

Assigning Property Rights in the Common Pool: Implications of the Prevalence of First-Possession Rules for ITQs in Fisheries

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Abstract *Rights-based institutions have been adopted for certain natural resources in order to more effectively mitigate the losses of the common pool. Past central government regulation has not proved satisfactory. A major issue has been the assignment of those rights. In this paper, I examine three different allocation rules: first-possession, lottery or uniform allocation, and auction and draw predictions as to when they might be adopted. I analyze the assignment, timing, and nature of the rights granted in five resources: oil and gas unit shares, water rights, radio spectrum rights, emission permits, and fishery ITQs. I find that rights-based arrangements generally are adopted late, but when they are implemented, first-possession rules dominate where there are incumbent users. Lotteries and auctions are rarely used. I discuss criticisms of first-possession rules and argue that first-possession is likely more efficient than previously recognized. Accordingly, restrictions on ITQs (rights set-asides for particular groups and exchange limitations) may be costly in the long run for maximizing the value of the fishery resource.*

Key words Property rights, ITQs, first possession.

JEL Classification Codes K11, L79, N52, Q22.

Introduction

On-going efforts to mitigate the losses of the commons in various environmental and natural resource settings have brought renewed consideration of the use of property rights arrangements.¹ These include individual transferable quotas (ITQs) in fisheries, tradable emission permits in air pollution control, and exchangeable development permits in land use planning (Tietenberg 2007, 63). While attractive because of their ability to better link private and social net benefits in decision making than is possible with traditional command-and-control regulation, property rights instruments face complicated institutional design and implementation problems.

For example, disputes over the types and distribution of ITQs to be granted in U.S. fisheries resulted in a four-year moratorium on their expansion in 1996.² Five U.S. marine fisheries operate under ITQ regimes (as compared to over 40 in

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¹ The arguments in this paper draw from Libecap (2007, 2006). See Stavins (2007) for discussion of the movement toward market-based instruments.

² Sustainable Fisheries Act, 16 USC 1801.

Canada). These are: the Mid-Atlantic surf clam and ocean quahog fishery, the Alaskan halibut fishery, the Alaska sablefish fishery, the South Atlantic wreckfish fishery, and the Alaska crab fisheries. These ITQs are more limited and are a weaker property right than found in many other major fishing countries (Arnason 2002, pp. 12, 52–57; Leal 2005). Some U.S. ITQs are reserved for community development and not granted to individuals. There also are formal limits on the size of individual quota holdings and their transferability. In the Alaska halibut fishery, for example, only transfers from larger to smaller vessel classes are permitted, and no individual is allowed to own more than 0.5% of the total quota. There are other controls on share consolidation to limit holdings and to maintain a targeted number of vessels in the halibut fleet (Doyle, Singh, and Weninger 2005). ITQ policies are molded by distributional concerns and the political influence of small vessel owners and fish processors.

The lesson of this paper is that these issues have been encountered before in other resources, and a survey of those experiences is useful for placing current debates over fishery ITQs into perspective and to observe the productive effects of different approaches in the allocation of property rights. One finding is that formal property rights institutions are adopted only late, after conditions have deteriorated for many regulated resources. By that time, political conflict over the assignment of the costs and benefits of a new property regime is swamped by the overall costs of not taking action. Unfortunately, by that time many of the resource rents have been dissipated. Another finding is that first possession (grandfathering) allocations dominate where there are incumbent users. First possession may have efficiency benefits generally overlooked in the literature. Auctions and lotteries (uniform allocation) are infrequently used, but work best in new resource settings. Allocation issues are critical for the success of property regimes because once adopted they have long-term distributional and productive consequences, and they are very difficult to change if they are deemed *ex post* to be non-optimal (Libecap 2007).

The Allocation of Property Rights

Demsetz (1967) suggested a smooth process of the emergence of property rights as resource values rose, offsetting the costs of definition and enforcement. But experience reveals that the process of institutional change is more complex than he envisioned. Allocation is contentious because of the assignment of wealth and political influence associated with exclusive property rights. Property rights are political institutions and the underlying negotiations determine the nature of the rights arrangements that ultimately emerge, their timing, and effectiveness (Libecap 1989). As emphasized by Coase (1960), allocation rules are always important for distribution and they affect production opportunities in the presence of transaction costs. Property rights allocation is also affected by other factors, including the physical nature of the resource, the number and heterogeneity of the parties involved, equity norms and precedents, and the legal environment. There are several allocation mechanisms:

First Possession Rules

First possession is the dominant method of establishing property rights.³ It assigns ownership on a first-come, first-served basis or first-in-time, first-in-right. First possession rules are attractive because they recognize incumbent parties that have

³ See discussion of first possession in Epstein (1979), Rose (1985), and Lueck (1995).

experience in exploiting the resource and hence, may be the low-cost, high-valued users. Incumbents also have a direct stake in access to the resource and will be important constituents in any property rights distribution. They are concerned about past investment in specific assets, which otherwise would not be deployable to other uses. Since first possession rules recognize these investments, this security should encourage future outlays in human and physical capital, as well as in the resource stock. Additionally, by recognizing existing resource users who have perhaps the most accurate information about the state of the resource, first possession rules encourage collaboration between exploiters and regulators in setting total allowable harvest or extraction rates. In this way the most precise information can be incorporated into regulatory policy, and users have more incentive to comply with rules that they believe are correct and reflect their knowledge of the resource.⁴

There are other reasons why first possession rules can be efficient. In principal, they reward first movers, innovators, and entrepreneurs, who first experiment with and use a resource. Society benefits from innovative, risk-taking activities, and first possession compensates such actions. Further, under first possession the market determines optimal claim size, whereas under other allocation arrangements bureaucratic or political objectives define the assignments. If these are not consistent with optimal production size, then further trade is required. If transaction costs are high, such exchange might be limited. Hence, first possession can economize on transaction costs.

Examples of first possession rules include allocating property rights based on historical catch in fisheries, on past fuel use in emission permits, prior appropriation in water rights, past utilization in spectrum allocation, and on novelty in patent and copyright assignment. First possession rules also often include beneficial use requirements for maintenance of the right to limit hoarding and constraints on valuable new entry.⁵

The rule-of-capture that applies in fishing, oil, and groundwater extraction is a type of first possession rule. Ownership is granted to the party that invests in extraction. But the rule-of-capture grants ownership to the flow and not generally to the resource stock, and hence in the presence of open-access conditions, it can exacerbate competitive extraction incentives.⁶ If the competing parties are homogeneous and ownership is short term, then full dissipation is possible as parties rush to “capture” the asset. If, on the other hand, the parties are heterogeneous and use rights are long term, then first possession assignments to a flow mitigates rent dissipation, as is the case with fishery ITQs.⁷

The same criticism of first possession rules and rent dissipation applies if homogeneous claimants race to establish property rights to the stock.⁸ But as before, if the parties are heterogeneous and the resulting rights are secure and permanent, then full dissipation will not occur. There are costs with any rights allocation rule, and

⁴ For a similar argument in his discussion of the problems of taxing quota value, see Johnson (1995, p. 336).

⁵ As discussed below, heterogeneity reduces the losses of competitive rush for first-possession rights. Beneficial use requirements can instill heterogeneity by requiring that claimants place the asset into production. This requirement can act as a sorting device on potential claimants.

⁶ The property right is granted to the flow, rather than to the stock, because stock ownership may be too costly to define and enforce due to the nature of the resource or to political constraints. For discussion of reasons to limit alienation in these cases, see Epstein (1985).

⁷ Johnson and Libecap (1982) show that heterogeneity among fishers limits rent dissipation even under open access and the rule of capture.

⁸ Stavins (1995) refers to grandfathering as a give away. Inefficiencies would come through a race of homogeneous parties. See also Haddock (1986) for criticism of rent dissipation when the parties are homogeneous.

the “winners” of such a race may be the most efficient producers. Accordingly, first possession is unlikely to be more costly than other assignments. Generally, if the transaction costs of subsequent exchange are high, then it makes sense to assign rights to low-cost users with histories of past involvement in the resource.

Despite their ubiquity, first possession rules often run afoul of fairness considerations, and this situation raises political opposition to them. First possession discriminates against new entrants. There are wide-standing views that “people should get what they deserve and deserve what they get.” If first possession ownership is viewed as rewarding those who by luck and connections were allocated the right, then they may be opposed or their returns taxed (Alesina and Angeletos 2005, pp. 960–80).

Uniform Allocation Rules

Equal sharing rules avoid the distributional concerns associated with first possession and better reflect egalitarian goals. If there are no restrictions on subsequent exchange of property rights and transaction costs are low, there are few efficiency implications. The resource still migrates to high-valued users. Uniform allocations also avoid the measurement costs of verifying claims of past production or use of documenting precedence claims that are part of first possession assignments. They can circumvent the costly pursuit of or rush for property rights when first possession is known to be the allocation rule.

Lotteries are examples of uniform allocations because each claimant is given an equal, random draw in the assignment of rights to the resource, and the allocation granted generally is partitioned equally among lottery winners. Uniform allocations via lotteries are most effective when applied to new resources where there are no incumbent claims and all parties are relatively homogeneous. They can also be used when the access and use rights granted are short term and no long-term ownership is implied, such as with lotteries for annual hunting licenses.

Auction Allocation

A third allocation mechanism is auction. It can directly place an asset into the hands of those who have the highest value for it. Auction thereby avoids the transaction costs of reallocation. Auctions also generate resources for the state and avoid the windfalls that might be considered unearned and divisive. Auction returns can be used to cover the costs of defining and enforcing property rights and other costs of resource management. As with lotteries, auctions work best for new, unallocated resources where there are no incumbent claimants and where resource values are very high. By granting more of the rents to the state, auctions reduce the distributional implications of first possession.

Incumbents naturally resist auctions in the allocation of rights because they are forced to pay for something they believe they are already entitled to because of first possession. There are other costs to auctions. The state must be able to measure and enforce resource boundaries and individual allocations secured by auction. The terms of the auction may also be influenced by competing claimants who lobby for rules that provide them with specific advantages.⁹ For these reasons, auctions are

⁹ See discussion by McMillan (1994) regarding the experimentation and costs of designing auctions for the spectrum. Tietenberg (2007, pp. 80–81) notes the pervasiveness of first possession rules and the free allocation of use rights. Lueck (1998, p. 36) points to the costs of auctions.

not used as often as economists have predicted.¹⁰ Auctions can be applied in conjunction with other allocation arrangements to provide an adjustment margin when some parties are not allocated sufficient property rights for efficient production and the transaction costs of gaining additional increments from others are high.

It is often argued that auctions can transfer rents to the state without important distortions or incentive effects for resource users. But caution is in order. The effect depends on meeting restrictive conditions in auction design that may not be feasible. In a similar setting, Johnson (1995) has shown that the imposition of taxes on quota rents in ITQ fisheries could lead to reduced incentives of fishers to conserve (invest in) the fish stock.

Transaction Costs

Property allocation systems are affected by transaction costs. These are a function of information about the resource, the nature of the asset, the number and homogeneity of the claimants, equity concerns, and public trust or public interest notions. Throughout the discussion below, the comparison is between open access and a property regime, but it applies as well with a comparison with central government regulation and property rights.

The Nature and Distribution of Information about the Open-access Problem

If there is limited or asymmetric information about the size of open access or regulatory losses or of the costs of addressing them, the expected gains from a property rights allocation as a solution will be uncertain. This situation raises the transaction costs of assigning rights. Resource users will not be able to effectively compare the advantages of a more formal rights system with returns under open access and regulation or to determine how they will fare in the new arrangement. There are costs of organizing to influence the rights allocation mechanism, as well as costs of defining and enforcing individual claims. If the benefits are more uncertain than are the costs at any point in time, then a consensus on property rights will be difficult to obtain. Some parties that have adapted well to open access or regulation may conclude that they are better off under the status quo.

For these reasons, formal property rights often are not implemented until either resource values are very high (the rental losses of open access or central regulation are very large) or until late in the use of a resource when the open-access losses have largely been borne and the stock is close to depletion. At that time, the benefits of property rights become clearer. Information about open access or regulatory losses and the costs of addressing them is spread more evenly among users. Additionally, transaction costs are lowered because with reduced earnings and the depleted state of the resource, there are fewer claimants to involve in the allocation of property rights.

In order to avoid long-term rent dissipation, an appropriate state response is to provide credible, scientific information about open-access losses, such as the size of declining fish stocks, air pollution costs, or lost amenity values of a resource and the sources of those losses. Recognition of existing users in any proposed rights arrangement and enforcement guarantees also can speed institutional change. First

¹⁰ See Libecap (2007) for summary of where first-possession claims were and were not recognized on the U.S. frontier and the consequences.

possession allocation rules reduce uncertainty for incumbent users in the calculation of individual net gains from adoption of property rights.

The Physical Characteristics and Value of the Resource

Larger, more mobile, unobservable environmental/natural resources such as ground-water, air, and fish and wildlife stocks have higher measurement and enforcement costs in assigning and protecting property rights than do stationary resources such as land. Accordingly, ownership of these resources is granted to the flow (rule of capture) because extraction is more easily measured than is the stock. The state may lower transaction costs by providing information about the boundaries of the stock and by defining and enforcing individual partitions of it. Accurate measurement and effective enforcement are critical for the success of any rights-based regime.

More valuable resources also are associated with higher enforcement costs because there are more claimants and potential entry. Resource values may rise due to exogenous supply and demand factors or due to the gradual depletion of the resource under open access. As open-access losses increase for valuable resources, the returns to the assignment of property rights rise. Capturing a portion of rents that are saved is the motivation for individual parties as they negotiate for the assignment of property rights. As outlined by Demsetz (1967), more valuable resources tend to have more precise property rights because the larger benefits from definition and enforcement offset the higher costs of doing so.

The Number and Heterogeneity of the Bargaining Parties

An extensive body of research on collective action regarding natural resources as well as within cartels, reveals that larger, more heterogeneous groups have higher costs of reaching agreement and enforcing compliance. There is potential for free riding, holdup, and defection. The state can mitigate these problems by defining property rights to limit entry and by punishing those who violate contracts and trespass. In contrast, smaller, more homogeneous groups are better able to find consensus on the allocation of property rights. This suggests that allocation of rights to new resources with no pre-existing claimants can occur at less cost than will be the case for established resources with heterogeneous incumbent claimants and new entrants (Libecap 1989, pp. 21–28). Similarly, Ostrom (1990) and others have shown that small homogeneous groups with frequent interaction can effectively reach agreement on resource allocation and use. These groups often use community property rules to mitigate open-access problems and enforce them through norms and customs. These arrangements, however, may not be sustainable in the face of exogenous increases in price and entry by new claimants.

Equity and Precedent of Resource Ownership, Access, and Use

As noted above, norms of fairness affect the allocation of property rights. An ownership distribution that is highly skewed and is not open to entry by ambitious non-owners can be costly to enforce and hence, unstable. Resentment of windfall allocations that are based on luck or political connections may lead to reallocation efforts or to tax policies that capture at least a portion of the windfall gains. These actions add uncertainty to any property rights regime and reduce its effectiveness in

addressing open-access losses. For example, if ITQs are allocated based on historical catch and the fishery stock rebounds under the new arrangement, quota owners may receive considerable gains in wealth. Those denied access to the fishery under the allocation rules may lobby for a share of those gains via taxes or other quota restrictions. This sets the stage for political conflict over the regulation of the fishery.

Summary of Property Allocation Concepts and Predictions

If resource users locally contract to assign property rights as resource values rise or definition costs fall, they will do so through first possession. First possession recognizes their uses, knowledge, and past investments. Even if the numbers are large and the resource is not easily bounded so that bargaining will be limited, informal allocations to the flow (rule-of-capture) will be based on first possession. Formal state recognition of these local rules will incorporate their first possession distributions.¹¹ Allocations that do not consider the position of incumbents will face opposition, raising the costs of rights assignment and enforcement. Indeed, grandfathering in initial allocation has been a necessary ingredient in building political support (Tietenberg 2007, p. 81). When property rights are assigned exogenously by the state to a new resource, following costly search and discovery as with patents, then first possession is also optimal because it rewards exploration and risk taking.

When there are no incumbents and rights are distributed by the state to a new, valuable resource and transaction costs of subsequent exchange are high, then auction is optimal. It directs the resource to those who will maximize its value and the resource rents can be secured by the state, mitigating distributional concerns. If transaction costs are very low and equity concerns are paramount, then lotteries or uniform allocations can be used. Each participant has an equal chance to gain the asset, and the rents will go to lottery winners.

In all cases, if the assigned property right allows for full alienation, then trade can reallocate the resource over time to higher-valued users and more efficient production scales and input mixes. Restrictions on transferability are driven by political motives to maintain local control, production, and small-scale activities. In general, these alienation restrictions reduce resource values. However, the politics of addressing common-pool losses may require some community ownership or other types of trade limits. If these are prerequisites for obtaining political consensus on a property regime, as compared to continuing open access or adopting less-effective central regulation, then they will be welfare enhancing, despite their added costs.

The discussion suggests a number of predictions for allocation rules: (i) First possession will be used when there are incumbent users; (ii) Uniform allocations or lotteries will be used for new, naturally provided resources; (iii) Auctions will be adopted for new resources where both potential rents and the transaction costs of subsequent trades are substantial; (iv) Adoption of rights-based institutions will come late in resource use when the costs of both open access and central regulation are high; and (v) The most complete rights will be assigned to resource stocks that are more valuable, less mobile, and more observable.

With these concepts in mind, we now turn briefly to five environmental and natural resources where allocation of rights has been used to address open access: oil and natural gas, water, the radio spectrum, air pollution emission permits, and

¹¹ This summary of allocation of use rights across various resources necessarily is incomplete. Some additional cases are noted in the notes that follow. Even so, they too conform to the arguments outlined in the text.

fisheries. Implications and conclusions are drawn in the final section of the paper.¹²

Allocation of Rights to Subsurface Oil and Gas Reservoirs in North America

In the USA and Canada, rights to access oil, natural gas, and other minerals generally are assigned to surface land owners. Actual ownership of subterranean oil and natural gas flows comes through the common law rule of capture, which, as noted, is a form of first possession. Unless unitized or regulated, the hydrocarbon stock remains essentially open access. Under the rule of capture, ownership depends upon extraction. This ownership rule, however, creates conditions for competitive open-access extraction if there are multiple surface owners above the deposit.

The common-pool problem has been recognized since oil was first discovered in the USA in 1859, and it has plagued petroleum production wherever there are numerous firms producing from a single formation. The first response to open access was state regulation of production, with most regulations adopted between the early 1930s and 1960. Libecap and Smith (2002) describe the pattern of state regulation of oil and gas production. Overall production “allowables” were determined each year in each state based on geologic conditions and more importantly, on estimated oil demand and supply. These allowables were then prorated among the regulated firms as annual production quotas. First possession was the quota allocation mechanism, and the specific factors included past production and investment, such as the number and depth of existing wells on a lease. The latter variables encouraged denser drilling of deep, costly wells in order to increase prorationing quotas; thereby shifting production allowables from low- to high-cost producers. Further, to gain their political support for regulation, the owners of numerous small, high-cost firms in Texas were able to obtain exemption from prorationing rules for their so called “stripper” wells (very high-cost, low-production wells). These and other preferences to high-cost small firms reduced the overall benefits of regulation by over \$2 billion annually by the early 1960s, but they allowed for some of the margins of competitive output to be controlled (Libecap and Smith 2002, p. S595).

The most complete solution to open access in oil and gas production is field-wide unitization, which assigns ownership to both the flow and the stock of hydrocarbons to the unit. Under unitization, production rights are delegated through negotiation to a single firm, the unit operator, with net revenues apportioned among all parties on the field (including those that would otherwise be producing). As the only producer on the field and a residual profit claimant, the unit operator has incentive to maximize field rents. Despite these attractions for mitigating the substantial losses involved in common-pool crude oil production, early, complete, and voluntary field-wide unitization has not been widespread. The key issue of contention is the allocation of shares of the net proceeds of unit production among the various parties (Libecap 1989, pp. 93–114). Wiggins and Libecap (1985) examine the bargaining problem underlying unit formation, and Libecap and Smith (1999) describe

¹² Not included in this summary of oil and gas units are federal auctions of lease or access rights for drilling and production offshore in the USA, especially in the Gulf of Mexico. Nevertheless, the practices there are consistent with the arguments outlined in the text. The federal government owns the offshore mineral rights and auctions them off in order to capture the rents. There are no incumbent occupiers or users of the resource. Hence, the rule of first possession does not apply, and the use of auctions follows the predictions outlined above. For discussion of the auction of federal oil and gas leases, see Porter (1995) and Mead, Moesidjord, and Sorenson (1986).

the nature of a complete unit contract. As a result of conflicts over allocation, unit agreements can take a very long time to negotiate or breakdown and result in incomplete units that cover only part of a field.

In all cases, agreement on voluntary unitization did not occur until late in primary production. The incentive to agree to the unit at that time came because secondary oil recovery through artificial injection of water or other substances to expel remaining oil is more effective with unitization. In addition, disputes about production potential became less important as all leases neared primary depletion. Unfortunately, by that time many of the open-access losses associated with competitive production were already inflicted on the field.¹³

The Allocation of Surface Water Rights in the Western USA

In the USA there are two types of water rights, riparian and appropriative. Riparian rights tie ownership of water to the ownership of the land that is appurtenant to water flows. Riparian rights are the common law institutions that dominate in the eastern USA. They are recognized to a lesser degree in some western states, such as California and Texas. Each land owner has a claim to use a reasonable portion of the water that flows across or adjacent to his or her property. Riparian rights are a type of common property.

The other surface water ownership arrangement, prior appropriation, is found in the semi-arid West and it is based on first possession. The appropriative doctrine emerged in the 19th century in response to the development of mining and agriculture in the semi-arid West where growing numbers of people and economic activities were increasingly concentrated in areas where there was too little water (Thompson 1993, p. 681). Under the appropriative doctrine, the first claimant can divert a certain amount of water from its natural course for private beneficial purposes on land remote from the point of diversion (Getches 1997, pp. 74–189). Subsequent claimants can also divert water with lower priority rights.

Because appropriative rights can be separated from the land and sold or leased, they can be the basis for private water transfers in response to changing economic conditions. But trades that change the location of water diversion, nature of use, and timing, especially if they are large relative to stream flow, are restricted by state law and regulated by state agencies. To be approved, transfers must demonstrate that they will not harm other diverters on the stream. Some states have more restrictive regulations regarding transfers than do others. Changes in location of diversion to points upstream, for example, could harm other rights holders by reducing downstream flows. Changes in the location of use, particularly those that are out of basin, reduce return flows and available water to other rights holders. To mitigate these effects, state water agencies typically allow changes in diversion and location for historical consumptive uses only, which are difficult to measure.¹⁴

Conflicts over allocation occur when there are proposed trades to reallocate water from low- to high-valued uses. In the American West, approximately 80% of consumptive water use is in agriculture, often in low-valued or subsidized crops. New water demands for growing urban areas, such as Los Angeles or Las Vegas, and for environmental and recreational uses to augment instream flows, substantially raise water values at the margin. The misallocation of water has been recognized as

¹³ Anderson and Johnson (1986) and Johnson, Gisser, and Werner (1981), who describe how specifying a property right in water in terms of consumptive use with options for third-party grievances, can be an effective method for promoting transfers.

¹⁴ Hazlett (2001, p. 353). More market driven approaches in NZ, Australia, and Latin America.

a problem for a long time, yet water markets have developed slowly and amid controversy in the USA. The conflict is over the nature of water rights and their exchange. There are: legitimate concerns about the impact of water trades on other water users (third-party effects); pure rent-seeking efforts to capture a greater share of the often very large returns possible from reallocation; and efforts to block any private water trades and to assert greater state control over water rights (Getches 1997, p. 11).

Allocation of Rights to the Radio Spectrum

The radio spectrum is a range of frequencies over which electromagnetic signals can be transmitted. It is not a scarce resource in the same sense as oil or water. The extent of electromagnetic range is limited only by technology, and new technologies have increased the density of information that can be transmitted on a wave; therefore reducing minimum channel sizes. New technology has also expanded the portion of the spectrum that is commercially usable.

There are formidable technical problems in allocating property rights to the electromagnetic spectrum. A signal occupies a place in a multidimensional space—time, geophysical space, frequency, power. Signals are encoded in amplitude and modulation of waves of electromagnetic radiation. There is a problem of interference. When signals collide, some of the information they carry is lost. Signals cannot be fenced if they are in the same location, similar power, time, and same or adjacent spectrum frequencies.

In the USA, the spectrum was first used commercially by radio in the 1920s, and entry was open with flow or use rights to frequencies claimed under first possession. Broadcast rights were assigned incrementally. The Department of Commerce awarded short-term licenses to the frequencies under the Radio Act of 1912 to minimize interference. The license dictated where a station could broadcast, on what frequency bandwidth, and when. Initially license holders could determine how powerful their signals could be. Early on, there was little chaos or frequency interference (Hazlett 2001, p. 353). By 1922 there were over 500 radio stations. Frequency interference charges were handled in courts, and the licenses were exclusive, transferable, and recognized as a property right (De Vany 1998, Farber and Faulhaber 2002, p. 3). As entry increased and interference rose, there were symptoms of open-access problems and demands for more specific property rights.

These demands could have been addressed by greater enforcement of first possession claims via the courts. But in 1926, Congress made the spectrum the inalienable possession of the people of the USA and established the Federal Radio Commission to assign wave lengths, determine power, determine location of transmitters, regulate equipment used, and prevent interference. These are powers now held by the Federal Communications Commission (FCC), established in 1934. The previous process of allocating spectrum rights based on first possession was replaced with a system of administrative licensing of use privileges or operating permits, not property rights, under the Radio Act of 1927. This practice remains today.

In 1927 because most of the spectrum remained undiscovered, unused, and unclaimed, the government might have used auctions to allocate licenses to use new frequencies, even if the government retained actual ownership to the spectrum. This did not happen, in part because the value of the spectrum was still generally unknown, although auctions would have elicited information that was not generated under other allocation mechanisms. The FCC might also have continued recognizing new possessory claims, but it did not, largely due to lobby pressure by incumbents.

The broadcast licenses administratively assigned by the FCC allocate blocks or slices of contiguous bandwidth frequency, power, time of use, equipment, and nature of use. These license stipulations address interference by controlling inputs. The licenses are not transferable or subdividable, and the frequency bandwidth included in the license cannot be used for different purposes. Although license holders are generally prohibited from selling their licenses, the companies that hold the licenses can themselves be bought and sold. License acquisition through mergers is commonplace (White 2000, p. 14).

Administrative allocation of licenses remained the dominant assignment mechanism until 1981 and today still accounts for 98% of the spectrum that is available commercially.¹⁵ In 1981 the FCC was authorized by Congress to use lotteries for non-broadcast spectrum uses. In 1993, in response to new technologies and efforts to capture more of the rents associated with the spectrum, the FCC began to use auction allocation for unused spectrum (previously withheld for military use) for cellular telephones, fax, and wireless internet service. The nature of the right was not changed; it remained a use privilege. In 1997 Congress authorized further auction of broadcast licenses (Cramton 1997, pp. 431–95).

Allocation of Air Pollution Emission Permits

Early regulatory efforts to reduce air pollution in the USA were costly and not generally effective. They relied on relatively inflexible, uniform air quality standards and required that polluting firms meet them. Regulation included rules on emissions; equipment to be used, such as types of scrubbers; and performance standards. The uniform rules did not recognize that the costs of controlling emissions varied across and within firms. Traditional regulation gave advantages to old plants and technology. There were no incentives to develop new technologies, and central regulation was often used politically to disadvantage certain firms and regions at the behest of entrenched interests with little environmental benefit (Pashigian 1985). Beginning in the mid-1970s, dissatisfaction with the costs and performance of centralized air pollution regulation led to the adoption of emission trading programs, despite some resistance from regulatory agencies (Deweese 1998). The relatively late turn to property institutions follows the timing predictions described earlier.

Under the pollution permit system, an annual targeted level of emissions is set and then prorated across permit holders, who are allowed to discharge a specified amount of pollution. The permits, or flow rights, have been allocated through first possession, based on past electricity production, heat generation, fuel use, or emissions, free of charge. There is more information about production and fuel use than for past discharges. In some cases, a small portion, about 2%, have been auctioned to provide flexibility and to allow new entry by firms that did not have production histories. Since auctions were not used, the private sector received the scarcity rents. Some have criticized this outcome because of transaction costs of exchange and the ability to use auction proceeds rather than distorting taxes to finance the program (Fullerton and Metcalf 2001). One of the most successful programs was authorized under the 1990 Clean Air Act Amendments to allow electric utilities to trade allowances to emit sulfur dioxide, SO₂, to reduce acid rain.

This program is the centerpiece of Title IV of the 1990 Clean Air Act Amendments. The objective was to reduce SO₂ and NO_x emissions by 10 and 2 million tons, respectively, from their 1980 levels. These are the principle gases associated

¹⁵ I thank the anonymous referee for this insight.

with acid rain and they largely were emitted by electrical utilities. Two phases were used. Phase I, which ran through 1995, assigned emission permits to over 400 electrical generating plants and Phase II, which extended regulation to almost all generating units (Stavins 1998, pp. 6–13). Total emissions were gradually reduced each year to achieve the targeted level. Within the annual total, tradable emission permits were allocated across generating units. Emission permits were allocated based on first possession so that existing polluters were grandfathered and newer units were disadvantaged. Units that began operating in 1996 or later were not allocated any units, but had to purchase their allowances on the open market.

Phase I allowances were allocated free of charge based on past power generation as indicated by heat input. The allocation formula granted emission rates of 2.5 pounds of SO_2 /mmBtu (million British thermal units) of heat input, multiplied by the unit's baseline, mm Btu (the average fossil fuel consumed from 1985 through 1987). Some variations were allowed, in part to make the program politically viable and to encourage investment in new, renewable energy technology. Accordingly, utilities in certain states such as Illinois, Indiana, and Ohio were allocated an additional 200,000 allowances annually during Phase I. In these states there were important coal interests, and all had ranking members or chairs of key Congressional subcommittees (Ellerman 2000, pp. 40–43). Additional allowances were granted to plants where scrubbers had been installed that reduced SO_2 emissions by 90% and where emissions were reduced through use of renewable energy. A small portion of the allowances, 2.8% of the total allowances for a year, were auctioned by the EPA (Ellerman 2000, pp. 8–9).

Phase II allowances are part of a tighter overall annual emissions cap. The formula used in determining the initial allocation took an emission rate of 1.2 pounds of SO_2 /mmBtu of heat input, times the unit's baseline. As with phase I, exceptions and additional allowances were made for political and technical reasons. For instance, additional allowances were allocated to units that did not perform at their capacity during the base year due to equipment malfunctions. Greater allowance allocations were granted to smaller units (Ellerman 2000, pp. 43–48). An opt-in program also was used to encourage very low-polluting utilities to enter by granting them allowances that could be traded to others. The flexibility underlying the tradable emission permit system overcame political opposition to the ambitious air pollution reduction objective. There are various estimates of the cost savings of the program, but they range from \$5 to \$12 billion over a central regulation alternative.

Allocation of ITQs in Fisheries

Historically, the initial regulatory response to open access has been to deny entry to certain groups based on political influence—noncitizens with expansion of the Exclusive Economic Zones (EEZs), sports versus commercial fishers, inshore versus offshore fishers, large-vessel versus small-vessel fishers, or vice-versa, and so on. This action temporarily reduced fishing pressure, but it did not solve the fundamental problem which is that rents exist for those who can find ways around the regulations.

As these failed, new regulations, such as fixed seasons, area closures, and gear restrictions, were put in place. These arrangements are politically attractive to regulators because they do not upset *status quo* rankings, minimize existing transaction costs, and call for major regulatory mandates, which are attractive to regulators and politicians. But they have not been successful. They do not align the incentives of fishers with protection of the stock. Further, given heterogeneous fishers and limited and asymmetric information about the stock and the contribution of fishing relative

to natural factors, there are disputes about the design and efficacy of these regulations. Finally, there is no basis for fishers to contract among themselves to reduce fishing pressure and thereby to capture the returns from an improved stock. There are no property rights to exchange.

There has been a turn to individual transferable quotas (ITQs) in some fisheries, almost always after continued declines in the stock under centralized regulation, a finding consistent with the predictions outlined above and practices with other resources. ITQs require restrictions on entry, the setting of an annual total allowable catch, TAC, the allocation of flow rights or quotas to a share of the TAC, and enforcement. As such, ITQs are a usufruct right—the right to fish—not a right to the stock and the aquatic habitat. This limited rights arrangement is similar to those for subterranean oil, western water, the radio spectrum, and pollution emission permits.

The more secure, definite, durable, divisible, and permanent the ITQ, the more complete is the property right. And complete property rights better link the incentives of fishers with the goal of maximizing the economic value of the fishery. Government regulators still determine the annual catch and then distribute it among ITQ holders. With permanent and transferable catch quotas, the quota holders find it to their advantage to preserve and, if necessary, rebuild the marine resources. The value of the share of the TAC depends on the state of fish stocks and the sustainability of the fishery (Arnason 2002, p. 1). Enforcement costs may decline relative to those under other forms of regulation because fishers have a stake in the preservation of the stock as shareholders in the right to fish and self monitor.

The allocation of ITQs is controversial because it implies a more permanent, transparent private claim to resource rents than exists under open access or central government regulation. Further, some parties that are excluded or affected by changes in fishing practices are made worse off. These effects have important wealth and political distributional implications that affect the timing and nature of the ITQ system adopted.

Established fishers with a history of fishing are the most formidable constituency in ITQ allocation discussions, and these fishers benefit from quota distributions based on historical catch and past vessel and gear investment (first possession rules). No ITQ could be implemented in a fishery where the interests of established fishers are ignored or importantly compromised. For that same reason, uniform quota allocations or auctions are more likely to be used in new fisheries where there are no established fishers.

There is more than political expediency in the allocation of ITQs based on historical catch. As outlined above, it is efficient as well. Assigning quotas to those with knowledge and past experience in the fishery is consistent with granting rights to the low-cost users. This practice reduces the need for subsequent reallocation. On the other hand, if incumbents have been selected on the basis of political criteria rather than efficiency and are awarded ITQs through first possession, then further trading will be required. If transaction costs are low, as they might be if there are no restrictions on trade and holding quota, then the ITQ approach with grandfathering can be a low-cost method of removing inefficient agents who entered the industry through their political contacts. Because their positions are recognized, they have little incentive to oppose the assignment of more definite property rights and their exchange.¹⁶

¹⁶ See criticism of grandfathering in Fullerton and Metcalf (2001). Johnson (1995) discusses the importance of heterogeneous inputs, input rents beyond fishery rents, and the non-neutral impact of a tax on quota value. Such a tax would result in adjustments in fishing effort and desired stock that could undermine conservation objectives. An auction that transferred quota value to the state could have a similar impact. See Grafton (1996) for comment and Johnson (1996) for reply.

Reserving fishery rents to fishers, rather than granting them to the state via auctions, enhances long-term incentives of fishers for protection of the stock as owners and provides incentives for investment in it, as well as in human and physical capital. The value of the latter, in part, will depend upon maintaining and enhancing the value of the stock. As noted above, collaboration between fishers and regulators in setting the TAC not only reduces resistance to the catch limit, but incorporates stock and habitat information collected by the industry.¹⁷ Because there is less antagonism between fishers and regulators in these circumstances, marine scientists are more likely to take account of industry recommendations and insights to advance the fish stock and achieve more effective regulatory policies. Accordingly, ITQs can lead to the setting of more optimal annual harvest rates, reduced free riding, and greater compliance by fishers. A portion of fishery rents are often taxed to cover at least some ITQ administration costs.

Other parties, such as processors and other input suppliers (crews, dock owners, boat and equipment sellers, and support providers) and their communities, however, may be adversely affected by changes in harvest patterns made possible by ITQ regimes. There is a change in the composition of resource users with successful ITQs. An important efficiency gain from mitigating open access is reduced labor and capital requirements, but these benefits will not be captured by those who have redundant supplies under the new arrangement. There are additional concerns that transferability of quotas and associated consolidation of the industry, which also bring efficiency gains, will gradually squeeze out small vessel owners.

These allocation issues are similar to those that molded the timing and nature of oil field production controls in the USA where the concerns of small producers led to exemptions and delay in adoption of mandatory unitization laws in Texas. Similar allocation concerns also arise in water, where transfers are restricted to protect rural community interests or limits on the percent of the TAC that can be held by any single ITQ holder.

Concluding Remarks: Summary and Implications for Future ITQs in Fisheries

The summary of property rights allocations provided here shows that first possession allocation rules dominate and that property regimes are adopted late in resource use and common-pool losses. Where incumbent users existed at the time of establishing the rights regime, first possession was employed. There is also recognition for past investment. Auctions are adopted very infrequently, only for fringe allocations where there are no incumbents and where resource values have been shown to be very high, as in the case of the radio spectrum. Although first possession is criticized by many economists as being inefficient, its empirical regularity suggests that there are efficiency advantages beyond political expediency. Except in the spectrum where transfers of spectrum rights have been restricted historically (except for recent auction allocations) and in water where long-term trades that change nature and location of use are subject to regulation, transaction costs of exchange appear to be low in most resources. Accordingly, initial rights assignments could be redeployed with comparatively low transaction costs regardless of the allocation rule.

Granting rights to incumbents who have experience in the industry appears to be consistent with an assignment to high-value, low-cost users. The state does not receive the rents when rights are awarded at no cost, as it would with an auction or with taxes on quota value. These practices, however, might reduce the interest of the users in protecting and investing in the resource stock, and it is not obvious that

politicians and regulatory agency officials would apply the revenues to achieve distributional or efficiency objectives.

There is the potential for waste due to a race to establish credentials for the subsequent assignment of use rights if first possession is known to be the allocation rule and the parties are homogeneous. Just how important this problem is depends on the empirical case at hand. In general, for most of the resources examined here, there was a long history of prior use before the introduction of rights-based institutions and the claimants were heterogeneous. Hence, the real costs of race may have been comparatively low.

In every case except for oil and gas unit shares, the rights granted are use rights only. They are not a right to the resource itself. In general, ownership of the stock is much more difficult to define and enforce than to the flow of use. Political interests have also influenced the nature of the regulatory system and the rights that are possible under it. This is observed in oil and gas regulation and unitization legislation, as well as with reservations of rights to certain groups in some fisheries and small parts of the radio spectrum. In some cases, the use right is weak and uncertain due to state regulation. Restrictions on entry to protect incumbent broadcasters under public interest regulation suggests that caution is order when predicting that regulation will advance public, as compared to private, interests in resource use. Further regulatory constraints on trade likely lower the value of the use rights granted.

In terms of implications for future ITQs in fisheries, first possession or historical catch will govern where there are incumbent fishers, as is most common. Uniform allocations will be granted in new fisheries and auctions in new fisheries where there are high-valued species. Preferential assignments to certain groups of fishers (small, community) and accompanying restrictions on exchange lower the value of the rights and the value of the fishery. They may be important for political support of the rights arrangement, but they come at a cost. Finally, the stronger the right, the better the arrangement will protect the long-term value of the fishery. A broad regulatory mandate in the public interest may not be consistent with maximizing the value of the fishery and its contribution to well being of fishers who are part of it.

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