NBER WORKING PAPER SERIES

VARIATION IN STATE RESPONSE TO OPEN ACCESS: CONSTITUENT CHARACTERISTICS

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Working Paper 32021
http://www.nber.org/papers/w32021

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
January 2024

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NBER Working Paper No. 32021
January 2024
JEL No. D72,H41,K11,K32,N51,P14,Q15,Q22,Q28,Q32,Q38

ABSTRACT

Open access, competitive exploitation can be incredibly damaging to valuable resources and the human populations that depend upon them. Even though wealth, resource rents and stocks are at stake, open access often seems to be ineffectively addressed across time and space. Institutions vary. Devising and assigning access and use rights of some type privately or within a group, recognized by the state, is the most straightforward way of confronting the problem. Alternatively, regulation can be implemented that involves limiting entry, assigning input and related capital controls, restricting exploitation times, and/or setting output restrictions. Across three settings, hard-rock minerals, oil and gas deposits, and fisheries, I outline institutional differences and provide hypotheses as to why they occur. The open-access problem is described and followed by discussion of the political economy of regulation. Variation in industry structure, resource characteristics and value, as well as heterogeneity of interests in combating open access determine outcomes. The cases are drawn from the US, but may be representative of general patterns.

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But still another inquiry remains; one often agitated by the more recondite Nantucketers. Whether, owning to the almost omniscient look-outs at the mast-heads of the whaleships, now penetrating even Behring's straits, and into the remotest secret drawers and lockers of the world; and the thousand harpoons and lances darted along all continental coasts, and so remorseless a havoc; whether he must at last be exterminated from the waters, and the last whale, like the last man, smoke his last pipe and then himself evaporate in the final puff." (Melville, Moby Dick, 1922, 425).[1]

1. INTRODUCTION

The passage from Herman Melville's 1851 novel, *Moby Dick*, describes the global race to exploit the enormous, rich whale stocks that roamed the world's oceans. Whales were *open-access* resources, subject to intense competitive exploitation. They provided valuable oil, baleen, and ambergris. Prior to electricity, candles from whale-oil wax and whale-oil lamps were the most sought-after sources of illumination. A single large whale could yield up to 120 barrels of oil, and they were harvested in the tens of thousands by whaling vessel crews annually over the 19th and early 20th centuries. By the 1930s competitive slaughter had depleted once seemingly inexhaustible whale populations, driving up costs, lowering catches and returns. Moreover, petroleum had displaced whale oil in most markets. The industry and whaling ports like Nantucket and Martha´s Vineyard, fell into economic decline.

This competitive "race to fish" illustrates the *Tragedy of the Commons* (Hardin 1968) and the economic and social losses inherent in it. With open access and no constraints on entry, whales were harvested at a rate and to a level far beyond that which would have maximized economic returns. Had whales been "owned" in some manner, whaling would have been curtailed (not halted) far sooner. Stocks would not have been so depleted, and economic losses would have been reduced, and indeed, some whaling would have continued at a diminished rate from some ports. There would have been efforts to conserve the stock and to explore new markets.

As indicated in this case, open access, competitive exploitation can be incredibly damaging to valuable resources and the human populations that depend upon them. Even though wealth, resource rents and stocks are at stake, open access often seems to be ineffectively addressed across time and space. Devising and assigning access and use rights of some type privately or within a group, recognized by the state, is the most straightforward way of confronting the problem (Scott 1955). Informal controls are observed for many local common-property resources when the resource is of limited value and the costs of restricting entry are low as argued by Ostrom (1990) and Schlager and Ostrom (1992). Local group

[1] I am grateful to Jim Smith who brought this passage to my attention. I also thank the editors Mary Shirley and Claude Menard for their helpful comments.

arrangements, however, may not easily scale up when the resource is very valuable and large, the parties are numerous and heterogeneous, and new entry remains feasible (Cox et al 2010). Under these circumstances, more formal individual property rights or regulatory controls that rely upon the police power of the state are more effective in addressing open access.

Effective mitigation of common-pool losses requires a property right of some type—the granting, recognition, or refining of group rights or tradable, durable private rights (Arnason 2007). If comprehensive, property rights internalize benefits and costs in exploitation and eliminate externalities (Cheung 1970). Alternatively, regulation can be implemented that involves limiting entry, assigning input and related capital controls, restricting exploitation times, and/or setting output restrictions that may include issuing short-term use privileges. Depending on its structure, regulation may or may not sufficiently internalize net benefits in private entry and production to avoid a race to exploit. It still may be a second-best improvement over pure open access (Homans and Wilen 1997).

With all government responses, there are distributional consequences. Whether through the assignment of private property rights, enforcement of common property, or imposition of state controls, effective remedies to open access require that some parties be denied. Political reaction to distributional outcomes inherent in open-access restrictions involves mobilization of lobby groups. Competition among these groups focuses on limiting common-pool losses and distributing the associated costs and benefits. Politicians react to and depend upon the support of key constituents and the regulatory bureaucracy requires the backing of political mentors and outside parties for mandates and budget authorizations. What on the surface might be viewed as a public-good response to open access, underneath is molded by competing lobbying interests, political objectives, and constraints (Stigler 1971, 1975; Peltzman 1976; Karpoff 1987).

For these reasons, an understanding of government regulation of common-pool resources requires examining the composition and organization of constituents and their desired political actions. This information, in turn, provides background for assessing how observed regulations come about and why they take the forms that they do—even those that appear on their face to be inefficient. Welfare conclusions, however, require caution because the transaction costs of lobbying and political responses are real and minimizing those costs along with open-access losses must be considered in aggregate assessments.

This paper outlines institutional differences and provides hypotheses as to why they occur. The open-access problem is described and followed by discussion of the political economy of regulation. Three cases are presented to illustrate how variation in industry structure, resource characteristics, and heterogeneity of interests in combating open access determine outcomes.

The empirical cases examined here are drawn from the US, but likely are representative of general patterns. The cases begin with US mineral rights where the potentially harmed industry was uniform in seeking remedies, there were no competing outside interests, and representatives turned to the state for refinement of privately-negotiated individual mineral rights. Open-access losses were minimal, the legal property rights arrangements adopted

persisted, and the mining economy expanded. Indeed, the US produced more under the observed secure property rights regime than its resource endowments alone might have predicted (David and Wright 1997).

A second case involves US oil and gas producers, who also faced severe common-pool costs. The industry, however, was more heterogeneous among large and small producers, the nature of their holdings (oil or natural gas), and the losses they faced. Some parties benefitted from open access or were disproportionately harmed by proposed solutions. Distributional differences across firms created conflicting incentives for addressing the open-access problem. These differences, in turn, affected the formation of cohesive lobby groups and regulatory responses from politicians and agency officials. With competition among lobby groups, regulations were delayed and took forms to mitigate both distributional concerns and open-access losses. These combined objectives led to regulatory regimes that seem inexplicable without detailed examination of industry, political, and bureaucratic positions. Ultimately open access was addressed in a complex fashion, the industry expanded with limits on production spillovers across producers, and overall, there were aggregate net economic gains.

The third case involves US fisheries, where the affected parties and resource stocks have been far more fragmented than in the other cases, leading to differential positions on various property rights/regulatory options. Moreover, fisheries have been viewed broadly as public resources or common property, raising the political transaction costs of assigning well-defined private property rights where they might have been useful (Allen 2000). Regulatory agency officials and outside parties aligned with them have played an integral role not found in mining or oil and gas. Lobbyists from small and large fishers, sports and commercial fishing groups, their suppliers, processors, and marketers, as well as marine biologists, other academics, and consultants have sought potentially competing arrangements. While more formal property rights in fisheries were implemented in New Zealand and Iceland, in the US comparatively weaker use rights were adopted slowly and in a more limited manner across fisheries. Further, the eight US regional fishery management councils that draft and administer management plans are composed of multiple voting and nonvoting members. These include federal and state regulatory agents and other government officials, as well as those nominated by state governors, drawn generally from industry, academics, and environmental NGOs.

Although the statutory aim of US fishery laws was collaboratory management, such a heterogeneous mix has made common-pool regulation more political, costly, and uncertain than it might have been. Moreover, when fisheries are treated as a public resource, rather than primarily as an economic one, biological objectives, such as maximum sustainable yield, rather than maximum economic yield, become regulatory objectives. When biological objectives dominate economic goals, open-access fishery controls will not necessarily be consistent with economic efficiency or wealth maximization.[2]

[2] As described below, one political and academic aim of fishery management that has raised the transaction costs (Allen 2000) of assigning property rights for more effective fishery management has been the effort to protect small fishing communities from industry consolidation and competition from fishers with greater access to capital, larger vessels, and reduced labor requirements. This "equity" problem also exists in agriculture and elsewhere in the economy as economies of scale, price shifts, and new technologies change the location and nature of production. Moreover, excess entry and over capitalization in the industry means that effective open-access controls require reduction in labor and capital inputs, all of which impacts fishing communities.

2. THE TRAGEDY OF THE COMMONS, AND THE ROLE OF THE STATE

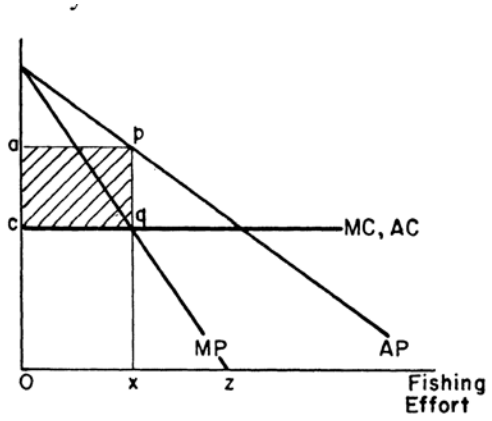
Open-access or common-pool problems are long-standing ones across all societies and times. When there are few constraints on access and use of a valuable resource, agents have an incentive to rush to capture immediate rents and to over-exploit. The rule of capture dominates. There is no waiting for less wasteful ways of producing, conservation, or rising prices. The resource cannot be distributed to more productive agents because there are no property rights underlying exchange to do so. There can be violent confrontation among competitors (Umbeck 1977; Alston et al 2000). With sufficient entry by enough parties that are relatively uniform in cost, the total rental value of the resource is wasted, and all parties eventually are made worse off.[3]

H. Scott Gordon (1954, 124), who studied open-access fisheries, described the problem: "There appears then, to be some truth in the conservative dictum that everybody's property is nobody's property. Wealth that is free for all is valued by no one because he who is foolhardy enough to wait for its proper time of use will only find that it has been taken by another...The fish in the sea are valueless to the fisherman, because there is no assurance that they will be there for him tomorrow if they are left behind today." Similarly, Garrett Hardin (1968, 1244) in his famous article in *Science* outlined the problem with herders and an open-access meadow: "Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit—in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest..."

Economists, including Frank Knight (1924), H. Scott Gordon (1954), Anthony Scott (1955), and Steven N.S. Cheung (1970), analyzed the problem of the commons in their classic articles. Using open-access fisheries to define the issue, Gordon (154, 130) discussed the motivation and effects of infinite entry by homogeneous fishers, operating under the rule of capture. Following his Figure 1, reproduced below, entry occurs so long as the private marginal costs of access and harvest are less than or equal to average returns for all parties. Continued exploitation eventually dissipates all economic rent. Alternatively, rental values are maximized when productive effort or entry is limited to point, *x*, an outcome possible with property rights to the resource.

Figure 1: Open-Access Exploitation

[3] Johnson and Libecap (1982) outline how some resource rents are maintained when the parties are heterogeneous in cost. Low-cost entrants earn rents and outcompete less-productive parties, reducing their expected returns, and limiting overall entry.



Source: Gordon (1954, 130).

Not all resources are so affected. Low-valued ones do not attract enough entry and production to generate much waste, so that open access alone is not sufficient to lead to an economic problem. But as resource values rise or exploitation costs fall, the potential for loss increases. Accordingly, parties have an incentive to bargain to assign and enforce group or private property rights to limit access and use and with the latter institution, to facilitate trade. In the case of common property, after examining multiple settings Elinor Ostrom (1990) found that local collective action to control access and production could reduce the losses of the common pool. Such collective action was feasible when user groups were relatively small, homogeneous in cost and resource objectives, costs and benefits were shared proportionately, and the resource was of sufficiently low value to limit competitive entry (Cox et al 2010).

Under these circumstances it can be relatively easier for a small group of similar people who have a history of interaction with one another to gather and interpret information about the resource's status and to agree upon the types of uses and constraints necessary to conserve it. They also can accept the distribution of the costs and benefits (and ultimately, of wealth and political influence) within the community that is inherent in any informal definition and assignment of internal property rights or use privileges. Community management of regional, typically small-scale, agricultural irrigation water, pastures, or inshore fisheries provides examples of successful mitigation of the losses of the commons (Ostrom 1990, Schlager and Ostrom 1992).

Scaling up, however, can be challenging for these local arrangements. They rely upon stability in the group's social hierarchy, small membership numbers, and homogeneity of goals for bargaining, and often, in maintaining use of known technologies and capital equipment. New production methods and capital may change the scale of productive units, labor requirements, and the knowledge required for operation, distribution, and marketing. All these factors, introduced by markets, can be disruptive. Common-property arrangements typically do not support market trades and significant reallocation that can undermine local cohesion and traditional production structures and methods. Rising prices, new markets, and changes in economic processes and units, invite entry by more numerous, dissimilar parties. When this occurs, community agreements break down. Local social values and political ties are eroded by new pecuniary opportunities. Additional parties may have access to new resource information, markets, and output opportunities previously unknown to past members. Negotiations within and across groups of resource users become more costly. Additional claims to resource rents must be resolved and more parties must be excluded. These conditions raise the transaction costs of agreement on any type of property rights (Allen 2000).

When these conditions arise, it becomes challenging to reach a policy consensus and to enforce agreement. Parties who have adapted well to open access and local arrangements may anticipate that proposed property rights or regulations will make them worse off relative to the *status quo* (Johnson and Libecap 1982). They see few benefits from the new regime and attempt to block or seriously modify it. Other parties perceive that planned property rights remedies of any type will harm them unless compensated, but compensation is difficult to measure and agree upon. Outside observers who typically do not bear the losses of open access also can oppose the introduction of property rights and shifts in production technologies. They are attracted to historical, informal community arrangements and oppose the rise of more market-based, perhaps less-picturesque, institutions. Further, a well-defined property rights regime reduces the need for bureaucratic/political management, an arena where nonowners or nonusers may lobby to achieve their particularistic policy objectives at low cost. As Hannesson (2006) points out, inefficiencies create their own constituencies.

Equity concerns can be a major impediment to the assignment of more formal property rights, particularly as resource values rise and undermine previously-effective informal controls. Formal property rights demonstrate ownership, with those excluded opposing them, even if their actions result in broader open-access losses. Their private injustices are more apparent to them than are aggregate losses. This situation is illustrated in Hardin's solution (1968, 1247) to the tragedy of the commons, which is coercive regulation of individual behavior— "mutual coercion, mutually agreed upon" to escape the "horror of the commons." He notes, but does not develop, the critical problem of distributional outcomes that are not acceptable to key parties. He asserts that "injustice is preferable to total ruin." Despite Hardin's assertion, total ruin is *not* so obvious to all parties in many common-pool settings. Injustice is *not* acceptable to them, but their proposed remedies can weaken the entry and harvest constraints needed to address open access.

Despite all of this with much at stake, private agents have an incentive to negotiate to address the common pool by establishing more complete constraints on resource access and use through the definition and assignment of property rights. As resource values rise, stricter and more precise property rights of some type—negotiated private or group rights or regulatory-generated privileges--are required to control competitive open-access rental losses. State recognition and enforcement initially can involve settling disputes among existing parties and policing trespass or other infringements by outsiders to common property or informal private property regimes. With state acknowledgment, further internal negotiations beyond enforcement can take place to refine common property or private property rights in a manner outlined by Demsetz (1967) and empirically examined by Libecap (1978).

In the assignment of property rights and determination of production levels, there are economic optimal rates of exaction for both renewable and nonrenewable resources. These are based upon time preferences, interest rates, costs, projected resource prices, technologies, product substitution, as well as capital and technology cost trajectories as supplies diminish (Dasgupta and Heal 1974; Hannesson 1987). Optimal extraction rates, however, require stable property rights or other controls on entry and production. Absent property rights, resource use is governed by open-access imperatives, not long-term value maximization.

Further, optimal exploitation rates are unlikely to be consistent with popular notions of "sustainability." Sustainability is an equilibrium, engineering concept, not an economic one. Economic markets are not equilibrium institutions. They are designed to incorporate new

information on prices, costs, and technologies, and reallocate resources or change output incentives. *This is their key contribution to economic welfare*. As such, markets are inherently destabilizing, affecting rates of production and conservation beyond any sustainability notion.[4]

Demsetz (1967) focused on the emergence of economic property rights that could be exchanged in markets, with the state having a restricted role in formal rights definition and enforcement. In potential open-access conditions, the introduction of property rights institutions advance welfare because they explicitly enlist user incentives for resource conservation, and when tradable, facilitate the redeployment of valuable assets when economic conditions change. With trade, both the holder of the property right and society benefit as the resource moves to higher valued uses. Trade equalizes marginal willingness to accept with marginal willingness to pay in reallocation so that any market adjustment is Pareto improving. Further, owners are motivated to invest in and conserve the resource and to self-enforce conservation. Resource assets are valuable only so long as they are not depleted through excessive, non-economic exploitation.

Even so, formal property rights solutions to open access are observed in a surprisingly narrow set of cases. In many cases, state regulation rather than private property rights, is implemented through explicit, not-exchangeable access restrictions, authorized time periods, such as exploitation/production periods or seasons, input constraints, and output or harvest limits. Because they are imposed and not tradable, these restrictions may not generate clear user incentives to protect, conserve, and exchange the resource. Moreover, the longevity and nature of regulatory controls may be uncertain due to shifting political coalitions.

Politicians and agency officials have shorter-time horizons than most resource exploitation possibilities. They generally are not owners, and may not benefit from transferring the resource across time. Further, in the absence of property rights and markets, such transfers are very difficult. Finally, when costs and benefits of resource use are not internalized by agents under regulation, compliance may be limited. Despite such drawbacks, observed regulatory arrangements can advantage particular parties, including state officials and their constituencies. Narrow benefits accrue while imposing generalized opportunity costs. Nonetheless, broad user regulation may be a second-best improvement over open access albeit with lost opportunities (Homans and Wilen 1997).

3. STATE REGULATION WITH HOMOGENEOUS LOBBY PARTIES: WESTERN US MINERAL RIGHTS.

The case of western US mineral rights clearly outlines the process of institutional change for property rights that can occur to address open access and the role of government in that progression as resource values rise, technology changes, and the number of competitors increases. It also makes clear how a homogeneous user lobby group could secure beneficial property rights refinement that advanced resource values. In the case at hand, the resort to the state was to more effectively address open access and not to redistribute mineral rents.

[4] Differences in these concepts arise for example, in fisheries where biologists and population ecologists often support harvest at maximum sustainable yield (MSY) not maximum economic yield, to maintain the stock at a targeted level. Economic exploitation, however, may be less or more than MSY depending upon costs, interest rates, and expected prices.

Nevada and the fabulously rich Comstock Lode (1858-1895) provide a laboratory for analyzing Demsetz's (1967) hypotheses about the emergence of property rights and subsequent adjustments as costs and benefits change. At the time of major ore discoveries in 1858 population numbers were small, the mineral-bearing region was narrow, and there were no existing mineral rights, informal or formal. Initially some 100 prospectors worked along with Comstock with few conflicts over marginal land under common-property regimes or mining camps. Things changed dramatically when valuable new silver ore discoveries were made in 1859 and the number of claimants to resource rents jumped to 20,000 by 1861. Libecap (1978) follows the 39-year period of major ore discovery and production when there was rapid legal change regarding mineral rights. Mine owners were the major advocates, and there was general support among the population that benefitted from growth in the mining industry. Relative to the rest of the population, mine owners were a relatively small and organized group whose interests generally coincided, making them an effective lobby (Olson 1965, 53-65).

To avoid competitive open-access losses, mining camps were created at first in 1859 to outline common-property local rules for claiming and working mineral land with enforcement by local courts and miners' groups. Even so, conflicts over ownership of subterranean ore deposits grew, threatening the ability of mining companies to secure funds for new technologies for ore extraction as production shifted to capital-intensive, deep underground excavation. By 1861, the newly formed Nevada Territorial Government and later in 1864, the state government, enacted legislation at the behest of leading mining companies to clarify the nature of mineral claims and subsurface boundaries that was particularly important if there were parallel ore veins. Territorial, and later state, courts adjudicated disputes over claim perimeters, property abandonment, and taxation. There is little indication of serious disagreement among the leading mining companies in lobbying the legislature or in turning to the judiciary. Between 1861 and 1895 mineral rights in Nevada became precisely specified and secure though litigation and legislation (Libecap 1978, 349-350). Production grew so that by 1889 the Comstock region had produced over 12% of all the gold and silver ever produced in the US (Libecap 1978, 354).

Moreover, the unified industry and responsive politicians (who also often were mine owners) led to the successful enactment of the US Mining Laws of 1866 (14 Stat. 251) and 1872 (17 Stat. 91-96) that recognized existing private mineral claims on federal lands and authorized further private exploration and production. This was the *last* major federal lands legislation that endorsed easy private claiming of the federal estate.

4. STATE REGULATION WITH LESS HOMOGENEOUS PARTIES: US OIL AND GAS.

Subsurface oil and gas reservoirs are potential common-pool resources when multiple parties competitively extract migratory hydrocarbons from a subsurface reservoir. Under the rule-of-capture in the US, ownership of subterranean oil is obtained only upon extraction. The open-access problem occurs because ownership of mineral rights above a reservoir often is fragmented, with many firms obtaining access leases from surface owners to competitively capture the same oil. Under these circumstances, firm owners have incentives to maximize the economic value of their leases, rather than that of the whole reservoir. They competitively drill and drain, including the oil of their neighbors, to increase their private returns, even though these actions reduce the overall value of the reservoir. Capital costs are driven up with excessive investment in wells, pipelines, and surface storage, and production costs rise with

too-rapid extraction. This practice leads to the premature venting of natural gas or other fluids that help drive the oil to the surface. Total oil recovery is reduced.

In early US production, private common-property remedies at the oil field level were hindered by the number of parties on each reservoir; differences in size (usually number and scope of production leases); variation in reservoir characteristics (quantity of hydrocarbons below lease lines, mixture of oil or natural gas, and geological conductivity); and asymmetric information about lease values. The number of competitive producers on Oklahoma and Texas fields in the 1920s and 1930s suggests the bargaining problem. On the Yates, Hendrick, and Seminole fields there were respectively, 16, 18, and 40 different lease holders, and on the huge East Texas field, over 1,000 (Libecap and Wiggins 1984, 89-94).

A possible solution was early consolidation of production rights through the buy-out of all leases and thereby eliminate competitive withdrawal. The early or 'gusher' stage of field development with its fury of production and waste, however, was the time of least information about the value of individual holdings, limiting the possibilities for exchange (Wiggins and Libecap 1985).

Another option was to prorate group-regulated production across all leases on a field according to an agreed-upon formula, such as surface acreage (Libecap and Wiggins 1984). Under prorationing, a total monthly or annual field output was to be set and divided among the producers. Where producers were relatively homogeneous in size, lease holdings, or in subsurface deposits, these common-property prorationing agreements could be reached. Such conditions described smaller oil fields, but on larger, more heterogeneous reservoirs with mixed distributions of oil, gas, and geological conductivity, the parties could not reach agreement. The most valuable lease holders often in the center of the deposit, were reluctant to agree with prorationing rules that did not recognize their preferential deposits, while more marginal lease holders, who relied more upon draining neighbors, resisted rules that differentially limited their drainage ability.

The most complete common-property remedy to open access, absent outright purchase, was unitization that placed the management of the reservoir under a single firm, while granting other producers shares in the net revenues (Wiggins and Libecap 1985; Libecap and Smith 2003). Two issues complicated negotiations. One was selection of the unit operator and the other was the share formula to divide the net proceeds of unit production among the various parties. Agreements often were not forthcoming until late in a reservoir's productive life, when enough common information had emerged about the nature and value of both the reservoir and individual leases.

If unit contracts were to succeed, they had to award each party a *fixed* share of production and costs, making them residual claimants to reservoir-wide rents. Once unitized production ensued, the distribution of hydrocarbons and production would change permanently. If such uniform shares could not be agreed to, then either no unit was formed or less-effective partial unit contracts were concluded. The latter required that producers in the partial unit drill wells along boundaries with other, non-unit producers to limit oil migration and drainage by injecting natural gas to block internal oil flows. Hundreds of such costly fencing wells might be required, depending on field size and number of partial units.

In their analysis of unitization negotiations on seven fields in the United States, Wiggins and Libecap (1985, 377–83) found that on average it took six years for unit contracts to be

completed. During the process, many parties became discouraged and dropped out of unitization efforts. The bargaining problem was so widespread that even as late as 1975 only 38 percent of Oklahoma and 20 percent of Texas production came from unitized fields (Libecap and Wiggins 1985, 702).

Similarly, the parties on the immense Prudhoe Bay field of Alaska could not reach common agreement on the value of their respective leases to assign cost and revenue shares to a complete unit. As a result, the reservoir was partitioned in 1977 into two potentially competitive units, "oil rim," where most parties held oil and "gas cap," where most parties held natural gas. A unit operator was selected for each partition, and there were separate allocations of production costs and benefits among the parties in each partition or subunit, even though they covered the *same* reservoir.

Conflicting motivations for oil and gas production controls were inherent in the arrangement, resulting in serious waste, causing the field to prematurely decline in productivity. Low-cost oil production required injection, not sale, of natural gas. Removal of natural gas left some oil deposits stranded in subsurface formations. No remedy was reached until 1999, *22 years after the Prudhoe Bay discovery*, when company mergers and consolidation of holdings finally completely unitized the reservoir (Libecap and Smith 2003).

In face of these bargaining problems within common property, oil and gas producers in Texas, Oklahoma, Louisiana, and Alaska lobbied state legislatures and regulatory agencies for constraints on competitive production. Some took their competitors to court to reduce open-access losses. Because of their differences, however, firms formed competing lobby groups that affected how politicians and regulatory agencies responded. In Texas, state-enforced controls on production and prorationing of output within each field was the most common political action. Regulations limited the drilling of wells, controlled their spacing, and constrained output according to assigned production or prorationing quotas.

In lobbying the state for regulation, the position of larger producers conflicted with the objectives of smaller lease holders. The latter were more numerous and politically influential and were able to secure preferential regulations. Small, high-cost producers (often called "independents") were in almost every Texas county, and they had close ties to local politicians. Further, they were serviced by local oil-field supply firms and they hired local labor. These firms were comparatively homogeneous and effectively organized for political action as the Texas Independent Producers Organization (TIPRO). Larger producers (the so-called, "majors") often were headquartered out-of-state and hence, viewed as "foreign." Moreover, they were located on the largest, most productive fields, which were in fewer parts of the state. They often had internal oil-field supply support and brought in their own labor. For these reasons, despite their wealth and size, the major oil firms were less politically effective in designing oil production regulation in Texas than were the independents.

These political differences molded state regulatory policies. The Texas Railroad Commission set monthly statewide production levels and allocated the total among regulated wells. The production rules were applied uniformly to all fields, even though each oil field had a unique physical configuration and optimum production potential. This approach raised production costs relative to what might have occurred with alternative regulatory designs. Small firms dominated on older, less productive fields that larger firms had exited. Further, the numerous and politically-influential owners of high-cost wells on all fields were exempted from production controls altogether (Libecap and Smith 2003).

Similarly, in terms of unitization, large firms attempted to gain political acceptance in state legislatures of forced unitization rules. The policy mechanism was to define a majority of producers on each field who had to agree to unitize the entire reservoir and then force the holdouts into the unit. Compulsory unitization laws were adopted in most states, but in Texas, political resistance by small firm owners blocked enactment. Small firm owners lobbied to protect the production advantages they held under existing prorationing regulation (Libecap and Wiggins 1985). Opposition also occurred where oil and natural gas holdings differed among lease holders, and proposed unit agreements did not fully compensate those with more natural gas. Especially for smaller producers the formula for natural gas value conversion to oil value was critical because they could not offset losses across leases as effectively as could larger firms (Libecap and Smith 2001).

5. STATE REGULATION WITH HETEROGENEOUS LOBBY: US FISHERIES.

Migratory ocean and inshore fisheries historically have been characterized by open access and a race to fish. Since the colonial period when stocks were extremely plentiful and the source of low-cost food, wild fish have been held as legal public property. They were common property by law and exposed to easy entry by fishers along vast ocean, river, and lake shores. US inshore species were once so abundant that early residents harvested great quantities of crabs, oysters, clams, sturgeon, herring, and shad. More remote fishing fleets harvested cod off New England and sardines in Monterey Bay, California. The Pacific sardine fishery was at one time the largest fishery in North America, peaking in the 1930s and 1940s and described by John Steinbeck in his 1945 novel, *Cannery Row*. By the 1950s the fishery was in collapse due to natural population fluctuation and intense overharvest. Similarly, Atlantic cod harvests that peaked in the late 1960s, fell sharply by the 1980s with fishing periodically halted. Not all US fish stocks suffered as dramatically, but patterns were similar for many fisheries where there was easy entry and the absence of property rights (Scott 1955).

With falling harvests, incomes, and fish stocks, fishers and fishery biologists mobilized politically to lobby their state and federal government representatives and regulatory agencies for relief. Local US sports and commercial fishing industries and communities were important political constituencies at least through the 1990s, and politicians responded to excessive harvest by denying access to those with the least political influence—non citizens. In the case of ocean fisheries, the adoption of 200-mile exclusive economic zones, beginning in 1976 by the U.S and other countries, meant that foreign fishers could be restricted, reducing harvest pressure.[5] The US adopted the Fishery Conservation and Management Act of 1976 (Public Law 94-265) to define US fishery access and regulation to address open access.[6] Fisheries outside the 200-mile limit were subsequently placed under various international agreements where compliance and outcomes were variable. Within the 200-mile exclusive economic zone, domestic fishers, however, were not so constrained, and increased their fishing pressure in response.

In the US a frenzy of investment in new boats and equipment, often subsidized by federal and state governments, soon replaced the excluded foreign fishers (Christy 1997). With

[5] The Law of the Sea Convention of 1982 authorized 200-mile exclusive economic zones.

[6] See *A Legislative History of the Fishery Conservation and Management Act of 1976.* Government Printing Office, October 1976.

harvests and stocks falling within the 200-mile zones, political pressures mounted once again. Industry differences based on vessel size and home port, primary target species and techniques and gear type—purse seine, trawl, long-line, sport and commercial fisheries fragmented political efforts. Had the divisions only been among heterogenous fishers as described by Karpoff (1987), buyouts or compensating regulation might have been feasible, as occurred among oil and gas producers. Unlike oil and gas, however, fishing attracted the attention of marine biologists, other academics, and environmental NGOs. They formed an influential, potentially competing constituency, at least with some segments of the fishing industry, with a focus on biological stock preservation, rather than on the economic profitability of user groups.[7] For these reasons, along with industry divisions, the direct impact of fishery interests was diluted, affecting the ultimate design of US fishery regulations.

As stocks, harvests, and incomes fell in the 1970s and 1980s, the initial regulatory response was to differentially control access or harvests of domestic fishers with more limited political influence. For example, in the Gulf of Mexico shrimp fishery analyzed by Johnson and Libecap (1982) inshore bay shrimpers and offshore Gulf shrimpers competed to place differential constraints on one another.[8] Absent property rights, the less-controlled segment, however, expanded with initial rising harvests. As catch and incomes-per-unit-of-effort ultimately declined, not only did lobbying of state and federal fishery agencies increase, but internally, officials called for reduced pressure on biological stocks.

Additional limited-access controls, such as briefer fishing seasons, as well as gear and vessel-size restrictions were implemented. Short, but uniform fishing periods were politically popular because they appeared to be equitable and were comparatively easy to define and monitor. Better fishers still outcompeted their less-skilled or smaller competitors so that as seasons were further reduced, the smaller, less-capitalized vessel segment was particularly affected. In addition to seasons, there were equipment restrictions that disproportionately harmed fishers who had adopted new techniques, added capital, and were more productive. While such regulations were popular with small vessel owners, they reduced the overall efficiency of the industry. Grainger and Parker (2013) describe the distributional conflicts that affected the regulatory response and made the industry less efficient.

Because the regulatory structure did not make fishers residual claimants of the rental value of the stock, fishers continued to compete on unregulated dimensions, dissipating the economic value of the fishery. Common-property regimes that might have constrained some competition, faced non-member vessels entering from beyond community limits as well as differential adjustments among members to rising prices and technologies. These heterogeneities reduced the effectiveness of any local controls as well as government regulations. As costs rose and harvest incomes fell, some smaller, less-efficient fishers left the industry (Johnson and Libecap 1982; Grainger and Parker 2013). Those who remained were larger with more capital-intensive vessels and crews. They were more homogeneous in expected long-term fishery prospects and anticipated benefits from effective fishery management, such as assignment of property rights. Property rights could mold incentives for investment in and exploitation of the fishery over time, improving both profitability and stocks.

[7] There does not seem to be recent analysis in the literature of voter characteristics for fishing communities or environmental NGO members to assess relative political influence. The link between income and voting is described in Tollison and Willett (1973).

[8] General fishery regulation problems are described in Johnson and Libecap (1982); Karpoff (1987); and Wilen (1988).

Small-scale fishers, regulatory agency personnel, and academics, however, were not always supportive of the highly-capitalized, more industrial fishing firms. Their efficiency posed greater harm to fish stocks absent property rights, alarming fish biologists. Moreover, that industry segment which often was vertically integrated had less need for government services in information, measurement, or enforcement. Finally, larger, more capital-intensive fleets often were headquartered at larger ports and not older, more traditional communities. Even so, small, more traditional fishers, who sought protection via regulation, however, generally were not as efficient as their larger competitors and less able to generate wealth and value in the industry.

For these reasons, there was no cohesive lobby as there was with mineral rights, for widespread adoption of some type of property rights. The fragmented lobby included actual fishers, regulatory officials, and academics. The latter favored policies they believed would provide more regulatory control over the biological stocks and small-scale practices in the fishery. Larger, more capital-intensive fishers sought opportunities for consolidation and investment in new distribution and marketing channels.

The Pacific Northwest halibut fishery's record illustrates the efficiency problems arising from regulation of the heterogeneous industry when there were no property rights. The relevant data are provided in Table 1 from Grafton, Squires, and Fox (2000) for the British Columbia fishery. The stocks are migratory and the fleets similar, only partitioned by national ocean boundaries between the US and Canada.

Following general fishery regulations in 1980, entry was limited in British Columbia to those who were granted fishing licenses. The maximum number of vessel licenses was set at 435. Additional gear restrictions and minimum fish size rules also were adopted. Even so, among the licensed vessel owners, a fishing derby ensued as fishers competed by adding vessels, crews, and times spent fishing. The number of vessels rose quickly from 333 in 1980 to the limit of 435 by 1988, when total harvest peaked at 12,859,562 pounds, up 128 percent from 1980. The halibut stock declined, forcing regulators to reduce the allowable season to protect the stock. By 1990 the season had shrunk to *6* days from 65 days in 1980. Karpoff (1987, 191) notes that in the US portion of the fishery the season was *4* days in 1984.

Homans and Wilen (1997) modeled a regulated fishery with entry controls and an aim to protect the stock and then empirically compared its predictions to Gordon's (1954) open-access model using data from the Pacific Northwest halibut fishery. They find that regulation actually increased the amount of capital attracted to the fishery because of a higher regulated biomass and no effective constraints on vessel capital. The only regulatory option was to shorten the fishing season, raising capital redundancy and cost.

Moreover, the value of the harvest declined. With a very short fishing season, the catch had to be stored frozen for the rest of the year, denying consumers higher-valued fresh fish. This unsatisfactory situation led to a new regulatory approach, the introduction of use rights, Individual Transferable Quotas (ITQs) in British Columbia in 1991 and in Alaska in 1995. Through quota exchanges, gradually the number of vessels declined, the stock rebounded, and the season was extended, reaching 245 days by 1993.

Table 1: Season Length, Number of Fishing Vessels, and Total Catch in the British Columbia Halibut Fishery.

Year	Season Length (days)	Number of Active Vessels	Total Catch (pounds)
1980	65	333	5,650,447
1981	58	337	5,654,856
1982	61	301	5,524,783
1983	24	305	5,416,757
1984	22	334	8,276,152
1985	22	363	9,587,902
1986	15	417	10,240,471
1987	16	424	12,251,086
1988	14	435	12,859,562
1989	11	435	10,738,715
1990	6	435	8,569,367
1991	214	433	7,189,273
1992	240	431	7,630,198
1993	245	351	10,560,141
1994	245	313	9,900,958
1995	245	294	9,499,717
1996	245	281	9,499,717

Source: Grafton et al (2000).

The ITQs implemented in modified form in the Pacific Halibut fishery were described almost 20 years earlier by Christy (1973). They were an incentive-based, property rights regulatory alternative in fisheries (Buck 1995). Total allowable catch (TAC) was to be set with shares or individual transferable quotas (ITQs) granted fishers as a property right to the flow of harvest. With a property rights system, there were potentially self-enforceable controls on entry and compliance. Further there were individual incentives to protect and invest in the stock. The value of fishery ITQs depended upon long-term stock viability. Additionally, if ITQs could be traded easily, the number of fishing vessels could be reduced voluntarily, leaving the most productive fishers in the industry. Trade would increase overall output-per-unit-of-effort. The remaining, more efficient fishers could better access capital markets for additional investment, new product development and delivery.

Hannesson (2006) describes a general pattern of moving from uncontrolled entry to prescriptive government controls to the adoption of property rights with their efficiency advantages. There is documented success of ITQ catch shares as property rights in improving stocks and fishery incomes (Arnason 2007, 2009; Costello et al 2008). Despite all of this, the political process and lobbying by differential constituencies across fishing countries, however, led to varying implementation of property rights regimes.

ITQs were adopted in New Zealand in 1986, and in 1991 in Iceland, two nations that depended critically on their fisheries and conservation of the stock, and were more homogeneous in fisheries, vessels, techniques, and markets than in the US. Political opposition among constituencies in the US, however, resulted in ITQs being placed on hold with more abbreviated rollout that included controls on distribution and design. In 1996, the US placed a 6-year moratorium on the introduction of additional ITQs. ITQs typically were distributed via grandfathering (Anderson et al 2011), and small vessel owners, often from more remote communities, were concerned that they would be gradually eliminated from the industry through exchange.

To address these distributional concerns, constraints were placed on trading to limit vessel consolidation in some fisheries and to retain a small-vessel, community-based fishery

(Singh and Weninger 2015). Some academics were critical of granting of ownership windfalls to a common property, public resource (Bromley 2009). Unlike New Zealand and Iceland, ITQs were deemed expressly not a property right in the US, but a privilege and potentially revocable without compensation (Creed and McCay 1996). These constraints weakened the property right granted and its efficiency benefits. Grainger and Costello (2014) compare dividend price ratios (lease price/sales price) and find that the ratios were significantly higher in the U.S. with riskier sales and more reliance upon leases, than in New Zealand where clearer property rights existed. It is informative how long a more effective property rights response to open access took through the political process in light of constituent heterogeneity. Slow adoption exceeds even that found in US oil and gas exploitation, extending costs and welfare losses.

6. State Regulation of the Common Pool: Concluding Remarks

Theory and research regarding collective action to regulate common-pool problems suggest that it comes when: a). There is broad consensus on the aggregate benefits to be gained; b). The parties perceive positive net gains from agreement; and c). They are homogeneous with respect to bargaining objectives and in the distribution of the costs and benefits to be incurred. Agreements reached under these conditions tend to be self-enforcing because it is in the interest of all parties to ensure success. Collective action may also achieve its objectives if the parties are heterogeneous with respect to the net gains from cooperation if: a). The spread in net gains among the parties is not too great; b). There is little uncertainty as to the consequences of agreement; and c). Side payments and exchange are feasible to compensate those parties that may bear more costs or receive fewer benefits.

In the cases examined here, the political processes of securing state responses to the common pool have been complex, influenced by heterogeneity of the lobby parties. Heterogeneity has raised the costs of collective action and molded the ultimate results. Mineral rights agreements involved the most uniform parties and were the most complete. Oil and gas producers who encountered open-access losses were differentially affected so that their lobby efforts were disjointed, delaying and molding the regulations ultimately adopted. In fishing the parties have varied even more radically. As a result, although the mitigation of open-access losses is understood and documented, reforms toward more secure property rights have been limited.

The problem of devising and implementing clear incentive-based user systems that internalize externalities and equate marginal social costs and benefits in use, conservation, and exchange is exacerbated when the resource is defined normatively in some cases as a common property. As described by Ostrom (1990) and Schlager and Ostrom (1992), there clearly are settings where homogeneous groups manage resources effectively as common property to avoid the losses of the common pool. In settings where Ostrom's conditions for successful collective action are not met (Cox et al 2010), broader common-property designation likely raises the political transaction costs of designating private property rights as a more effective solution.

This condition also describes western US federal lands, often referred to as "public lands." These are vast resources with numerous, heterogeneous users that contain valuable timber, grazing, minerals, oil and gas deposits, recreational opportunities, and critical ecosystem/species preservation locations. These uses often conflict, but there is no easy common-property mechanism to resolve competition, avoid open access in some cases, and to

raise overall resource values. Instead, advocate lobbying molds political allocation and management. As a consequence, well-defined, secure, tradable user rights are less common than are contentious, potentially short-term regulatory controls (Libecap 2018).

Across the three cases examined here, the regulatory institutions have been long-standing with important efficiency and wealth-generating implications. Some have incorporated clear property rights institutions with welfare improvements, whereas others have relied upon less-effective arrangements. Understanding why this is so and assessing the economic, welfare, and resource impacts requires attention to bargaining among the affected parties, the collective action costs involved, and the roles and incentives of politicians and agency officials.

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