

The North American Pacific Salmon Wars: Crafting the Treaty of Peace

Robert McKelvey,
University of Montana, USA

ABSTRACT.

Conflicts over natural resource utilization are difficult enough to resolve when management authority is vested in a single jurisdiction. The difficulties are compounded when such authority is divided among jurisdictional entities whose interests may diverge sharply. Such has certainly been the case historically with regard to transboundary Pacific salmon stocks, along the northwest coast of North America. These stocks originate in a series of rivers, from Alaska south through British Columbia to California, often migrate for thousands of miles along the coast--and are subject to harvest along the way--before returning to their rivers of origin to spawn. For nearly a century, Canada and the United States have been seeking in vain to craft a stable treaty for coordinated management of these stocks that both countries harvest. Indeed both governments have long recognized the potential thereby for achieving sustainable fisheries at enhanced harvest levels that could benefit both countries. However agreements have always foundered on disputes over appropriate conservation escapement levels and fair harvest allocations among the various national fleets. Here we review the history of efforts at cooperative management, emphasizing the evolution of concepts of shared ownership of the stocks, and describing the special problems which arise in the binational context. These exacerbate the classical management difficulties in a unified jurisdiction: indirectness of stock appraisal, unanticipated change in the physical and biological environment, and incomplete and privately-held information about operational costs and landings valuations. We then articulate insights, supported by recent game-theoretic modeling, concerning basic requirements for achieving stable cooperative arrangements, and describe institutional arrangements that might meet these needs.

1. INTRODUCTION

For nearly a century, Canada and the United States have been seeking in vain a stable accord for joint management of the Pacific salmon stocks that both countries harvest--the so-called transboundary stocks. These originate in a series of rivers, from Alaska south through British Columbia to California, often migrate for thousands of miles along the N.W. Pacific coast of North America-- and are subject to harvest along the way--before ultimately returning to their rivers of origin to spawn.

Despite repeated failures by the two governments to negotiate sustainable cooperative fisheries management arrangements, the effort to do so continues. Indeed, both governments recognize the corrosive effects on fish stocks and profits of unbridled competition, and the benefits, in sustainable fisheries at enhanced harvest levels, which cooperation could achieve. But agreement has foundered on continuing disputes, over both the size of total harvest and its allocation in national

harvest quotas. (Gordon Munro et. al., [1997])

Fisheries relations between the nations remain confrontational, and repeatedly deteriorate into irrational and mutually destructive "fish wars". These are characterized by aggressive harvesting that continually degrades the stock, and is marked by repeated serious miscalculations that threaten the continuing viability of the fishery.

The need for coordinated management of "shared" marine fish stocks, i.e. those which cross national jurisdictional boundaries, is world-wide. (Doulman [1996].) It thus is disquieting that two of the world's most politically sophisticated and technologically advanced fishing powers have been unable for so long to work out a stable cooperative arrangement for one of their most important shared fisheries. It raises the question of whether their situation is an isolated one, or rather is typical of the obstacles to achieving coordinated management of shared stocks worldwide.

2. WHO OWNS THE FISH?

A pervasive theme in the twentieth century history of marine fisheries has been the gradual evolution in perceptions of ownership rights to various trans-boundary stocks. This evolution has occurred in particular for North American Pacific salmon stocks, and is central to an understanding--and, I believe, to ultimate resolution--of the ongoing disputes.

In general, ownership rights to any tangible property include the right to use it and to derive income from that use, to enhance or degrade the property, and to sell or lease it to others for their use. The "bundle" of rights to a property may be held exclusively or may be divided among several or many owners. A pragmatic (rather than legalistic) view of property rights holds that rights are never absolute, but are inherently limited in various degrees by incomplete definition, imperfect measurement, and inadequate enforcement. (Yoram Barzel [1989])

For traditional marine fisheries on the high seas, ownership rights initially followed the "rule of capture": anyone, of whatever nationality, had the right to fish, and whoever caught the fish had full right to dispose of them and to profit from so doing. Effectively, a fish stock was a public good: no one owned it, and so no one had authority to restrict its use. The result was a full-blown "tragedy of the common", in which stocks were depleted and fisheries declined, sometimes precipitately.

One response to this problem, in mid-twentieth century, was the unilateral extension, by many coastal states, of national management authority out to 200 miles--creating the so-called "exclusive economic zones (EEZs)". This action was subsequently accorded treaty recognition in the 1982 Law of the Sea Convention. While the creation of EEZs lessened the extent of the "global common", it also created a new problem: that of achieving rational co-management of "shared stocks".

If a harvested fish stock remains, throughout its life history, within a single EEZ, then effective management is possible, through a single centralized national authority. However, in many cases stocks cross EEZ boundaries, and management is "shared". In some instances the

stock ranges beyond all national management zones into international waters--these are the so-called "straddling stocks". For both shared and straddling stocks, ownership rights remain ambiguous.

In international law (e.g. The Law of the Sea Conventions and the agreed "Code of Conduct") two opposing principles have emerged as attempts to better demarcate ownership rights.

The first (and earlier) of these affirms the importance of maintaining "historic rights" to harvest. This principle asserts that national policies should avoid disruption of long-established transborder fisheries.

The second principle, often in conflict with the first, asserts the "superior" management rights of nearby coastal states over distant water fleets. This so-called "equity principle" is strengthened, in the case of anadromous stocks such as salmon, to the "state-of-origin principle": superior rights are held by the state-of-origin, in whose rivers the stocks spawn.

Both "principles" have been justified on grounds of fairness, and also, more pragmatically, as reflecting inherent capabilities to harm or enhance the fishery. Both are imprecise in scope and application, and subject to self-interested interpretation by fishing states. Furthermore neither is fully enforceable. As a practical matter, each nation has the unfettered ability to set its own rules for harvest within its own EEZ. The stock is in effect the common property of a group of harvesting states.

Game theoretic models predict, and experience confirms, that in these circumstances, and unless the separate national management policies are coordinated, the shared or straddling stock situation will be little improved over the open-access tragedy-of-the-common: harvest policies of the national authorities will become purely antagonistic and may degenerate to full-bore fish wars with all of their destructive consequences. (See C. Clark, [1990], and an extensive literature since.)

3. THE CASE OF PACIFIC SALMON

The history of management of the anadromous North American Pacific salmon stocks shows a close conformity to this general pattern. (Munro and Stokes [1989].)

In the early years of this century, the focus of dispute between Canada and the U.S. was on the important sockeye salmon runs on Canada's Fraser River. Since the river mouth is very near to the U.S. border, a large part of the annual catch was taken by American fisherman--a complication that could not be erased by extending national management zones. Absent any bi-national coordination to limit total catch, the stock was being badly overharvested. Furthermore, with no assurance of reaping the benefits from undertaking riverine enhancement, Canada was unwilling to embark on the major expenditures necessary to restore up-stream passage for spawners, blocked by major rock slides since 1913-14.

Thus, prior to signing of the 1930 Fraser River Convention, the harvesting of Fraser River sockeye was governed by the "rule of capture". In the Convention the two parties agreed to set up an International Pacific Salmon Commission to manage the fishery. The major portion of the harvest, that near the river-mouth, was allocated equally between the fishing fleets of the two countries, as were the costs of riverine enhancement. Thereby, for a period of several decades, disputes over the harvesting of Fraser sockeye stocks (and later also Fraser pink salmon stocks) ended, and through joint management the stocks recovered substantially, with both partners benefited from greatly enhanced harvests.

Note that this resolution effectively amounted to acceptance of bi-national joint ownership, on a 50-50 basis. This pragmatic principle, which merely recognized the ability of either country to unilaterally savage the stocks, seems to have been acceptable to both parties until, in the late 1960's, changing circumstances led both countries to dissatisfaction with the status quo.

The Canadians came to believe that the then current arrangements were no longer equitable, but increasingly favored the U.S. side. They contrasted the continuing vitality of Fraser stocks to the spectacular decline of Columbia River stocks, due to major dam-building in the U.S. Thus Canada was bearing substantial unilateral opportunity costs by forbearing from building dams on the Fraser. Furthermore they saw a potential for further building of Fraser stocks by additional habitat enhancement on the river, and felt that the rewards for such activities should belong exclusively to Canada.

A second problem for the Canadians was the increase in interceptions by U.S. fishermen of other Canadian-origin stocks, particularly in Alaskan waters. Canada strongly favored minimizing all interceptions and bringing them into balance.

For their part, the Americans were increasingly alarmed that Canadian interceptions, especially off Vancouver Island, were damaging extremely fragile Columbia River stocks. Some of these were formally listed under the politically potent U. S. Endangered Species Act, and U.S. managers had therefore been forced to undertake extraordinary measures for their conservation.

4 THE 1985 TREATY

The above considerations led to extended negotiations which culminated in the signing of the 1985 U.S.- Canada Pacific Salmon Treaty. The treaty undertakes to set up a mechanism for coordinated management of *all* North American transboundary shared Pacific salmon stocks, whether originating in Canada or the U.S.

The treaty takes, as its two central goals, *stock conservation* and the allocation of benefits according to very strong version of the state-of-origin *equity principle*.

Specifically it asserts that:

"Each Party shall conduct its fisheries and its salmon enhancement programs so as to:

(a) prevent overfishing and provide for optimal production and

(b) provide for each Party to receive benefits equivalent to the production of salmon originating in its waters."

At the same time the treaty language accepts that some interceptions are inevitable, and indeed directs the Commission to take into account historic harvest rights,

by taking into account *" the desirability in most cases of reducing interceptions, the desirability of avoiding undue disruption of existing fisheries, and of annual variations in abundance of stocks"*.

On its face the equity principle would seem to assign something like exclusive stock ownership

rights to the state-of-origin. In the Canadian view, implementing it requires minimizing interceptions, carrying out a meticulous accounting of both the quantity and the value of those harvest interceptions that do occur, and even--apparently--adjusting interceptions so that they are essentially in balance. Thus, while the Commission assigned to U.S. fishers a quota of Fraser River salmon approximating their historical catch, Canada expected to compensate for this by their own harvest of U.S.-bound salmon off Vancouver Island.

The Americans have never accepted this strong interpretation of the requirements for "equity". (See Yanagida [1988] and Huppert [1996].) The two sides remain far apart on the measurement of extent and valuation of interceptions, as well as on the need to balance interceptions "fish-for-fish".

Furthermore, as a practical matter, whenever the parties have been unable to agree on seasonal allocations for a particular year, they have simply reverted to uncoordinated unilateral management in their own EEZs: Sole ownership, it seems, remains a "sometime-thing".

5. FACT AND PERCEPTION: THE ROLE OF INFORMATION

Fisheries management is a classic example of decision-making "under uncertainty". The inherent complexity and stochastic character of the marine environment causes fish stocks to fluctuate widely from year to year, thereby masking secular trends until these are well advanced. Furthermore, with present technology, the assessment of stock size and age structure at the present time is necessarily indirect and circumstantial. Also, both data limitations and ecosystem complexity have required sophisticated statistical modeling techniques which nevertheless possess only limited predictive power.

The result is that scientific judgements of acceptable harvest levels and other permissible management options inevitably must be hedged by wide uncertainty bands--and may, despite this caution, be confounded by unpredicted environmental shifts. In such circumstances, the combination of unfavorable environmental conditions and excessive harvest stress have been implicated in many of the catastrophic declines of exploited marine ecosystems that have occurred throughout the twentieth century.

Furthermore, the impediments to achieving sound conservative management are exacerbated in the case of transnational fisheries which cross jurisdictional boundaries. The circumstance of divided authority, combined with uncertainty over the expected outcome of particular actions, has often meant that political pressures, motivated by short-run parochial interests, have led to high-risk confrontational policies among the national authorities.

In the case of the North American transboundary Pacific salmon fishery, cooperative arrangements, worked out painfully over extended periods, repeatedly have been disrupted and finally destroyed by their inflexibility in the face of changed environmental and sociopolitical conditions. The task posed for analysis is to understand the extent to which more flexible institutions, combined with more accurate and timely environmental information, might overcome these recurring impediments to stable sustainable joint management.

With uncertainty, disputes arise over assessments of both of stock dynamics and of harvest valuations.

In part, the stock and harvest *measurement problem* is a dispute over "objective fact": For example, Canada and the U.S. have frequently disagreed widely in their estimates of the level of interceptions that have been occurring. According to Huppert [1996], this particular problem arises mainly for Alaska pink salmon--a relatively low value fishery--and is gradually being overcome.

A related, but more difficult, measurement problem is presented by attempts to sort out the causes of temporal changes, sometimes very large changes, that occur unexpectedly in stock sizes and recruitment levels. At issue is: what part of this is due to fisheries management practices, and what part merely to natural environmental factors?

A case in point is the spectacular increase in recent years in northern stock levels at the same time as southern stocks have been experiencing serious decline. It is not possible at present to sort out with assurance the reasons for this: contributing factors likely include marine environmental changes--El Nino effects or global climate change--as well as effects of contrasting fisheries management practices and anthropogenic alterations of the southern riverine habitat.

All the parties have an obvious stake in this assessment. Alaskans, for example, have protected their riverine environment from degradation (from mining or dams) and in recent years have devoted considerable effort to control over-harvest of their stocks. They feel that these conservation measures (rather than merely fortunate short term climate change) are responsible for much of the remarkable growth of Alaskan stocks. Hence they are most reluctant to forego harvesting the bounty in their waters in order to protect the relatively few endangered southern salmon that are intermixed there with the Alaskan-spawned stocks. (Miller [1996].)

Not surprisingly, Canadian and Northwest fishing interests have challenged this Alaskan appraisal, claiming that Alaskan harvest levels are excessive, and that Alaska has not been living up to its conservation responsibilities.

A fundamental disagreement, partly conceptual in nature, has arisen over setting the criteria for conservation, in particular over determining stock escapement levels that are "prudent and sustainable". Both the data and the theoretical basis for doing this are weak, and confidence intervals are very wide. Since the trade-offs are directly between short-term harvest levels and long-term conservation risk, it is natural that the parties will be strongly influenced in their assessments of conservation requirements by their own more immediate interests.

Equally divisive is *the valuation problem*: the disparity between the U.S. and Canadian concepts of equity, and specifically of what each believes is required to appraise the net value of imbalances in interceptions. The Canadian position has been that it is technically feasible to devise explicit accounting mechanisms to obtain quantitative valuations of harvests, and that such an approach should be the basis for adjusting interceptions to achieve equity.

The American position has been that such accounting is nowhere required in the language of the treaty, and that furthermore would "involve too many highly speculative variables" to be practical.

"The accounting procedure would require not only agreement on origin but also on the value of an intercepted fish. However its value varies, inter alia, by species, quality of meat, time of year, stage

in its life cycle when caught, type of gear used to catch it, market demand, and currency fluctuations. The potential as well as the actual size of the fish must be considered, since it might be worth more to a fisherman who caught it later in its life cycle."

Thus any "effort to create an accounting scheme would invite costly and perhaps divisive and inconclusive debate over biological and economic variables..." Furthermore, since any scheme for adjusting imbalances is "subject to the approval of the parties, political acceptability will be prerequisite for its implementation." (Yanagida [1987].)

More fundamental conceptual issues arise in any attempt to measure the *indirect and non-market values* of landings. Beyond the concrete difficulties of measuring (potential) net value of landings denied by interceptions, there are other real and politically important values, attributable to the harvesting of fish, which are even more difficult to appraise. Among these are the economic value of maintaining use of existing vessel and processing capacity, and the social value of maintaining employment within the local fisheries communities.

It is important to recognize that, in the bi-national contest over harvesting of fish, the various "stakeholders" will almost certainly have fundamentally different perceptions of what, beyond net landings return, fishing is worth to them. Furthermore, policy-makers may be motivated as much or more by such indirect and less tangible considerations as by the more direct and concrete ones that have been the focus of discussion.

The debate of course turns on *information*: its quality, its cost, and its interpretation. High costs have, for example, invariably limited the extent and quality of data gathered for stock assessment, despite a realization of its importance in conservation. And monitoring of landings, to enforce quotas or to measure interceptions, has likewise been limited for the same reason. As technology changes, the ability to obtain quality information increases and its cost declines—but then the demand for quality information expands accordingly!

Furthermore, since each party has—and acts on—its own perception of the value of fishing to its own constituencies, therefore obtaining accurate information means each party achieving a realistic understanding of the importance placed on fishing

by all of the other parties to the dispute. Since the parties may not have articulated all of these values--even to themselves--and in any case have an incentive in negotiations to hide or mis-represent them, attaining open and accurate information on valuations is a profoundly difficult problem.

6. DESIGNING A RESOLUTION-- BASIC REQUIREMENTS

An obvious criticism of the 1985 Treaty is that, in order to obtain the signatures of all politically influential interests, many fundamental differences were papered over--only to emerge again, almost immediately, in negotiations over annual quotas. These become contentious when stock status and harvest valuations unexpectedly change, due to evolving or strongly fluctuating environmental and socioeconomic circumstances. (Miller [1996].)

It is thus natural to believe that, for a future treaty to be stable, it must be based upon institutions that themselves are stable. At the same time, the treaty must incorporate flexible mechanisms for negotiating adjustments, in response to unexpectedly changing circumstances.

As described earlier, perceptions of stock ownership seem to have evolved slowly, and a consensus seems to be developing that primary, though not necessarily absolute, rights should reside with the state-of-origin. Determination of harvest allocations, on the other hand, remains contentious, and stakeholders' views of what is appropriate can change rapidly with changing circumstances.

Ownership confers the right to reap the flow of benefits that derive from the fishery. It also carries with it a responsibility for the long-term sustainability and vitality of the fishery--as well as the obligation to absorb the risks inherent in making the relevant management judgements under conditions of uncertainty.

It thus seems appropriate that the state-of-origin should have the responsibility to protect and enhance habitat and the authority to set total annual harvest escapements. It should also have the right and ability to capture most of the enhancement in harvest return that results from these conservation measures.

On the other hand, these improved stock conditions and enhanced harvest levels could not occur without

the cooperation and restraint of the other management authorities across whose jurisdictions the stock migrates. Furthermore, absent an agreement to cooperate, these jurisdictions retain the ability to determine unilaterally the levels of interception they consider to be appropriate.

Plainly, these circumstances place a limit on the effective level of ownership which the home-country authority can achieve.

At the minimum, all parties must believe themselves to be better off from cooperating than otherwise, or they will prefer to act unilaterally. (Munro, et.al. [1997]) This condition is called "individual rationality". Agreeing to meet all jurisdictions' individual rationality condition, then, is the necessary concession by the home country in order to obtain cooperation by the other stakeholders. Within this constraint, the full residual harvest value can be retained by the state-of-origin.

Note, however, the strong implications of such a policy. At least during the stock-rebuilding phase, optimal management may require that the intercepting fleet hold down its harvest well below that which it could have maintained through unilateral operation. In order to induce such cooperative behavior, while yet maintaining individual rationality, the intercepting fleet will require some kind of compensating transfer payment--i.e. a bribe--from the state-of-origin. This can be in the form of compensating interceptions from other stocks or as a credit against future harvests from the present stock.

Fortunately, the overall gain from optimal coordinated management is probably large enough that the individual rationality requirements of *all* parties (including the home country) can easily be met--though, as suggested, only if the direct and indirect benefits from harvests are redistributed over place and time by means of transfer payments.

Often this will mean that interceptors pay the home country a royalty for the right to harvest. However, as noted, in some cases the home country will have to bribe the interceptor in order to keep harvest levels down!

The determination of these transfers has to be made a part of the agreement that sets harvest quotas in the first place. Furthermore, the package of harvests and transfers will have to be renegotiated

regularly, in light of changing circumstances.

Note that transfers to achieve individual rationality may run counter to transfers to achieve equity. Consequently, while the home country will receive a larger net return cooperatively than it would have in competitive conditions, it may not receive benefits equal to those it would have received as a sole harvester! In this case, the parties either must agree to accept that there are practical limitations on state-of-origin ownership (and therefore forego achieving full "equity"), or equity transfers must be obtained from outside this particular fishery. This means a trade-off through balancing interceptions in other salmon stocks, or a payback from outside of the fishery sector.

It has been asserted, especially by Canada, that interceptions should be kept at a minimum. However, a case can often be made that a substantial part of the increment in values from cooperation is available *only* if a certain quota of the fish are landed in particular jurisdictions, other than in the home waters. That is, the total return to a *joint* harvest may well exceed that from a harvest limited to the home-country fleet harvesting alone! Put another way, there is a price to be paid in economic efficiency for restricting or eliminating interceptions in the name of equity.

For example, there is a substantial benefit to Alaska in being accorded an allotment of certain Canadian sockeye, since these intermix in Alaskan waters with Alaskan pinks, which therefore cannot be targeted for exclusive harvest. This benefit would not be realized by anyone if those sockeye were instead harvested in Canadian waters.

Similarly, there is a benefit to U.S., in lessened domestic costs for protecting Columbia River endangered stocks, when Vancouver Island fishers accept a quota limiting their harvest of mixed Northwest stocks. The benefits might include e.g. some cutbacks in the barging of smolts, or of drastic drawdowns of reservoir pools on the Columbia, which are now undertaken to facilitate the movement of these immature salmon to the sea. The relatively low price, for obtaining the necessary Canadian cooperation in restricting Vancouver Island harvests, is a comparable restriction of U.S. harvests of sockeye from the Fraser.

If the gains from joint harvest over sole-fleet harvest are sufficiently large, it even may be

possible to satisfy simultaneously both the interception fleet's individual rationality condition and the state-of-origin equity principle.

7. REVEALING PRIVATE INFORMATION

If the state-of-origin negotiators could know exactly the interceptor's i.r. levels, they could induce cooperation by offering an optimal combination of harvest levels and transfer payments to merely improve modestly on those returns.

But individual rationality is founded on the interceptor's *own* perception of values--and these also fluctuate as circumstances change. Certainly, an adverse value determination asserted by the home state is not likely to elicit an interceptor's willing cooperation!

Furthermore, it will be very difficult for others to draw out what a particular party's bottom-line bargaining position really is: Negotiators will have a strong motivation to posture and to bluff, in order to appease their own constituencies as well as to mislead their negotiating partners. Arriving at a mutually acceptable agreement depends on the skill of the negotiators, but also on the institutional framework within which the negotiations are carried out.

In the following, we briefly shall describe a particular negotiating process, a procedure borrowed from the "principal-agent" literature (Fudenberg and Tirole [1991]), and first proposed in design of insurance contracts.

The prototype model (McKelvey [1997]) considers a single stock and single interceptor, where the value of interception fluctuates from year to year, and the current unit value of the interception is private information, known in advance only to the interception authority's bargaining team.

We envision a negotiating mechanism which concedes a leading role to the home fleet's management authority, recognizing the state-of-origin's position of primacy in stock ownership. Thus, in each season, the home state sets an overall conservation escapement and proposes a schedule of royalties (positive or negative) to be paid by the interceptor, depending on the size of the interception.

The interception authority then selects from the

schedule, choosing how large a harvest to buy. This decision is based on the choices offered, plus the authority's privately-held knowledge of its valuation of the harvest. If the interceptor authority finds that no offers on the schedule meet its individual rationality criterion, it rejects cooperation, and for that season only both parties revert to non-cooperative competitive harvesting. Both would lose by persisting in this, and therefore both will be motivated to try again in the following season. A rejection would signal to the home authority that its original range of options was too small.

In constructing its schedule of alternative offers, the home authority thinks it knows the range of possible unit values of the landings to the interceptor, and has assigned a subjective probability distribution to these possibilities. Based on these assumptions, it then sets up the schedule for which three conditions must hold:

First, the schedule must be *implementable* i.e. given the interceptor's unit value of harvest, its negotiators must regard one choice from the schedule as superior to all others offered. In effect, the schedule has been crafted to design a particular choice targeted to that value level.

Second, the selected choice must meet or exceed the intercepting fleet's individual rationality requirement, given its harvest valuation.

Third, the schedule should be optimized so that the total return to the home fleet, from its own (expected) harvest plus the transfer payment from the interceptor will net out as large as possible. Optimization is based on the home authority's subjective probability schedule of interceptor valuations (which can be updated for the following season, on the basis of the interceptor's choice this time--i.e. on the revealed private information.)

Analysis shows (McKelvey [1997]) that these three conditions always can be realized simultaneously. However this is likely to be achieved only at a price to the state-of-origin: Namely it will not in general be able to capture all of the rent--the excess return--attributable to optimal cooperative management. Sometimes a portion of the rent must be ceded to the intercepting fleet: in effect, this is a price of "buying" private information. Or it may be necessary to accept a second-best joint return to the fishery in order to meet the three requirements --in this case, obtaining the private information exacts a

price in economic efficiency.

These shortcomings are not the consequence of the particular mechanism described, but rather with the objective situation in which decisions are being made. Divided authority with conflicting objectives cannot be entirely overcome through any cooperative scheme. This indeed is the unsolved problem of managing the global common.

8. REFERENCES

- Barzel, Yoram, *Economic Analysis of Property Rights*, Cambridge U. Press, 1989.
- Clark, Colin, *Mathematical Bioeconomics*, 2nd ed., Wiley-Interscience, N.Y., 1990
- Doulman, David J., *An Overview of World Fisheries: Challenges and Prospects for Achieving Sustainable Resource Use*. FAO Fisheries Dept., Rome 1996.
- Fudenberg, Drew and Jean Tirole, *Game Theory*, MIT Press, Cambridge, MA, 1991
- Huppert, D.D., *Why the Pacific Salmon Treaty failed to end the Salmon Wars*, SMA 95-1, School of Marine Affairs, U. Washington, Seattle, 1995
- McKelvey, Robert, Game theoretic insights into the international management of fisheries, *Natural Resource Modeling* 10:129-71, '97
- Miller, Kathleen A., Salmon stock variability and the political economy of the Pacific Salmon Treaty, *Contemp. Econ. Policy* 14:112-129. 1996
- Munro, G.R., R. McKelvey, and T. McDorman, *Transboundary fisheries resources and the Canada-U.S. Pacific Salmon Treaty*, draft manuscript, 1997
- Munro, G.R. and R.L. Stokes, The Canada-United States Pacific Salmon Treaty, in *Canadian Oceans Policy: National Strategies and the New Law of the Sea*, D. McRae and G. Munro, eds. U. British Columbia Press, Vancouver, 1989, 17-35
- Yanagida, J.A., The Pacific Salmon Treaty, *Amer. J. Inter. Law* 81: 577-92, 1987