* and *res divini juris*) [hereinafter Rose, *Romans*]; Henry E. Smith, *Semicommon Property Rights and Scattering in the Open Fields*, 29 J. LEGAL STUD. 131, 131 (2000).

127. See, e.g., COLE, *supra* note 126, at 9 ("Actual property regimes invariably combine features from different ownership categories."); Robert C. Ellickson, *Property in Land*, 102 YALE L.J. 1315, 1397 n.413 (1993) ("Interestingly, both law-and-economics and CLS sympathizers have come to share the view that land regimes inevitably will (and implicitly should) mix private and public elements.").

United States are privately owned, we also have huge chunks of government-owned property (the public lands), corporate property (such as university campuses) and religious property (such as churches). Our mixing of regimes is not unique: aboriginal societies and the Romans, among others, also had complex systems of property law that mixed different forms of ownership.<sup>128</sup>

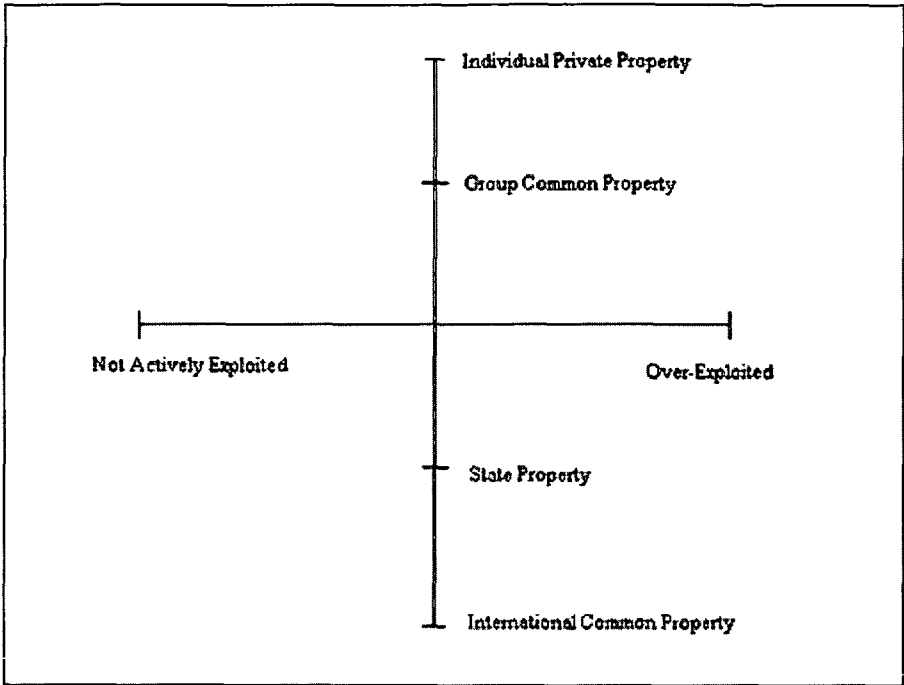
Building very loosely on an effort a few years ago by Carol Rose to make sense of the various typologies, we might think of the different types of property arrangements as falling within four quadrants defined by two lines.<sup>129</sup> The horizontal line measures the level of use of the resource. At one end of the line we have resources that have been used to the point that they are sub-optimally over-exploited. At the other end, we have resources that are not being actively used. This non-use could be economically sub-optimal (maybe because there is the anti-commons problem of too many property holders blocking use) or it could be optimal (maybe because preserving the resource is its most socially valuable use). The vertical line tells us something about who controls the resource. At one end of the line we have the paradigmatic form of individually-owned private property. Moving down the vertical axis, we have forms of property owned by increasingly larger numbers of people through collective entities: from common or communal property (owned by a group and managed perhaps through informal norms), to state-owned property, to international property such as the high seas owned by mankind and managed on our behalf by states (at least in theory).

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128. On property rights in aboriginal societies, see, e.g., Martin J. Bailey, *Approximate Optimality of Aboriginal Property Rights*, 35 J.L. & ECON. 183, 184, 194–95 (1992) (arguing that aboriginal societies had various combinations of property rights and explaining these combinations as economically optimal). On the Romans, see, e.g., Richard A. Epstein, *On the Optimal Mix of Private and Common Property*, in PROPERTY RIGHTS 17, 20, 24, 28 (1994); Rose, *Romans*, *supra* note 126; see also Dean Lueck, *The Economic Nature of Wildlife Law*, 18 J. LEGAL STUD. 291, 291–92, 303–05, 321 (1989) (arguing that wildlife law, although “complicated,” is economically rational in the sense that it maximizes net wealth).

129. I borrow three ideas from Rose, *Left Brain*, *supra* note 126. One is the idea of distinguishing between whether a resource is being used and who owns the resource. *Id.* at 480–81. Second is the idea of aligning types of owners along a vertical axis. *Id.* at 482. Third is the use of a horizontal line to illustrate the spectrum of level of use. *Id.* at 480. Note, however, that Rose’s horizontal line is bounded by the anti-commons (a situation of nonuse) and open access (a situation of overuse). *Id.* at 480–81. Also, Rose vertically graphed the different types of ownership at the optimal level of use on the horizontal line, something which I do not do. *Id.* at 483. Rose emphasized these differences between her scheme and mine when I presented this Article at the Symposium.

Figure 1: Typology of Property Arrangements



We should be able to place any real-world resource somewhere in one of the four quadrants defined by the two lines. By way of example, Figure 2 places a few U.S. fisheries in the quadrants. The Washington State farmed salmon fishery is near the individual property edge of the vertical axis since salmon farms have property rights in the salmon they are harvesting, and they lease sites from the state for pens.<sup>130</sup> The farm fishery is situated midway on the horizontal axis, although there is room to argue about whether current production levels are optimal given the debate about whether we should encourage more or less marine aquaculture.<sup>131</sup> The Alaska halibut fishery is midway between “not actively exploited” and “over-exploited” on the horizontal line since it is probably being optimally exploited.<sup>132</sup> It is near the individual private property edge of the vertical

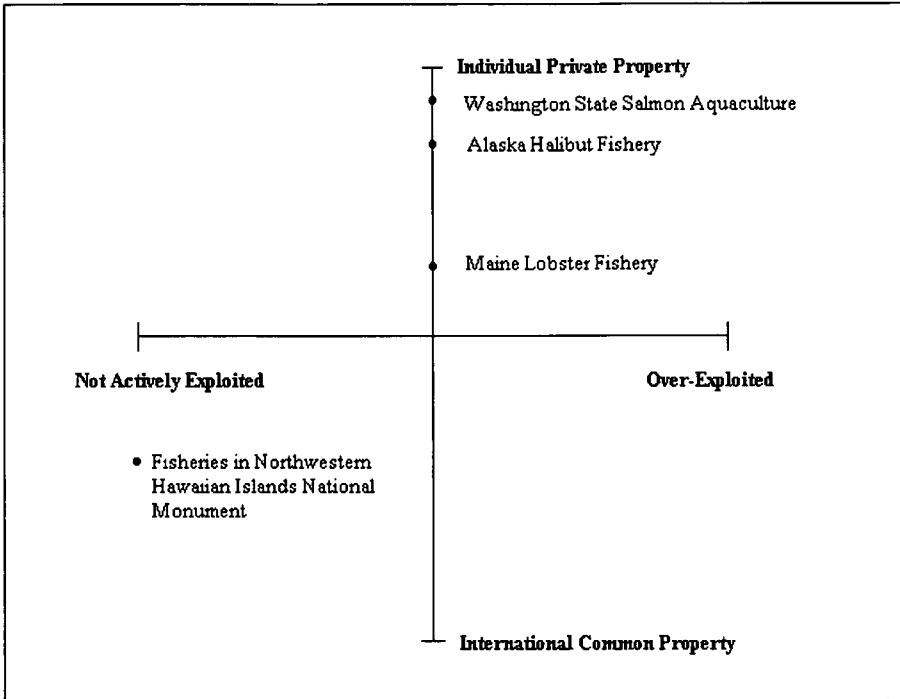
130. See Washington State Department of Natural Resources, Leasing Washington State Aquatic Lands for Aquaculture, [http://www.dnr.wa.gov/BusinessPermits/Topics/ShellfishAquaticLeasing/Pages/aqr\\_aqua\\_leasing\\_aquaculture.aspx](http://www.dnr.wa.gov/BusinessPermits/Topics/ShellfishAquaticLeasing/Pages/aqr_aqua_leasing_aquaculture.aspx) (last visited Mar. 25, 2008) (referring to leases for salmon aquaculture).

131. See Tom Paulson, *Fish Farming Still A Small Industry Here: Effect on Wild Salmon Is a Key Concern*, SEATTLE POST-INTELLIGENCER, May 9, 2007, at A9 (indicating that in Washington State there is only one salmon farming company, which owns only eight marine net pens, and describing concerns about environmental consequences of salmon farming).

132. See NOAA FISHERIES, *supra* note 98, at ST-52 (Table C: Species managed under International Agreements), available at [http://www.nmfs.noaa.gov/sfa/domes\\_fish/StatusofFisheries/2006/2006RTCTablesAB.pdf](http://www.nmfs.noaa.gov/sfa/domes_fish/StatusofFisheries/2006/2006RTCTablesAB.pdf) (indicating that Pacific halibut is not overfished or subject to overfishing).

line because it is harvested using ITQs.<sup>133</sup> The Maine lobster fishery, which also may be exploited at optimal levels,<sup>134</sup> is governed under a common property regime that is gradually evolving into a state-managed regime.<sup>135</sup> The fisheries in the Northwestern Hawaiian Islands Marine National Monument designated by President Bush in 2006 are not actively being exploited (or at least won't be once they are phased out in accordance with the national monument designation).<sup>136</sup>

Figure 2: Application of Typology



The reason I offer this typology is to identify more precisely the potential range of approaches for managing fisheries. In particular, the typology isolates a

133. See HANNESSON, *supra* note 1, at 141–45 (describing history of Alaska halibut and sablefish individual transferable quota programs).

134. See NOAA FISHERIES, *supra* note 98, at ST-53 (Table D: Summary of stock status for species not contained in federal fishery management plans), available at [http://www.nmfs.noaa.gov/sfa/domes\\_fish/StatusoFisheries/2006/2006RTCTablesAB.pdf](http://www.nmfs.noaa.gov/sfa/domes_fish/StatusoFisheries/2006/2006RTCTablesAB.pdf) (indicating that two of three stocks of American Lobster are not overfished or subject to overfishing but that one stock, the southern New England stock, is depleted and being overfished).

135. Acheson & Brewer, *supra* note 40, at 47.

136. See Establishment of the Northwestern Hawaiian Islands Marine National Monument, 71 Fed. Reg. 36,443, 36,447 (June 15, 2006) (banning “[c]ommercial fishing for bottomfish and associated pelagic species . . . within the monument” after five years from the date of the proclamation). Note that in 2007 the reserve was renamed the Papahānaumokuākea Marine National Monument. See Papahānaumokuākea Marine National Monument, *supra* note 16 (citing sources on history of the reserve and renaming).

few possibilities for fisheries discussed in Part III: (1) arrangements in which individual private property predominates and the resource is actively exploited; (2) arrangements in which communal rights predominate and the resource is again actively exploited; and (3) arrangements in which states own the resource and close it to extractive uses including fishing.<sup>137</sup> The typology has limitations, however. For instance, it does not provide a way of differentiating property rights regimes based on the sticks that the rights-holder enjoys, such as exclusivity, durability, or transferability. While the typology differentiates between property rights arrangements in which harvesting is allowed (such as aquaculture and individual transferable quotas) and those in which it is banned (such as marine reserves), it does not differentiate between the rights enjoyed by culturists and individual transferable quota-holders. In particular, it glosses over the distinction between the exclusive right that a culturist has to a stock of fish and the right that a quota holder has to a share of the flow of a fishery by owning a percentage of the total allowable catch. Even so, the typology is useful because it allows us to identify many of the possible property rights arrangements in fisheries.

### III. THE OPTIMIZATION PROBLEM

The major challenge confronting fisheries policymakers today is to define the optimal arrangement of property rights in marine fisheries, taking into account the rise of aquaculture and the status of wild fisheries discussed in Part I and the various possible types of property rights regimes examined in Part II. But what exactly is the optimal arrangement of property rights? My goal in this Part is to suggest the contours of the optimization problem that fisheries policymakers face, rather than to solve that problem. Indeed, I am skeptical that there is a single solution. As I argue below, economic theories of property rights suggest that the optimal arrangement of property rights in marine fisheries is likely a mix of the different property regimes identified in Part II, with the elements of the mix varying for different fisheries.<sup>138</sup>

#### *A. What should we optimize in defining property rights in fisheries?*

Once we recognize that designing property rights in marine fisheries is an optimization problem susceptible to economic modeling, we must consider what we want to optimize in designing property rights in these fisheries.

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137. For clarity, the use of a graph to illustrate the typology is not meant to suggest or deny any particular relationship between the degree of exploitation of a resource and individual or collective ownership. For instance, it is possible that the identity of the rights-holder (the vertical axis) is partly a consequence of the degree of exploitation (on the horizontal axis). It is also possible that the identity of the rights-holder (on the vertical axis) might affect the degree of exploitation (on the horizontal axis). For example, a fishery could be privatized because it is exploited, because demand for a resource induces the creation of property rights. The same fishery also could be exploited at the optimal level because it is privately owned by actors with an economic stake in its future.

138. Epstein, *supra* note 128, at 22, 30; see also Carol M. Rose, *Rethinking Environmental Controls: Management Strategies For Common Resources*, 1991 DUKE L.J. 1, 2 (arguing that there is no "absolute 'best' or least-cost approach" for managing environmental resources).



The proper objectives for fisheries policy have been a source of contention for years.<sup>139</sup> Should we be trying to maximize employment in the fisheries sector, with the attendant costs that this may impose on the marine environment in the form of depleted wild fish stocks and pollution from fish farms?<sup>140</sup> Or should the goal be the biological one of maximum sustainable yield?<sup>141</sup> Alternatively, our objective might be the environmental one of protecting the sea and its resources from exploitation, which could entail an outright ban on aquaculture and wild fishing.<sup>142</sup> Politicians and regulators might favor a fourth goal: minimizing social conflict to achieve what has been called the ““minimum sustainable whinge”” from fisheries interest groups.<sup>143</sup>

I argue that we should be trying to design the property rights arrangement that will produce the greatest net benefits from a societal perspective. This is the standard starting point for normative economic analysis of property rights.<sup>144</sup> It also could be highly protective of the environment, notwithstanding the tendency to assume that maximizing economic gains is in tension with environmental protection. A recent article in *Science* emphasizes the potential for maximizing economic gains to yield better environmental outcomes than maximizing biological yields.<sup>145</sup> Economists Quentin Grafton and Tom Kompas and scientist Ray Hilborn argue that, under reasonable assumptions, setting the allowable catch at the level that will produce the largest discounted profits will leave more fish in the ocean than establishing the catch level at maximum sustainable yield. The reason is that fishing is more profitable when fisheries are more abundant.<sup>146</sup>

139. I agree with Ray Hilborn that “[t]here are four major categories of fisheries’ objectives: biological, economic, social and political.” Hilborn, *supra* note 12, at 153.

140. See *id.* (referring to “maximum job yield” as a potential objective for fisheries policy and arguing that “[e]mployment in harvesting will be maximized at the highest possible sustainable exploitation rates”).

141. *Id.* (referring in passing to maximum sustainable yield’s “long and controversial history within fisheries science”).

142. *Id.* at 153–54 (“[E]cosystem preservation will be maximized by zero exploitation . . .”); *id.* at 155 (indicating that ENGOs have different objectives for fisheries but observing that “there is a strong group of environmental NGOs whose objectives are ecosystem and species protection,” which are goals that “are clearly in conflict with maximum biological utilization”).

143. *Id.* at 153 (attributing the term to J.G. Pope, *Fisheries Resource Management Theory and Practice*, in NEW ZEALAND FINFISH FISHERIES: THE RESOURCES AND THEIR MANAGEMENT 56 (J.L. Taylor & G.G. Baird eds., 1983)); *id.* at 154 (discussing the objectives of fisheries managers).

144. See, e.g., Epstein, *supra* note 128, at 20 (“[A]ny responsible search for a sound system of property rights searches for the net social advantage by minimizing the sum of the rival inconveniences.”).

145. R. Q. Grafton et al., *Economics of Overexploitation Revisited*, 318 SCIENCE 1601 (2007).

146. *Id.* at 1601; see also Hilborn, *supra* note 12, at 154 (“[E]conomic profits . . . will usually be maximized by holding stocks at levels as high or higher than biological maximization . . .”); *id.* at 157 (arguing that “environmental protection and economic rationalization . . . have a great deal in common” although they “may seem to come from greatly differing philosophical perspectives”).

“Conservation,” they emphasize, “promotes both larger fish stocks and higher profits.”<sup>147</sup>

Maximizing net benefits from a societal perspective entails a variety of choices. For instance, we must decide how much fish to harvest—the “MAXLEVEL,” to borrow a term from Carol Rose.<sup>148</sup> Then, we have to decide how to produce that desired harvest level. Should we rely more on aquaculture and less on wild fish, taking into account the costs and benefits of both approaches? Notably, notwithstanding the environmental concerns with aquaculture, there are arguments that “per hectare of water-space aquaculture generally provides more economic wealth than capture fisheries.”<sup>149</sup> Assuming we settle on some mix of farmed and wild fish, how should we structure the extraction of these two sources of fish? As discussed earlier, economists typically argue that private property rights are the lowest-cost method of achieving a desired level of harvesting.<sup>150</sup> But the economic arguments for private property rights often leave unanswered many questions about how private rights should be designed to maximize net benefits. For example, assuming we decide to allow some aquaculture in U.S. federal waters, we will have to structure the rights of culturists. Structuring these rights will require determining whether to grant culturists full ownership rights or merely leases. If leases are granted (as seems likely), we must then determine their duration and whether and how lessees will pay the federal government for the lease rights and environmental costs of fish farming.<sup>151</sup> Fisheries regulators already have considerable experience designing individual rights in wild fisheries because of the longstanding existence of TURFs and the recent introduction of ITQs. In reauthorizing the Magnuson–Stevens Act in 2006, however, Congress legislated new provisions that will affect the design of individual rights granted in wild fisheries in the future.<sup>152</sup>

The policy choices that must be made about how much fish to harvest and how to harvest them are not independent: how many fish we decide to harvest may influence which harvesting method is least-cost. For example, the more fish we decide to harvest, the greater the justification may be for investing in an administratively costlier property rights arrangement in order to address the higher external costs of harvesting. Similarly, the choice of the least-cost method of

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147. Grafton et al., *supra* note 145, at 1601. Grafton et al.’s argument echoes a longstanding theme among fisheries economists that focusing on economic objectives will protect the environment. See, e.g., FRANCIS T. CHRISTY, JR. & ANTHONY SCOTT, *THE COMMON WEALTH IN OCEAN FISHERIES: SOME PROBLEMS OF GROWTH AND ECONOMIC ALLOCATION* 236 n.3 (1965) (arguing that fisheries policy should promote “economic efficiency” and then noting that “[t]he reader should bear in mind that economic efficiency is not antithetical to conservation”).

148. Rose, *supra* note 138, at 7 n.18 (referring to the “exploitation level” as the MAXLEVEL).

149. Gibbs, *supra* note 32, at 114 (citing Hoagland et al., *supra* note 17).

150. *Supra* note 110 and accompanying text.

151. These and other issues are addressed in the Bush Administration’s proposed National Offshore Aquaculture Act of 2007, H.R. 2010, 110th Cong., available at [http://aquaculture.noaa.gov/pdf/06\\_whole07act.pdf](http://aquaculture.noaa.gov/pdf/06_whole07act.pdf). For criticism of the proposed legislation, see Eichenberg Testimony, *supra* note 73.

152. See 16 U.S.C. § 1853a (2006) (limited access privilege programs).

structuring harvesting may affect our choice of how much fish to harvest. For instance, choosing the least-cost method might allow us to conservatively limit the allowable harvest because fewer fish will need to be harvested for the fisheries to be profitable.

The reality is that we almost certainly lack the resources—and probably the political will—to actually design property rights in marine fisheries that will be economically optimal in the near-term, let alone the long-term. Changes in tastes and preferences, new information, and technological developments mean that optimal harvest levels and methods will change over time. Already there are indications that the ITQs that have benefited many wild fisheries also have had the unintended consequence of hindering the establishment of new and now more valuable uses of the oceans than wild fishing, such as marine reserves, aquaculture, and wind farms.<sup>153</sup> The best that we can probably hope to do in fisheries is to design property rights keeping in mind the advantages of maximizing net benefits in the present and going forward. The difficulties entailed in designing optimal property rights inevitably will require us to take analytical shortcuts and make compromises along the way. Furthermore, we should expect that different countries, and regions within individual countries, will make different choices, due to heterogeneous preferences and environmental conditions, among other factors.

### ***B. Factors influencing optimality***

In the past several decades economic analysts of property rights have emphasized that there is no single optimal arrangement of property rights for all times and places. Instead, different arrangements are best for different times and places, depending on a range of factors. Four of the factors that influence which arrangement is best for a particular time and place are the level of demand for a resource, the externalities from resource use, the prospects for realizing economies of scale, and administrative costs. Below I discuss the implications of these four factors for the design of property rights in fisheries. It will be important for fisheries policymakers to keep in mind these and other determinants of optimality as they tailor property rights to address the distinct conditions in individual fisheries.

#### *1. Demand for the resource*

Perhaps the most basic lesson of economic theorizing about property rights is that the optimal arrangement of property rights is partly a function of the level of the demand for the relevant resource. One of the central insights of Harold Demsetz's classic article on the evolution of property rights is that an increase in demand for a resource, triggered for example by the emergence of a new market or a rise in population, could justify shifting from communal to private property holding other factors constant, because the greater pressure on the resource would give rise to higher external costs.<sup>154</sup>

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153. See, e.g., Gibbs, *supra* note 32, at 113–16 (describing some of the “[l]esser-known consequences” of New Zealand’s highly successful ITQ system).

154. Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347, 350 (1967).

Turning to fisheries, the increase in the demand for seafood due to factors such as worldwide population increases and changes in consumer preferences likely justifies the spread of private property rights occurring in wild fisheries.<sup>155</sup> The increase in demand has put greater stress on wild fisheries, contributing to their depletion and harming the marine environment generally,<sup>156</sup> and this higher level of pressure likely justifies creating private rights in wild fish to internalize some of these negative externalities. The higher pressure on wild fish stocks also might justify the spread of aquaculture to the extent that the negative externalities of fish farming, such as harm to wild fish and water pollution, do not overwhelm the benefits that come from reducing wild fishing.

It is also worth considering, however, that rising demand for a resource might not only justify changing the identity of the rights-holder from communities to individuals, and the sticks in the rights-holder's bundle, but also reducing the degree of resource exploitation. As demand for exploiting the resource rises, demand also may increase for preserving the resource in an unused state.<sup>157</sup> If the demand for preservation is high, satisfying this demand by restricting exploitation might produce larger economic benefits than exploiting the resource. Turning again to fisheries, as wild fisheries have been depleted we have seen an increase in proposals to protect them from exploitation by establishing state-owned marine reserves.<sup>158</sup> Indeed as mentioned above, in 2006 President Bush established the Northwestern Hawaiian Islands Marine National Monument, a marine reserve that is the largest nature reserve in the world.<sup>159</sup> Reserves like this one might be justified in economic terms if people place a higher value on preserving fish in the sea than eating the fish.

## 2. Externalities

A second factor widely regarded as influencing which arrangement of property rights is optimal is which arrangement generates the optimal level of negative externalities.<sup>160</sup> Wild fishing generates many negative externalities.<sup>161</sup>

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155. On rising demand for fish, see FAO, *supra* note 44, at 40 (discussing demand for fish in developed and developing countries); NOAA, *supra* note 88, at 11 (discussing rising fish consumption in U.S.).

156. On the reasons for the rising demand for fish, see FAO, *supra* note 44, at 40; NOAA, *supra* note 88, at 11. On the current state of wild fish stocks, see *supra* notes 89–96 and accompanying text.

157. For example, James R. Rasband and Megan E. Garrett argue in a recent paper that there has been a shift toward public reacquisition of land since the passage of the Wilderness Act in 1964 due to increasing public interest in using land for recreation and preservationist purposes. Rasband & Garrett, *supra* note 124.

158. See *supra* note 118 (listing sources in which scientists and ENGOs call for creating marine reserves).

159. See *supra* notes 16 and 136 (discussing the Northwestern Hawaiian Islands Marine National Monument, which was renamed the Papahānaumokuākea Marine National Monument in 2007).

160. See Demsetz, *supra* note 154, at 348 (“A primary function of property rights is that of guiding incentives to achieve a greater internalization of externalities.”).

Every fish that is harvested means there is one less fish in the sea for others to catch and to help reproduce the fish population. Wild fisheries harm the broader marine environment by removing fish that are prey for other species and disturbing marine habitat. Aquaculture also has many negative side-effects. As mentioned above, farmed fish may eat wild fish and thereby deplete wild stocks.<sup>162</sup> Farmed fish may interbreed with wild fish and transmit parasites to them. Discharges from aquaculture operations pollute the marine environment.

In fisheries, our ultimate—but likely unrealizable, for practical and political reasons<sup>163</sup>—objective should be to design the property rights arrangement that generates the optimal level of negative externalities. That would be the arrangement that strikes an appropriate balance between the negative consequences of wild fisheries and aquaculture, and the benefits that humans derive from capture fisheries and fish farming, such as food and income.

Economic analysis of property rights often suggests that private property rights will generate the optimal level of negative externalities because private property owners internalize the costs and the benefits of their conduct.<sup>164</sup> In practice, though, private property rights may not deal with all the negative externalities that should be addressed. Externalities operate on various spatial and time scales.<sup>165</sup> Private property is most likely to internalize small-scale externalities that impose costs felt close in time and space.<sup>166</sup> Properly designed and implemented private property rights in fisheries, such as aquaculture leases or ITQs, will induce rights-holders to consider the costs of harvesting one unit of the fish caught today for the future availability of fish tomorrow. That is because property-rights holders face a price for harvesting a fish today: harvesting the fish means there is less available to harvest tomorrow. Private rights are likely to be less successful in getting rights-holders to take into account the broader impacts of their activities on other fisheries or marine habitats generally, unless the value of the rights is affected by these broader impacts.<sup>167</sup> Thus culturists in many parts of

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161. Garrett Hardin alluded to these externalities as an example of the tragedy of the commons. Garrett Hardin, *The Tragedy of the Commons*, 162 *SCIENCE* 1243, 1245 (1968).

162. See *supra* notes 70 and 78–82.

163. See *supra* text accompanying note 153.

164. See, e.g., Demsetz, *supra* note 154, at 348, 350.

165. Ellickson, *supra* note 127, at 1325 (distinguishing between small, medium, and large events).

166. *Id.* at 1331 (private property preferable “for activities that result in mostly small and medium events”).

167. See, e.g., Elliot A. Norse, *Ending the Range Wars on the Last Frontier: Zoning the Sea*, in *MARINE CONSERVATION BIOLOGY: THE SCIENCE OF MAINTAINING THE SEA'S BIODIVERSITY*, *supra* note 14, at 422, 430 (“IFQs [individual fishing quotas] address some important problems concerning commercial fishing but do not address a host of others. When used alone they do not necessarily conserve marine biodiversity, improve the situation of other user groups, or even maintain fisheries.”); Grafton et al., *supra* note 107, at 705–06 (arguing that fishing’s impact on the marine environment justifies public oversight even after individual rights are established because fishers will not protect this environment if it does not affect the value of their harvesting rights); Amy Sinden, *The Tragedy of the Commons and the Myth of a Private Property Solution*, 78 *U. COLO. L. REV.*

the world are criticized for polluting the marine environment to the detriment of the wild fish near fish farms, other marine wildlife, and humans who also are attempting to use the waters where farming is taking place.<sup>168</sup> Similarly, ITQ holders in wild fisheries are criticized for focusing only on the condition of the stocks to which they hold quotas, and neglecting the implications of their fishing for other species, such as stellar sea lions in Alaska.<sup>169</sup> Remaining externalities almost certainly justify some continuing government oversight of wild fisheries and aquaculture even after property rights are allocated.

Marine reserves are another tool that could complement individual rights and government regulation of fishing to mitigate the broader social costs of wild fishing and aquaculture. Indeed the proponents of marine reserves often emphasize the positive externalities that they promise for wild fisheries and the marine environment generally, both within and outside reserve borders.<sup>170</sup> But marine reserves must be of a sufficiently large scale to offset the deleterious consequences of wild fishing and aquaculture. Moreover, large reserves generate their own negative externalities. For example, large marine reserves restrict the areas open for fishing, thereby harming fishers and people who depend on wild fisheries for food and income.<sup>171</sup> Reserving certain areas of the oceans also might displace fisheries and their attendant environmental harms to other areas.<sup>172</sup> The point is that marine reserves, like other types of property rights, may address the externalities that fisheries generate, but reserves also have their own limitations.

### 3. *Economies of scale*

A third factor to consider in attempting to design optimal property rights arrangements is the potential for different arrangements to give rise to economies of scale.

Carol Rose argues that waterways and roads historically have been considered public property—by which she means property open to all that is

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533, 602 (2007) (arguing that “there are so many wide-ranging and overlapping externalities associated with the use of ocean resources that a scheme of private property boundaries that successfully internalizes all of them is difficult, if not impossible, to imagine”).

168. See *supra* notes 78–81 and accompanying text.

169. See, e.g., *MSC Clears Alaska Pollock Certification*, 24:5 SEAFOOD BUSINESS, May 1, 2005, at 4 (reporting that Marine Stewardship Council certified Gulf of Alaska pollock fishery even though environmentalists argued “fish managers were not being conservative enough in protecting endangered Stellar sea lions”).

170. See, e.g., NAT’L RESEARCH COUNCIL, *supra* note 16, at 1 (referring to the benefits of protecting areas of the oceans “for conserving the ocean’s living assets”); Sumaila et al., *supra* note 48, at 308 (discussing benefits of marine reserves on high seas).

171. One distributional point that counts in favor of closing portions of the high seas is that most of the boats that would be displaced are from developed rather than developing countries. According to one source, over “95% of the reported high seas bottom trawl catch in 2001” was harvested by “fishing vessels flagged by 13, mostly rich countries.” Sumaila et al., *supra* note 48, at 308.

172. See, e.g., Beddington et al., *supra* note 53, at 1715 (arguing that marine protected areas “are not a universal solution because . . . protected areas will simply displace [fishing] elsewhere”).

regulated through norms<sup>173</sup>—because leaving them in this state produces economies of scale. Everyone benefits from leaving open channels of commerce, such as roads and waterways, because it facilitates trade and commerce.<sup>174</sup> Private property arrangements also may create opportunities to realize economies of scale in production. For instance, freely tradable individual transferable quotas allow efficient wild fishers to buy out their less efficient colleagues, and to improve profitability by consolidating harvesting in a smaller number of vessels.<sup>175</sup>

We also might establish marine reserves to benefit from economies of scale in the production of conservation. The proponents of marine reserves often suggest larger reserves are more beneficial than small reserves, and that networks of reserves are more desirable than isolated reserves. The idea is that protecting fisheries and marine habitats on larger scales will produce greater per-unit environmental benefits than protection on a smaller scale. There also is empirical evidence that the per-unit cost of managing larger marine reserves is lower than the per-unit cost of managing smaller reserves.<sup>176</sup>

#### 4. Administrative costs of property rights

The costs of establishing, complying with, and enforcing different property rights arrangements must be set against the benefits they produce, such as fewer negative externalities.

Holding the level of resource use constant, the number of parties that must be regulated and the ease of monitoring them may affect the relative desirability of different property rights regimes. For instance, communal property arrangements may be administratively optimal if the resource users are readily identifiable and small in number because small numbers of easily identifiable users may be able to readily parcel the resource and to police the resultant parcelization.<sup>177</sup> Private property may be cheaper to administer than communal

173. Carol Rose, *The Comedy of the Commons: Custom, Commerce, and Inherently Public Property*, 53 U. CHI. L. REV. 711, 745 (1986); Rose, *Romans*, *supra* note 126, at 99.

174. Rose, *supra* note 173, at 723 (“[S]ervice to commerce was a central factor in defining as ‘public’ such properties as roads and waterways. Used in commerce, some property had qualities akin to infinite ‘returns to scale.’ Thus here, the commons was not tragic, but comedic, in the classical sense of a story with a happy outcome.”); *see also* Rose, *Romans*, *supra* note 126, at 97–98 (attributing the “‘publicness’ of travel lanes” to network effects).

175. *See, e.g.*, Gibbs, *supra* note 32, at 113 (discussing “the rationalisation or aggregation of fishers and vessels” in New Zealand under individual transferable quotas). The salmon cooperative that Robert Deacon et al. discusses in an Article in this Symposium also allowed its members to reap the benefits of consolidating harvesting in the hands of the most efficient fishers. *See generally* Deacon et al., *supra* note 42.

176. Balmford et al., *supra* note 122, at 9695 (“[P]er unit area, bigger MPAs [marine protected areas] cost substantially less to run . . .”).

177. Hentrich & Salomon, *supra* note 9, at 716 (“If a TURF system is managed by a group of fishers (GRF) within a specific marine region, the relatively small size of the group can limit the costs of monitoring and ease the resolution of potential conflicts regarding stock use.”); Ray Hilborn et al., *Institutions, Incentives and the Future of Fisheries*, 360 PHIL. TRANSACTIONS ROYAL SOC’Y LONDON, SERIES B. 47, 55 (2005) (“The

property at the same level of resource use if there are many resource users and they cannot easily monitor each other because they are geographically dispersed. Establishing a private property regime entails physically parceling the resource into individual holdings<sup>178</sup> and initially assigning the rights to individuals, which is likely to be politically contentious.<sup>179</sup> But the higher costs involved in establishing a private property regime compared with a communal regime may be offset by the lower enforcement costs in a regime where individual holdings are clearly defined, and the higher revenues from the trade that individual holdings facilitate.

The existing regulatory infrastructure also may affect the costs of different property rights regimes. Private property rights in wild fisheries may be cheaper to implement in jurisdictions such as developed countries where there are already vast systems of private rights in many other resources, and administrative bureaucracies and courts accustomed to enforcing these rights. In developing countries, there may be an argument for retaining some existing forms of communal rights in wild fisheries if there is not much history of administering private property or norms are not compatible with private property.<sup>180</sup>

Marine reserves may be costly to establish and enforce in developed and developing countries. Reserves are often difficult to establish because they entail closing off areas of the ocean to fishing and other extractive activities. Closing off areas can be at least as contentious as dividing up access to a resource among individuals. For example, a *New York Times* article describing the background to President Bush's 2006 designation of the Northwestern Hawaiian Islands Marine National Monument recounts that it took him and President Clinton "eight years to upgrade the areas into a reserve." According to the article, "[t]he main obstacle was a tiny, marginally profitable fishing fleet composed of eight boats and employing fewer than 20 people, most of them part-time, but vigorously defended by a powerful senator and an entrenched federal bureaucracy."<sup>181</sup> There are also ongoing costs associated with marine reserves after they are established. Reserves may have opportunity costs, such as lost revenues from fishing.<sup>182</sup> Reserves also may be costly to manage.<sup>183</sup> Their boundaries must be policed, and it may be necessary to undertake measures in areas bordering reserves to protect the areas inside them.<sup>184</sup>

The overall point is that configuring property rights in marine fisheries to accommodate the rise of aquaculture and the depletion of wild fisheries will be a

successful cooperatives in the US west coast have involved small fishing groups; the two groundfish cooperatives have less than a dozen companies, while the Chignik cooperative has 70 members.").

178. Rose, *supra* note 138, at 21.

179. See LIBECAP, *supra* note 9, at 74–75, 80–86 (discussing political obstacles to contracting for property rights in fisheries).

180. See generally Daniel Fitzpatrick, *Evolution and Chaos in Property Rights Systems: The Third World Tragedy of Contested Access*, 115 YALE L.J. 996 (2006).

181. Pala, *supra* note 16, at F3.

182. Balmford et al., *supra* note 122, at 9697.

183. See generally *id.* (examining factors influencing costs of managing marine protected areas).

184. *Id.* at 9696–97.



balancing act. Policymakers will have to weigh many factors even if they proceed on the basis that the goal is to create the economically optimal arrangement of property rights. These include the level of demand for fisheries, the externalities from wild fishing and farming, economies of scale, and administrative costs. Complicating matters, analyzing these factors is unlikely to suggest a simple optimal arrangement that can be formulaically applied to many different fisheries in many different places. Variation is likely to be the order of the day, with policymakers adopting many permutations of the individual, communal, and state property arrangements discussed in Part II.

### CONCLUSION

Early economic analysis of property rights drew heavily on problems in fisheries. As Gary Libecap once explained, “[t]he classic articles outlining common pool problems . . . are built around open access fisheries.”<sup>185</sup> In this Article, I have attempted to use the economic analysis of property rights that problems in fisheries helped to spawn to characterize the property rights challenge facing contemporary fisheries policymakers. One of the most important lessons economic theorizing about property rights teaches is that the optimal arrangement of property rights depends heavily on the context. Today, fisheries policymakers around the world confront several broad trends, chief among them is the leveling off of wild fish catches and the prospect that farmed fish may supplant wild fish as the main source of fish for human consumption, much like cattle supplanted bison in nineteenth century America.<sup>186</sup> Given the similarities in the problems confronting policymakers, it is tempting to think that they should adopt similar policy responses. But economic theories of property rights suggest just the opposite. Rather than expecting—and counseling—the same solutions the world over, we should be striving to implement contextually appropriate combinations of the many conceivable types of property arrangements.

While it is difficult to get many people worked up about the future of fish, there is much greater awareness today than there was a decade or two ago about the decline of wild fisheries and the rise of farmed ones. One illustration of this heightened awareness is food writer Michael Pollan’s advice about eating fish in his most recent book *In Defense of Food*. The book’s main argument is that people should “[e]at food. Not too much. Mostly plants.”<sup>187</sup> As for fish, Pollan argues for eating wild fish over farmed fish because wild fish “generally have higher levels of omega-3s” but he is hesitant to recommend eating many wild fish because many species are endangered.<sup>188</sup> The more people come to share Pollan’s concerns about fish, the more likely it is that fisheries policymakers will be forced to confront the contemporary property rights challenge in marine fisheries analyzed in this Article.

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185. LIBECAP, *supra* note 9, at 12.

186. See, e.g., Dean Lueck, *The Extermination and Conservation of the American Bison*, 31 J. LEGAL STUD. 609, 639–44 (2002) (explaining the replacement of bison with cattle).

187. MICHAEL POLLAN, *IN DEFENSE OF FOOD: AN EATER’S MANIFESTO* 1 (2008).

188. *Id.* at 171.

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