THEME 3
Allocations within sectors

Assigning property rights in the common pool. Implications of the prevalence of first-possession rules

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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 selected fishery ITQs in six countries (Australia, Canada, Chile, Iceland, New Zealand and the United States). 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 such allocations (rights set-asides for particular groups and exchange limitations) may be costly in the long run for maximizing the value of the resource. I also look at government regulation of use rights to water and the radio spectrum under the public interest and public trust doctrines. The record suggests that private, rather than public interest considerations dominate agency decisions. There may be similar regulatory effects in fisheries and other resources.

1. INTRODUCTION

There is an accelerated trend toward assigning property rights of some type to resources in order to mitigate the losses of the common pool.[146] A recent survey found that tradable use permits were used in 9 applications in air pollution control, 75 in fisheries, 3 in water, and 5 in land use control.[147] These institutional innovations have taken place as the resources have become more valuable, as they have faced growing open-access or common-pool losses, and as dissatisfaction has increased with existing centralized

[146] See Stavins (2003) for discussion of the movement toward market-based instruments.
[147] Tietenberg (2003, p1).

regulation.[148] There are multiple advantages of property rights arrangements including flexibility, cost-savings, information generation, migration to high-valued uses, and better alignment of incentives for conservation or investment in the resource. The more complete are property rights, the more the private and social net benefits of resource use are meshed, eliminating externalities and the losses of the common pool.[149]

By contrast, centralized (command and control) regulation, which typically relies upon uniform standards, arbitrary controls on access, constraints on timing of use, and/or limits on technology or production capital, suffers from a variety of well-known problems including high cost, inflexibility, ineffectiveness, and industry capture. Further, regulatory decisions take place in the absence of information about alternative uses that market trades generate. Finally, centralized state regulatory rules may or may not align with the incentives of actual users of the resource. Generally, no party involved – actual users, regulators, politicians – is a residual claimant to the social gains from investment or trade.[150] Accordingly, extraction, production, investment, and allocation decisions are based on other factors that are apt not to be consistent with maximizing the economic value of the resource or of conserving it. Indeed, the experience with many central regulatory regimes has not been satisfactory—fisheries continue to be depleted; air pollution abatement targets have not been achieved; water has not been re-allocated effectively; and technological change in the radio spectrum has been retarded.

Despite the attractions of more definite property rights, they remain controversial, limiting or slowing their adoption. They generally are adopted only late, after conditions have deteriorated for many regulated resources.[151] Allocation is the most controversial aspect because of the distributional implications involved in moving from open-access or central regulation to a property regime.[152] In many cases, at least some constituencies, including regulators, who benefited from the previous regulatory arrangement, will be disadvantaged under a new rights system. Hence, these parties will resist the new arrangement until there are few options.

More broadly, any property right that has meaning involves exclusion, so that some parties that previously used the resource will be denied access. Production under a property rights regime has a different composition of inputs and timing than what occurs under open-access or regulation, with negative impacts on certain groups of labor, input sellers, service organizations, and processors. These production changes are inherent in the efficiency gains of privatization, but not all parties directly benefit from them. Further, as the resource rebounds and becomes more valuable, new owners have wealth, status, and political influence not available to those without access privileges. These distributional factors, along with the costs of bounding, measurement, and enforcement constrain the extent and timing of the assignment of property rights to address the common pool. In this paper, I examine these issues across a variety of resources and develop generalizations for application of ITQs in fisheries.

2. OPEN-ACCESS AND THE ALLOCATION

2.1 The losses of the commons

Garrett Hardin's the Tragedy of the Commons (Science, 1968) made clear in the popular scientific press what resource users had always understood, that open-access can result in important economic and social losses.[153] Hardin was not the first to call attention to the tragedy of the commons. More than a decade before his article, H. Scott Gordon

[148] Stavins (1998b).
[149] Libecap (1989), Dahlman (1972).
[150] Johnson and Libecap (1994, 156-71).
[151] Tietenberg (2003, 10), also notes this empirical regularity.
[152] Definition and enforcement costs for mobile, unobserved resources are also issues as discussed below.
[153] Discussion drawn from Libecap (1998).

(1954) clearly outlined similar logic in another classic: "The Economic Theory of a Common-Property Resource: The Fishery. Gordon=s analysis was extended by Scott (1955), Cheung (1970), among others.

Under open-access, individuals are attracted to valuable resources so long as their private marginal costs of access and production are less than or equal to the average returns for all parties from resource use. Waste occurs for a variety of reasons. One is that short-term production levels are too high and investment is too low. Because property rights are not clearly assigned, individuals in their production decisions do not consider the full social costs of their activities. Accordingly, the net private and social returns from individual production decisions diverge. Production by one party lowers the productivity of others. These technological externalities are seen by all parties, leading them to rush production before their competitors. As a result, total output or harvest by all parties exceeds the social wealth-maximization point, where social marginal costs equal social marginal returns. Therefore, individuals exploit the resource too rapidly and intensively at any time, relative to interest rate and price projections. Further, the emphasis on competitive, short-term production ignores long-term investments. The incentive to invest is reduced because investors cannot anticipate that they will capture the resulting returns.[154]

Another source of waste is limits on exchange due to the absence of more definite property rights. Demsetz (1967) argued that an assignment of property rights was a prerequisite for markets to facilitate socially-valuable trade among economic agents and thereby, to create asset prices that reflected underlying demand and supply. In the absence of market price signals, open-access resources do not flow smoothly or routinely to higher-valued uses as economic conditions change. Moreover, they are not allocated effectively over time. When market prices indicate that the present value of resource rents is greater from future, rather than current use, exploitation will be delayed. Under open-access, however, there is little incentive for economic agents to postpone resource use to the future.

Finally waste occurs because under open-access competing claimants must divert labor and capital inputs from socially-valued production to predatory and defensive activities.[155] Rent-dissipating violence among competing claimants is possible.

2.2 Central state (command and control) regulation

In cases where the resource is relatively easily bounded and measured, such as land, and where the numbers of parties involved are small, some type of locally-devised property institution effectively mitigates the losses of the commons.[156] Group or common property arrangements are an example. Where these conditions are not met, the initial response to open-access generally has been state regulation of entry and production to include: (a) restrictions on access or time of use, such as limits placed on non-citizens or non-residents in fisheries or prohibitions on use of large parts of the radio spectrum; (b) equipment controls, such as on vessel size or technology used in fisheries and uniform requirements for scrubbers on power plants; and (c) extraction regulations, such as prorationing in oil production and air pollution emission controls. The aim of these regulations is to constrain output to more optimal levels and thereby avoid some rent dissipation.

State regulation is the initial resort for a number of reasons. One is that it avoids the complex, costly, and controversial allocation of more definite property rights, which could directly address the problem of externalities. Second, state regulation may involve

[154] Indeed, empirical studies of land use in developing areas document the importance of property rights for mitigating common-pool conditions and encouraging investment (Alston, Libecap and Schneider 1996).

[155] Umbeck (1981).

[156] Issues of measurement are addressed in Barzel (1997).

lower costs of measurement, bounding, and enforcement, and if the resource is of relatively low value, more definite property rights may be too costly to be an option.[157] Another reason is that state regulation is consistent with the notion that many natural resources are rightly "public" with ownership reserved in the state rather than in private parties. Similarly, if there are important public goods associated with the resource, then state ownership and regulation of access may be optimal. There are, however, potential problems associated with use and regulation under vague and uncertain concepts of the "public interest" or the "public trust" as described below. Finally, state regulation can advantage certain influential political constituencies who mould regulatory policy in their behalf. While market processes are relatively transparent, political and bureaucratic processes are less so, facilitating preferential treatment to certain parties.[158] This situation underlies the notion of regulatory capture.[159]

One of the constituencies in regulation is the bureaucracy itself which develops a stake in the maintenance and expansion of state authority and resistance to property regimes where more decision-making responsibility is granted to actual resource users. Agencies often are relatively insulated especially when resource management requires scientific knowledge that may not be generally available to citizens. Hence, agency officials can manage the resource to maximize budgets and regulatory discretion, to advantage particular favoured constituencies, and/or to advance particular political, scientific, and professional views of resource access and use. Since neither politicians nor bureaucrats are direct residual claimants to the resource rents that are saved by mitigating the losses of open-access, their regulatory decisions may or may not increase the social or economic value of the resource.

For all of these reasons, when the costs of central regulation become large and its effectiveness in stemming open-access losses questioned, other options become considered. If the resource is of high enough value to warrant more definite property rights, then they can be adopted. But property rights arrangements are costly and how they are implemented affects their efficacy in addressing the losses of the commons. A key issue is that of allocation.

2.3 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.[160] 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 determines the nature of the rights arrangements that ultimately emerge, their timing, and effectiveness.[161] As emphasized by Coase (1960), allocation rules are always important for distribution and they affect efficiency in the presence of transaction costs. Property rights allocation also is 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:

[157] See Alston, Libecap and Schneider (1996) for discussion of the emergence of property rights as resource values change.

[158] For discussion of the problem of oversight when information is limited, see Johnson and Libecap (2001).

[159] Posner (2003; 346-349, 370-374, 529-537). "Over time, regulatory agencies come to be dominated by the industries regulated."

[160] Rose (1998).

[161] See Libecap (1989).

2.3.1 First-possession rules

First-possession is the dominant method of establishing property rights.[162] 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, who have 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. Allocations that do not consider the position of incumbents will face opposition, raising the costs of rights assignment and enforcement.[163] Accordingly, grandfathering in initial allocation has been a necessary ingredient in building the political support necessary to implement the approach.[164]

There are other reasons why first-possession rules can be efficient. In principal, they recognize first-movers, innovators, entrepreneurs, who first experiment with and use a resource. Society benefits from innovative, risk-taking activities, and first-possession recognizes 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, and if transaction costs are high, such exchange might be limited. Hence, first-possession can economize on transaction costs.[165]

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.

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. 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 can mitigate rent dissipation.[166]

The same criticism of first-possession rules and rent dissipation applies if homogeneous claimants race to establish property rights to the stock.[167] 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 the "winners" of such a race may be the most efficient producers. Accordingly, first-possession may not 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

[162] See discussion of first possession in Epstein (1979), Rose (1985) and Lueck (1995, 1998).

[163] On the American frontier, "squatters" moved ahead of the federal land survey. When the land was subsequently surveyed and opened for claiming, "claims clubs" formed to prevent outsiders from encroaching on pre-existing holdings. See Gates (1968, p152).

[164] See also, Tietenberg (2003, p10).

[165] See Epstein (1979).

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

[167] Stavins (1995) refers to grandfathering as a give away. Inefficiencies would come through a race of homogeneous parties.

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.[168] In the case of intellectual property rights, where the fixed costs of research and development are low, as may be the situation in software, it is argued by proponents of the "open source" movement that copy rights and patents are inefficient. They deny access, expansion of the market, and related subsequent innovation.[169]

2.3.2 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 or of documenting precedence claims that are part of first-possession assignments. They can also avoid the costly pursuit of 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 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. Where there are existing parties who use a resource informally (and sometimes illegally), implementing a uniform allocation rule for the assignment of formal property rights is resisted because it does not recognize prevailing claims. Opposition by established users to the reallocation of rights as part of a uniform allocation rule will raise the costs of definition and enforcement.[170]

2.3.3 Auction allocation

A third allocation mechanism is auction. It can directly place asset into the hands of those who have the highest value for the asset. It 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 or uniform-allocation.

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. For these reasons auctions not used as often as economists have predicted.[171] Auctions can be used 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.

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[168] Alesina and Angeletos (2005, pp960-980).

[169] Lerner and Tirole (2005).

[170] On the United States agricultural frontier, the existence of incumbent informal land claimants or squatters led to enactment of the Preemption Acts that gave them preference in the allocation of formal property rights. Failure to do so would have led to conflict between existing and new claimants.

[171] Tietenberg (2003, p10) notes that auctions were used extensively in just one ITQ in Chile. Historical catch was the dominant allocation mechanism. Lueck (1998, p136) points to the costs of auctions.

As with other allocation arrangements, there are 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.

2.4 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.

2.4.1 The nature and distribution of information about the environmental/resource problem to be addressed by a property rights allocation

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 who 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. 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 about the sources of those losses. Recognition of existing users in any proposed rights arrangement and enforcement guarantees also can speed institutional change. First-possession allocation rules reduce uncertainty for incumbent users in the calculation of individual net gains from adoption of property rights.

2.4.2 The physical characteristics and value of the resource

Larger, more mobile, unobservable environmental/natural resources such as groundwater, 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. The state may lower transaction costs by providing information about the boundaries of the resource and by defining and enforcing individual partitions of it. Accurate measurement and effective enforcement are critical for the success of any rights-based regime. Large migratory resources that are difficult to bound may not be successful candidates for individual property rights because partitioning may not be feasible. Larger rights allocations covering extensive territories may be more plausible, but they involve greater enforcement costs.

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.

2.4.3 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.[172] 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.

2.4.4 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, be 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 reduces 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. As Johnson (1995) shows, these taxes are not neutral in terms of impact on the incentives of ITQ holders to conserve the stock.

Some resources, such as water or some wildlife, have been viewed as inherently public and private ownership has been resisted. Two related regulatory concepts are those of the public trust and the public interest.

2.4.5 Public trust/public interest

The "public trust" is a common law principle creating the legal right of the public to utilize certain lands and waters, such as tidewaters or navigable rivers, and other waters and natural resources with high amenity or public goods values.[173] Under the doctrine, the rights of the public are vested in the state as owner of the resource and trustee of its proper use. It historically had fairly narrow application, but broader interpretations

[172] Libecap (1989).
[173] Getches (1997, p217, pp224-228).

are advocated by some parties.[174] For example, recent water diversion restrictions have been implemented in the United States West under the public trust to protect natural habitat.[175]

The justification for public trust is that many vital natural or environmental resources provide important public goods that would not be provided effectively by private ownership because of the inability to exclude and to appropriate the returns from production and investment. Other justifications are based on equity of access; that private ownership would result in excluding most citizens from access to naturally-occurring resources. Therefore they should be held in the public trust and not given away.[176]

The public trust, however, is a vague concept that can be used opportunistically by interest groups to advance their preferred uses of the resource without compensating other parties. Where there are undisputed public goods at stake, then the public trust can be used to protect them via state regulation. Where there are mixed private and public values at stake in resource use, then the benefits are not so clear. While market failure to provide public goods is articulated by proponents of the public trust, the incentives of the state to provide public goods are less clearly outlined. That is, regulation in the guise of pubic trust can be used to advance special interests rather than resource or environmental improvements.

Accordingly despite its attractions, extension of the public trust doctrine as justification for limits on rights-based approaches comes at a cost. The associated regulatory interventions weaken property rights, promote open-access conditions and conflict, and thereby potentially dissipate private and public values of the resource. Valuable trade is reduced; useful information about alternative resource uses is not generated; important private investment is foregone; and competition over the common resource brings waste. Additionally, with so many interests involved, it may be impossible to reach consensus in allocation and use decisions. The high transaction costs of reaching agreement result in paralysis and lock-in of resource use in existing patterns, even though new, more valuable demands for its use may have arisen.

2.4.6 Predictions

Although an analytical framework has not been presented here, the discussion suggests a number of predictions for allocation rules:

1. First-possession will be used when there are incumbent users;
2. Uniform allocation or lotteries will be used for new resources where there are no influential incumbents;
3. Auctions will be adopted for new resources where there no incumbent users and where both potential rents and the transaction costs of subsequent trades are high. They also will be used on the margin to add flexibility to an existing first possession allocation system;
4. Adoption of rights-based institutions will come late in resource use when the costs of both open-access and central regulation are high; and
5. The most complete rights will be assigned to resources that are more valuable, less mobile, and more observable.

With these concepts in mind, we now turn to five environmental and natural

[174] Sax (1994, p14) references use of the public trust doctrine in the Mono Lake case of National Audubon Society v. Superior Court, 33 Cal. 3rd. 419, 1983, whereby Los Angeles was restricted from excessive diversion of water from the surrounding watershed that was causing Mono Lake's level to decline. The city was required to limit diversion of water, even though it held the water rights due to purchase of properties in the 1930s. Hence, the city's water rights were weakened. An alternative approach would have been to purchase water rights from Los Angeles in order to raise the lake's level.

[175] Gould (1995, p95), Simms (1995, p321).

[176] Tietenberg (2003, p15).

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

3. ALLOCATION OF RIGHTS TO SUBSURFACE OIL AND GAS RESERVOIRS IN NORTH AMERICA

In the United States and Canada rights to access oil, natural gas, and other minerals generally are assigned to surface land owners.[177] Actual ownership of subterranean oil and natural gas comes through the common law rule of capture, which as been noted, is a form of first possession. 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.

Oil and gas are lodged in subsurface reservoirs under great pressure. When any part of the surrounding geologic formation is punctured by a well bore, a low-pressure area is created. Natural gas and oil migrate rapidly toward the opening. The extent of migration depends upon subsurface pressures, oil viscosity, and the porosity of the surrounding rock. Reservoirs are not uniform. These characteristics differ across the field, generating inherent variation in well productivity. This migration potentially allows adjacent landowners to extract their neighbor's oil. Because this potential is recognized and because most oil and gas fields in the United States lay below multiple surface land owners (over 1,000 in the huge East Texas field), the stage is set for wasteful, competitive withdrawal.

Land owners grant extraction rights to firms through oil and gas leases. By this process, multiple firms gain access to the pool, and the lease, rather than the field, becomes the unit of production. Many firms, particularly major producers, obtain multiple leases on a reservoir and have operations on many fields. Each firm has incentive to drill competitively and drain to increase its share of oil field rents, even though these individual actions lead to aggregate common-pool losses. Rents are dissipated as capital costs are driven up with the drilling of excessive numbers of wells (more than geologic conditions require or price and interest rate projections warrant) and with the construction of surface storage, where the oil can be held safe from drainage by other firms. Unfortunately, once in surface storage, oil is vulnerable to fire, evaporation, and spoiling. Rapid extraction also increases production costs as subsurface pressures are vented prematurely, forcing the early adoption of pumps and injection wells. Total oil recovery falls as pressures decline because oil becomes trapped in surrounding formations, retrievable only at very high extraction costs. Finally, rents are dissipated as production patterns diverge from those that would maximize the value of output over time.

The common-pool problem has been recognized since oil was first discovered in the United States in 1859 and it has plagued petroleum production wherever there are numerous firms producing from a single formation. The problem also arises in Canada where surface ownership is fragmented as in the United States and parts of the North Sea, the Caspian region, and the Middle East when hydrocarbon deposits cross-national boundaries and producing firms.[178] There never has been disagreement over either the nature of the open-access problem or the general solutions to it. The conflict has been over allocation of oil net revenues under regulation or the assignment of property rights under unitization of production.

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)

[177] With hard rock minerals, such as gold or silver, this ownership arrangement has been modified to grant ownership to an ore vein, allowing the mining owner to follow the deposit below the surface properties of others. For discussion, see Libecap (1978).

[178] For general discussion of the common-pool problem in oil and gas production, see Libecap (1998).

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 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, and thereby shifted 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.[179]

The most complete solution to open-access in oil and gas production is field-wide unitization. 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. Accordingly, unitization results in important economic gains: a time stream of output that more closely approximates the rent maximizing pattern, increased oil recovery, and reduced wells and other capital costs.

Despite these attractions for mitigating the substantial losses in involved in common-pool crude oil production, early, complete, voluntary field-wide unitization has not been widespread. Libecap and Wiggins (1985) reported that as late as 1975 only 38 percent of Oklahoma production and 20 percent of Texas production came from field-wide units. For a unit to be complete, it must cover all of the formation and include all leases. Under voluntary unitization then, unanimity is required for agreement on a unit contract, and there is potential for holdouts to block agreement.

The key issue of contention is the allocation of shares of the net proceeds of unit production among the various parties.[180] These shares are property rights to the unit rents. Shares are assigned as first-possession rights based on lease values, but measurement is a major obstacle. Each lease's share is assigned in part on current and cumulative past production, which advantages those leases that were oldest and produced the most over newer leases with more limited production histories. The other allocation factors are estimates of the lease's strategic position on the hydrocarbon formation or future production potential. Strategically-located leases may be on the path of oil migration or have other locational advantages that allow them to do well under open-access production. These leases have the greatest potential to hold out. Measuring past output is not a source of contention; rather allocation conflicts are based on both legitimate disputes over the future production potential of a lease where information is imperfect and over strategic maneuvering.

Wiggins and Libecap (1985) examine the bargaining problem underlying unit formation and Libecap and Smith (1999) describe 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 their detailed analysis of 7 units in Texas and New Mexico, Wiggins and Libecap found that they required from 4 to 9 years from the time negotiations began until agreements could be reached. Moreover, in 5 of the 7 cases the acreage in the final unit was less than that involved in the early negotiations. With incomplete units, part

[179] Libecap and Smith (2002, S595).
[180] Libecap (1989, 93-114).

of the reservoir remains open-access or is organized into competitive subunits with significant losses.

Owners of small, very productive, strategically-located leases systematically withheld agreement in order to extract larger shares that better reflected what they believed they could get under unregulated production. At the same time firms with large holdings on a given field were most likely to agree early to a unit regardless of allocation because they bore more of the fieldwide losses of competitive extraction. Giving up some share allocation was offset by increases in overall production at lower cost. Negotiators for these firms tended to be more flexible in negotiations over allocation rules.

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.

To speed unitization, states have intervened with so-called compulsory or forced unitization statutes. These statutes relax the unanimity voting rule on share allocations. Between the late 1940s and the 1960s, all oil-producing states, except Texas adopted some form of forced unitization law to facilitate unit formation. Only in Texas was the power of small firms sufficiently great to block the legislation. Not surprisingly, Texas has a lower share of production from fully-unitized fields than does other states. It also has had more high-cost producers than other states.

4. THE ALLOCATION OF SURFACE WATER RIGHTS IN THE WESTERN UNITED STATES

In the United States 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 United States. They are recognized to lesser degree in some western states, such as California and Texas.[181] 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.[182]

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.[183] Subsequent claimants can also divert water with lower priority rights. On a stream, then there is a ladder of rights, ranging from the lowest to the highest priority. During times of drought when stream flows are reduced, the highest priority claimant receives water before junior claimants, who share the residual according to their priority. Hence, the more senior the claimant the more definite the amount of water secured by the right.

Importantly, under the appropriative system, individuals generally gain only usufructory or possessory rights to water, subject to the requirement that the use be beneficial and reasonable and to oversight by the state in monitoring transfers to

[181] California, Nebraska, Oklahoma, Oregon, Washington, North and South Dakota, and Texas have some riparian systems. See Getches (1997, p8).
[182] Thompson (1993, p681), Glennon (2002, pp14-21).
[183] Getches (1997, pp74-189).

insure that they are consistent with the public interest.[184] Measurement of beneficial use typically is physical diversion. Accordingly, possessory rights holders have had little incentive to conserve water or to leave it in stream since that could be evidence of a lack of beneficial use.[185]

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. 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 only historical consumptive uses, which is difficult to measure.[186] All water rights exchanges that involve changes in location, timing, or nature of use require state regulatory approval with opportunity for third-party protests of potential harm. 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.

Conflicts over allocation occur when there are proposed trades to re-allocate water from low to high-valued uses. In the American West, approximately 80 percent 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. Whereas farmers may pay $15/acre foot, urban and environmental values may be $300 to $20,000 or more. Griffin and Boadu, (1992, p. 274-5) estimated that the average transfer produced net benefits of $10,000/acre foot. As a result there are significant allocative gains from moving some water from agriculture to urban and environmental uses.

The misallocation of water has been recognized as a problem for a long time, yet water markets have developed slowly and controversially in the United States. The conflict is over the nature of water rights and their exchange. First, there are legitimate concerns about the impact of water trades on other water users (third party effects); there are pure rent-seeking efforts to capture a greater share of the often very large returns possible from reallocation; and there are efforts to block any private water trades and to assert greater state control over water rights under the public trust doctrine. Because individuals typically hold only usufruct rights to the water, there is the potential for retroactive regulatory applications of the public trust doctrine that roll back pre-existing appropriative rights.[187] As discussed above, unless narrowly defined, public trust interventions potentially weaken property rights and their advantages in addressing open-access.

For example, in a far-reaching ruling by the California Supreme Court in 1983 in the Mono Lake case (National Audubon Society v. Superior Court 685 P.2d 709) the court limited Los Angeles' ability to divert water from streams where it had held appropriative rights since the 1930s and 1940s. In general, Los Angeles was not compensated for the lost water and had to secure alternative sources. Public trust extensions emphasize that private water usufruct rights are non-vested and revocable and that such actions are

[184] Gould (1995, p94), Simms (1995, p321) Getches (1997, p83).
[185] There has been movement to recognize instream flows as a beneficial use.
[186] Anderson and Johnson (1986) and Johnson *et al.* (1981) 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.
[187] Getches (1997, p11). Simms (1995, p321).

non-compensable.[188] There apparently is no constitutional basis for takings challenges of public trust restrictions of private water rights.

Because water rights are comparatively weak (relative to land) and subject to considerable regulatory oversight, the transaction costs of exchange can be high - 20 percent or more of the value of the exchange.[189] And large transfers can take years to complete, as is evidenced by the recent purchase of water from the Imperial Irrigation District by San Diego which took some 20 years to negotiate. For all of these reasons Ker, Glennon, and Libecap (2006) show that the gap in water prices from those involving agriculture to urban and environmental exchanges relative to those solely in agriculture have been growing not declining since 1987.[190] This implies that the costs of misallocation are increasing.

Efforts to increase instream flows for valuable fishery habitat, recreation, and amity values illustrate the problems of reallocating water rights. Instream flows require that diversions be restricted, potentially undermining prior appropriation claims based on them. Monitoring costs are high because instream rights are vulnerable to increased diversion by downstream appropriative rights holders.[191] Water supply uncertainty also complicates reallocation. Periodic drought requires a rationing mechanism for allocating the reduced supply among traditional diversions and stream flows. If a minimum flow level is necessary to provide public goods amenities, then traditional irrigation diversions must be reduced. If the mechanism employed is clear, predictable, and involves reasonable compensation, then instream flow rights and appropriative rights can coexist. If the mechanism is more arbitrary, uncertain, and does not include fair compensation, then appropriative water rights are weakened. And the more they are weakened, the greater the losses of open-access conditions for water - more costly conflict, reduced investment and trade, and less information about alternative water uses.[192]

5. 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. Future breakthroughs promise to fundamentally alter the way the spectrum is used. This could be done by spreading a signal over a larger range, but with very low power, jumping from frequency to frequencies, or by patching together multiple small pieces of frequency. Uses of the spectrum include radio, television, wireless internet, remote controls, cordless (home/office) and mobile (cell/pcs) telephony.

The usual measurement of the spectrum is in Hertz, a unit of frequency. A 1 Hertz wave repeats every second. Therefore, more Hertz means a longer wave. The longer a wave is, the longer an antenna needs to be to capture all the information on the wave. The more information a wave needs to carry, the more it must modulate its frequency. That means it uses a broader range of frequencies (which cannot be used by other transmitters). A TV "channel" is about 6 MHz wide. An FM "channel" is about 2 MHz wide. Thus, TV signals require 30 times the capacity as FM radio signals.

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[188] Blumm and Schwartz (1995, pp709-11).
[189] Thompson (1993, pp704-5).
[190] Ker, Glennon, and Libecap (2006) and Libecap (2006, Chapter 1).
[191] Anderson and Johnson (1986) discuss the problems of defining rights to instream flows under the current appropriative water rights doctrine when diversions or instream flow rights are large relative to stream size.
[192] See summary of open access losses in Libecap (1998, p318).

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 United States, the spectrum was first used commercially by radio in the 1920s and entry was open with 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. There was little chaos or frequency interference early on. Spurred by the burgeoning popularity of this new medium, the number of frequencies available to broadcast rose from 2 in 1920, to 70 in 1923, to 89 in 1924.[193] 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.[194] As entry increased and inference rose, there were symptoms of open-access problem 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 United States and established the Federal Radio Commission to assign wavelengths, determine power, location of transmitters, to regulate equipment used, and to 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, and this practice remains today. Indeed in applying for a license, the applicant must acknowledge that the license does not imply a property right to the spectrum, although the licenses themselves (as use rights) are considered property. There was considerable emphasis on the public nature of the spectrum. Hence, broadcasters acquire no vested interest in the air waves and are issued licenses of no more than three years' duration.

The FCC was granted considerable regulatory discretion that added uncertainty to broadcast licenses. Existing broadcast licenses were grandfathered in their frequencies at no cost to holders as first-possession claims, but new licenses were restricted to be assigned by administrative allocation after review of the ability of broadcasters to serve the public interest. New entry was limited, and values of grandfathered licenses rose. Although incumbent licenses generally were routinely renewed, in re-application holders had to verify to the FCC that their programming was in the public interest, detailing the percentage of time devoted to different types of programs such as entertainment, religion, news, education, discussion, and community. Where two or more parties applied for the same frequency, the FCC assigned the license to the party whose use was considered most suitable.[195]

In 1927, because most of the spectrum remained undiscovered, unused, and unclaimed, the government might have used auctions to allocate licenses to 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

[193] Hazlett (2001, p353).
[194] De Vany (1998), Farber and Faulhaber (2002, p3).
[195] White (2000, p9).

other allocation mechanisms. The FCC might also have continued with recognizing new possessory claims, but it did not, largely due to lobby pressure by incumbents. The National Association of Broadcasters as an industry trade group helped to draft the license allocation procedures and they served to limit new entry to protect incumbents.[196] Under the Radio Act of 1927 licensing system, the major broadcasting networks emerged, NBC, ABC, CBS, and remained dominant. In exchange for these limits on entry, the industry agreed to content control by the FCC.

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 sub-dividable, 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. In fact, over 70 percent of the current owners of television stations are not the entities that originally received the licenses from the FCC. The sale prices of such companies have largely reflected the scarcity value of their licenses. This transfer, however, is not costless. The FCC uses its authority to extract "voluntary" concessions from license holders that wish to assign or transfer licenses in a merger context."[197]

The same block allocations and dedicated purposes are assigned across the country, but use values vary greatly. Much of the spectrum is not used as a result. New uses require new licenses. As such, the rigid administrative allocation mechanism has hindered the development of new technologies and uses of the spectrum.

Administrative allocation of licenses remained the dominant assignment mechanism until 1981 and still today accounts for 98 percent of the spectrum that is available commercially.[198] The alternative is to define specific exclusive rights to the spectrum in time, area, field strength, and bandwidth. For example, bandwidth confined within fiber optic cables, which is technically identical to wireless, is privately owned and traded.

In the late 1970s technology made possible cellular telephone uses and demand grew for access to more spectrum. The administrative process was slow and there was little public interest content in cellular phone use. In 1981 the FCC was authorized by Congress to use lotteries for non-broadcast spectrum uses. Over 1,400 transferable cellular telephone licenses were granted through 1989. The FCC restricted the lotteries to applicants who could certify themselves as "capable of constructing and running mobile phone systems," but brokers emerged to secure licenses to resell them. A flourishing secondary market emerged and demonstrated the enormous profits that could be made selling licenses.[199]

In 1993, again in response to new technologies and efforts to capture more of the rents associated with the spectrum, the FCC used 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.[200]

Auctions account for only 2 percent of the total radio frequency spectrum, and access to some auctions was limited to designated parties, such as women and

[196] The Fourth National Radio Conference, the government assembly responsible for crafting the new legislation, passed a provision including the public-interest test shortly after receiving a resolution the National Association of Broadcasters had passed suggesting it (Hazlett 2001, p351).
[197] White (2000, p14).
[198] Hazlett (2001, p353). More market driven approaches in NZ, Australia, and Latin America.
[199] McMillan (1994, p3).
[200] Cramton (1997, pp431–495).

minorities.[201] Set-asides, price preferences, or instalment payments plans were used for targeted firms. The FCC also gave premium license acquisition terms to companies who developed pioneering technologies, a practice known as pioneer preferences.

The FCC has been more lenient with authorizing auctioned licenses to be subdivided and subsequently leased by licensees. In the case of cellular telephony the Commission has allowed licensees to slice spectrum into increments of any size and to occupy or lease those increments more or less as they see fit.[202] More lenient regulations also apply to Direct Broadcast Satellite (DBS).[203] These options strengthen use rights, and huge values are involved. The use of lotteries and auctions as allocation mechanisms to new spectrum and the assignment of more definite property rights as resource values rise are consistent with the predictions outlined in Section II.

6. ALLOCATION OF AIR POLLUTION EMISSION PERMITS

Early regulatory efforts to reduce air pollution in the United States were costly and not 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.[204] 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.[205] 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 have been allocated through first-possession, based on past electricity production, heat generation, fuel use or emissions, free of charge. There more information about production and fuel use than for past discharges. In some cases, a small portion, about 2 percent, 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.[206]

Emission permits are a right to use the air to discharge waste products in production. They can be traded, although under the EPA emission trading program each time a permit is traded the authorized pollution under the permit is reduced by 20 percent, discouraging exchange. As with all of the resources described thus far, except oil, they are use rights only, not a property right to the air. Their value depends on their security, the longevity of the program, and the ability to trade and bank. Where these have been constrained, values have been lowered.

The use of emission permits provides incentives for greatest reduction in pollution by those firms that can do so at lowest cost. Rather than equating pollution levels across firms, these instruments equalize incremental costs across firms to reduce pollution so that marginal abatement costs are equalized. Differential abatement cost information

[201] Hazlett (2001, p415).
[202] Shelanski and Huber (1998, p593).
[203] Shelanski and Huber (1998, p594).
[204] Pashigian (1985).
[205] Dewees (1998).
[206] Fullerton and Metcalf (2001).

was not generated under central regulation. Those firms with pollution below their allowable allotments can sell the residual emission rights, apply them to offset excess emissions in other parts of their operations, or bank them. Other firms can buy them, and an active market has developed in most emission systems where tradable permits have been used.[207]

Two of the most successful programs were those authorized under the 1990 Clean Air Act Amendments to allow electric utilities to trade allowances to emit sulfur dioxide, SO_2, to reduce acid rain and the Los Angeles basin, RECLAIM (Regional Clean Air Incentives Market) program.

6.1 SO_2 and NO_x allowance trading

This program is the centerpiece of Title IV of the 1990 Clean Air Act Amendments. The objective was to reduce SO_2 and NO_x emissions by 10 million and 2 million tonnes respectively from their 1980 levels. These are the principle gases associated 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.[208] Total emissions were gradually reduced each year to achieve the targeted level. Within the annual total, tradable emission permits were allocated across generating units.

The emission permits explicitly are not a property right: "An allowance under this title is a limited authorization to emit sulfur dioxide…Such allowance does not constitute a property right.[209] Emission permits were allocated based on first-possession so that existing polluters were grandfathered and newer units were disadvantaged. Units that began operating in the year 1996 or later were not allocated any units, but were 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 and 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.[210] Additional allowances were granted to plants where scrubbers had been installed that reduced SO_2 emissions by 90 percent and to plants 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.[211]

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 lbs 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.[212] An 'opt-in' program also was used to encourage very low-polluting utilities to enter by granting them allowances which could be traded to others. The flexibility underlying the tradable emission permit system overcame

[207] Tietenberg (2003, p12), Stavins (2003, p4).
[208] Stavins (1998, pp6-13).
[209] 104 Stat 2591.
[210] Ellerman (2000, pp40-43).
[211] Ellerman (2000, pp8-9).
[212] Ellerman (2000, pp43-48).

political opposition to the ambitious air pollution reduction objective. There are various estimates of the cost savings of the program, but they range from US$5 to US$12 billion over a central regulation alternative.

6.2 RECLAIM (THE REGIONAL CLEAN AIR INCENTIVES MARKET)

This program was established in January 1994 to reduce NO_x and SO_2 in a four-county area in the Los Angeles basin to meet federal and state clean air standards by 2010.[213] The basin has some of the country's worst smog or ozone levels, the only area to fall into extreme non-attainment for ozone. South Coast Air Quality Management District (SCAQMD) sets total emissions set annually and tradable emissions permits granted to the largest fixed facilities emitting pollutants, as well as brokers, and environmental groups. Allocation is also first-possession, based on historical emissions—peak emissions activity between 1989 and 1992. Each facility received an allocation for each year between 1994 and 2000 based on a constant rate of reduction (7.1 percent for NO_x and 4.1 percent for SO_x). For the years 2001 to 2003, the allocation levels were decreased further (8.7 percent in NO_x and 9.2 percent in SO_x).[214]

7. ALLOCATION OF ITQS IN FISHERIES

Wild ocean fisheries are the classic open-access resource with over entry, over fishing, over capitalization, falling catch per unit of effort, and depleted stocks. These conditions follow from the fugitive nature of offshore species, huge distances involved, overlapping political jurisdictions, and large numbers of heterogeneous, competing fishers.[215] Unfortunately, the implications of open access have been understood for a very long time. Scott Gordon described it in 1954, yet 46 years later, Grafton, Squires, and Fox (2000), could still describe the dramatic wastes of over fishing and regulation in the Pacific Northwest halibut fishery, and a 2003 Nature article by Myers and Worm (2003) could report that the world's major predatory fish populations were in a state of serious depletion.[216]

Historically, the initial regulatory response has been to deny access to certain groups based on political influence—non-citizens 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

[213] Gangadharan (2004).

[214] Fromm and Hansjurgens (1996, p373; Regulation XX, Rule 2005.)

[215] Libecap and Johnson (1982), Leal, (2005), Tietenberg (2003, pp5-12) and Hannesson (2004) for discussion of the emergence of various regulatory/property regimes.

[216] A similar conclusion for deep-sea fisheries was reported by Devine, Baker and Haedrich (2006), also in *Nature.*

finding consistent with the predictions outlined in Section II and practices with other resources. ITQs require restrictions on entry, the setting of an annual total allowable catch, TAC, the allocation of 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 western United States water rights, United States spectrum allocations, and pollution emission permits.

The more secure, definite, durable, divisible, and permanent the ITQ, the stronger is the property right. And stronger 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 that catch 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.[217] 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, however, is controversial because it implies a more permanent, transparent private claim to resource rents than exist under open-access or central government regulation. And some parties who 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 can be efficient as well. Assigning quotas to those with knowledge and past experience in the fishery likely is consistent with granting rights to the low-cost users. This practice reduces the need for subsequent reallocation and therefore, economizes on transaction costs. Reserving the fishery rents to fishers, rather than granting them to the state via auctions, also, enhances long-term incentives of fishers for protection of the stock and provides incentives for investment. 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.[218] A portion of fishery rents often are 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

[217] Arnason (2002, p1).

[218] 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.

of quotas and associated consolidation of the industry, which also bring efficiency gains, will gradually squeeze out small vessel owners. Indeed, the concerns of these groups who anticipated being harmed by ITQs led to a four-year moratorium on their expansion in the United States in 1996 under the Sustainable Fisheries Act (PL 104-297). Regulators also may resist ITQs because of a potentially reduced regulatory mandate or diminished ties to specific constituents that become less active in the fishery under the ITQ.

These allocation issues are similar to those that moulded the timing and nature of oil field production controls in the United States 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.

The following summarizes selected ITQ allocations and the strength of the property rights granted in fisheries in five countries, Australia, Canada, Chile, Iceland, New Zealand, and the United States.

7.1 Australia

There are at least 20 ITQ-managed fisheries in Australia, covering about 34 percent of the volume and 22 percent of the value of the country's fisheries.[219] They involve both state-inshore and federal (commonwealth)-off shore fisheries. The dominant allocation method is first-possession based on historical catch. Prior investment plays a smaller role. There are equity considerations in certain fisheries leading to equal or uniform quota distributions and/or restrictions on the maximum and minimum amounts of quotas that can be held as well as requirements that quotas be exchanged only among license holders. Allocations of ITQs are without charge, although standard income and capital gains taxation apply, and there is some administrative cost recovery through license fee charges. ITQs in Australia are comparatively strong property rights, being permanent, divisible, and transferable, and apparently can serve as collateral for long-term loans.

One important ITQ fishery is the Southern bluefin tuna fishery, where ITQs were implemented in 1984 after serious deterioration of the stock. Quotas were allocated to all significant participants in the fishery who had landed at least 15 tonnes during the three seasons prior to 1984, based on formula of 75 percent catch history and 25 percent value of vessels. Another is the Southeast trawl fishery, where ITQs were adopted in 1992 in the face of declining stocks. The allocation rule weighed historical catch by 70 to 80 percent (depending on the trawl type) and 20 to 30 percent on past investment. A third ITQ fishery is the Southern Zone rock lobster fishery. After stocks crashed in the 1980s a TAC was set in 1992-3 and ITQs allocated in 1993-4. They initially were allocated based on past catch or pot share of total catch, but modified in 1994-5 to assign an equal share of TAC per pot, but the number of pots varied among license holders based on past practices. Hence, the allocation rule remained based on historical catch. Limitations were placed on the maximum and minimum number of pots that could be held by any license holder. Until 1998, quotas were transferable only among family members, but thereafter among any license holder.

7.2 Canada

There are ITQs in about 40 fisheries in Canada, accounting for over 50 percent of the value and volume of landings.[220] In established fisheries, allocations are based on historical catch, modified by vessel size, capacity, and recent investment. The quotas are granted without charge. Most quotas, such as those for Pacific halibut (1991) and

[219] Arnason (2002, pp3-11).
[220] Arnason (2002, pp12-17).

sablefish (1990), were adopted between 1982 and 1998. In one newer fishery, the North Atlantic shrimp fishery, a uniform quota allocation of the TAC was used. In that fishery there are a small number of licenses and limited historical catch records. This practice follows the prediction described earlier. ITQs as property are weaker than in Australia. They do not have the legal status of property, but rather held as a use privilege, subject to renewal and regulation. In most fisheries there are no limits on number of quotas that can be held, but there are no guarantees of permanence. Their term is the same as the fishing license, which generally is more or less automatically renewed.

7.3 Chile

In 2002, there were four ITQ fisheries in Chile, the squat lobster, yellow prawn, black hack, and orange roughy.[221] The squat lobster and yellow prawn ITQs were adopted in 1992 and 1997 following sharp declines in the stock and the black hake and orange roughy ITQs also in 1992 and 1997, as newly developing fisheries. Unlike the Australian and Canadian systems, initial allocation was by auction, followed by annual auctions of 10 percent of the outstanding quota shares. There are few participants (less than 10) in each of these fisheries so that allocation issues may have been less contentious. ITQs have durations of 10 years, but do not have the status of property in Chile with fisheries held as public resources, although the right to fish under an ITQ is property. The ITQs are perfectly transferable, divisible, and are not linked to a vessel. There are no maximum limits on the number of quotas that can be held by a firm, but during the annual auctions no firm can bid for more than 50 percent of the TAC. Based on the success of these ITQs, they were to be extended to other established fisheries, such as the horse mackerel fishery. There are existing firms and they may be more numerous than in the other fisheries. Hence, ITQs are to be allocated based roughly on 50 percent weight on historical catch for the past four years for purse seiners and past two years for trawlers, and 50 percent vessel hold capacity. There are restrictions on transferability to existing fishers.

7.4 Iceland

Iceland is one of the first countries to adopt ITQ's.[222] Herring quotas were implemented in 1975 and 1979; quotas in the capelin fishery in 1980 and 1986; quotas in the demersal fisheries in 1984; and ITQs to all fisheries in 1991. 16 species are covered for 95 percent of the volume of the total catch. The quotas were granted without charge and include a right to catch a given proportion of the TAC every year. TAC shares are divisible and transferable. In the demersal, lobster, scallop, and deep-sea shrimp fisheries, ITQs were allocated on the basis of vessel historical catch, 3 years prior to quota system adoption. In the herring and inshore shrimp fisheries, where smaller vessels may have predominated, there were initially equal shares for eligible vessels. There have been some restrictions on the transfer of annual quotas between geographical regions to protect local employment, and recent requirements that vessels holding quotas must be involved in harvest, a type of beneficial use requirement like that found in western United States water rights.

7.5 New Zealand

New Zealand is also one of the first countries to adopt ITQ systems.[223] After declines in deep water stocks within the 200-mile EEZ, New Zealand adopted ITQs in 1983 based on 1982 catch volume and vessel capacity. In 1986 an inshore ITQ system was adopted for vessels active in 1985 based on 1982-4 catch histories. In both the offshore

[221] Arnason (2002, 18-23).
[222] Arnason (2002, 24-33).
[223] Arnason (2002, 45-51).

and inshore fisheries ITQs initially were fixed quantities, but these were changed to shares in 1990. Equity concerns led to assignment of 40 percent of the quota to the Maori. The ITQs are permanent, divisible, and transferable, with no restrictions on trade among participants. The rights apparently are as secure as those that exist for land. The rights security is similar to that found in Australia.

7.4 United States

ITQs are more limited and are a weaker property right in the United States than in many other major fishing countries.[224] Only four United States marine fisheries operate under such regimes: the Mid-Atlantic surf clam and ocean quahog fishery, the Alaskan halibut and sablefish fishery, and the South Atlantic wreckfish fishery, all adopted in the early 1900s. Two extensions were under consideration in 1995 for the Gulf of Mexico red snapper and Pacific sablefish fisheries, but tabled with the 1996 Congressional 4-year moratorium on further ITQs. The ITQs are a permanent share of the TAC, divisible and tradable. They are allocated on the basis of historical catch at no charge. For example, in the quahog and surf clams fisheries, quotas were allocated on the basis of vessel catch 9 years prior to introduction of the program, 1979-1987, for quahog and 4 years catch history during 1986-89 for surf clam. The quotas can be held by non fishers, and there are no restrictions on transferability. In the Atlantic wreckfish fishery, half of the TAC allocation was based on vessel catch recorded in 1989 or 1990 and half was equally allocated to all vessels that had a catch of 5,000 bounds prior to 1991. Transfers are unrestricted within the management area.

In the Alaska halibut and sable fish fisheries, allocations went only to vessel owners who had landings during 1988-90 (historical catch) and were based on the best five of seven harvest years between 1984 and 1990 for halibut and best five of six harvest years between 1985 and 1990. Quotas go the vessels and owners must be on the vessels (a type of beneficial use requirement). Part of the halibut TAC is reserved for community development quotas. ITQs in these two fisheries are weaker than in the others. There are restrictions of transferability to those in same management area and vessel class involving fishers with 150 days commercial fishing and there are minimum and maximum quota limits.

8. CONCLUDING REMARKS: SUMMARY AND IMPLICATIONS FOR FUTURE ITQS IN FISHERIES

Table 1 summarizes practices across the five resources with respect to the nature and strength of the property right granted, timing, allocation mechanism, existence of incumbents and high resource values and political constraints.

As shown in the table first-possession allocation rules dominate, and 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 re-deployed with comparatively low transaction costs regardless of the allocation rule.

[224] Arnason (2002, 52-7).

TABLE 1
Summary of allocation mechanisms and strength of property right for five natural resources

Resource	Nature of the property right	Timing in assignment	Allocation	Incumbents, high resource values?	Political constraints
Oil and Gas Unit Shares	Full, legal property right	Late in resource use and common pool losses	First Possession (Rule of Capture)	Incumbents	No restrictions on trade Small producers granted preferences in regulation and restrictions on mandatory unitization laws in Texas
Water Rights	Use rights Used as collateral for short-term loans only Value capitalized in land value	Early allocation but quantification comes late	First Possession (Priority)	Incumbents	Trades affecting time, nature, and location regulated Public trust doctrine review
Air Emission Permits	Use rights Explicitly, not a property right	Late in resource use and common pool losses	First Possession Limited (2.8%) Auction in Phase I	Incumbents Auction (extra or fringe permits, no incumbents, high values)	Some preferences to coal using states in SO_2 permits More restrictions on banking in RECLAIM
Radio Spectrum	Use rights Explicitly not a property right to the spectrum	Administrative allocation early, lottery and auction late	First Possession Administrative allocation Limited lottery and auction (2%)	Incumbents Auction (new spectrum, high value)	Incumbent broadcasters benefited under allocation and regulation to limit entry Auction set asides for designated groups
Certain Fishery ITQs					
Australia	Use rights Legal property right	Late in resource use and common pool losses	First Possession (historical catch, some past investment)	Incumbents	Some quota trade restrictions
Canada	Use rights Not property	Late in resource use and common pool losses	First Possession (historical catch and past investment and vessel size) Uniform allocation	Incumbents New fishery	Some quota trade restrictions
Chile	Use rights	New Late in resource use and common pool losses	Auction First Possession (historical catch and vessel size)	High value Incumbents	Some quota trade restrictions
Iceland	Use rights Fairly strong property right	Late in resource use and common pool losses	First possession (historical catch, vessel size)	Incumbents	Some quota trade restrictions
New Zealand	Use rights Legal property right	Late in resource use and common pool losses	First Possession (historical catch and past investment)	Incumbents	Some quota trade restrictions Reservation of quota share for Maori
United States	Use rights Uncertain	Late in resource use and common pool losses	First Possession (historical catch)	Incumbents	Some quota trade restrictions Community quota reservations Actual fishers.

Hence, stickiness of use based on initial rights assignment is unlikely to be a major source of efficiency loss. 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, of course, 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 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. Political interests have 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 under the public trust or public interest doctrines. Restrictions on entry to protect incumbent broadcasters under public interest regulation suggests that caution is order in predicting that public trust or interest regulation will advance public, as compared to private, interests in resource use. And 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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Customary/Indigenous allocation issues

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Kia ora. He mihi mahana ki a koutou na tenei uri o Ngapuhi. E nga iwi o te motu, e nga iwi o tea o…tena koutou tena koutou ten ara tatou katoa.

I am honoured, if not a little daunted, at the invitation to speak to you today. However, I do relish the opportunity to tell you the hugely exciting story that has arisen from "the sharing of the fish" in the Maori Fisheries Settlement in Aotearoa New Zealand and specifically the impact that this has had on the success of my Tribe, Ngapuhi.

While I am currently a Deputy Secretary, responsible for national operations and programme delivery with the Ministry of Maori Development or Te Puni Kókiri as it is usually known, for almost four years I was the Chief Executive (CE) of Te Runanga a lwi o Ngapuhi (the Runanga) – the Ngapuhi Tribal Council, based in Kaikohe in the far north of the North Island.

The Runanga is the Tribal Authority responsible for the economic, social, cultural and spiritual development of the Ngapuhi Tribe and all of its descendants. In my time there, the Tribal body was very involved and influential in seeing the delivery of the Maori Fisheries Settlement and also rapidly building capacity in managing fishing assets. But today I stand before you, representing Ngapuhi as Ngapuhi, not as the CE of Runanga. I no longer hold any executive or directional role with my Tribe.

I have developed a conference paper which covers the history of the fisheries settlement with New Zealand's indigenous people. The paper presents a comprehensive overview of the intentions of the settlement, how it was put together and implemented. I hope that this will be a good reference for you and provide some of the detail that you policy leaders and thinkers so require.

In my time today I want to focus on the personal view of the effect of the fisheries settlement on Ngapuhi and the people in the fisheries industry, both Maori and non-Maori New Zealanders. And while there is still significant work to be done in gaining the same success in the customary share, as has been achieved in the commercial arena, this is a great story about successfully sharing some of the fish.

1. NGAPUHI POTTED HISTORY

Ngapuhi are renowned for innovation, adaptability and audacity. Ngapuhi has a colourful history. European settlement occurred first in our tribal territory and very quickly we became active traders with whalers, sealers, and eventually the burgeoning English colony on the east coast of Australia at Botany Bay.

As New Zealand towns grew Ngapuhi led the change in developing those new markets for our goods and services. Our people were leading protagonists in the musket wars in the early nineteenth century and in 1840, our Chiefs were instrumental and present at the signing of the Treaty of Waitangi, which is regarded as the founding document of our nation.

Today, Ngapuhi is the most populous of Maori Tribes in Aotearoa New Zealand. Almost 20% of all Maori are Ngapuhi with approximately 107,000 members. While about 20% of Ngapuhi live within the tribal boundaries (the 'winterless' far north of the North Island), it's estimated that 60% live in Auckland with the remainder spread throughout the rest of New Zealand, Australia and the world! Stacey Jones, the 'Little General' currently leads a Super Rugby League Club in France. Buck Shelford, both famous sportspeople; they're both Ngapuhi. And so too is the recently appointed CE of the Commonwealth Bank of Australia, Ralph Norris.

2. SOME FURTHER BACKGROUND

With the impact of urbanization and following World War II, many Ngapuhi, particularly in Auckland, were struggling (and continue to struggle) to meaningfully hold onto their Ngapuhi identity. For some, that struggle for identity has contributed to a sense of loss, exacerbating under-achievement, to the point that our negative social statistics (as for most Maori and other indigenous people the world over) is very telling. It has put a hand brake on achievement for Ngapuhi.

When I became CE of Ngapuhi, and faced with this reality, my strategic focus was on strengthening identity and providing Ngapuhi with the tools they required to strengthen their ties and reconnect with their Tribe.

2.1 What is Ngapuhi identity?

Over seven hundred years ago, our ancestors left Hawaiki, our place of origin, and settled in what was, and what is now, our tribal area. Since then, the Ngapuhi Tribe has steadfastly remained in the 'winterless' far north of the North Island. We have a long connection with our tribal lands and seas.

In essence Ngapuhitanga is a set of powerful concepts all interconnected with each other. Ngapuhitanga includes history, ancestors, song, dance, art craft, land, forests, waterways, seas and oceans.

Maori are tangata whenua, "people of the land". Tangata whenua also loosely translates to "indigenous" and each Tribe is tangata whenua to its own tribal boundaries. We have a special connection with the physical resources of our tribal boundaries. It is a unique sense of place.

Tribal boundaries, much like beautiful Ngapuhi women, have been fought over, defended, worshipped, celebrated and loved. Within these tribal boundaries, are where we have harvested, traded, developed, bred, lived and died since those first ancestors settled.

I know that many other cultures also have a strong sense of place that helps to make up their identity. However, our unique Ngapuhi culture, our identity, is defined by its place. So how do you reconcile this with the fact that our people are a diaspora spanning the globe?

The answer is by providing them with tangible and meaningful connections with their identity, where ever that may be. It is about equipping our people with a sense of identity so they can exude their Ngapuhi culture with confidence, where ever they are. For Maori, confidence is one's culture; in one's identity, it is very often a prerequisite to being successful in whatever chosen walk of life.

When identity is strengthened young people are assisted to start the journey of finding their own success and those already successful can be driven onto bigger and greater things. The Ngapuhi Tribal Authority has a very clear vision, which is that the sacred house of Ngapuhi, stands firm. The Authority's mission was and still is, to lead the spiritual, cultural, social and economic growth of Ngapuhi. The Authority faces a major challenge in that vision and mission.

Ngapuhi has a young population base. There is a burgeoning population of young Ngapuhi, who are more likely to be formally qualified than their parents. Being

young and more formally qualified in an educational sense, they are more mobile and are seeking careers that never existed in their parents' day! So the challenge of strengthening Ngapuhi identity among this changing group of young people is very real. To start with, young Ngapuhi need access to their whakapapa, their genealogy; they need to understand their families place in the Ngapuhi journey. In this context of building identity and a new confidence, for Ngapuhi the fisheries settlement was a catalyst, the first dawn of a new era in the history of Ngapuhi.

2.2 The fisheries settlement

To understand the 'first dawn', I need to share a very short account of the fisheries settlement. Actually, it was such a saga, that any account can only be short!

The establishment of the Ngapuhi Tribal Authority is completely intertwined in the history of the fisheries settlement. In 1988, Te Runanga a Iwi o Ngapuhi was incorporated as a Charitable Trust, it was also the year when the first interim fisheries settlement was made. I remind you that the fisheries settlement would not have happened unless the Treaty of Waitangi was signed back in 1840. The Treaty ceded New Zealand to British Authority but, guaranteed the Chiefs and Maori Tribes of New Zealand, the full exclusive and undisturbed possession of their lands, estates, forests, fisheries and other properties, for as long as Maori wished to retain them. Under the Treaty, Maori were granted "all rights and privileges of the British subjects" which was a major concession for indigenous people at that time.

For Maori, from 1840 onwards and until relatively recently, our history has been a procession of dispossession, both through voluntary exchange and injustice. But, in the 1980s, after nearly two decades of Maori activism and protest, the tide began to turn.

In 1986, Tom Te Weehi was charged with collecting undersized abalone. In Court, Te Weehi argued he was fishing in a customary Maori way and he was doing so with the permission to fish from an elder of the local South Island Ngai Tahu Tribe. He also said he was protected under the Fisheries Act which said nothing in the Act shall affect "Maori fishing Rights". Up until then, that Clause had been Law since the nineteenth century, but to little effect. The Judge ruled in favour of Tom Te Weehi saying that the Treat of Waitangi (1840) had preserved Maori fishing rights. It was a watershed decision of jurisprudence.

Initially, the decision was regarded as a non-commercial right for customary take. However, soon after that Court decision and, in a totally unrelated occurrence, the Government of the day came to the conclusion that all other methods of allocating fisheries rights had failed. The fisheries industry was not economically or environmentally sustainable. The Government then decided to introduce the Quota Management System.

To introduce the system, Government officials calculated how much was needed for recreational and customary Maori fishing and then allocated the rest to existing fisheries in proportion to their catch history. This quota could be traded like any other property. Fisheries who caught below a certain tonnage or did not have catch histories in the right years were deemed part-timers, had their fishing licenses removed and they were allocated no quota.

To make matters worse many Ngapuhi people were victim to this new round of dispossession. The Ministry of Fisheries noted that most of the 300 part time fishers who lost their licenses were Maori, supplementing their incomes from other part time activities such as shearing and freezing work. In late 1986, the Muriwhenua claim was presented to the Waitangi Tribunal. The Tribunal is a permanent commission of inquiry which investigates breaches of the 1840 Treaty. It also makes recommendation on redress for those breaches.

The unique thing about the Muriwhenua claim, was it was the first time Maori had laid claim to commercial fishing. Their claim was there had always been "a commercial

dimension to Maori fishing" and that Maori had never sold their rights to fishing. With the new quota system about to be introduced in October 1987, the Tribunal agreed to deliver a preliminary opinion. They found that the Muriwhenua Tribes made extensive fishing use of the sea to 12 miles and occasionally fished further out. They also found that the seas were property in the same way as land and the Tribes had the mana of that area. By mana they meant that Maori were able to exercise dominion over the zone or that they owned it. Right in the middle of the single biggest reform of commercial fishing in New Zealand's history, the tribunal opinion landed like a hand grenade.

The claimants marched straight to court. The High Court accepted that they did have proprietary rights which the Government had failed to take account of. Justice Greig granted an injunction that prevented the Minister of Fisheries gazetting the next batch of quota. It was time for the negotiations to begin. In essence, after a year of negotiations an interim settlement was agreed in 1989 allowing the quota management system to proceed with 10 per cent of the quota going to Maori via a new body, the Maori Fisheries Commission. Maori clearly weren't satisfied with just 10 percent, and the Government had a problem because to provide more would require them to buy quota on the open market which would be very expensive.

In 1992 an opportunity presented itself when a New Zealand corporation decided to sell its fishing subsidiary, Sealord which held about 22 per cent of total quota. A group of negotiators that was roughly representative of Maori Tribes cut a deal that had two major components. The first is that the Government would provide the cash to the Maori Fisheries Commission, now called Te Ohu Kai Moana, to purchase 50 per cent of Sealord. The second was Maori were to get 20 per cent of the quota of any new species brought into the quota management system.

2.3 The allocation

The 1989 interim settlement and the 1992 Sealord settlement brought to a close the negotiations on the amount of redress available to Maori. Te Ohu Kai Moana, the commission, now had to develop a means for allocating the settlement assets among Maori Tribes. That was 1992. In 2005 Ngapuhi were the first iwi to uplift our share of the assets. It took 12 years to work out how the allocation would work. And no wonder... Do you divide the assets by population, or do you divide the assets by coastline controlled in tribal boundaries?

On the basis that the settlement should benefit all Maori, suggesting equitable sharing or distribution of the assets, Ngapuhi advocated for a distribution model based on the tribal population. Ngai Tahu was a very influential Tribe in the settlement process as their coastline consists of virtually the entire South Island, including Fiordland and Marlborough Sounds, so, not surprisingly they wanted a coastline length-oriented allocation method. Also, some Maori leaders saw the settlement as an opportunity to build pan-regional Maori structures emancipated from tribal politics. Others saw the settlement as an opportunity to rebuild the tribal authorities and tribal mana.

In the end the final allocation settlement was a compromise between the all of these methodologies. The quota assets were handed back to Tribes. The fishing company shares in Sealord and a number of other fishing companies, subsequently acquired by Te Ohu Kai Moana, were retained in a single corporation called Aotearoa Fisheries Limited which pays its dividends to the Tribes.

It is amazing and a credit to Maori that we were able to settle on an allocation method at all. It is a triumph of compromise. I believe Ngapuhi pushed hardest for compromise. We always believed that the negotiations had the potential to damage all Maori. There was always the threat that the allocation negotiations would become a process for lawyers and not for Maori. Litigation without end was our collective enemy. That interim quota Ngapuhi received, at reduced lease costs from the Commission until final allocation, and the preparation for, and the receiving of the settlement assets

brings me back to the central theme of my talk today; the fisheries settlement was a catalyst, the dawn of a new era in Ngapuhi's development.

In saying that, I need to give you an idea of how successful Maori have been in the two decades of their involvement in the fishing industry. Today, Maori directly control one third of the industry through ownership of quota, and influence up to another 20 percent through leverage of their quota. The Maori fishing workforce has doubled as a percentage of the total fishing workforce from around 15 to 30 per cent, from 1800 to approximately 9000 workers. Maori are the dominant commercial force in New Zealand's fifth largest export sector, generating $1.3 billion in export revenue, double the amount in 1986. This is an inspirational achievement. It is a totem of success.

3. EFFECTS OF THE SETTLEMENT

Speaking for Ngapuhi, I will illustrate the effects of the settlement in a number of ways.

3.1 The settlement assisted the Tribe to come together and address significant issues collectively.

The settlement gave Ngapuhi a reason to come together and stay together and learn to work together to address significant issues. From 1945 to the 1980s, there was virtually no public role for tribal organizations or tribal committees. But, in the late Eighties, Ngapuhi has to set up a company (Ngapuhi Fisheries Limited) to manage its fishing activities.

The company needed to develop its own policies and strategies to address the settlement and allocation negotiation. Ngapuhi leadership was being tested in ways never contemplated before, which brings me to the second point; the impact of the settlement on developing Ngapuhi's governance capabilities.

3.2 A new focus on developing Ngapuhi's governance capabilities

Ngapuhi did not become instant experts in governance theory, however, Ngapuhi identified that governance capabilities in a number of areas, including establishing new democratic processes to elect representative was needed, if they were to hold assets on behalf of the Tribe! Ngapuhi needed to learn the skills of separating leadership and governance decisions from management decisions. Ngapuhi leaders also needed to learn the difference between the interests of beneficiaries of the Charitable Trust and the linked, but separate commercial interest of the Tribe's business activities.

Ngapuhi made some early 'mistakes' which looking back, were an inevitable part of developing governance capability. In 2001, after an extensive internal review, I was appointed CE of the Runanga. Fisheries income was the mainstay of the Runanga, but there were debts and a number of under-performing activities that were holding development back. I took a 'crash course' in the business of fishing!

3.3 Professionalising Ngapuhi's tribal management

Te Ohu Ka Moana provided Tribes with an income source by leasing quota at a discounted rate. In 2001, Ngapuhi decided to take its entitlement to this leased quota and sublease it to the market, using an open competitive tender process.

Additionally, with the application of more transparent management practices in the fishing company, a focus on quota exploitation through Joint Ventures, that year we made a remarkable turn around and showed a net profit of $1.5 m, all of which, went to the owner – the Tribal body! This was from a company which, in comparison, for the previous 10 years, had returned on average $50,000 to the Tribe.

With that, the debts were cleared, a sustainable income was secured and a fresh start was made. During my time as CE, I was privileged to work with Sonny Tau, a Chairman with considerable patience and wisdom. Together, we formed a strong

partnership that continued the professionalization of Ngapuhi's tribal management. Sonny continues as Chairman of the Runanga today and the management of the Tribal Authority remains thoroughly professional. And they need to be. Last year following the allocation Ngapuhi's fishing assets were valued at $66m!

3.4 The impact on regional economic development

It is interesting to note that in the early days there was an expectation that returning the assets to Maori would lead to an increase in the number of Maori fishing companies, and that would allow more to enter the industry. It didn't work that way.

Quota enabled fishers to cash up and get out of the industry, and if you had an uneconomic parcel of quota, you had the mechanism to do so. The quota system led to a consolidation of ownership. The Maori owned fishing companies, such as Moana Pacific and Sealord, participated in this quota consolidation. They then set about consolidating the number of fishing ports. There were people who felt aggrieved about this, but as Mangers, there was a duty to get the best return on our assets on behalf of all Ngapuhi.

However, we actively helped where we could. For example, we held back a proportion of the inshore quota and made that available at less than market price so the Ngapuhi fishers could continue to participate in the industry. Further, there is nothing like success to breed success!

The sustainable income from fishing meant Ngapuhi was able to increase their investment in collecting, recording and distributing Ngapuhi stories and history, which are fundamental to Ngapuhi identity. Owing to that, Ngapuhi has increased access to that, for its entire Tribe. There is new confidence among our people – a confidence borne out of success and achievements.

3.5 Assisting Ngapuhi to build connections with non-Maori institutions and businesses

With that new confidence has come the ability to build new business partnerships with non-Maori companies, with other Tribes, community groups, local government, Crown agencies and the Government. Ngapuhi engages as an equal, a peer, rather than a supplicant or a beneficiary. Ngapuhi has the confidence and the resources to build new connections and new relationships which can extend the development, interest and influence of Ngapuhi.

3.6 Restored Maori confidence in New Zealand's institutions, particularly the law and reducing the powerful sense of alienation and injustice

The settlement restored Maori confidence in New Zealand's institutions, particularly the law and reducing the powerful sense of alienation and injustice Maori have felt for years. Critically, the process of alienation and injustice felt by Ngapuhi has been reversed. For man the sense of dislocation, alienation, and injustice hasn't gone away, but it has reduced. Redress was sought at the Waitangi Tribunal with the High Court confirming that Ngapuhi had proprietary rights to the fisheries.

Rather than the Law being a mechanism for the dispossession of Ngapuhi, it became an institution the Tribe could respect. In the last twenty years, some of the best and brightest Ngapuhi have entered the legal profession. I have no doubt that their whanau, their families went to see Maori lawyers build on the institution that is the legal profession, thereby ensuring that all Maori have access to justice. This is an extremely healthy and inclusive force for the future of our country.

3.7 Building a global confidence that has enabled Ngapuhi to succeed

I believe the settlement process was a catalyst for the re-emergence of a global Ngapuhi confidence. It is a belief that Ngapuhi can perform on the global stage in every sphere

of business, sporting or cultural activity and that where ever its people are, they remain a member of the Ngapuhi Nation.

4. CUSTOMARY FISHING

Before I conclude, I should touch on customary fishing.

As I mentioned before, it can be argued that the Maori fisheries settlement stemmed from the defiance of a single customary fisher in the south Island, Tom Te Weehi. But conflicts remain on the shoreline of customary fishing.

As has been fully discussed at this conference, there is a continual tension between commercial, recreational and customary fishers. This is no less the case in New Zealand. What makes things particularly interesting is now that Maori interests are a dominant force in the commercial fishing industry, the growth of Maori customary and recreational fishing has the potential to reduce the value of the commercial assets. This tension is being arguably debated within Ngapuhi and Maoridom as we speak. The debates require significant leadership from both Government and Maori.

5. CONCLUSION

Ngapuhi quickly took to the business of fishing. It was like it ran in our blood.

In the relatively short time of one generation, commercial fishing has enabled us to invest in our leadership, management and services to our people. These services are targeted directly at supporting Ngapuhi identity development. But indirectly it has given us a new confidence and strengthened our sense of purpose which in its own way is invaluable for the identity of our people.

When we look to the seas and oceans we no longer see injustice and dispossession. Rather, we look out over the great expanses of the Tasman Sea and the Pacific Ocean and we see that we have a share in the future, that we have a means to participate in the sustainable development of an industry and our people. The sense of pride among our people is palpable. The benefits for Ngapuhi are obvious to see, but also the benefits to our nation are also significant.

Non-Maori business interests look at us as business partners they can trust because we have a track record of success and reliability. The people of New Zealand and the Government have benefited too, because what is more corrosive to a nation's future than people who feel alienated and dispossessed? The world has too many people who feel dispossessed and alienated and hatred and wars are the symptoms of this disease.

Today I believe for Ngapuhi this process has reversed. There is still a lot to be done. But we know we can meet the challenges of serving the Ngapuhi house to stand firm, even though our members stand all over the globe.

Allocation policies and its implications for recreational fisheries management in inland waters of Argentina

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ABSTRACT

The Northeast, Central, Western and Northwestern, and Patagonia and Tierra del Fuego regions dominate Argentina inland recreational fishing. Being each unique in terms of environmental context, fish fauna and fishery types. High species diversity, extractive fishing and highly priced fly-fishing catch and release fisheries characterizes the Northeast. The Central Western and Northwestern fisheries are extractive, targeting few species. Patagonia and Tierra del Fuego have extractive and catch and release salmonid fisheries on the Andes. There are extractive fisheries of native species on Atlantic drainages of northern Patagonia, and anadromous rainbow and brown trout fisheries on southern Patagonia and Tierra del Fuego.

In the Northeast, Central, Western and Northwestern regions conflicts between fisheries sectors (e.g. recreational vs. commercial) exist. In Patagonia and Tierra del Fuego conflicts within the recreational sector associated to fishery types and fisher philosophies (e.g. extractive vs. catch and release, highly price lodges vs. free access) predominate.

Allocations, where implemented are generally set by specific interest groups not as part of an official strategy. This is part of a broader problem namely lack of integrated approaches towards the sustainability of Argentina's inland recreational fisheries.

[225] The paper was delivered by Dr José Bechara on behalf of all the authors.

1. INLAND RECREATIONAL FISHERIES OF ARGENTINA: AN OVERVIEW

Recreational fishing in Argentina is an expanding activity suspected of a high economic turnover at the local, regional and national levels (Urzua Vergara, 1992; Vigliano and Alonso, 2000; Cleminson, 2000). The Northeast, Central, Western and Northwestern and Patagonia and Tierra del Fuego regions (Figure 1) dominate the scene of Argentina's inland recreational fishing. Each region has unique characteristics in terms of environmental and socio-economic context, fish fauna fishery types and conflicts, defining a complex scenario, where base line studies and management programs are still insufficiently developed to provide guidance to interested parties. In general terms in all three regions - and based on target species sought for, their characteristics, the type of fishing gear and fishers socio-economic level - five types of inland recreational fisheries can be recognized (Table 1).

World-class fisheries: Characterized by fishers of very high socio-economic level mainly from outside Argentina and some nationals, highly specialized in terms of gear used and services required, making use of exclusive fishing lodges and outfitters. Their fishing experience is mainly oriented towards top predators of trophy size fish and pristine environments with little human presence, being usually catch and release advocates. In some cases, the lack of trophy size fish may be replaced by a high daily capture of very hard to catch fish such as dorado (Salminus brasiliensis) in the Iberá wetlands (Northeast).

Recreational 1: Characterized by high socio-economic level fishers mainly nationals that use lower priced lodges and outfitters than the previous group, they also favour top predators and big size fish, being less specialized in terms of gear and uniqueness of the fishing experience, mostly advocates of catch and release.

Recreational 2: Upper middle-to-middle class socio-economic level national and international fishers from foreign countries. Generalist with regards to gear and services required targeting a wider range of species, which include predators, planktivorous, and omnivorous fishes, and seeking not only sizes but also numbers of fish, conformed by both catch and release and extractive advocates.

Recreational 3: Lower middle-class-to-middle-class local and regional extractive fishers that do not hire specialized services. The fishing experience is not necessarily centred on catching fish and may be more related to the possibilities of outdoor activities with family or friends. In terms of fish they seek numbers, targeting carnivorous, planktivorous, and omnivorous fishes.

Recreational 4. This fourth category has to be considered carefully because it is actually an extractive fishery, characteristic of highly populated areas where poor people target mainly detritivorous as well as omnivorous species, seeking numbers for consumption even

FIGURE 1
Inland Recreational Fishing Regions of Argentina: 1. Northeastern region, 2. Central, Western and Northwestern regions. 3. Patagonia and Tierra del Fuego regions

TABLE 1
General characteristics of Argentinean inland recreational fisheries

FISHERY TYPE	RESOURCE CHARACTERISTIC SOUGHT	TYPE OF TARGET SPECIES	MAIN TARGET FISH SPECIES OR SPORT FISHERIES	FISHERS SOCIO-ECONOMIC LEVEL	COMPETITION WITH COMMERCIAL AND SUBSISTENCE FISHERIES	ARGENTINEAN REGION	REGIONAL HUMAN DENSITY
World Class Fishing Lodges	trophy size high numbers of fish per day	top predators carnivorous	SALMONIDS Salminus	very high, international clientele and some nationals of high socio economic level	nule	Tierra del Fuego Southern Patagonia Ibera Swamps (Ne)	very low
Recreational: Fishing Lodges	large size fish	top predators carnivorous large omnivorous	SALMONIDS Salminus Pseudoplatystoma Piaractus Brycon	high, national clientele of high socioeconomic level	very low	Northern Patagonia Parana-Paraguay Confluence Upper Bermejo And Upper Parana Rivers below Yacyreta Dam	low
Recreational 2	size and numbers of fish caught	predators planktivorous and omnivorous	SALMONIDS Odontesthes hatcheri Odontesthes onariensis Salminus Pseudoplatystoma Piarctus	upper middle class and middle class	low-middle	Northern Patagonia Pampa Plain Upper Middle Parana River	middle
Recreational 3	number of fish caught	carnivorous planktivorous and omnivorous	SALMINUS Pseudoplatystoma Odontesthes bonariensis	middle class-lower middle class	middle-high	Lower Middle Parana River Parana Delta Pampa Plain Western and Northwestern Reservoirs Yacyreta Dam (Ne)	middle-high
Recreational 4: (Banned for enironmental reasons)	number of fish caught	omnivorous but mainly detritivorous	Cyprinus carpio SMALL RIVERINE FISH	low-middle class and poor people	high	Rio de la Plata River	high

though fish species caught are usually banned for consumption due to environmental problems such as contaminants in fish flesh. Even though this type of fishery could be considered subsistence we have chosen to include it as recreational because it has no commercial value and people engaged in it have a mixed recreational subsistence view of it.

Preservation, recovery and improvement of natural resources are guarantee through the Argentine Constitution, the National Environmental Policy Law # 25.675, the National Parks Law # 22.351, the Wild Fauna Conservation Law # 22.421, Provincial constitutions and Provincial laws and regulations. Basically this body of norms state that natural resources must be managed as to preserve, recover or improve the quality of both natural and cultural resources promoting their rational and sustainable use. The provinces mostly regulate recreational fishing in Argentina, national law having precedence over provincial ones. Where interprovincial or international jurisdictions apply joint commissions are established to deal with conflicts and resource management.

2. NORTHEASTERN FISHERIES

Recreational fisheries of Northeastern Argentina have several distinctive features from the others of the country. The most remarkable is the large number of targeted species as a result of the high diversity of native Neotropical fish fauna. The most common fishery types are recreational 2 and 3. World class fisheries and recreational 1 have been growing during the last 10 years, with highly priced recreational fishing and international quality fishing lodges. Those fisheries rely mainly on dorado (Salminus brasiliensis), a highly valued species for fly cast due to its aesthetic, fighting and size attributes.

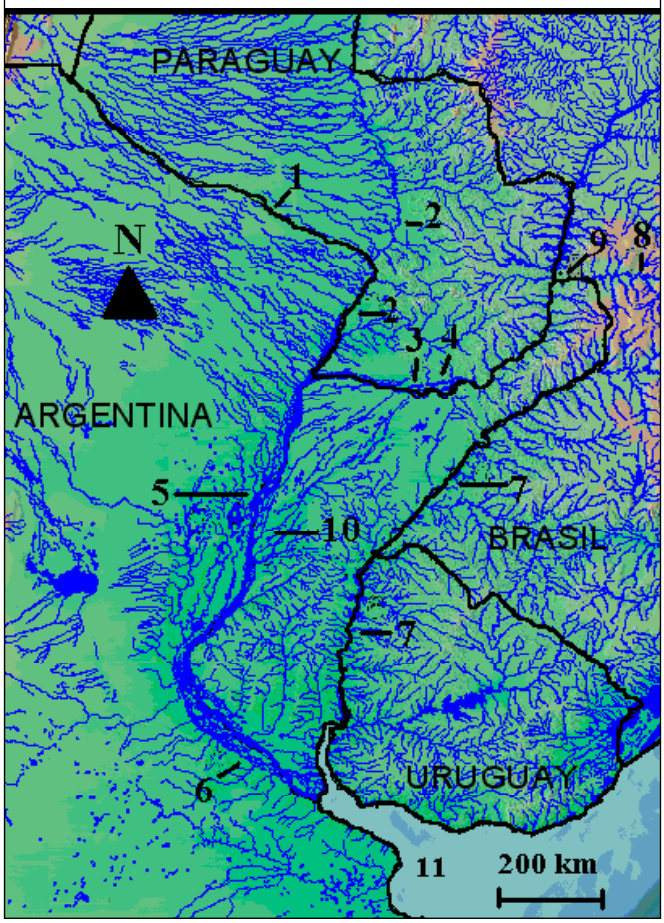
A second particular feature in the large rivers of the region is the existence of an important commercial fishing pressure, which generates frequent conflicts among fishers. Third, the region shares international waters in both, Paraná and Paraguay rivers (Argentina-Paraguay border), which is an additional source of conflicts. In Paraguay the main fisheries is commercial, but with an emerging number of World Class and Recreational 1 fisheries. Fourth, most of the fishing activities are carried out in the large rivers or in some of their affluents, with almost no recreational fishing in the abundant shallow lakes of the region.

Finally, fishing tournaments are very popular and numerous, at the point that every important fishing town of the large rivers has at least one annual competition.

As well as for most fisheries in Argentina, there are very few scientific or technical studies on Northeastern fisheries, and those available are mostly for commercial fishing. Even crude statistical data are also rare and hard to find. Most works were published in reports of limited diffusion or in regional scientific journals. Therefore, very little is known about the fisheries biology of the targeted species, the impact of the fishing and the evolution of exploitation rates.

North-eastern Argentina (Figure 1) comprises six different provinces (Misiones, Corrientes, Chaco, Formosa, Santa Fe and Entre Ríos), and is also named fluvial littoral region. It extends over 0,5 million km2, having a subtropical climate in the north that gradually changes to a warm temperate in the south. Population density is middle in the north to middle-high in the south (average of 16 inhabitants km2). The northern provinces of the region are among the poorest and less developed of Argentina, while the southern ones present much better human development. From the point of view of landscape, the region is placed in a transitional zone, moving from the Paraná subtropical rainforest in the north-eastern hills of Misiones Province and from Chaco dry forest in the plains of the north, to the Pampas plains in the south and south east. Many ecotonal landscapes develop between those major biomes.

FIGURE 2
Hydrology of the Northeastern region: 1. Pilcomayo river, 2. Paraguay river, 3. Upper Paraná river, 4. Yacyreta dam, 5. Middle Paraná river, 6. Lower Paraná river and delta, 7. Uruguay river, 8. Iguazú river, 9. Iguazú falls, 10. Corrientes river, 11. Río de la Plata river. (Modified from USGS Global GIS Data Base. Digital Atlas of Central and South America)



The entire region belongs to Del Plata Basin, which is the second largest watershed of South America after the Amazon. This basin comprises two of the most developed regions of the subcontinent, placed at the headwaters (Sao Paulo, Brazil) and the Río de La Plata and Paraná River delta mouth (Buenos Aires, Argentina).The major watershed within the basin corresponds to the Paraná River (Figure 2), which has important affluents such as the Iguazú and Paraguay rivers. Other minor tributaries are also important for recreational fisheries such as the Yabebiry (Misiones Province), Corriente and Santa Lucia Rivers (Corrientes Province), Salado and Colastiné (Santa Fé Province). The Paraná and Iguazú rivers have been heavily dammed and they are highly regulated by headwater dams in Brazil. This fact may be one of the reasons for a decline in population size of some valuable species, particularly omnivorus/frugivorous (Piaractus and Brycon) (Quirós, 1990).

Due to its size and complexity, the Paraná River can be divided in several reaches with their particular ecological features and recreational fisheries types. From the mouth of the Iguazú River up to Posadas City (Misiones Province), the river runs along a narrow and deep canyon almost without floodplain areas. From Posadas to Ituzaingó, the large reservoir created by Yacyretá Dam (1 140 km^2) dominates the scene, forcing fishermen to completely different fisheries styles since 1994. From this dam to the confluence with the Paraguay River the river has an anastomosed channel with important development of floodplain sectors and islands, as well as areas of rapids with bedrock outcrops. All these reaches belong to the so-called Upper Paraná River. Below the Paraguay River embouchure begins the Middle Paraná River, it has a large mean discharge (17 000 m^3 at Corrientes City) and a huge fringing floodplain attaining 100 km wide in some sectors. The most developed region of the country is the lower portion of the Middle Paraná, the Delta and the Rio de la Plata, but it is also the most heavily polluted, with organic contaminants widely incorporated by fish (Colombo *et al.* 2000), a fact that precludes fishing for massive consumption. Paradoxically, waters from the Paraná River are mostly oligotrophic or mesotrophic. However, in the last years, large blooms of cianobacteria (mainly Microcystis aeruginosa) have been observed in the upper and middle sectors, probably related to upper dams and the growing load of wastewaters effluents.

The other major river of the region is the Uruguay, which is also dammed, but bears a far less important development of recreational and commercial fisheries.

The Paraguay River basin is mostly undammed and unregulated, draining the Gran Pantanal waters in Brazil. This meandering river has a large alluvial plain, and collects

TABLE 2
List of the most important recreational target species in North-eastern Argentina, with some relevant data on sizes and some regulations

Order	Scientific name	Spanish common name	Habits	Minimum allowed length1 (total length, cm)
Characiformes	*Salminus brasiliensis*	dorado	potamodromous, top predator	75
	Piaractus mesopotamicus	pacú	potamodromous, omnivorous/ frugivorous	45
	Byrcon orbignyanus	pirá pita, salmon del Paraná	potamodromous, omnivorous/ frugivorous	45
	Hoplias malabaricus	Tararira	non migrant, lake dweller, top predator	–
	Leporinus obtsudiens	boga	potamodromous, omnivorous	45
Siluriformes	*Pseudoplatystoma corruscans*	surubí a lunares	potamodromous, top predator	85
	Pseudoplatystoma fasciatum	surubí atigrado	potamodromous, top predator	80
	Paulicea luetkeni	manguruyú	potamodromous, top predator	100
	Zungaro zungaro	manguruyú abá	potamodromous, top predator	40
	Luciopimelodus pati	patí	potamodromous, top predator	70
	Hemisorubim platyrhynchos	manduré tres puntos	potamodromous, top predator	35
	Sorubim lima	cucharón	potamodromous top predator	40
	Pimelodus albicans	moncholo	potamodromous, top predator	30
	Oxydoras kneri	armado chancho	non migrant, benthic feeder	45
	Pterodoroas granulosus	Armado común	potamodromous, omnivorous	35
	Pimelodus maculates	bagre Amarillo	potamodromous, benthic feeder	25-30
Perciformes	*Plagioscion ternetzi*	corvine	non migrant, top predator	30
Atheriniformes	*Odontesthes bonariensis*	pejerrey	non migrant, lake dweller, planktonic and benthic feeder	–

1= May vary according to provinces and type of fishing.
"–"= not found.

waters of two important affluent from Andean mountains: the Bermejo and Pilcomayo rivers.

The Paraná River geological activity during the Pliocene and Pleistocene at Corrientes Province has brought a large alluvial fan which abandoned beds and levees constitute the large Iberá marshland complex and related wetlands (Popolizio 2003). Some of these wetlands are pristine, and protected as provincial reserves or national parks. They are fed mostly by local rains with ultraoligotrophic or distrophic waters, with sandy bottoms widely covered by large floating peat soils. The most important wetland is Iberá, which comprises an area protected by a Provincial Reserve of 12 000 km^2, part of it belonging also to a Ramsar site.

Alluvial fans are also important in Bermejo and Pilcomayo Rivers, which have a large load of suspended solids (mostly colloidal clay). The old channels of these rivers in the Chaco encompass today important areas for fish reproductive migrations and spawning, and are exploited by type 3 Recreational fishers. All the fish of the area are also important to subsistence fisheries of aboriginal populations.

This region possesses by far the highest fish diversity of Argentina, which consists of about 350 fish species, being exotic only four of them (López *et al.* 2005). Just in 12 000 km^2 of Iberá marshlands, more that 111 species have been described (Casciotta *et al.* 2006). Most species belong to the group of tetras and related species (Characiforms), as well as catfishes (Siluriforms of several southamerican families). About 20 species are the most important in recreational fisheries (Table 2), while other 10 are used as living baits.

Both major orders have large trophy size species, a fact related to their migratory behaviour. Indeed, most large fish are potamodromous species that move upstream every year during low water periods (late winter and spring) to spawn during late spring or summer at the rise of the water level. Migratory fish spawn in the water column. They

usually employ reaches with intermediate depth and moderate currents. In the Paraná River, spawning takes place mainly in the Upper reach and in the northern portion of the Middle reach. This behaviour is important when considering decisions concerning season closures. Eggs are semi pelagic and derivate downriver; larvae and juveniles enter the flooded areas where they found refuge and food to growing up, maturing in 2-4 years, to come back to the river main channel for migration and reproduction.

The dominant recreational fishery types of the region are extractive for most species and extractive and catch and release for dorado. However, this latter modality has begun also to be implemented in the latter years in most tournaments.

In the upper section of the Paraná River the presence of the largest specimens of surubí and dorado have given rise to recreational 1, 2 and 3 type fisheries. They are mostly boat fishers (Iwaszkiw, 2001) and in lesser proportion coastline fishers. They may be found in the area between Augusts to May, except during the season closure period in November-December. They use a variety of fishing gears including casting, trolling, spinning and down rigging. Trolling is frequently employed to catch large silurid specimens, mainly surubí. High power outboard boats go upstream, and special artificial baits move up and down within the water column. Depths can reach more that 20 metres in those sectors of the river, and the large silurids are usually found in the deeper channels. Many of them are virtually hooked by the tails, a type of fishing that is banned by present regulations. Every artificial usually bears two triple hooks and it has been suggested by managers to put out the distal one to avoid these unwanted catches. However, this change is hard to introduce in the artificial bait industry.

Living baits are common, giving rise to an occupational activity of locally named "moreneros" because they capture mainly morenas, a common name given to Gymnotiformes (knife fish), particularly of the genus *Gymnotus*, *Brachyhypopomus* and *Eigenmannia*. Other species used as living baits are swamp eel (*Synbrachus marmoratus*), South American lungfish (*Lepidosiren paradoxa*), cascarudos and hoplos (*Calliichthys calliichthys, Hoplosternum littorale and Lepthoplosternum pectorale*), and tararira (*Hoplerythrinus unitaeniatus*). All of them share adaptations to breathe atmospheric air and have high rusticity, standing alive for long periods of time in water containers, even during the hottest summer days. Unfortunately, all these fish are collected from floodplain and marshes and angler demands are continuously growing. There are no regulations or rules for allocation concerning these fishes and particularly in the genus *Gymnotus*, several still unknown species are being used as baits. Fishermen only need annual licenses to carry out this activity, which is mainly for subsistence, since they usually belong to the poorest socio-economic levels.

There are few conflicts within the recreational fishing group in the large rivers of the region. Most problems are related to commercial versus recreational and the international use of waters by Argentina and Paraguay fishers. A new controversy has been growing that confronts catch-and-release and conservationist organizations against extractive anglers.

Out of tournaments, catch-and-release practices are limited to affluents such as Corriente River, placed in the protected area of Iberá Swamps, where only this kind of fishing is allowed for dorado (Bechara *et al.,* 2005). Fisheries types are world-class and recreational 1. The technique employed is mainly fly cast but using large streamers, which occasionally promotes by-catch of piranhas (*Pygocentrus nattereri* and *Serrasalmus spilopleura*) and some other species (*Brycon orbignyanus*, *Hoplias malabaricus*, *Acestrorhynchus pantaneiro* an*Crenicichla vittata*). Some anglers also practice catch-and-release spinning with artificial baits.

To support these fisheries, four lodges placed along the Corrientes river or its source lakes are presently operating. They are located close to the headwaters, where the largest fish concentrations occur. Several outfitters services are also offered. Fish caught are generally smaller than the big trophy size more commonly obtained in the Paraná

River (Bechara *et al.*, 2005). Casting anglers go for a large number of catches (5 to 10 in a fishing day), and at least one of two specimens closer to trophy size (8-10 kilos). However, the number of fish caught is variable and there have been a decrease in the last five years, probably related to the lack of large floods within the system and the increase of extractive fishing.

A decrease in fishing success can eventually result in the closure of those expensive lodges. Fishermen pay several thousands United States dollars a week of fishing including a variety of high-quality level services. They usually fish with the help of local guides using specially prepared boats in pristine and isolated areas, surrounded by a rich and diverse wildlife of aquatic birds, caimans, marsh deer, capybaras and many other wild animals. All these features, plus the famous fighting ability of dorado makes fishing in this area a highly searched experience for casting anglers from all around the world.

An evaluation of the mortality caused by catch-and-release practices, along with an analysis of the practices that reduce injuries are necessary. Although there are no studies on the impact of catch-and-release practices on dorado fish populations, they are supposed to be low, given that this species seems to be very resistant to physical injuries. This species makes large jumps over the water when caught, in an attempt to get out of the hook, a fact that is frequently achieved by the fish. Hooks produce injuries in the mouth and the gills, and large numbers of scales are lost during fights. Moreover, the same specimens can be captured several times in a year or during a fishing season. However, it is expected that mortality related to high and frequent stress will increase as fighting behaviour of dorados is coupled to better-experienced fishermen arriving to the region.

This argument is used by local extractive anglers, who are in conflict with catch-and-release advocates; mainly lodge owners and conservationist organizations that are against extractive fisheries in Iberá marshes. A management plan for the whole wetlands was recently finished and is presently under intense debate among different social statements and interest groups, to be finally established as a provincial law. This plan, in its original form prohibits any type of extractive fishing and limits catch-and-release fishing of dorados. The unsatisfied fishers that support extractive fishing are mostly Recreational 2 and 3 types. They obtained recently a permission from the Corrientes Province government to carry out extractive fishing in a reach of the Iberá Provincial Reserve. However, this allocation is allowed for all the species excepting the most valuable: dorado, surubí and manguruyú.

In the upper portion of the Middle Paraná, recreational 2 and 3 are the most common types of fishing. Most anglers search for fish in motorized high power boats because they have to rapidly find good fishing spots among thousands of islands and channels in the river corridor. Fishing excursions typically last a complete journey from early morning to late afternoon. The fishing guides are usually well informed about sites of school concentration and move dozens and even hundred kilometres a day to find good fishing areas. The economic activity of this kind of fishing is extremely important. Cleminson (2000), estimated for the Santa Fe province a mean daily capture of 5.45 kg/day/fishermen. This activity resulted in about U$ 2 x 10^6 gross annual turnover for the most prosperous years for the six largest fishing shops of the province. To this figure we should also add the economic turnover of small shops, the secondary input from the boat industry, gasoline, hotels, baits, fishing and boat licenses, among many others.

The number of fish every fisher can catch per day is limited according to the species. However, particularly in recreational 3 type, cheating is a frequent practice, especially when large numbers of fish are present. As in any fisheries, fishing success is variable, and the level of exploitation in the Paraguay-Paraná is large enough to provoke a considerably reduction in the unit catch per fishermen. When large schools are found many fishermen take much more than the number allowed per day. This practice

has given rise to a concealed fishing because some anglers may sell their catch in the black market, where in the case of dorados the commerce is banned by law in most provinces.

The general perception of fishers is that number of fish is declining in the river (Cleminson, 2000), and that fishing two decades ago was far more abundant and diverse. Fishers attribute this decrease to commercial fishing, concealed fishing, fishing in the Paraguay, and to the impact of Yacyretá Dam. However, the available statistics from tournaments in the last 10 years reveal that variations in catch may be related to river discharge and hence the amount of water that enters and remains within the floodplain. For example, the number and average weights of dorados remained constant in around 0.11-0.13 kg/hour/angler between 1998 and 2001. In addition, several studies in the Middle and Upper Paraná revealed a significant positive relationship between flood intensity and fish catch with a time lag related to fish size and mean age (Quirós and Cuch, 1989; and Ruiz Díaz, 2004). This fact is rarely taken into account by anglers and even official managers. Others studies have shown that in commercial fishing, large silurid catches in the last 15 years remained fairly constant for the total fishery, although a decrease was observed in fish mean size and average total weight captured per fishermen (Vargas *et al.*, 2004). The total number of fishing licenses increased and the total catch per fisher remained constant probably because artisanal fishers retain species that were formerly discarded. In Yacyretá Reservoir yield-per-recruit assessments showed that *Leporinus obtusidens* present fishing effort is below maximum sustainable yield (Araya *et al.,* 2005). However, there are some evidences that the number per fisher and average sizes of large silurid and pacú decreased in the Middle Paraná River, independently of river discharge fluctuations (Cleminson, 2000; Iwaszkiw, 2001).

The total fish catch for the year 2001 in the Paraná River at Corrientes Province has been estimated from licenses in about 3.000-4.000 tonnes, being half attributed to recreational fisheries, 50 percent of the recreational catches correspond to dorado, 30 percent to surubí and the remaining to the other species (Ovidio Eclesia, pers. comm.). These figures were estimated based on the number of fishing licenses sold, which in that Province, the most important for recreational anglers, amounted in that year near 5 000 a year for local anglers and more that 20 000 a year for tourist anglers.

Along the Paraná River at Corrientes Province, more than 100 lodges, hotels and fisher services are located in the eight more important fisher towns (Iwaszkiw, 2001). Services include experienced fishing guides, boats and bait provision, rooms in hotels and lodges of variable services according to the socioeconomic levels.

In the Yacyretá Reservoir and upstream, deep changes in fisheries occurred after damming. The dam produces a blockage of migrating fish schools coming from more productive areas downriver to spawn. Only a small fraction of these fish are allowed to pass presently by two fish elevators. Capture per unit effort was estimated in the Posadas City area, considering weekend fishing excursions and statistics of seven tournaments (Hirt *et al.,* 2003). They varied between 0.08 and 0.21 kg/hour/fisher, which is a very low value compared with the 0.7 kg/angler/hour that would correspond to Santa Fé Province (Cleminson, 2000, assuming a 8 hours fishing journey) and close to the figures found for dorado fishing tournaments (see below). The most common activity was boat and costal fishing of the type 3. The species more frequently caught were also uncommon for Paraná River recreational fishing due to the scarcity of potamodromous fish, consisting mainly in piranhas (*Serrasalmus* spp.), freshwater rays (*Potamotrygon* spp.) and small Pimelodidae (*Pimelodella* spp.). Other more valued species, such as *Pimelodus maculatus, Leporinus obtusidens, Hemisorubim platyrhynchos, Sorubim lima* and *Zungaro zungaro*, were less common in catches.

Tournaments merit a special paragraph given their popularity and usefulness for fisheries' evaluation. Many type 2 and 3 recreational fishers desire to win one of those

tournaments and they always participate in large numbers. Anglers competing in the famous dorado fishing tournament in Paso de la Patria reached a maximum of 582 fishers and 194 boats in 2004, while 1454 fishers and 497 boats participated in the surubí tournament in Goya (both localities in Corrientes Province) (Iwaszkiw 2001). Those tournaments have been major social, cultural and economical events for the riverine towns for more that 40 years. They are an important part of the tourist attractions of the region, assembling thousands of people during two to three days. Dozens of killed fish remained displayed in the "gancheras" after a fishing session being part of the show in these tournaments. However, as explained earlier, in the last three years there has been a decrease in the number of fish caught in the Middle Paraná River. This fact forced organizers to change from extractive to catch-and-release modes, a fact that allowed increasing the number of specimens to be caught because size is no longer a limitation. Now, the exhibition of killed fish is replaced by large screens showing to the public scenes of fishing and the prized fish registered by official video cameras during the day. With this new type of fishing, the number of dorados and surubí caught per angler during tournaments doubled or tripled, although the lower size range decreased in about 20 to 30 cm.

As explained earlier recreational fishing in Argentina is regulated by the provinces, except in National Parks. Giving that most rivers share provincial and international jurisdictions, this political scheme generates frequent problems and conflicts concerning different uncoupling among provinces. Fortunately, during the last ten years, an international joint commission between Paraguay and four limiting provinces of Argentina has been consolidated. The countries signed an agreement and formed a coordinating committee for conservation and development of fisheries resources in the border reaches of the Paraguay and Paraná River. In order to establish regulations, the commission relies on consultation with an Advisory Committee formed by different interest groups related to the resource (e.g. scientists, technicians, commercial and recreational fishing organizations, outfitters and lodge owners and administrators, coast guard, etc.). The code establishes target species that may be captured in common waters; species specific daily catch quotas per fisher, fish size limit regulations for the most important species, season closure periods, types of gears and fishing practices banned, reserves and protected areas, and other general policies. These regulations apply to most waters of the large rivers of the region including interprovincial waters. For example, season closure, which usually takes place between November 1 and December 20 every year, is generally applied in the overall extent of the four northern provinces and Paraguay.

This code was achieved by consensus among the parts, taking into account previous management schemes, but without major revisions of the objectives and usefulness of the rules to be applied. As in other waters of Argentina, very little is still known about the processes that should direct sound management schemes. Real managers in most provinces are lacking (Cleminson, 2000) or in the best cases they cannot act as expected, because of the very few resources available, and the limited capacity for taking decisions. They usually work hard to solve critical or conflictive points that threaten political or social stability, remaining the rest of the time limited to bureaucratic tasks and trying to keep track of the fisheries without adequate budgets to consider any major management plan. Socials claims in Argentina have increased since year 2000, and artisan fishers do not hesitate to threat cutting the Paraná River commercial navigation with its boats or to stop the traffic for several days in critical bridges over the river if their claims are not listen by the government.

There are not catch quotas for any of the fishing types allowed. Therefore, the total fish catch in the region is open since the number of licenses sold is not limited and increases every year (Iwaszkiw, 2001) and the number of fish allowed per angler remains constant in time. Therefore, the only limitation to over fishing is the allowed

fish minimum size, provided all anglers respect that size. Those sizes were fixed 30 years ago following approximate rules and kept with minor changes. Fortunately, most of them are no so far from critical sizes, according to the criteria of Froese and Binohlan (2000) (Table 2) and all figures are above mean size at first maturation. Presently, all those sizes are under revision by the advisory committee of the international joint commission of Paraguay and Argentina, and they possibly will be adjusted to closely follow actual critical size minus 10%. However, this kind of management presents several drawbacks. First, the lack of enough number of large specimens to fulfil some angler expectations will deter the highest levels of recreational anglers, and recreational 2 and 3 type anglers will be forced to target fish of the less valuable species. However, fish minimum size varies according to species, and fishing gears employed for some small species may force the by catch of larger species below the allowed size. In some cases the fish can be released, but in others such as in the corvina (*Plagioscion ternetzi*) they generally die after being captured. Second, there are no allocations, so the fisher group with the most effective fishing technique will take a larger portion of the available fish, which is an unfair situation that can promote conflicts. Recently, provinces along with national officials have been trying, to convince commercial and artisan fishermen to limit the number of licenses, which seems to be hardly accepted by northern artisan fisher associations. The main reason of these new policy was the industrial fishing implanted in the lower portion of the Paraná River (Iwaszkiw, 2001), which is supposed to catch more than 50 000 tonnes a year of sábalo (*Prochilodus lineatus*) only for exportation. In the future, those limitations would extend to recreational anglers so as to establish quotas, which should be equitable and reached by consensus.

In Corrientes Province, the type of fishing (commercial vs. recreational, catch and release vs. extractive) is usually allocated by areas. Only a restricted section of the river is allocated for commercial fishing, while the whole river is open to recreational fisheries. In natural reserves, catch-and-release is the only allowed form of fishing. However, these rules are widely violated because artisan fisheries are established in areas where they are not supposed to be permitted. In other provinces of the Northeastern region, different kinds of fisheries share the same area. Those allocation schemes do not respond to an integral management perspective taking into account biological productivity of a given fishery, the mandates of different institutions and/or the requirements of fishers harvesting the resource. As in others rivers of Argentina, the lack of comprehensive management based on solid research programs and monitoring, generate conflicts such as when world-class fishing lodges oppose extractive fishing by local inhabitants (e.g. Corriente River). However the large spatial and temporal complexity of river systems makes this task a real challenge, and requires of flexible management plans that should be sensitive to many different types of needs with awareness of seasonal variability (Cleminson, 2000).

There are very few fish controls along the rivers, which opens the door to frequent rule violations. The most serious acceptance to the rules occurs during season closures, when controls are stricter and more frequent, and for which a general consensus among fishers exists about the importance and effectiveness of this management rule. However, from a strictly scientific point of view, there is no evidence of its effectiveness regarding species, time of the year and length. However, this practice is so popular and widely accepted, that it is worth to preserve as a management tool.

There is still a lot of work to be done in this region of Argentina to achieve an equitable sharing of the rich fish resources. Provinces and National government still invest very little in research for improving management, or in monitoring the actual impact of implanted regulations.

The lack of funded research programs reflects also the slight interest that official managers put on knowledge to improve management policies, which is part of the general cultural backwardness of the region. This is somewhat contradictory because

recreational fisheries are extremely important for local economies and many small towns along the river for which recreational fisheries and tourism are the main income source. Only fishing tournaments are carefully evaluated because of the need of correctly giving the prize to the winners. The selling of licenses generates large revenues in some provinces, but they are not adequately employed to improve the present state of the fishery. It is expected that in a near future, authorities will finally understand the importance of scientific information, monitoring and adequate controls, and will establish sound policies of integral and equitable management in agreement with all parts ensuring the sustainability of this valuable resource.

3. CENTRAL, WESTERN AND NORTHWESTERN REGIONS

The Central, Western and Northwestern regions of Argentina (Figure 3) have the most massive recreational fisheries in natural and artificial lakes. These fisheries are principally directed to the relatively wealthy Argentinean middle class. However, the socio-economic information necessary to manage those fisheries is scattered in many provincial jurisdictions or it is directly lacking. The emphasis in fisheries regulation is usually stressed on closed seasons and bag limits but fishery regulations fluctuate widely among jurisdictions. In lakes and reservoirs, stocking of larval fish is the favourite tool for fisheries managers mainly due to the lack of monetary and technical resources. The lack of studies or any other information about stocking results and efficiency is a general pattern.

For these regions, fish is a public common resource as well as for most of the Argentinean freshwaters but fisheries law enforcement and control is weak for most of the sites. Responsibility for regulating fisheries in public waters rests with provincial fisheries agencies. However, the disperse attempts to manage and control exploitation are generally insufficient and largely political. Fishery regulations have been issued generally in response to the declining fisheries and the desire to protect stocked fishes. Most laws regulate either the seasons or methods of recreational fishing. Closed seasons are implemented to protect spawning fish, under the implicit belief that spawners are needed to assure future catches. Such regulations interspersed with ambiguities and contradictions are usually ineffective for fish conservation,. The few regulations that do exist for sport fishing are even less likely to be enforced due to lack of coherent policies, and few fishery officials aided by ordinary police. Moreover, valuable data to fisheries managers like total catch and effort data are usually not sought for or reported.

The management of freshwater lake recreational fisheries is not an important issue for provincial and local government levels in Central and Northern Argentina. The participation of the public in the management decision-making process is practically null. The last country wide national intent in order to get basic lake and reservoir limnological and fish information crashed more than 20 years ago (Quiros, 1990). Fisheries science is at present dispersed in a few universities where poorly financed small research groups struggle to get some narrow local results.

In the central regions of the Pampas plains, both recreational and commercial fisheries are common. The pampean lakes contain a relatively diverse temperate fish community (López *et al.,* 1996); more than 60 fish species have been identified in these lakes (López *et al*. 2001). The "pejerrey" (*Odontesthes bonariensis*), a visual planktivore atherinid, and the "tararira" (*Hoplias malabaricus*), an ambush top predator, are usually the fish species preferred by both recreational and commercial fishers. A particular feature for the larger very shallow lakes at the Pampas is the existence of an important poaching activity for these fish species, which generates frequent conflicts with recreational fishers.

Recreational pampean fisheries are based mainly on "pejerrey", a fish highly valued mainly due to its size and flesh flavour attributes. According with our classification, the prevalent recreational fisheries types are 2 and 3 (Table 1) for this region. The remnant

shallow "clear" lakes are preferred fishery sites to catch few bigger big fish (Quiros *et al*. 2002). However, the large saline lakes are the preferred sites to fish more and larger "pejerrey" fish when diluted during heavy rainy years.

Recreational fishing is an important leisure activity for the habitants of the Pampa's plains. There are more than 450 sport angler clubs in Buenos Aires metropolitan area (López *et al.,* 1996). Fishing tournaments are common for this region. The angler mean displacement for a fishing trip ranges between 150 and more than 500 km. The fishing gears used in the shallow lake recreational and sport fisheries to catch the pelagic "pejerrey" are exclusively monofilament nylon with floats and hook and bait. Rods and lines are operated from the lake shoreline, small boats or wading in shallow lakes. Hook and line gear is usually used to catch the predator "tararira" in the recreational fishery. However, flies and lures are also commonly employed to catch this last fish.

There is a general perception that recreational fisheries for "pejerrey" has deteriorated during the last 20 to 30 years, mainly due to habitat alteration by unregulated agriculture and urbanization development. The pristine lakes were "clear" and macrophyte dominated but lake eutrophication conducted to predominant "turbid" green lakes (Quirós *et al.,* 2002). Recreational anglers are concerned that most of the lakes have not sustained populations of "pejerrey" with large fish. Moreover, for lakes heavily loaded with urban sewage discharges "pejerrey" is usually displaced by a pelagic filter feeding planktivorous fish ("bagarito", Parapimelodus valenciennesi).

The numerous natural lakes in the Pampas and the lack of appropriate management and timely fishery information makes it difficult to predict the sport fishery. The "pejerrey" populations of a very few lakes have been studied more intensively (Freyre, 1976; Rosso, unpublished data) but the general pattern is a lack of results from particular lake population studies. This insufficiency of fishery studies outcome makes fishery management for individual lakes still more difficult. Minimum size limits for "pejerrey" were recommended in lakes where the quality of the fishery needed to be improved, or for very productive lakes where fishing pressure is intensive. Slot limits have been also recommended in order to provide protection for a diversity of fish sizes (Baigún and Anderson, 1993). Although fish in pampean lakes have been exploited by commercial fisheries for many years, fishery management objectives are mostly directed to recreational fisheries by provincial law today (Table 1). Very few studies have been implemented in order to estimate angler preferences and exploitation rates (Baigun and Delfino, 2003). The highly variable ecological characteristics of the landscape are reflected in lake functioning, and hydrological variability among years is clearly reflected in lake fish population abundance. This fate limits seriously the value of results obtained from the application of angling surveys to individual lakes on a time discontinuous basis.

In the Western and Northwestern arid and semi-arid regions of Argentina (Figure 3), recreational fisheries are mainly developed in small to middle-sized reservoirs (5 to100 km^2). Riverine fisheries are only important in the northern part of the region, at the tributaries of the large rivers. The main land use in these regions is for agriculture and most of the reservoirs are eutrophic or hypertrophic (Quiros, 1990). Although fishing was generally a secondary objective for most reservoirs constructed in arid and semi-arid regions, they are intensively used for recreational fisheries today. The fish resource is middle to highly exploited by man but environmental degradation due to agriculture and urbanization is an actual threat for it (Quiros, 1990). There are not commercial fisheries in reservoirs but subsistence fisheries based in common carp are relatively important in some more densely populated poor regions. Also an increase of water reservoirs for aquaculture purposes is planned. Recreational fisheries in reservoirs are based mainly in introduced game fish as the pampean silverside "pejerrey", the predator "tararira" and the common carp. Recreational fishermen do not depend on the fishery for employment, treating fishing more as a temporary pastime. They are

often a relatively middle class wealthy group frequently with some urban professional backgrounds (Volante *et al.*, 1997). They are, therefore, external to the rural milieu in which they find their sport. For these regions, recreational fisheries are, according with our classification, type 3 (Table 1); large fish are not usually common in Western and Northwestern Argentinean reservoirs.

4. PATAGONIA AND TIERRA DEL FUEGO FISHERIES

Patagonia and Tierra del Fuego recreational fisheries are centred on cold-water species, mainly salmonids that in some cases meet world-class standards (Leitch, 1991; Vigliano and Alonso, in press). As a consequence during the past twenty years the region has seen a rapid development of highly priced recreational fishing and the establishment of international quality fishing lodges and outfitters. This in turn has brought to the attention of local governments the potential economic turnover of recreational fishing and in some cases conflicts with local, regional and national fishers. Demands for management have sparked a growing trend on recreational fisheries oriented research (Vigliano and Alonso, 2000; Pascual *et al.*, 2001; Pascual *et al.*, 2002; Riva Rossi, 2003; Ciancio *et al.*, 2005; Macchi *et al.*, in press; Pascual *et al.*, in press).

Argentine Patagonia and Tierra del Fuego (Figures 1 and 4) compromise the Neuquén, Río Negro, Chubut, Santa Cruz and Tierra del Fuego provinces covering over 1 7million km^2, from the Andes on the west to the Atlantic Ocean in the east. The region is characterized by a harsh cold climate and low population densities (1.2 inhabitants/km^2). Most of Patagonia and Tierra del Fuego show a marked climatic gradient from west to east brought about by the Andes acting as an effective barrier against the moist westerly winds which causes humidity to drop rapidly defining two distinct sectors. The Andean sector in the West is characterized by a temperate forest landscape presenting countless ultra-oligotrophic and oligotrophic lakes and streams (Calcagno *et al.*, 1995; Modenutti *et al.*, 1998a, 1998b). The Patagonian steppe sector east of the Andes is an arid landscape that extends to the Atlantic Ocean. Major watersheds (Figure 4), fed mostly by thawing winter snows and spring and autumn rainfall are born in the Andes. Six of these drainage cross the Andean range draining into the Pacific Ocean. The remaining drainage's flow East through the Patagonian steppe draining into the Atlantic Ocean being their lower reaches under tidal influence. Some of these drainages like the Rio Negro basin in northern Patagonia

FIGURE 3

Hydrology of the Central, Western and Northwestern regions: 1 Río De La Plata, 2. Paraná river, 3. Salado river (Buenos Aires province), 4. San Borombon river, 5. Canal 5 river, 6. Mar Chiquita, 7. Colorado River, 8. Slado river (La Pampa province), 9. La Amarga lake, 10. Atuel river, 11. Diamante river, 12. Tunuyan river, 13. San Juan river, 14. Jachal river, 15. Quinto river, 16. Cuarto river, 17. Tercero river, 18. Segundo river, 19. Primero river, 20. Mar Chiquita lake, 21. Dulce river, 22 Salado river. (Modified from USGS Global GIS Data Base. Digital Atlas of Central and South America)

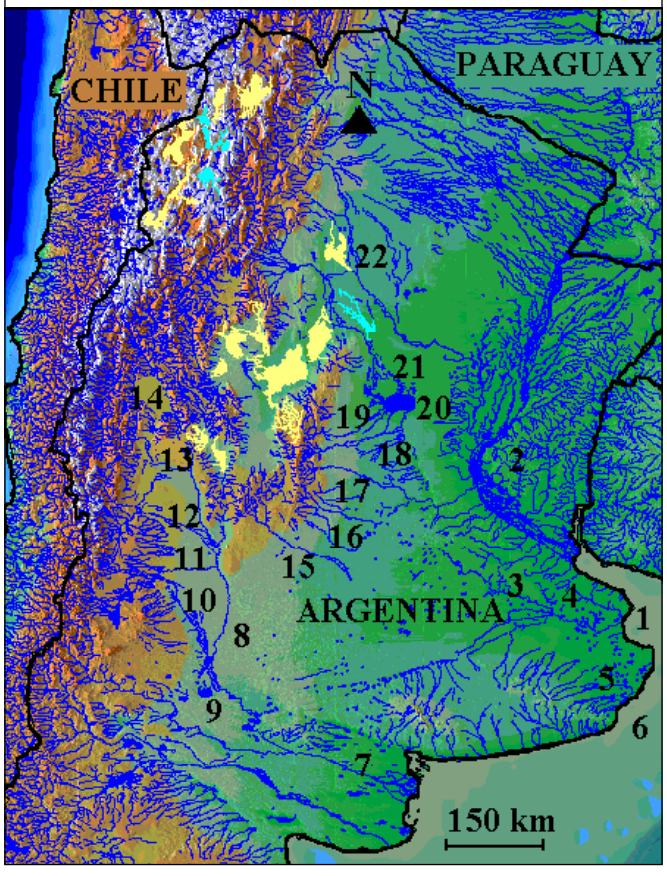
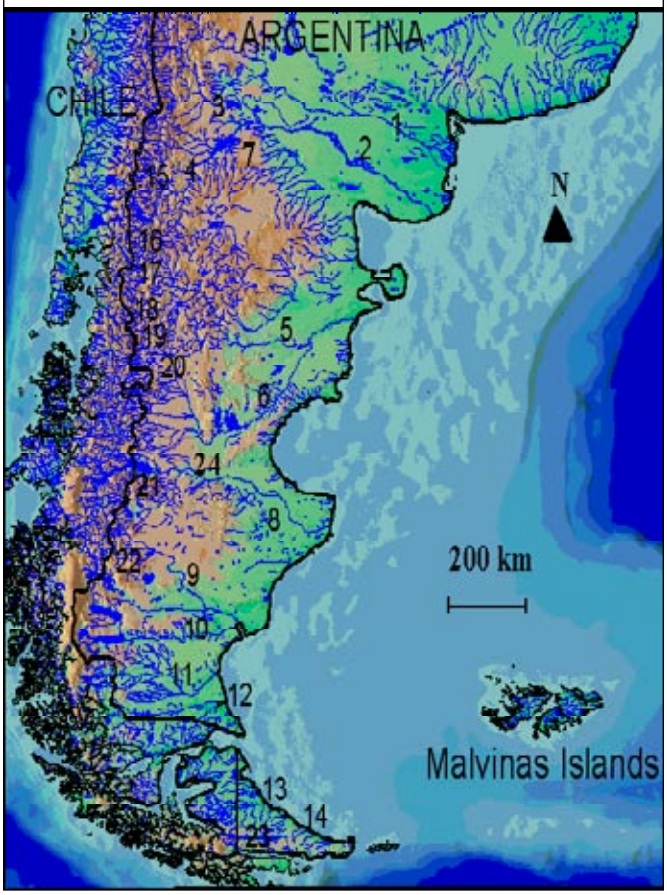


FIGURE 4
Hydrology of Patagonia and Tierra del Fuego regions. Atlantic drainages: 1. Colorado river, 2. Negro river, 3. Neuquén river, 4. Limay river, 5. Chubut river, 6 Chico river (Chubut province), 7. Senguerr river, Deseado river, 9.Chico river (Santa Cruz province), 10. Santa Cruz river, 11. Coig river, 12. Gallegos river, 13. Grande river, 14. Ewan river, Pacific draining: 15. Lacar lake, 16. Manso river, 17 Puelo lake, 18. Futaleufu river, 19. Corcovado river, 20. Pico. lake, 21. Pueyrredon lake, 22. San Martín lake, 23. Fagnano lake, Endorheic basin 24. Senguerr river. Modified from USGS Global GIS Data Base. Digital Atlas of Central and South America)



have undergone huge changes due to the construction of hydroelectric dams along the Neuquén and Negro rivers. Others such as the Santa Cruz drainage in southern Patagonia are being considered for hydroelectric development.

Within National Parks jurisdiction conservation of native fish species is a main priority, to the point that all native species caught within National Parks must be immediately released. On the other hand no further than 10 years ago, salmonids were unofficially seen as a nuisance that did not deserve to be studied or taken into account. Today, sport fishing for salmonids is seen as an important recreational activity, but the processes that govern native – exotic interactions and thus structure fish communities are at best poorly understood (Pascual *et al.,* 2002). Within this context possible outcomes upon fish communities brought about by fishing regulations such as mandatory release of all native fish and the kill quotas established for salmonids are anybody's guess.

Argentine Patagonia and Tierra del Fuego have a low fish diversity consisting of 36 fish species of which 16 species are targeted by recreational fishers (Table 3). Salmonids are not only the most important group of introduced exotics but also the generally preferred targets (Pascual *et al.,* 2002; Vigliano and Darrigran, 2002). Introductions started in the early 1900´s, (Tulian, 1908; Marini, 1936), shifting stocking policies trough out time (Macchi, 2004; Macchi *et al.,* in press) eventually gave rise to feral populations of rainbow trout (*Oncorhynchus mykiss*), chinnok salmon (*O. tshawytscha*), brook trout (*Salvelinus fontinalis*), lake trout (*S.namaycush*), brown trout (Salmo trutta) and landlocked Atlantic salmon (*S. salar*) (Pascual *et al.* in press). Of these species rainbow trout brown trout and brook trout became widely distributed and the basis for an extensive salmonid catch and release and extractive recreational fisheries through out the region. Also in some locations, like the Traful, Curruhue grande and Cholila lakes the Atlantic salmon managed to adapt becoming landlocked and giving rise to particular fisheries.

Native fish (Table 3) such as perch (four species), the pejerrey (two species), the common carp and some of marine origin such as the liza, robalo and flounders that swim into river mouths and tidal influence sectors are also sought for.

TABLE 3
List of the most important recreational target species in Patagonia and Tierra del Fuego

Order	Scientific name*	Spanish common name	Habits
Salmoniformes	*Oncorhynchs mykiss*	Trucha arco iris	freshwater and andromous/ top predator (fish and macrozoobenthos)
	Salmo trutta	trucha marron	freshwater and andromous/ top predator (fish and macrozoobenthos)
	Salmo salar	Salmon encerrado	landlocked/top predator (fish)
	O. tshawytscha	Chinook salmon	andromous/top predator
	Salvelinus fontinalis	Trucha de arroyo	freshwater/top predator
	S. namaycush	Trucha de lago	freshwater/top predator
Atheriniformes	*Odontesthes hatcheri*	Pejerrey	freshwater/benthic and planktonic feeder
	O. bonaeriensis	Pejerrey	freshwater/benthic and planktonic feeder
Perciformes	*Percichthys altispinis*	Perca	freshwater/fish and macrozoobenthos
	P. colhuapensis	Perca	freshwater/fish and macrozoobenthos
	P. trucha	Perca	freshwater/fish and macrozoobenthos
	P. vinciguerrae	Perca	freshwater/fish and macrozoobenthos
	Eleginops maclovinus	Robalo	marine – brackish water/
	Mugil liza	Liza	`marine brackish water/
Cypriniformes	*Cyprinus carpio*	Carpa	Freshwater/omnivorous
Pleuronectiformes	*Paralichthys sp.*	Lenguado	Marine- brackish water/top predator

* Scientific names according to Fish Base.

Biogeography, histories of introductions, environmental and socio.-economic characteristics have determined the existence of distinctive fisheries in this region. As stated by Pascual *et al*. (in press), towards the west in the slopes of the Andean range unregulated streams and rivers and glacially originated lakes introductions of salmonids gave rise to feral populations and world class, recreational 1, 2 and 3 type fisheries (Table 1). Thus diverse groups of resource users which in general terms are shore and boat fishers (Vigliano and Lipppolt, 1991; Vigliano and Grosman, 1997) may be found in the area during the November to April fishing season using a variety of fishing gears and tackle (e.g. fly fishing, spinning, casting trolling, down rigging). The different human groups involved (e.g. strictly catch and release fishers, highly extractive ones, family recreational fishers, lodge owners and outfitters) do not share precisely the same goals and expectations with regards to fishing trip outcomes (Vigliano *et al.,* 2000). This has brought about conflicts between fishers groups and their perceived right to access waters, catch and dispose of fish.

Today, salmonid sport fishing is seen as an important recreational activity, but the processes that govern native – exotic interactions and thus structure fish communities are at best poorly understood (Pascual *et al.,* 2002). Within this context possible outcomes upon fish communities brought about by fishing regulations such as mandatory release of all native fish and the kill quotas established for salmonids are anybodies guess.

In northern Patagonia, rivers (e.g. Río Negro and Colorado rivers) that traverse the steppe and drain into the Atlantic ocean sustain type 2 and 3 recreational fisheries of mostly native species, which include two silversides (*Odontesthes hatcheri, O. bonariensis*), four species of Percichthyds, (*Percichthys altispinis, P.colhuapiensis, P. trucha and P. vinciguerrae*) and three species of marine origin that swim up river: a mullet (*Mugil liza*), a flounder (*Paralichthys sp.*) and the patagonian blennie (*Eleginops maclovinus*). This fishery is predominantly extractive, live bait is commonly used

and the fisher's goal generally is to maximize catch and retention of fish which are consumed.

Some southern Patagonia and Tierra del Fuego rivers draining into the Atlantic and Pacific oceans sustain runs of anadromous salmonids which gave rise to world class and recreational types 1, 2 and 3 fisheries. The Santa Cruz River in the namesake province holds an anadromous rainbow trout population that, according to genetic analysis, developed from fish originally introduced from populations of the McCloud River in California (Pascual *et al.,* 2001; Riva Rossi, 2003). This has led in the past ten years to the development of an on growing recreational fishery centred on the Santa Cruz "steelhead trout", which is rapidly becoming a local generator of economic turnover. Two types of fishers use the resource, local ones and people from other areas attracted by the possibility of catching steel head trout. Meanwhile the first group is mostly extractive, the second one is a mixture of catch and release fishers. An initial outfitter business is starting to develop, but formal international level fishing lodges have not established yet. Also, the establishment of a Chinook anadromous salmon population on the headwaters of the Santa Cruz drainage system has recently been confirmed (Ciancio *et al.,* 2005), being this the first citation for an Atlantic draining system in South America. According to the same authors these fish may have originated from escapes from ranching experiments in the 1980s or from introductions conducted almost a century ago. Whether this will lead to a recreational fishery of economic importance remains to be seen.

Also draining towards the Atlantic: the Gallegos in Santa Cruz province and the Menendez, Grande and Ewan in Tierra del Fuego rivers, have runs of anadromous brown trout, which are sought for by world class and recreational types 1, 2 and 3 fishers. In the first three rivers; caught specimens normally weight more than 5 kg. All three rivers have well-developed and established fishing lodges which restrict access to local and regional fishers. A good example of the importance of these developing fisheries in terms of local and regional economic turnover is the one supported by the world class Río Grande fishery in Tierra del Fuego. Twenty years ago only one fishing lodge existed which recorded a couple hundred caught and released fish averaging 5.5 kg. By 1997 this same lodge recorded releasing more than 4 000 fish of approximately the same size, some weighting up to 12 kg and with records of up to 16 kg. The river now holds 5 fishing lodges with strict catch and release policies giving complete service to an international clientele that may pay between 3 000 and 6 000 United States dollars per week (Vigliano and Alonso, in press). The river is also fished by people from the local city of "Río Grande" (40 000 inhabitants), which are mainly extractive and resent that access to most of the 150 km river has been restricted by lodges. The huge benefits for lodge owners makes them adamant to a less restrictive policy and suspicious of any approach to scientifically manage the resource. The huge success of the lodges has prompted other landowners to close access to the rivers that run through their properties and to request licenses in order to start their own lodges thus creating more conflict. The provincial government does not have a comprehensive policy or strategy to deal with these conflicts.

Because some of the drainages that originate in the Eastern side of the Andean range head west and drain into the Pacific Ocean (Figure 4) these systems are subject to colonization by salmonid species that escape from Chilean aquaculture facilities. Thus the Pacific drainages of the Futaleufu and Corcovado river basins in Chubut Province, have runs of Chinook salmon, that were first reported as spawning in 1991 (Grosman, 1991; Pascual *et al.,* 2002). The appearance of this species has caused mixed feelings, while fishers are exited about the possibility some fishing guides and outfitters worry that it may produce a change in the system that could bring harm to the already successful recreational type 1 and 2 fisheries of rainbow trout and brown trout in the area.

Also reports of Atlantic salmon apparently appearing in other Pacific draining systems such as the Puelo basin in both Chubut and Río Negro provinces are starting to be common and even if they require confirmation, it may indicate future changes to come to the existing fisheries in those drainages.

Recreational fishing in Patagonia and Tierra del Fuego has been regulated for the past 10 years by a common fishing code developed and actualized every year by a Consultive Commission on Patagonia Continental Fishing, which brings together Provincial governments and the National Park Administration. In order to establish regulations the commission relies on consultation with different interest groups related to the resource (e.g. technicians, fishing organizations, outfitters and lodge owners and administrators, fishing guides, etc.). The code establishes target species that may be sought for in each water body and jurisdiction; species specific daily catch quotas per fisher, special fish size limit regulations, fishing seasons, types of gears allowed and other general policies. For most cases these regulations are not based on formal fishery studies but rather on perceived resource status and trends. Thus, for most, environments regulations are set according to specific mandates of particular agencies such as the total protection of native species within National Park jurisdictions mentioned earlier, specific provincial policies or interest, or those of joint comities of shared basins between Chile and Argentina with little data on the resources involved to support them. While there has been a considerable increase on biological and biogeographical data on the past ten to fifteen years, what is known about the processes that could direct sound management programs it still very little. As stated by Pascual *et al*. (in press) research usually responds to concern of specific interest groups in relation to specific issues or fisheries, "but without the umbrella of an integral view of freshwater management".

Within this context allocation in Patagonia and Tierra del Fuego as a policy is established in terms of catch quotas such as number of fish of a given species that may be retained by any fisher on a daily basis, varying according to water body jurisdictions and related interest groups. This allocation scheme usually does not respond to an integral management perspective taking into account biological capacities of a given fishery, the mandates of different institutions and/or the requirements of fishers harvesting the resource. Instead allocations as explained rely mainly on the particular perception of specific sectors and interest groups. The lack of comprehensive management based on sound research and more akin to interest groups has in many situations generated conflicts such as where world-class fishing lodges interest have restricted access to historical fishing grounds (e.g. rivers Grande, Menendez and Ewan in Tierra del Fuego, Gallegos in Santa Cruz province, Traful in Neuquén province etc.) to local and regional residents.

Shared jurisdiction is a common trait of Argentine Patagonia and Tierra del Fuego waters leading in many cases to contradicting regulations. Such is the case of Laguna Blanca, a Ramsar site mostly under National Parks administration but with a small portion under Neuquén province jurisdiction, meanwhile the former allows fishing the latter one prohibits it in its sector.

To ensure an equitable and sustainable use of the recreational fisheries of Patagonia and Tierra del Fuego more fishery oriented studies that take into account not only the environmental and biological constrains of the involved resources, but also the intricacies of the human factors associated to them are needed. For this the human resource base dedicated to the problem as well as the funding for infrastructure and research will have to be expanded. Today only four research groups related to the fish resources of Patagonia and Tierra del Fuego are radicated within the region. Lack of comprehension of the inherent complexities and economic potential of recreational fisheries is hardly understood by politicians. Funding for research is usually scarce and oriented towards particular problems and not to understanding the processes that lead to those problems.

Comprehensive views for each fishery are lacking and will have to be developed in a dynamic way in order to produce management schemes that correspond to reality and offer chances of maintaining the recreational fisheries trough out time.

5. FINAL REMARKS

As mentioned before, a wide body of laws and regulations exists in relation to conservation and management of natural resources. However, despite the existing jurisprudence, there seems to be a mismatch between the purpose of the law and actual management. This mismatch seems to stem from the lack of awareness of politicians and other stakeholders regarding the complexities of managing dynamic systems such as fisheries. This in term implies lack of integrated approaches towards the sustainability of Argentina's inland recreational fisheries.

Through out the present paper we have shown that allocations for most situations in inland Argentine fishing are not set by information resulting from management oriented research. That is to say, in most cases allocations are not driven by careful analysis of environmental, biological and human factors, but rather by decisions based on particular agendas or perceptions of particular interest groups. We have also to consider that particular allocation strategies are not usually monitored through out time, resulting on "guesstimates" of their outcomes, which some times are in term used as criteria to determine new allocations policies. This course of action tends to generate conflicts within and between sectors and no guarantees with regards to resource integrity and sustainability.

It thus seems obvious that a common series of priority gaps must be resolved in all three regions in order to ensure the sustainability of Argentina's inland recreational fisheries. These should include: (1) creating awareness about the dynamic complexities inherent to fisheries and therefore of the need of management-oriented research; (2) develop local and regional research programs that could generate environmental, biological and the human factor information that may lead to sound management decisions and allocation policies; and (3) to integrate all stakeholders of particular fisheries into the decision process.

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Commercial allocation issues

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ABSTRACT

It is now widely recognized that property rights are conducive to economic efficiency in fisheries and, moreover, the higher the quality of property rights the more efficient the associated economic activity. Economic efficiency in fisheries generally implies a high degree of sustainability in the sense that the risk of a stock collapse is small. Note, however, that maximizing the efficiency of commercial fisheries may involve the decimation of non-commercial stocks or stocks of little commercial value. This may or may not be socially optimal.

Property rights suggest the need for (an initial) allocation of these rights. In this paper it is shown that if either the markets are not perfect or the property rights not perfectly tradable, the allocation of rights can make a difference for the outcome in terms of efficiency and sustainability. So, at least in these terms, allocation matters. This suggests two questions: How much does allocation matter and what would constitute a good allocation? The paper considers these questions and attempts to provide partial answers. The paper goes on to examine the income distributional implications of the allocation of fishing rights. It is shown that contrary to common beliefs, it is not generally true that the initial recipients of fishing rights receive all or even most of the benefits associat4ed with using these rights. It is shown, moreover that attempts to effect a more equitable distribution of income by imposing constraints on the trade in fishing rights may easily be counterproductive.

1 INTRODUCTION

The purpose of commercial fisheries as that of any other economic activity is to contribute to human well-being. To maximize this contribution, commercial fisheries must be as economically efficient as possible. Efficiency is synonymous with the maximum flow of economic benefits over time. Due to the nature of fish renewal processes, this generally implies fairly large stocks of the valuable species.[226] Thus, economic efficiency in fisheries generally implies a high degree of sustainability in the sense that the risk of a stock collapse is small. Note, however, that maximizing

[226] There have several theoretical studies of optimal extinction of animal species (see e.g. Clark). From this literature and other more advanced considerations (e.g. the option value of keeping a species alive), it appears that for valuable species, extinction can only be optimal when either the stock is so small that it is not worth preserving, or the rate of discount is so high that the future is worth very little. The first situation happens only by accident - it basically violates the fundamental optimality of sustainability. The second situation is where society has no interest in the future in which case extinction, and, in fact, general liquidation of assets would be optimal.

the efficiency of commercial fisheries may involve the decimation of non-commercial stocks or stocks of little commercial value. This, depending on conservation sentiments, may or may not be socially optimal.

It has been known for a long time that high quality property rights promote economic efficiency (Smith, 1776, Furubotn and Richter, 2005). Later research indicates that high quality property rights may be sufficient for efficiency and economic growth (Demsetz, 1967; Arnason, 2006a). Fisheries are no exception to this rule. It has been found both theoretically and empirically that property rights are conducive to economic efficiency in fisheries and that the higher the quality of fishery property rights the more efficient the fishery operations (Arnason, 2006b). Moreover, it has also been found, that attempts at fisheries management that are not based on private property rights are generally failures, often abject ones (OECD, 1997). It follows that if we want efficiency in fisheries, we must look to property rights-based regimes.

Property rights do not exist in nature. They are a human creation, a social institution. To apply this social institution, that is to say create property rights, requires the (initial) allocation of these rights. This, obviously, raises the question of how. Clearly the allocation of property rights has implications for the distribution of wealth and income. Whether it also has implications for economic efficiency and, in the case of natural resources, sustainability, is much less clear.

In this paper we explore the implication of allocation of fisheries rights to commercial fishermen. First and foremost we will be interested in the effects of allocation on economic efficiency. The basic result is that if markets are perfect and trading costless, the allocation of fisheries property rights has no impact on the economic efficiency of the fishing activity. So, in that special case allocation doesn't matter. If, on the other hand, markets are not perfect or the property rights not perfectly tradable, the allocation of rights will generally make a difference for the outcome in terms of efficiency and sustainability. Therefore, under these circumstances, allocation matters. We will also look briefly on the distributional implications of the allocation of fisheries property rights. The general assertion here, much branded about, is that the initial recipients of the property will receive all the benefits it can offer. It is shown that as a general theorem, this is not true, although as an empirical matter, the initial recipients may well receive the bulk of the benefits.

The paper is organized broadly as follows: In the next section we will talk about allocation of fisheries rights and the resulting efficiency of the fishery. In the following section we will consider allocation and distribution. Finally, in the last section of the paper we will attempt to draw practical conclusions from our investigation.

2. ALLOCATION AND EFFICIENCY

To rigorously study the impact of allocation of property rights in the full dynamic setting of the fishery is a complicated undertaking. Fortunately, it so happens that the key results of the theory can be deduced and explained in a reasonably simple manner and without having to resort to any higher level mathematics.

Consider a fishery subject to some overall rights to be allocated to individual fishers or fishing firms. These rights can theoretically be any fishing rights defined by the fisheries authorities including fishing licences, allowable fishing days, catch quotas, rights to apply certain fishing gear, enter certain areas and so on. However, it is probably easiest to think of them as just harvesting rights. In that case the overall rights would be the total TAC and the allocated rights individual harvesting quotas or quota shares. For simplicity, we assume that the rights, whatever they are, can be allocated in any quantity to any number of potential receivers.

In most fisheries, the number of potential receivers of fishing rights is very high. To derive our basic results in an easy manner, it is sufficient, however, to consider just two potential receivers. The reason is that the allocation to any number can be analysed

as first an allocation between one individual and all the rest, and then the allocation between the first individual in the rest and the then remaining group and so on.

The fishers or fishing firms in question may derive some benefits from using the rights they receive. If they derive no benefits from the right, the right is worthless and there is no problem of allocation.[227] These benefits would often be profits but could be anything of value to the fishers. In what follows, we will measure these benefits, irrespective of their nature, in monetary units. It is important to realize that this is totally unrestrictive.[228]

Formally express the benefits to the fishers as the benefit functions:

(1) B(q(i);i), i=1,2,

where q(i) denotes the quantity of the right allocated to fisher i. As already mentioned, we only consider two fishers, fisher 1 and fisher 2. The two benefit functions will generally be different, hence the index i in the functions, but could be the same. We take it that for both functions, the benefits increase in the quantity of rights received, at least up to a point.

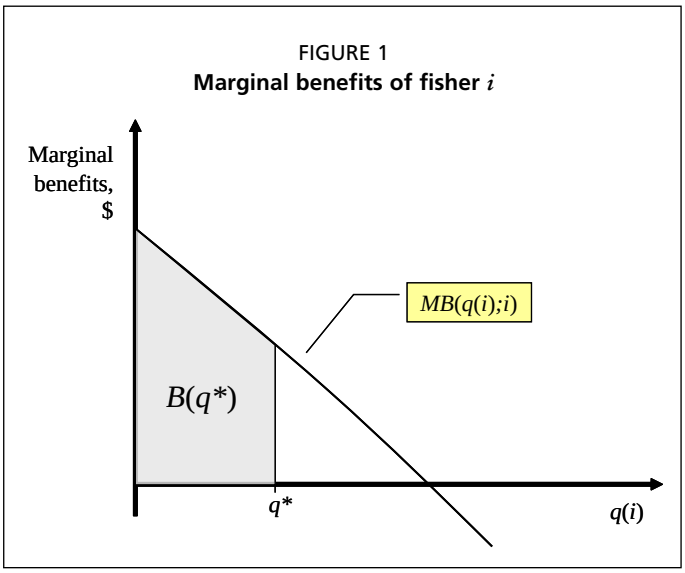
Since we are considering the allocation of more or less rights to the fishers it is helpful to consider the marginal benefit function, i.e. a function describing the additional benefits they get from additional units of rights. This function is formally defined as:

$$(2)\quad MB(q(i);i) \equiv \frac{dB(q(i);i)}{dq(i)} \qquad i=1,2,$$

where the notation MB is supposed to indicate marginal benefits. In accordance with basic economic premises (the law of diminishing marginal returns, see e.g. Varian, 1992), we assume that the marginal benefits of additional fishing rights are falling as the rights increase, at least ultimately. On this basis we can illustrate the marginal benefit function as in Figure 1.

As indicated in the figure the marginal benefits are initially high positive but as the quantity of rights increases, the marginal benefits decline and, as the figure is drawn, finally become negative. This last part may be unrealistic, but is of no consequence for the analysis that follows. As far as that is concerned, we may just as easily have a marginal benefit curve that is asymptotic to the horizontal axis.

FIGURE 1
Marginal benefits of fisher *i*



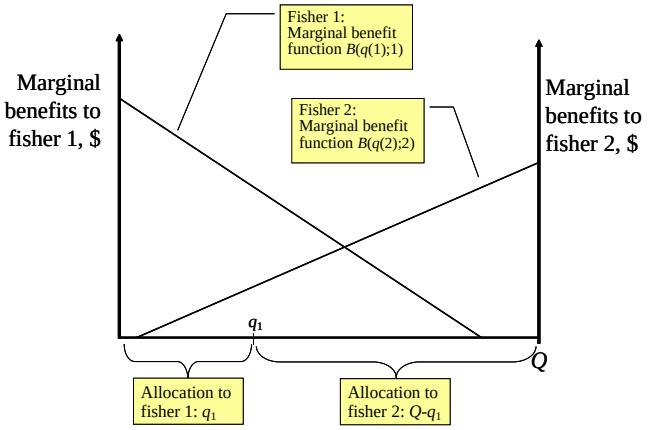
To understand the analysis that follows, it is important to realize that the total benefits to fisher i from any quantity of rights, q(i), he receives are given by the integral of the marginal benefit curve from zero to that quantity. For instance, in Figure 1, the total benefits fisher i receives from using rights q* are given by the area underneath the marginal benefit curve to q* as indicated in the diagram in Figure 1.

[227] Under a poor fisheries management regime, equilibrium profits in the fishery are zero and, consequently, rights to such a fishery are approximately worthless.

[228] As is well known utility can in general be expressed in monetary units (money metric utility function, see e.g. Varian 1992).

Now, consider the allocation of an aggregate fishing right, e.g. a TAC or some other right, to our two fishing firms. Let us refer to the total right to be allocated as Q. The essentials of the situation can be expressed as in Figure 2. In this figure, we measure the marginal benefits of rights allocation to fisher 1 on the left-hand vertical axis and the marginal benefits to firm 2 on the right-hand vertical axis. The total right to be allocated (i.e. Q) is measured along the horizontal axis between the two vertical axes. Any point on the horizontal axis represents a given allocation to the two fishers. Thus the point q1 represents the allocation of q1 units to fisher 1 and the remaining (Q-q1) units to fisher 2.

FIGURE 2
The basic allocation diagram



Finally, we assume that total social benefits from the fishing activity are equal to the sum of individual benefits. More formally:

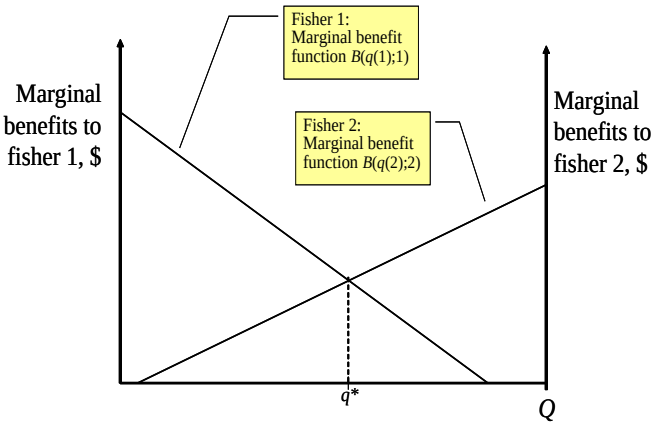
$$(3)\ W = B(q(1);1) + B(Q - q(1);2)$$

where W denotes the social benefits (or welfare) generated from a fishery allocating rights q(1) to fisher 1 and Q-q(1) to fisher 2. Note that by this adopting this assumption, we are explicitly ignoring the possible impacts the fishing activity might have on other agents and sectors in the economy.

To be able to assess the efficiency impacts of allocation of fishing rights, we obviously need to identify the most efficient, i.e. the socially optimal, division of the use of the fishing rights (as opposed to the mere allocation of these rights). A moment's thought will reveal that provided both fishers harvest, this point occurs where the two marginal benefits are equal, i.e. MB(q(1);1)=MB(Q-q(1);2). This point is illustrated in Figure 3.

Why this should be the case is easy to see. Let the division of the use of the fishing rights be at the socially optimal point, q* in Figure 3. Now imagine a little increase in the use by firm 1 and a corresponding reduction in the use by firm 2 — remember the overall right, Q, is constant. Then, a quick look glance at the two marginal benefit curves in Figure 1 reveals that the increased benefits to fisher 1 are not sufficient to compensate for the reduced benefits to fisher 2. Therefore, this change in use reduces the overall or social benefits. A corresponding argument holds for an increase in the use by fisher 2 (and a reduction in the use of fisher 1) from q*. Thus, q* must be the optimal division of the use of rights (i.e. resource use) by the two firms.

FIGURE 3
Optimal division of the use of fishing rights



The preliminaries are now over and we are in a position to examine

the efficiency impact of different allocations of fishing rights. Allocation of rights corresponds to a point on the horizontal axis in Figure 3. For many technical and administrative reasons this allocation would almost certainly not be the optimal division of rights use. To move from this point of allocation to the most efficient usage point, q*, requires trading of the allocated rights. Therefore, obviously, the efficiency of the allocation depends on how smoothly these trades can occur. In this study we consider two types of trading barriers; (i) formal restrictions on trades[229] and (ii) transaction costs which basically cover all sorts of market imperfections such as the cost of finding trading partners and effecting trades, the payment of commissions, registration fees and so on.

On this basis, we consider three special cases as follows: (1) perfect tradability of rights and no transaction costs; (2) perfect tradability of rights and transaction costs; and (3) non-tradability of rights and no transaction costs.

2.1 Perfect tradability, zero transaction costs

This case is straight forward. Irrespective of the initial allocation, both parties will benefit from trading toward the optimal usage point, q*. The arguments are the same as for the optimality of q* itself. At any point outside q*, say slightly below q*, the marginal benefits of fisher 1 from an increase in his use of fishing rights is greater than the cost to fisher 2 of reducing his right. As a result both will benefit from trade in the direction of q* and since there are no obstacles to trade, this trade will occur. This shows that the optimal division of the use of rights, i.e. q*, is the only equilibrium in the market.[230] So, in the absence of any trade barriers, the point q* will be reached. We conclude that in this case allocation does not matter for efficiency. More formally, we have the basic result:

RESULT 1

If there is perfect tradability and no transaction costs, then allocation of rights has no effect on efficiency — the division of resource use will be optimal irrespective of the allocation.

2.2 Perfect tradability, positive transaction costs

Let us now consider the case of transaction costs. To simplify matters, let the transaction costs be constant per unit of trade. So they are like fixed commission fees, trading taxes or simply the cost of finding a suitable trading partner that increases proportionately with the amount of trade. Without any loss in generality (but considerable gain in concreteness) let us assume the buyer bears this cost. So, for someone who has to purchase all his use rights, his benefits are simply reduced by the amount of transaction costs. This, in effect, shifts his marginal benefit curve of resource use downward by the amount of the transaction.[231]

So for the sake of illustration, consider the case where fisher 1 is allocated a smallish amount q1, as in Figure 4, and buys additional fishing rights from fisher 2. Then, his marginal benefit curve is reduced by the amount of the transaction costs as illustrated in Figure 4. The trading equilibrium is now at q', not q*. Therefore, the division of resource use will be sub-optimal compared to optimal allocation of rights. Remember that if the allocation had been at q*, there would have been no trading and therefore no transaction costs incurred. The loss in benefits is measured by the shaded area in Figure 4.

[229] Which is basically the same as reducing the quality of the property right (Arnason 2000).
[230] For a formal proof see Appendix 2.
[231] For the formal derivation of this consult Appendix 3.

These arguments show that in the presence of transaction costs, the division of resource use is no longer independent of the allocation of use rights. The wrong allocation - and there is only one correct one - will lead to a loss in economic efficiency. This establishes our second basic result:

RESULT 2
If there are transaction costs, the allocation of rights has implications for efficiency - only an allocation identical to optimal division of resource use will be fully efficient.

Note that with any allocation of rights falling in the interval [q', q*] and a corresponding interval on the other side of q*, there will be no trades. The benefits from trade will simply be too little to the fishermen to justify the associated transaction costs. Refer to this interval around q* as the non-trading interval.

From the diagram in Figure 4, it is easy to see that the efficiency loss depends on the amount of transaction costs, t, as well as the slopes of the two marginal benefit curves. Moreover, as we have already seen, it depends on the allocation of rights itself. If the allocation of rights is correct, there will be no losses, If the allocation of rights is within the non-trading interval the efficiency loss will be less than the one indicated in Figure 4. If the allocation is outside the no-trading interval the loss equals the one indicated in Figure 4. As a function of allocation, the efficiency loss of sub-optimal allocation under this type of transaction costs will be similar to the curve drawn in Figure 5.

FIGURE 4
Transaction costs

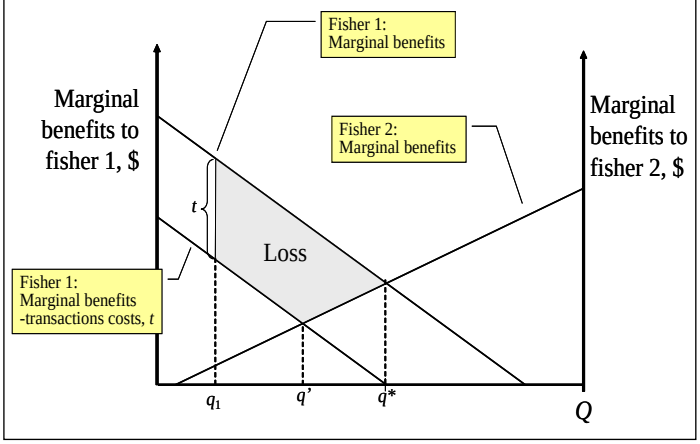
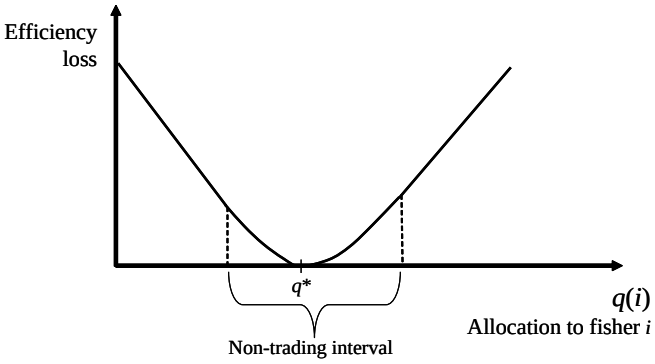


FIGURE 5
Transaction costs: Allocation and efficiency loss



2.3 No tradability, zero transaction costs

Resource use rights may not be legally tradable. This, for instance, is the case with non-tradable quotas, IQs. Obviously, non-tradability for legal reasons constitutes a substantial weakening of the property rights quality of the use right in question. Irrespective of its source, non-tradability may be represented as very high transaction costs, i.e. transaction costs so high that no trade can occur. So, basically, we can apply the analysis of the previous section with the modification that the non-trading interval now covers the whole allocation. So, in the case of non-tradability, the allocation of rights is also the division of resource use. Thus we have established our third basic result as follows:

RESULT 3

If there is no (or limited) tradability, then allocation of rights has implications for efficiency - only an allocation identical to optimal division of resource will be fully efficient.

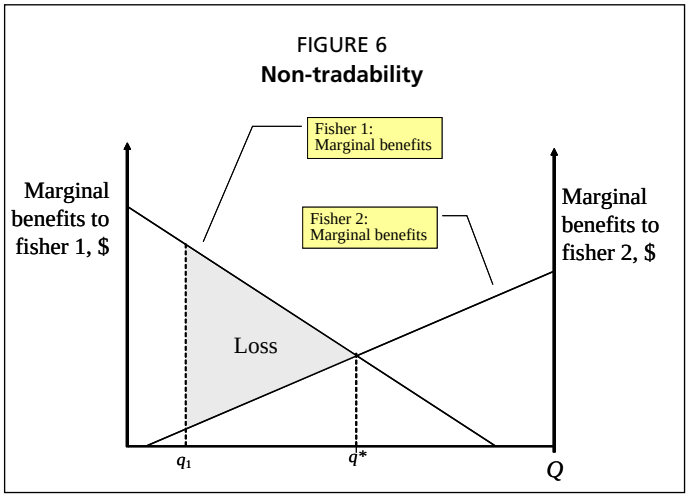


FIGURE 6
Non-tradability

The impact of non-tradability is illustrated in Figure 6. In this figure we have the same allocation as in the transactions costs case, namely at q1. Since trades cannot occur this is also the division of resource use and the loss, compared to full tradability and no transactions costs is as indicated in Figure 6.

Comparing Figures 4 and 6 immediately shows that provided the allocation is outside the non-trading interval, non-tradability can lead to much greater losses than in the case of mere transaction costs.

In terms of the diagram in Figure 5, this implies that the loss function is increasing at an increasing rate with the deviations from the correct allocation. In principle, the wrong allocation, i.e. one to someone who cannot use the resource profitably, can lead to loss of all benefits. In the case of non-tradability, therefore, the correct allocation is even more crucial than in the case of mere transaction costs of a reasonable magnitude.

3. ALLOCATION AND DISTRIBUTION

We have seen that the allocation of fisheries rights may or may not have an impact on efficiency of resource use. By contrast, the allocation of rights will generally be the major determinant of the distribution of the benefits associated with the right. As a general rule, provided the rent is transferable, the receivers of the allocation will receive a significant part of the benefits the right can generate irrespective of their own efficiency and how much use they will make of the right. To be more precise, the receiver of the right will normally receive at least the economic rents (Alchian, 1987; Arnason, 2006) associated with the right. He will, however, not normally receive the full benefits that the right generates. What he typically does not get his hands on in terms of benefits is the surplus, often referred to as intra-marginal rents, the more efficient buyer of the rights obtains.

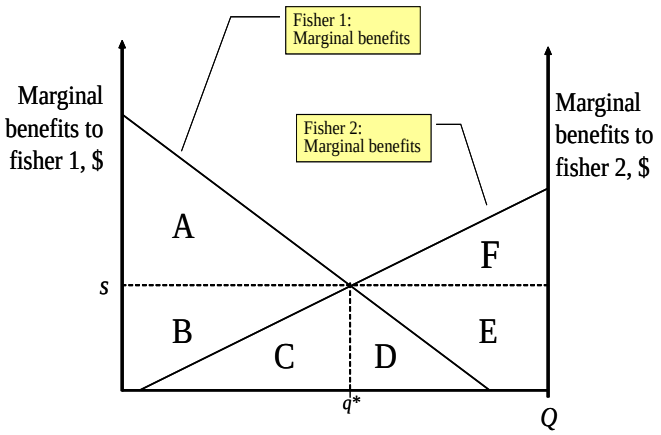
To analyse the general relationship between the allocation of fishing rights and the distribution of the benefits for the fishery is a very complicated task. Fortunately, it turns out that the essentials of the distributional issue can be illustrated with the help of a diagram similar to the ones employed in section 1. A more detailed analysis is given in Appendix 6.

Consider the case of two fishers as in Figure 3 above, where the optimal division of resource use is q*. Now, let all the rights be allocated to fisher 1. Then, if there are no barriers to trade, he will sell a part of this right, more precisely Q- q*, to fisher 2 at the approximately the market equilibrium price s (see Figure 7). At this price the two marginal benefits will be equal. More precisely $s = B_q(q^*;1) = B_q(Q - q^*;2)$ as illustrated in Figure 7.

Now, the total benefits generated by the fishery are represented by the area underneath the two marginal benefit curves. This area may be divided into six

segments, labelled A, B, C, D, E and F in Figure 7, whose sum equals total benefits. Note that a part of these total benefits, namely the segments B+C+D+E or more concisely the square s·Q represents fisheries rents (Alchian, 1987, Arnason, 2006).

FIGURE 7
Distribution of benefits



Now, out of these total benefits, fisher 1, the one receiving all the rights, will receive benefits A+B+C from using the resource (fishing) and benefits D+E from selling part of his rights allocation to fisher 2. So, in addition to all the fisheries rents he receives the intra-marginal profits, A. Fisher 2, on the other hand receives benefits amounting to D+E+F from his resource use but has to pay fisher 1 the rent D+E for the privilege. As a result his net benefits amount only to his intra-marginal profits, namely F.

So, in the case illustrated in Figure 7, fisher 1 gets most of the benefits. However, it is important to note, he does not get all the benefits. Fisher 2, who has to buy all his rights gets a part of the total benefits of the resource use. This establishes the basic result:

RESULT 4
The recipients of use rights allocations do not generally get all the benefits of using these resources.

From the diagram in Figure 7, it may appear that the recipient of rights gets the bulk of the total benefits. This, however, is only a feature of how the diagram is drawn and is not a does not have to be the case at all. Imagine for instance the case where the recipient of the right, i.e. fisher 1, is very inefficient while the other fisher (or, more generally, group of fishers) is much more efficient. This case is illustrated in Figure 8. In this case, fisher 1 will not do any fishing, although he can do that profitably. He will get all his benefits from selling is quota allocation. Thus, he will receive benefits indicated by areas A and B in Figure 8. All of these benefits are rents. Fisher 2, on the other hand will get C which, as the diagram is drawn, is actually larger than the rents. Obviously, other configurations of the situation can make fisher's 1 share arbitrarily low.

So, this analysis shows that, contrary to what is often asserted in the political debate about rights to resources, that efficiency is actually rewarded. Irrespective of the allocation of resource rights, the most efficient entities (firms and individuals) according to the above analysis generally receive a significant par of the benefits of resource use. If they are really highly efficient compared to the rest they may even receive the bulk of the benefits. This analytical result seems to be supported by everyday observations. Oil companies for instance generally have not been allocated many oil rights for free. In fact, most of their production is under

FIGURE 8
Distribution of benefits

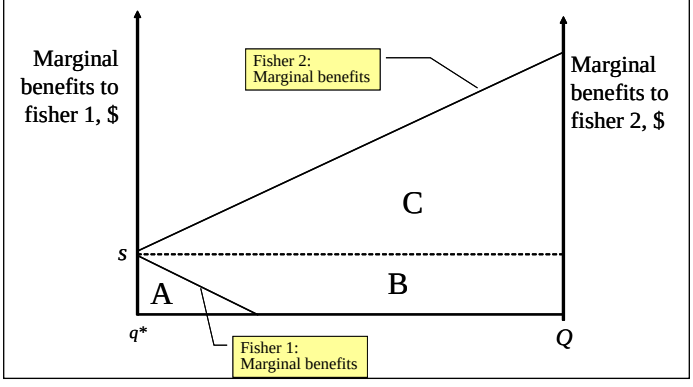
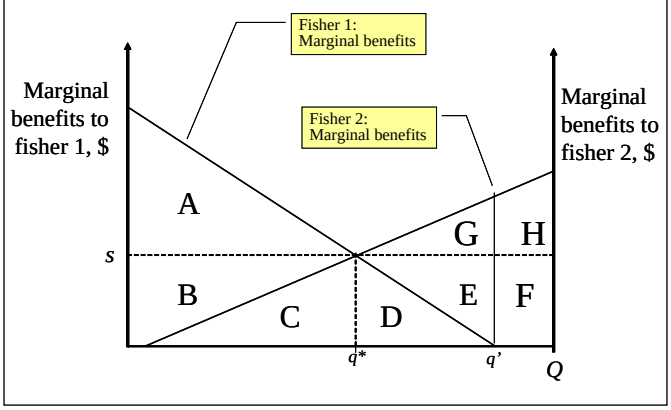


FIGURE 9
Restriction on trades: Distribution of benefits



licence with oil rich states which are both well informed and powerful. Many oil companies nevertheless make a lot of money. The most likely explanation is not that they are monopolistic and dishonest (although they may well be). The most likely explanation is that they make money primarily because they are more efficient in using oil reserves than the owners of the same reserves.

Sometimes, it is proposed to restrict transferability in order to achieve a fairer or at least more equitable distribution of the benefits. We can use the diagrammatic tool in Figure 7 to examine the validity of this claim. Consider again the situation depicted in Figure 7, with fisher 1 getting all the allocation and receiving the bulk of the total benefits of resource use. As we pointed out when discussing Figure 7, a good deal of these benefits are from selling use rights to fisher 2. Faced with this situation, let us assume that the authorities decide to restrict fisher 1's sales of use rights to Q-q'. This basically forces fisher 1 to fish at q' as illustrated in Figure 9.

This official restriction on trading will firstly, as we have already seen in section 2(3) on no tradability above, lead to a loss in total benefits amounting to G+E as illustrated in Figure 9. Secondly, it will obviously cause a disequilibrium situation in the use rights market - at least one of the parties, if not both, would like to trade more at the market price. However, if we are willing to assume for the sake of argument, that the price will remain the same, i.e. at s, it is easy to check the distribution of benefits between the partners before and after the imposition of the trading restriction. The result is summarized in Table 1.

TABLE 1
Trading restrictions or not: distribution of benefits

	Benefits		
	Fisher 1	**Fisher 2**	**Total**
No trading restrictions	A+B+C+D+E+F	G+H	A+B+C+D+E+F+G+H
Trading restrictions	A+B+C+D+F	H	A+B+C+D+F+H
Difference	E	G	G+E

Table 1 verifies our assertion that total benefits are reduced by the trading restriction. It also shows that fisher 1 is certainly hurt by the restriction. However, possibly unexpectedly so is fisher 2. In fact, depending on the shape of the two marginal benefit curves, he could well suffer even more from the restriction than fisher 1. Indeed, as should be clear from Table 1, it is by no means clear that fisher's 2 share of the new (and lower) total benefits is greater than before. We summarize these results as follows:

RESULT 4
Restrictions on trade will:
(i) Generally reduce overall benefits of resource use; and
(ii) Possibly lead to a more inequitable situation.

Taxes on the trade in rights, will generally lead to a sub-optimal use of the fishing rights. In this way they work very much like transaction costs. However, unlike transaction costs they are not economic losses, at least not right away. Thus, they could in principle be reallocated to those deemed disadvantaged by the configuration of rights

ownership. However, even so, it is quite possible that the reduction in efficiency and the allocation of that loss will more than outweigh the potential gain from reallocated tax revenues.

4. CONCLUSIONS

Good (high quality) property rights have been found to promote efficiency as well as sustainability in many fisheries around the world. This makes the creation of these types of fishing rights an appealing option for fisheries authorities.

The creation of fishing rights, however, implies the need to allocate these rights. This is a task with both technical and political ramifications. Technically, one allocation may be more efficient than another. Politically, allocation of rights (as well as duties) is always subject to controversy. This controversy tends to be the more heated the more valuable the rights are. It so happens that in commercial fisheries high quality rights are often quite valuable.

This paper has attempted to illuminate these questions. Primarily it has investigated the problem of efficient allocations. However, it has also examined the distributional impacts of particular allocations.

On the question of allocation and efficiency, the analysis has established the following basic results:

- If there is perfect tradability and no transactions costs, the allocation of rights has no effect on efficiency — the division of resource use will be optimal independently of the allocation.
- If there is either limited tradability or transaction costs, then the allocation of rights has implications for efficiency — only an allocation identical to the optimal division of resource will be efficient.

If efficiency is of concern, these results have certain fairly obvious policy implications:

1. It is generally not a good idea to restrict tradability of resource use rights.
2. Instead the authorities should consider taking steps to facilitate trades (by legislation, regulations, institutions etc.) in order to minimize transaction costs.
3. Since, there are always certain transaction costs, even when they are low, the authorities should attempt to allocate use rights to the most likely users.

The most likely users of fisheries rights are indeed existing fishermen. So, policy implication (3), provides support for the usual government procedure of allocating fisheries rights to those already established and with a track record in the fishery.

On the question of allocation of rights and the distribution of the benefits obtainable from using these rights, the analysis produced the following basic result:

- The recipients of use rights allocations do not generally get all the benefits of using these resources.

This result directly contradicts the conventional wisdom, much branded about in public debates about fisheries quota rights, that the initial receivers of quotas receive all the benefits of the resource. It may be true, as a general empirical pattern in fisheries, that most of the benefits from use of fisheries property rights will be reflected in quota values. However, the analysis shows that this does not have to be the case. Therefore, to assert otherwise can only be done on the basis of an empirical study of the fisheries situation in question.

While this paper may have managed to clarify the issues and, hopefully, correct so me of the most glaring misconceptions concerning the allocation of fisheries rights, the reader should be warned that it does not represent a deep or comprehensive analysis —far from it. The allocation of rights and the resulting efficiency and distribution of benefits is a complicated issue. This paper has done little more than scratch the surface of that issue. Among the things, of apparent importance but completely ignored in the paper are:

1. **What are the benefits?** The maximum benefits associated with rights depend among other things on the quality of these rights. Certain fishing rights, e.g. access licences, the right to invest etc., are of low quality and therefore not worth much. Other rights such as TURFs and ITQs are of high quality and can be very valuable. This distinction is completely ignored in the paper. One might say, although this is not accurate, that the paper proceeds as if the rights in question are always of high quality. The main thing is that with low quality property right the question of allocation and efficiency and allocation and distribution becomes largely irrelevant as there is very little efficiency to lose and very little benefits to distribute.
2. **Mistakes by players.** Fishers, like everyone else make mistakes. They may trade or fish erroneously. These mistakes will have implications for both efficiency and distribution. Taking the mistakes to be stochastic, the question rises what are the implication for policy. This is not at all dealt with in the paper.
3. **Fairness.** The question of fairness is also completely ignored in this paper. This is partly because economics, as, I believe, every science, has very little to say about justice and fairness. However, although it is probably not a topic for scientific inquire, a great deal of sensible things can be said about fairness. To attempt that, however, would be beyond the scope of this paper. This is the main reason why this topic was dropped from the paper.

Finally, it is interesting to note that historically speaking property rights are often takings. Over time, many of these takings become established as a part of the social order, almost as if they belong to the nature of things. Takings, at least when it is creating private property rights from previously common or totally un-owned natural resources, have many good economic properties. For one thing they constitute a solution or at least an alleviation of the common property problem as is very well known. It is less recognized that the social custom of recognizing property rights on the basis of takings generates a powerful incentive to entrepreneurs to invent and establish new types of property rights. If takings entail socially accepted property rights they will gain personally by these kinds of effort. And by their personal gain and the increased economic efficiency generated by a more extensive property rights system, most of the other members of society will gain as well.

These observations on the benefits of takings as a means of creating property rights seem to undermine the validity of public allocations of rights to individuals. Perhaps that is the wrong way to look at the problem. Perhaps, the state, the entity most people seem to have in mind as an allocator of rights, would be of more service if it just concentrated on establishing and supporting the property rights quality of takings. If so, the problem of allocation, with which this paper is concerned, would simply cease to be of relevance.

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Appendices

A1. Optimal division of resource use

Let Q represent total rights and the rights usage of fisher 1 be q. It follows that the usage of fisher 2 is q(2) = Q-q. Social benefits of this usage is

$$W = B_q(q;1) + B(Q - q;2)$$

In what follows, explicit reference to the two fishers will generally be dropped from the benefit functions unless confusion may arise.

Maximizing W with respect to q yields:

(Eq. A1) $$B_{q(1)}(q(1)) = B_{q(2)}(q(2))$$

In other words, maximum total benefits occur at the point where the two marginal benefits of resource use are equal.

A2. No trade barriers imply optimal division of resource use

Let $\bar{q}$ be the allocation to fisher 1. It follows that the allocation to fisher 2 is $Q - \bar{q}$
Let z be the purchase of rights by fisher 1 from fisher 2. Obviously, if the fisher 1 sells rights to fisher 2, then $z < 0$. With trades the rights usage of fisher 1 will be $\bar{q} + z$ and that of fisher 2 . $Q - \bar{q} - z$ With costless trading, private benefits for the fisher 1 will be:

$$B(\bar{q} + z) - s \cdot z \ ,$$

where s is the market price of quota. For him profit maximization (assuming no corner solutions) implies:

(Eq. A2) $$B_{q(1)}(q(1)) \equiv B_{q(1)}(\bar{q}(1) + z(1)) = s$$

For fisher 2 the private benefits will similarly be:

$$B(\bar{q} + z) - s \cdot z$$

and his profit maximization (assuming no corner solutions) implies:

(Eq. A3) $$B_{q(2)}(q(2)) \equiv B_{q(2)}(Q - \bar{q}(2) + z) = s$$

It follows immediately from (A.2) and A.3) that market equilibrium requires:

$$B_{q(1)}(q(1)) = B_{q(2)}(q(2)) \ ,$$

Which is identical to the social optimum expressed in (Eq. A1).

A3. Transactions cost imply sub-optimal division of resource use

Let there be transaction costs defined by T=t·z. Then one or both of the traders will have to bear this cost if trades occur. For convenience, and with no impact on the results, let the buyer bear this cost. His private benefits under trading then become:

$B(\bar{q} + z) - s \cdot z - t \cdot z$.

His profit maximizing condition under trade becomes (assuming no corner solutions):

(Eq. A4) $B_{q(1)}(q(1)) = s + t$.

The seller's profit maximizing conditions are unchanged and given by condition (Eq. A3) above.

Combining (Eq. A4) and (Eq. A3) yields the market equilibrium condition:

(Eq. A5) $B_{q(1)}(q(1)) - t = B_{q(2)}(q(2))$.

This expression shows that in market equilibrium the marginal benefits of resource use to the rights buyer will in general be higher than that to the resource seller, the difference being the unit transaction costs, t. So, comparing (Eq. A5) to the social optimality condition (Eq. A1), above shows that under transaction costs, division of resource use will generally not be optimal. More to the point it will not be optimal unless the allocation of rights will be perfect, i.e. precisely the same as the optimal division of resource use (i.e. trade is not necessary.

The inefficiency or loss in benefits associated with the less than perfect allocation of rights is difficult to work out in general. It depends as already indicated on (i) the initial allocation, (ii) the size of transaction costs and (iii) the shape of the two marginal benefit curves. Assuming that (Eq. A5) holds, i.e. no corner solutions, we may write this loss for any allocation q1<q' as

(Eq. A6) $L = \int_{q_1}^{q^*} B_q(\bar{q}(1);1) - B_q(Q - \bar{q}(1);2))dq + \int_{q_1}^{q'} (B_q(\bar{q}(1);1) - t - B_q(Q - \bar{q}(1);2))dq$

where q' refers to the actual and q* to the optimal division of resource use.

Qualitatively similar results can be obtained with other types of transaction costs such as transaction costs depending on the volume of the transaction and transaction costs that are fixed per transaction, i.e. independent of the volume of transaction.

A4. Non-tradability implies sub-optimal division of resource use

Non-tradability may be seen as an extreme case of transaction costs (infinite transaction costs) so that no trade can occur. In that case, the allocation of rights is also the division of resource use.

The two marginal benefits will be $B_{q(1)}(\bar{q}(1))$ and $B_{q(2)}(Q - q(1))$.

And it is obvious that only perfect allocation will result in socially optimal division of resource use (Eq. A1).

Assuming both fishers receive allocation of rights, the loss will be given by:

(Eq. A7) $L = \int_{\bar{q}}^{q^*} B_q(\bar{q}(1);1) - B(Q - \bar{q}(1);2)dq$

where q* refers to the optimal division of resource use and we have assumed that the allocation to fisher 1 is less than his socially optimal use of the resource.

A5. Size of loss

According to (A.6) and (A.7) the loss due to transaction costs (including non-tradability lies in the interval $[0,\Delta]$, where Δ is the maximum total benefits from the resources. The lower bound, 0, is reached when the allocation of rights is perfect. The upper

bound, Δ, is reached when all allocation is to a totally inefficient fisher,) $B_q \equiv B_{q(2)}$ and transaction costs exceed maximum marginal benefits of the other fishers.

A6. Allocation of rights and distribution of income

Assume that one of the fishers, e.g. fisher 1, receives the allocation $\bar{q}$. Assume he finds it beneficial sell a part or all of this allocation, z, say. The resulting resource use is: $\tilde{q} = \bar{q} - z$. Fisher 1's benefits are now:

$$B(1) = \int_0^{\tilde{q}} B_q(q)dq + z \cdot s$$

where, as before, Bq(q) represents is marginal benefits from the harvest level q and s is the price at which he can sell his quota. So, the first term in this expression represents his benefits from fishing and the last term his benefits from selling a part of his right.

The benefits of the buyer, i.e. fisher 2, from buying and using the purchased quantity z is:

$$B(2) = \int_0^{z} B_q(q;2)dq - s \cdot z$$

But B(2)≥0. Otherwise fisher 2 would not undertake the trade. Moreover, if B(q(2);2) is concave, which is the normal case, the marginal benefit function would be falling in the q and B(2) would be strictly positive (note that by market principles $s \leq B_q(z)$).

This proves, that provided there exist more efficient (for some part of the allocation) fishers than the one receiving the allocation, i.e. the receiver elects to trade some of his allocation, others will share in the total benefits of the right.

How much of the total benefits others will share depends on the parameters of the situation. It increases with the efficiency of the buyer and it falls with the efficiency of the one who receives the allocation. In principle, the buyer or the allocation, i.e. the one who ultimately uses the right may receive virtually all of the benefits.

Allocation of fisheries resources: a small-scale fisheries perspective[232]

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1. INTRODUCTION

Good afternoon everybody. First of all, I would like to thank the organizers of this conference for giving us this opportunity to share what we see as a small-scale fisheries perspective on resource allocation issues.

Much of what I'm going to say is based on work with fish worker organizations, primarily in countries of the south in Asia, Africa, and Latin America. I've worked with them for the past 20 years on various issues.

This presentation will focus on the developing countries, and it is important to keep in mind the fact that as much as 95% of the world's fisher population is in Asia, Africa, and Latin America, with 87% only in Asia. It's also important to keep in mind that Asia, Africa, and Latin America contribute 77% of the world's fish production, and 75% of the marine fish production, so we are really talking here about – in a sense – the tropical majority.

1.1 Importance of small-scale fisheries

I'd also like to briefly go over the importance of small-scale fisheries. I think we all know that they are an important source of employment, food security in diversified rural economies in the developing world income. An estimated 90% of the 38 million people recorded as fishers and fish farmers are small-scale. An additional more than 100 million people are employed in other fisheries-associated occupations – processing, trade, etc. It is important to keep in mind, is that these figures are likely to be underestimates. Millions of people fish seasonally, part-time, in coastal and inland waters, and are not recorded as fishers.

It's also important to keep in mind that, according to estimates, about 20% of the total number of fishers, or about 5.8 million fishers, are considered to earn less than 1 United States dollar per day. So we are talking about a sector which is quite economically vulnerable.

As important – small-scale fisheries in the developing world are often the main drivers in the rural economy. Those of us who are familiar with the recent tsunami saw that. With the collapse of the fisheries in the tsunami-affected countries, it affected not only the fisherman, but also a whole of host others who were dependent on the fisheries sector in remote areas – people supplying inputs, people buying, processing fish, people supplying inputs to fishing communities – painting their houses, selling

[232] Presentation can be found at http://www.fish.wa.gov.au/docs/events/ShareFish/papers/pdf/presentations/Present-ChandrikaSharma.pdf

things to them – they're really the main drivers in rural economy. So I think the importance of the sector should not be undermined. And, I think it's important that it has not been valued as correctly, or as appropriately, as it should have been – these sorts of backward and forward linkages are still not taken into account when estimates are made about the importance of the sector.

Small-scale fisheries account for nearly 50% of the global fisheries production, and most – in fact, all – almost all of what they catch goes to direct human consumption. And I think we can relate this to the earlier figure that there are 90% of fishers who are small-scale, but they're catching about 50% of the fish – something on sharing that.

Small-scale fisheries increasingly contribute to export markets and earnings and to national economies. I think this is a growing trend now. As important – from an environmental point of view – small-scale fishers harvest resources in *relatively* – I stress, relatively – more sustainable ways. Their ecological footprint is smaller, and this is increasingly important today as concerns about sustainability of our resources, the cost of inputs, the cost of fuel, and so on, rise.

1.2 Defining small-scale fisheries

A very basic issue, on which a lot of time has been spent, is the question of: What are small-scale fisheries? I think it's widely agreed that it is widely divergent from country to country, and particularly between the industrialized world and the developing world. There is a recent WTO note which tries to compile available definitions and that clearly brings this out. The sector is also referred to differently – artisanal, subsistence, small-scale, so on.

It's very important to note that the sector is not what it was two or three decades back. Technological changes have taken place. There is increasing differentiation within the sector with motorization and greater efficiency within the small-scale sector which makes defining it more challenging.

Just to give some basics: the Catamaran, from Tamil Nadu, India is just three logs of wood tied together; the beach seine from Mozambique is just that; you also have the fishing boat from Kerala. This is a growing sort of technology and investment is much more than in the trawling sector in India. The boat employs 30 people in one go and uses the mini purse seine. So you can see that within the sector there is a whole range of differentiation which one can see today.

And this is the pump-boat from the Philippines which actually carries, on its side, small boats which are handliners. These go out of the Philippines EEZ; it actually goes to other countries. It is a very artisanal technology, but it's going outside, as I said, the EEZ. This is also part of, in a sense, the small-scale sector.

You have the multi-day boats of Sri Lanka, which are recently evolved sort of vessel design. You find them not only in Sri Lanka, India; you find them in Madagascar, Somalia, and the Seychelles. These are small 15–20 metre boats and seen as part of the small-scale sector. So I'm saying we have a range now, within the sector, and it's important to keep that in mind.

I think the description of the FAO Working Group on Small-scale Fisheries does capture a bit of what this sector is – dynamic; evolving; labour intensive; supplies fish to local and domestic markets but also is export-oriented; widely different organizational levels, from self-employed single operators through formal sector businesses. It is important to keep this range in mind.

2. RECOGNITION OF SMALL-SCALE FISHERIES

2.1 Recognition of small-scale fisheries in international legal instruments

Very briefly, I'm going to skip over some of the kinds of recognition that small-scale fisheries has in the international legal framework. UNCLOS (Article 61) talks about the economic needs of coastal fishing communities, and the requirements of developing

States. The United Nations Fish Stocks Agreement (UNFSA) – important to note – talks about "the need to avoid adverse impacts on, and ensure access to fisheries by subsistence, small-scale and artisanal fishers and women fish workers" (Article 24.2(b)). This is important to keep in mind when we talk about the tuna boats of Sri Lanka, Philippines and, increasingly, in many other countries, targeting fish outside of EEZs because here we have small-scale fisheries, and there is a need by the UNFSA to ensure access to fisheries by these fishers.

Recognition of small-scale fisheries is also in Agenda 21 (Section 17.74b), and the Code of Conduct for Responsible Fisheries (CCRF) talks about giving "preferential access, where appropriate, to traditional fishing grounds and resources" (Article 6.18) – an important allocation suggestion there. Also important to note that the Committee on Fisheries of FAO has recently mandated the development of technical guidelines on small-scale fisheries under the Code of Conduct - and that has been published. It also reflects a growing recognition of the sector among states and the need to ensure protection of the sector to enable it to contribute to its full potential.

2.2 Recognition of small-scale fisheries in national legal frameworks

Many national legal frameworks also recognize access rights of small-scale fish workers:

- The Venezuela Constitution of 2000 talks about protecting the fishing banks of the communities of non-industrialized fisherman (Article 305);
- the Philippine Constitution of 1997 talks about protecting the rights of subsistence fisherman to marine and fishing resources, both inland and offshore (Article XIII, Section 7);
- the Thai Constitution recognizes the role of communities and organizations in management and conservation of resources;
- Marshall Islands Marine Resources Act, 1997 - and in fact, many other Pacific Island states - again, recognize the rights of access of small-scale fishing communities to resources;
- The recent Indonesian law (Law of the Republic of Indonesia No. 31 of 2004 Concerning Fisheries) exempts small-scale fishers and fish farmers from payment of fees and levies (Article 50) and from licensing requirements (Article 63.3), and allows them to fish in the entire fisheries zone of Indonesia.

Similarly, we have Ghana (Fisheries Act 2002), Zanzibar (Tanzania Fisheries Act 1988, Article 8 on *Protection of traditional fisheries*), Fiji (Fisheries Act) – the basic point being that many national legislations do recognize the need for preferential access rights for small-scale fisheries and to protect their rights to resources allocation.

The SADC Protocol on Fisheries (Article 12 on *Artisanal, Subsistence Fisheries and Small-scale Commercial Fisheries*), which is a regional document, also has very strong language which talks of the protection of artisanal and subsistence fishing rights, tenures and fishing grounds.

3. SHARING THE FISH: ISSUES OF CONCERN

3.1 Problems and conflicts

One could say the importance of the sector and of protecting its resources, of allocating its resources to it fairly is very recognized in international and several national legal instruments. Most of the developing countries have taken specific measures to protect access of small-scale to resources, the most common being the declaration of artisanal fishing zones, which is quite common in Africa, Asia, and Latin America.

However, I think when we look at the situation on the ground, we find that there is a continuing problem with accessing resources, despite this recognition. I think the most common problem which small-scale fishers face in accessing resources securely – thereby their livelihoods – is this whole conflict with the industrial sector over resources.

It's very common to find trawlers and large-scale vessels fishing in inshore areas, destroying nets, gears, crafts of the small-scale fishers, sometimes even lives. So this is a common issue – this is a sort of violation of existing regulations by the industrial sector, it's quite common. We have the joint venture of fisheries access agreements – very, very common in many countries – which directly also impinge on the rights of local fishers. The most recent conflict is Mauritania small-scale fishers saying they can clearly harvest their own lobster resources, but the EU is also there with a fisheries access agreement.

Continuing reports of conflicts between migrant and local fisherman – again, the rights of the migrant fisherman are often not well recognized or taken into account in national legal frameworks, and this also leads to conflict between the local and the migrant boats. The migrants are also traditional fishers.

3.2 Denial of access to resources

In Chile and South Africa, the introduction of ITQs, seen as a measure that denies artisanal fisheries/indigenous people, legitimate access to resources, has been met with protest, and even litigation. I think our colleagues from South Africa will be sharing some of their experiences there, and the court case that is now on in South Africa against the ITQ which is being introduced there.

I'd like to stress the statement from a workshop ICSF recently organized in Latin America which had participation of all fish worker organizations from the continent, which clearly said,

> *"We reject the use of ITQs as a management tool for artisanal fisheries, and express our concern that the use of ITQs can jeopardize the legitimate rights of artisanal fish workers, coastal communities, and indigenous people to secure and just fishery-based livelihoods."* (Santa Clara Workshop, Argentina, March 2005)

It's also important to point out here that, according to a calculation of a colleague, about less than 1% of the world's fishers are under ITQs. I think you're talking here of a very different context.

Other areas of concern for small-scale fish workers include marine protected areas. Increasingly, there is a focus on this, them being set up in non-participatory ways, exclusionary ways, denying small-scale fish workers access to resources. Here again, I'd like to emphasize that the implications for the small-scale sector of marine protected areas is quite different. People who lack the technology or the wherewithal to fish further are impacted much more by declarations of marine protected areas then, say, the larger-scale sector who can move away from the zones and fish further.

I was struck yesterday that in Australia there is a process where they have tried to estimate the socioeconomic impacts of MPAs and even have a structural adjustment package, because actually you can calculate the loss to a sector and compensate. In most of our fisheries, there is, at the first place, no recognition of the small-scale sector, or any data about how much they earn – so the issue of compensation is far more complicated. The power the industry has here is nothing compared to what small-scale fishers in remote rural areas have. So I think these are important aspects to keep in mind.

4. SHARING THE FISH: EMERGING ISSUES

4.1 Emerging issues within the sector

Small-scale fishers in several countries have also been affected by certain forms of coastal aquaculture. Often their access to fishing grounds have been disrupted, or the fact that the environmental impacts of aquaculture – catching of juveniles, say, for example, in shrimp – affects resource productivity, and clearly, access to the resource.

What are the sort of emerging issues? I think that's sort of important. As I mentioned earlier, growing differentiation within the sector. Adaptation of gear earlier used by the

industrial sector – mini-trawls, mini-purse seines, now within the small-scale sector – and therefore much greater conflict within the small-scale sector.

The small-scale sector, as I earlier mentioned, is now able to move much further, further offshore into international waters, into the EEZs of other countries, targeting highly migratory stocks such as tuna.

4.2 Emerging cross-sectoral issues

Emerging cross-sectoral issues are as important vis-à-vis allocation. Greater competition from other sectors: tourism, industry, conservation interests, oil exploration. Small-scale fishers increasingly are facing problems of displacement from fishing grounds/ habitations.

Another great issue, a very important problem, is this whole issue of pollution, which is growing, It affects resource productivity and clearly, access to the resources.

5. SHARING THE FISH EQUITABLY

5.1 Important considerations for allocation

So when you look at, what are therefore, allocation issues in the small-scale sector and what could be done, or needs to be done, I think first let's keep in mind some important considerations which we need to keep in mind apart from what was mentioned earlier.

The numbers of people involved in small-scale fisheries, and we're talking about millions of people here who depend on small-scale fisheries and not only those who fish, but those who depend on the fishing operations, those in post-harvest operations – very often women in developing countries. One needs to keep that in mind before looking at allocation issues in a developing country context.

Also, in view of the commitment which all of our governments have made - the MDG goals - halving between 1990 and 2015 the proportion of population below $1 per day.

Other important considerations are: the contribution of the sub-sector to national and local economies and to food security; the relatively sustainable harvesting of resources by the sector and, importantly, greater fuel efficiency, very often self-powered operations in many parts of the world are non-motored; recent technological changes also need to be kept in mind.

5.2 A small-scale fisheries perspective

So what we feel – from a small-scale fisheries perspective – given all these considerations, what seems to be important is to promote the small-scale model of fisheries development, progressively redistribute fishing space and resources to the small-scale fisheries – owner-operators and workers in the fishery – by phasing out large-scale, non-selective fishing units.

And how? By promoting "scale subsidiarity". Consider larger fishing units only after exhausting the possibility of employing smaller fishing units in the same fishery in the entire range of distribution of relevant fish stocks, with due consideration for the safety of such fishing operations as well as the safety and working conditions of fishers.

One can confidently say that in many countries the small-scale fisheries can, given today's context, harvest resources within the EEZ. And, I think the important aspect here is to ensure that the lowest scale of operations, non-motorized fishing vessels, should be confined to the inshore, they should have secure access rights while the ones with greater technology should be pushed further offshore.

Put in place management systems and approaches that recognize the rights of small-scale fishing communities to resources and to manage them, and to be part of decision-making processes. I think that's equally important – yesterday there's the

whole community based management, co-management, I think these are all important, need to be community-driven processes.

Rights to resources have to be linked to responsibility for their sustainable management, and there is a need to invest in capacity building of fishing communities and their organizations.

Some concrete measures probably, which, of course have to be based on better data, and I think all developing countries do need better data on which to base management decisions on. But I think one measure which has been effective - and which can be much more effective - is to continue with the zoning of artisanal fishing zones, to increase areas under artisanal fishing zones, effectively implement them, and prioritize in these zones the interests of the non-motorized artisanal sector using selective gear.

Consider allocating rights to harvest commercially important species such as shrimp and lobster in territorial waters exclusively to small-scale fishers using selective gear. I think this can be clear in many other countries, we don't need trawlers. And of course, there was a lot of discussion about the destructive impact of bottom trawling in high seas – you can imagine the destructive impact of bottom trawling in fertile inshore waters where a lot of the spawning and breeding takes place. We have technology which can harvest the same resources in more selective ways, by the artisanal sector in more equitable ways, so there is clearly a strong case for allocating resource rights to harvest species such as this, exclusively to the small-scale sector, and perhaps, taking part of the revenue from this to plough back into management, better management, or to improve the conditions in the sector.

Equally important to implement other effort control measures, particularly bans on destructive gear, such as bottom trawls or many purse seines, where proved destructive, whether small-scale or industrial. I think here we are recognizing that it's not blind defence of the small-scale sector. One needs to be clear that there are selective and non-selective technologies within the small-scale, and what is non-selective has to be controlled.

Ensure that the interest of small-scale fishers targeting highly migratory stocks are represented in RFMOs set up under the UNFSA. I think this is an emerging issue – we talked about representation of NGOs and so on and RFMOs – but so far, small-scale fishers targeting highly migratory stocks are not enough recognized though they do catch a significant percentage, in the Indian Ocean for example, of tuna resources. Their interests have to be better represented in RFMOs and their access to these resources protected.

Migrant fishers: Again as I mentioned, there is not enough recognition within legal frameworks of migrant fishers, particularly when they're from across the border. One should consider things like bilateral agreements, which allow small-scale fishers to fish in neighbouring country waters, legally regulated without conflict.

Put in place effective enforcement systems: This has been discussed – lack of enforcement creates de facto open access condition, a race for fish won by those with greater access to capital and technology, and in this case, clearly, the advantage is with the large-scale in developing countries.

Discourage measures such as the ITQ - inappropriate for the typically multispecies, labour surplus fisheries of the developing world, that also have the potential of leading to inequity and greater conflict of interests within communities. And here I think this whole issue is that to even consider quota based allocation, one needs sound information, and most developing countries, where stocks are typically many and small, don't have adequate information. So, to even consider systems like this is completely not appropriate in that context, by and large.

MPAs: Consider them only where they're proposed through participatory processes, and after ensuring that access to resources and livelihoods of the small-scale sector using

selective gear are not compromised. And this is also in keeping with the Convention on Biological Diversity, and many of the decisions within that. And I think we do have many examples of community conserved areas, so there are many precedents where communities have taken the decision to conserve, and I think the effort has to be to support such initiatives.

Ensure that fisheries access agreements, joint ventures and other similar arrangements do not affect the fishing operations of the small-scale sector, including their access to resources.

Ensure that coastal aquaculture development does not affect the access of small-scale fishers to resources, and is sustainable from a social, economic and environmental perspective.

And, finally, ensure that the livelihoods of those dependent on small-scale fisheries are not compromised by other users of coastal resources – tourism, industry, or development, and so on. There is need to recognize that the sector is important from a livelihood perspective. It has a right to coastal space.

There is a need to take steps to control pollution of coastal areas, and I think this whole ecosystem approach to management makes a lot of sense in this context.

Ensure access to coastal land for housing and other fisheries-related operations, recognizing that access to resources at sea has meaning only when linked to access to coastal lands. If you displace fishing communities from coastal lands and shift them inwards, you are effectively denying them access to resources, because it's impossible to fish when you're far inland.

6. SHARING THE FISH EQUITABLY: CONCLUSION

In conclusion: small-scale fisheries make better sense from a social, cultural, economic and environmental perspective.

There is a need to promote the small-scale model based on scale subsidiarity. An ecosystem approach to managing fisheries is called for, given particularly the growing problems due to pollution. The livelihood interests of the small-scale sector need to be protected as competition over coastal resources from other sectors increases.

Thank you.

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Sharing the Fish '06
Allocation issues in fisheries management

27 February–2 March 2006
Fremantle, Western Australia

These proceedings contain the main papers and presentations from "*Sharing the Fish '06: Allocation issues in fisheries management*" conference that was held in Fremantle, Western Australia, 27 February to 2 March 2006. They include the substantial work of the keynote and invited speakers covering the three themes of the conference which addressed the critical fisheries management topics of:
(i) allocations across jurisdictions (including governmental, regional and multilateral, and national allocation issues);
(ii) allocations within sectors (including extractive and non-extractive allocations issues; management issues; and, commercial, artisanal and tourism allocations issues); and
(iii) allocations between sectors (including customary/indigenous, recreational, commercial, and artisanal/subsistence allocation issues). The enclosed CD-ROM contains the papers from the concurrent sessions which delved further into each of these allocation topics as shown in the Conference Programme section and mentioned in the Summary Report and Conclusions section.

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