TRANSBOUNDARY FISHERY RESOURCES AND THE CANADA-UNITED STATES PACIFIC SALMON TREATY*

GORDON MUNRO
TED MCDORMAN
AND
ROBERT MCKELVEY

I. INTRODUCTION

It can be stated categorically that Pacific salmon constitute the single most prominent and important United States-Canada transboundary fishery resource. Since the early 1900s the United States and Canada have attempted to manage the resource jointly with varying degrees of success. The problem of achieving effective economic management of a shared fishery has long bedeviled the international community, causing conservation difficulties and strained relations between neighboring states.

The current Pacific salmon cooperative regime was established by the Canada-United States Pacific Salmon Treaty. When the articles of ratification were exchanged by President Reagan and Prime Minister Mulroney in March, 1985, there was an expectation that the United States and Canada would present an example to the world of cooperative resource

management and the mutual benefits which can flow therefrom. But since 1993 the Pacific Salmon Treaty has been marked by rancor and discord with both sides accusing the other of unrestrained "greed" and of destructive fisheries management practices. The summer of 1997 saw the outbreak of a full scale "fish war" when Canadian fishers blockaded the Alaska-Seattle ferry in the British Columbia port of Prince Rupert. The blockade, accompanied by a public burning of the American flag, led to cries of outrage in both Alaska and the states of Washington and Oregon, and later to a public letter of condemnation from President Clinton.[1] The government of the province of British Columbia, in turn, filed suit against the governments of the United States, Washington State and Alaska for failure to live up to the terms of the Pacific Salmon Treaty.[2]

The two federal governments agreed to appoint two "eminent persons," David W. Strangway from Canada and William D. Ruckelshaus from the United States, to re-start the negotiations over harvest allocations and thus terminate the "fish war." At the time of this writing the two "eminent persons" have submitted their report

---

Gordon R. Munro, an economist at the Universityof British Columbia, is the author (with Veijo Kaitala) of "The Conservation and Management of High Seas Fishery Resources," Natural Resource Modeling, vol. 10. (1997), *and co-editor, with Daniel Gordon, of* Fisheries and Uncertainty: A Precautionary Approach to Resource Managemtn (1996), *among other books and articles.*

Ted L. McDorman, as associate professor of law at the University of Victoria, has published "The West Coast Salmon Dispute: A Canadian View of the Breakdown of the 1985 Treaty and the Transit License Measure," Loyola of Los Angeles International and Comparative Law Journal, vol. 17 (1995), *among many articles pertaining to marine living resource and law of the sea issues.*

Robert McKelvey is retired from teaching mathematical sciences at the universities of Montana and Colorado. He is currently a free-lance consultant specializing in mathematical modeling of management and policy issues in the fields of bioeconomic and ecological risk management. He is founding editor of the journal, Natural Resource Modeling, *and past president of the Resource Modeling Association.*

but have not resolved the problem.[3] Nevertheless, the report has led to a truce which will hopefully lead to an armistice and, in due course, a resolution of the issues.

This paper reviews efforts to manage cooperatively this major transboundary resource. We shall commence with a two-part setting of the stage for our discussion of the Pacific Salmon Treaty and its travails by first presenting an overview of North American Pacific salmon fisheries which will make clear that the need for cooperative management of the resource is inescapable and essential. Then we shall bring to bear the theory of games. On the assumption that most readers have only a fleeting acquaintance, at most, with game theory, we shall digress to examine some of the basic concepts used in the theory of games. A fully developed theoretical game model of the Pacific salmon fisheries would be very complex[4] and would require a high level of mathematics. Without burdening the reader unnecessarily, we shall discover that even the rudiments of game theory provide valuable insights into the problems encountered in the cooperative management of Pacific salmon. While offering no firm solutions, we shall point to directions which, if taken in the reopened talks on harvest allocations, might lead to a declaration of peace.

II. THE NORTH AMERICAN PACIFIC SALMON FISHERIES: AN OVERVIEW

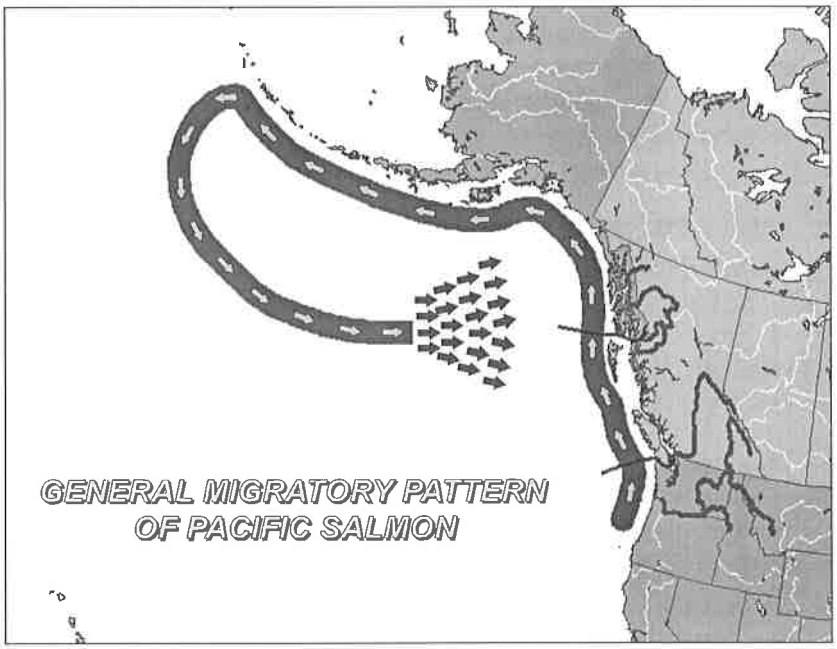
The Pacific salmon capture fisheries, which extend from northern California to Alaska, involve five major species: sockeye (red), coho (silver), chinook (king), pink (humpies), and chum (dog). The species vary significantly according to their unit market values. Sockeye, coho, and chinook are the relatively high-valued species, fetching prices that are, on average, some four times greater than those for pink and chum.[5]

While the harvests of Pacific salmon are subject to substantial fluctuation, historically the resource has played a major role in the fishing industries of Washington, Oregon, Alaska, and British Columbia. Since the Pacific Salmon Treaty was signed, the gross annual landed value of Pacific wild salmon during the best years for Canada and the United States exceeded US $1 billion. In the post-Treaty years, these salmon harvests at various times have accounted for in excess of 60 per cent of the total value of landings of all species in Alaska, roughly 50 per cent in British Columbia, in excess of 50 per

cent in the state of Washington and roughly 40 per cent in Oregon.[6] Thus the economic importance of the resource to the regions is not in doubt.

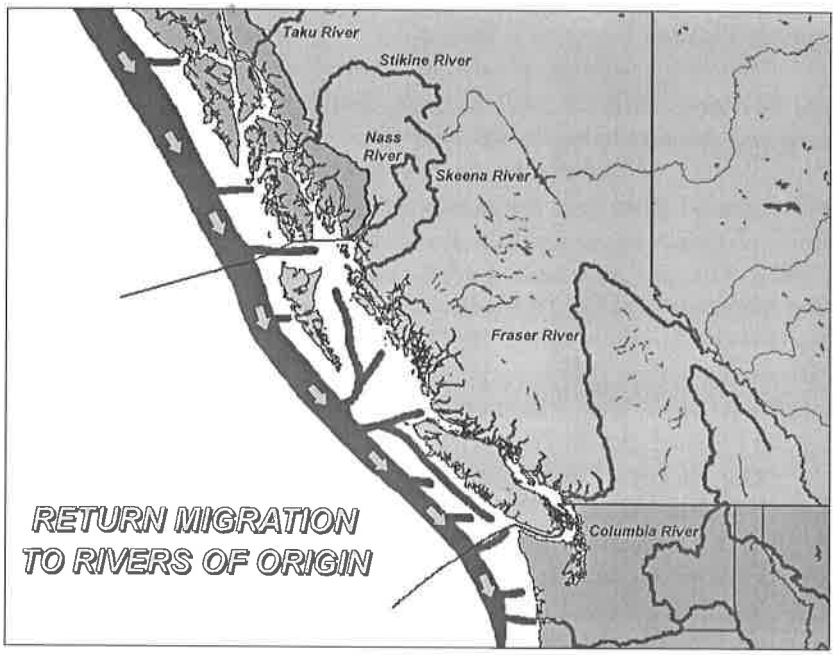
The defining characteristic of the Pacific salmon species (as well as other salmon species) is that they are anadromous in nature. That is to say, the fish spawn in fresh water — lakes, rivers, streams — and then move to the ocean. After lengthy ocean migrations, which in the case of sockeye, for example, can be as great as 3,500–4,000 kilometers and extend upwards of four years, the fish return to their fresh water habitats to spawn and die.[7] The salmon are normally harvested as they return to the fresh water habitats. Figures 1 and 2 illustrate the general migratory patterns of Pacific salmon.

Figure 1



Source: Canada (1997), Department of Fisheries and Oceans, *Pacific Salmon Treaty: Moving Towards Equity and Conservation,* paper prepared by Bud Graham, Director of Fisheries Management, Department of Fisheries and Oceans, Pacific Region.

Figure 2



Source: Canada (1997), Department of Fisheries and Oceans, *Pacific Salmon Treaty: Moving Towards Equity and Conservation,* paper prepared by Bud Graham, Director of Fisheries Management, Department of Fisheries and Oceans, Pacific Region.

As the Figures indicate, some salmon produced in American rivers and streams pass through Canadian waters during their migration. While in Canadian waters the fish are subject to "interception" (i.e. harvesting) by Canadian fishers. Conversely, some of the salmon produced in Canadian rivers and streams pass through American waters and hence are subject to the same treatment by American fishers. A further complication arises from the obvious fact that the relevant part of the United States consists of two distinct geographical regions: Washington/Oregon and Alaska. A significant amount of Washington/Oregon salmon is "intercepted" by Alaskan fishers prior to entering Canadian waters on their homeward journey. In an ideal world, it might be possible to reduce

salmon "interceptions" of all forms to zero. But the world is not ideal and full elimination of interceptions is unfeasible, with the consequence that the resource is inescapably transboundary in nature.

The measurement of salmon interceptions on the two sides of the border is difficult and, not surprisingly, has been a source of ongoing dispute between the two countries. Moreover, true interceptions will, of course, vary from year to year as conditions change. Having said all of this, the most careful assessment of the interceptions of which these authors are aware is to be found in Huppert (1995). Huppert examines both Canadian and American estimates and takes mid-points. The following estimates (Table 1) are averages for 1990-1991. They are reported for illustrative purposes and should be taken only as rough indicators. The estimates for Alaska are confined to southeast Alaska, which is the segment of Alaska covered by the Pacific Salmon Treaty.

The sockeye intercepted in Alaskan waters are produced in British Columbia. On the other hand, the coho and chinook intercepted by the Alaskans are accounted for both by British Columbia-produced fish, and by fish produced in Washington/Oregon. The British Columbia interception of coho and chinook is accounted for by Washington/Oregon produced fish, particularly those emanating from the Columbia River system. The striking Washington/Oregon interception of sockeye and pink is accounted for by sockeye/pink produced in British Columbia, particularly in the Fraser River system. Fraser River sockeye and pinks, returning to their fresh water habitats, usually (but not always) pass through the Strait of Juan de Fuca, south of Vancouver Island, and are thus subject to easy interception by the State of Washington fishers.

We are thus forced to the conclusion that: (a) the resource is currently of high economic importance, and (b) whether Canada and the United States like it or not, cooperative management of the resource is essential to the survival of the fishery. But we accompany this conclusion with a warning that there is a black cloud on the economic horizon of the Pacific salmon capture fisheries which may indicate that the two sides have but a limited time to put their resource "condominium" in order.

The black cloud takes the form of aquaculture (farmed) salmon. One important source of aggravation in the 1990s which undoubtedly helped to fuel the growing "fish war" was the decline in prices for landed wild Pacific salmon. It is estimated that the average

Table 1
Estimates of Interceptions in Commercial Pacific Salmon Fisheries by Species and Area
1990-1991

Area and Species	Interceptions	
	As a Percentage of Species Catch In Area	As a Percentage of All Species Landed Value
Southeast Alaska		
Sockeye	43	
Coho	14	
Chinook	55	
Pink	6	
Chum	4	
All Species	11	20
British Columbia		
Sockeye	<1	
Coho	32	
Chinook	52	
Pink	18	
Chum	4	
All Species		
Washington/Oregon		
Sockeye	100	
Coho	8	
Chinook	7	
Pink	84	
Chum	20	
All Species	46	50

Source: Huppert (1995), Table 1.

ex-vessel price (expressed in U.S. dollars) of wild Pacific salmon (all species) from northern California to Alaska declined by more that 50 per cent between the late 1980s to the mid-1990s.[8] There was nothing unique about these price declines. On the contrary, they showed the price declines of salmon worldwide.[9] While we have no definitive proof, the downturn appears to reflect substantial increases in the total world salmon production without comparable increases in demand.[10]

The wild salmon market is supplied overwhelmingly by Pacific (as opposed to Atlantic) salmon. Of the harvests of wild Pacific salmon, approximately two-thirds are accounted for by Washington/Oregon, British Columbia, and Alaska, with the remainder being accounted for by Japan and Russia.[11] Harvests of wild Pacific salmon did, in fact, increase significantly between the late 1980s and the mid-1990s. We shall comment at a later point on the striking increases in Alaskan harvests. Nonetheless, more than half of the increase of the world production over this period was accounted for by aquaculture salmon.

What must be disturbing for the harvesters of wild Pacific salmon is not so much the *level* of aquaculture salmon production as the trend. Consider Figure 3. At the beginning of the 1980s the production of aquaculture salmon (in volume terms) was just over one percent of harvests of wild salmon.[12] Since then, as Figure 3 makes abundantly clear, the growth of aquaculture salmon production has been dramatic and shows no signs of abating. Indeed, Figure 3 suggests that the growth of aquaculture salmon production has a decidedly exponential flavor to it.

We have fitted simple non-linear trends to the output over time of both wild and aquaculture salmon productions.[13] While recognizing the dangers associated with extrapolation, we can state that, if current trends continue, the volume of aquaculture salmon production will exceed wild salmon harvests well before 2010. If North American harvesters of wild salmon should hope for relief through the curbing of aquaculture production, we would point to one salient fact. Close to 90 per cent of aquaculture salmon production occurs outside of North America.[14]

With this brief overview of the Pacific salmon fisheries now complete, we digress to consider some of the basic concepts in the theory of games relevant to the issue of management of the Pacific salmon resource.

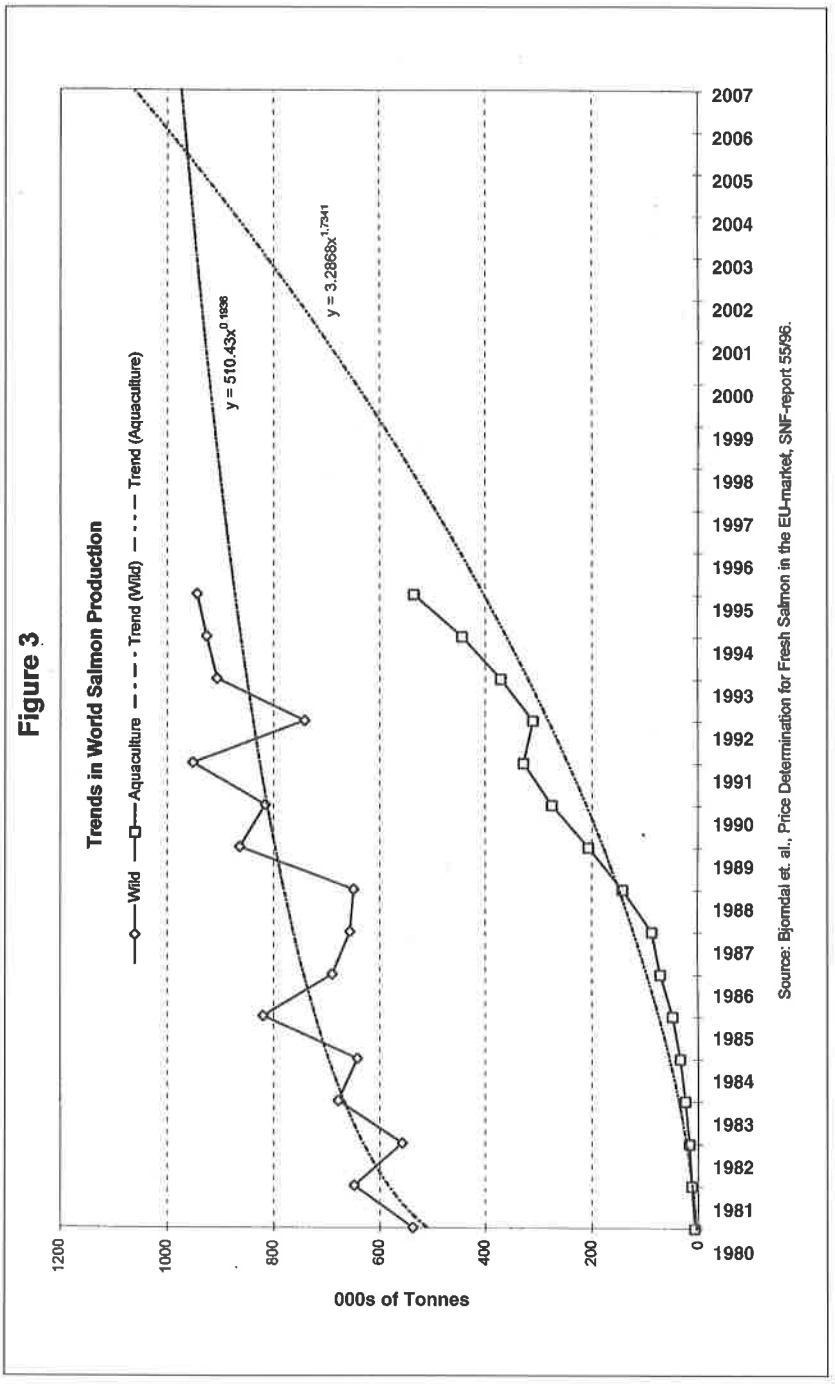


Figure 3
Trends in World Salmon Production
Wild
Aquaculture
Trend (Wild)
Trend (Aquaculture)
y = 510.43x^0.1936
y = 3.2868x^1.7941
000s of Tonnes
1200
1000
800
600
400
200
0
2007
2006
2005
2004
2003
2002
2001
2000
1999
1998
1997
1996
1995
1994
1993
1992
1991
1990
1989
1988
1987
1986
1985
1984
1983
1982
1981
1980
Source: Bjorndal et. al., Price Determination for Fresh Salmon in the EU-market, SNF-report 55/96.

III. SOME BASIC CONCEPTS IN THE THEORY OF GAMES

The theory of games is designed to analyze strategic interaction between and among "individuals" who may be persons, firms, regions, nations, or others. To take an example from industrial organization, another field of economics, firms operating in an industry characterized by a few large firms, so-called oligopolies, must take into account, when determining price and output policies, the impact of such policies upon rival firms and the subsequent reactions of these rival firms. Game theory proves to be invaluable in analyzing such situations.

In the case of transboundary fishery resources such as Pacific salmon, which are subject to exploitation by two or more nations or regions, the aforementioned strategic interactions are unavoidable. Game theory proves to be an essential tool in attempting to analyze the management of the resources, a fact now recognized well beyond academic circles. The OECD Fisheries Division has recently published a volume on the economic aspects of the management of living marine resources entitled *Towards Sustainable Fisheries*.[15] The discussion in the volume on the economics of transboundary fisheries management employs a game theory framework. The reader will find a close correspondence between the technical appendices pertaining to the economics of transboundary fisheries management in the aforementioned volume and what is to follow in this section.[16]

Perhaps the greatest drawback to the theory of games is the nomenclature, which creates the impression that it is frivolous. It is not. Within economics, but also in other fields such as international relations and legal studies, the use of game theory has spread rapidly. In economics, recognition of the importance of game theory was given in 1994 when a trio of specialists in it were awarded the Nobel Prize in economics. In commenting on the award, *The Economist* remarked that, while twenty-five years ago game theory was viewed in economics as a rather esoteric specialty, no student in economics today can hope to receive his or her degree without an understanding of at least the rudiments of game theory.[17]

In the theory of games, the interacting "individuals" are referred to as "players." The "players" are assumed to be rational and to have various courses of action open to them which are referred to as "strategies." The expected return to a player, in following a particular strategy, is termed a "payoff." The size of the expected

return, or "payoff," will also, of course, depend upon the expected reaction of the other individual or individuals. The stable outcome of a game is termed a "solution," but there is no assurance whatsoever that every game will have one. Many do not. In games having more than two players, a further complication arises, at least for certain classes of games. There exists the possibility that subsets of players will come together to form "coalitions". Once established, coalitions may break apart and new ones are formed.

There are two broad categories of games, cooperative and non-cooperative. In a cooperative game the players are assumed to be motivated strictly by self-interest but are given an incentive to cooperate. Of critical importance is the fact that the players are able to communicate effectively with one another. In non-cooperative, or competitive, games, by way of contrast, the lines of communication between and among the players are faulty or simply non-existent.

There are two points which need to be made about non-cooperative games. The first is that solutions are possible. The most famous of such solutions was developed by Nobel laureate John Nash. In taking the example of a two-player game, a solution will have been achieved when each player has no incentive to change in light of the strategies of the other player.[18] The second comment is that non-cooperative games, more often than not, produce results that, particularly from an economic standpoint, are likely to be highly unsatisfactory. This outcome is characterized by what is probably the best known of all non-cooperative games, the "Prisoner's Dilemma," in which the players are driven to adopt strategies which both recognize as being undesirable if not destructive. The name comes from a story used by the author of the game to illustrate his point.[19] Two thieves, the "players," are apprehended on less than convincing evidence. Upon being interrogated by the authorities, each has two strategies — to plead guilty or to plead not guilty. The thieves are kept isolated from one another, hence the game is perforce non-cooperative. If the thieves were able to communicate and thus exploit an opportunity to cooperate, and were capable of entering into a secure agreement, the two would plead not guilty. In playing a non-cooperative game, each player is driven inexorably to adopt the unsatisfactory strategy of pleading guilty with all that it entails.

The "Prisoner's Dilemma" has direct relevance to the management of transboundary fishery resources. What we might refer to as the theory of the economic management of transboundary fishery

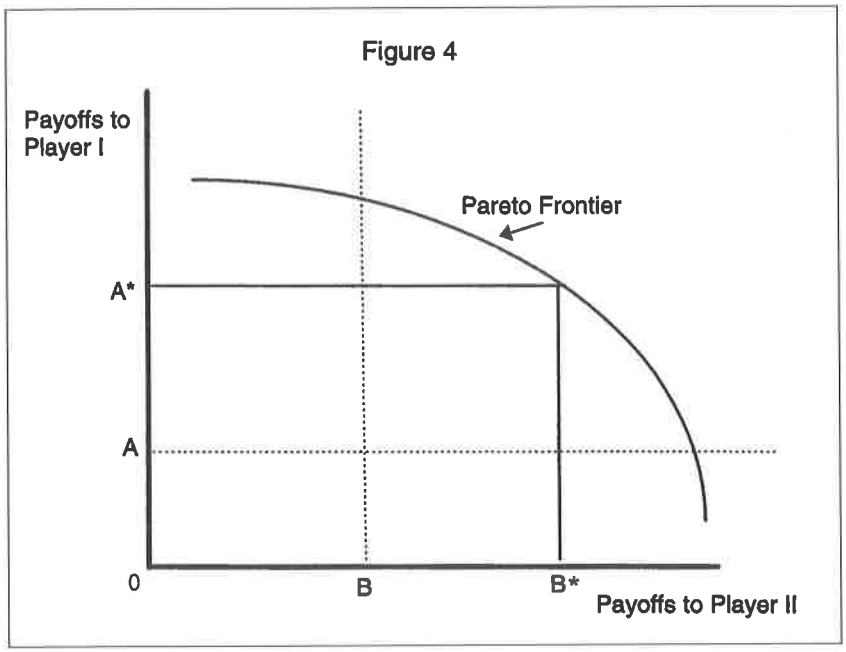
resources under conditions of non-cooperation[20] predicts that the joint exploiters will be driven to over-exploit the resource, a Prisoner's Dilemma type of outcome. The predictive power of the theory is high. The gross overexploitation of transboundary fishery resources in the form of "straddling" fish stocks, which gave rise to the recently concluded U.N. intergovernmental conference,[21] is one example. As we shall see, the theory will have direct relevance to the history of the Pacific salmon fishery.

Now let us turn briefly to cooperative games. In these games the players are able to communicate and therefore to weigh entering into a cooperative agreement. The incentive to cooperate arises from the possibility that all will be better off in light of the destructive consequences of non-cooperation. Altruism is not assumed to underlie cooperation. It is supposed that each "player" will bargain hard for as large a share as possible of the total benefits.

In order for there to be a "solution" to the cooperative game, two key requirements must be met. The first is that it must not be possible to make one player better off without harming the other(s) by some alternative agreement. To use the economist's jargon, the agreement must be "Pareto optimal." Secondly, it must not be true that any single player would be better off by refusing to cooperate. This is sometimes referred to as the Individual Rationality Constraint. We illustrate these points by the following diagrams for a two-player game.

In Figure 4 the line labeled the "Pareto Frontier" represents the combinations of payoffs from cooperative arrangement that meet the "Pareto optimality" rule. As one moves down the frontier, Player II is made better off, but only at the expense of Player I. Payoffs A and B represent the payoffs to players I and II respectively from non-cooperation. We might think of these as the payoffs arising from a non-cooperative game. To use John Nash's expression, A and B constitute the "threat point," the minimum payoffs players I and II must receive if there is to be a solution to the cooperative game.[22]

The sets of potential cooperative agreements in the two-player game in which both conditions are met are said to constitute the "core" of the game. In Figure 4, the "core" is represented by the segment of the Pareto Frontier between the dotted lines. In Figure 4, the "core" is positive. Where the players will end up in the "core" and what the "solution" to the game will be depends upon the relative bargaining strengths of the players. Let it be supposed that the



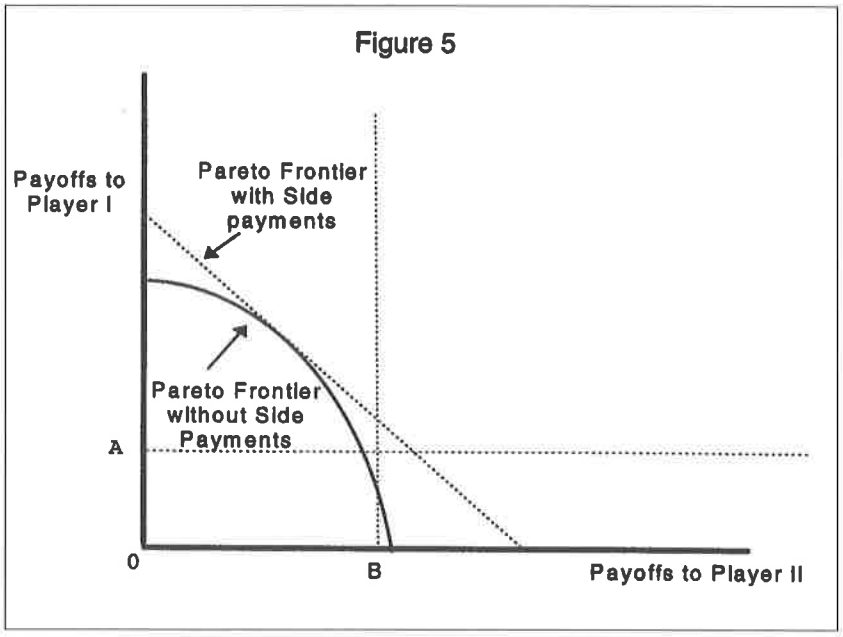
"solution" to the cooperative game is such that player I enjoys a payoff of A*, and player II a payoff of B*. The cooperative "surplus" (CS), the global economic benefits arising from cooperation, can be expressed simply as follows:

$$CS = (A^* + B^*) - (A+B)$$

There is, in fact, no guarantee that the "core" will be positive. There may be no point on the Pareto Frontier at which both players are assured payoffs from cooperation at least equal to their threat point payoffs. If the "core" is indeed empty, then attempts at cooperation will founder, and the players will revert to competitive, or non-cooperative, behavior.

If it appears that the cooperative game will founder because there is no point on the Pareto Frontier which promises both players payoffs at least equal to their threat point payoffs, then the only way out is to find means for broadening the scope for bargaining. One such means is through the use of so called "side payments." Side payments are essentially transfers between and among players which may take a monetary form but need not do so. With side payments (transfers) possible, the objective of the players becomes that of maximizing the global returns from the relevant activity and then

bargaining simply over a division of the returns. The Pareto Frontier becomes a 45° line, such that the sum of the payoffs at any one point on the frontier is equal to the sum of the payoffs at any other point on the frontier.



In Figure 5 we show two frontiers, one without side payments and one with them, and use the diagram to illustrate that, with side payments, it may be possible to transform a cooperative game without a core into one with a core. The threat point is such that there is no point on the non-side payments Pareto Frontier at which both players would be better off than they would be under non-cooperation. Once again A and B denote the "threat point" payoffs. The segment of the Pareto Frontier with side payments lying between the two dashed lines represents the "core" of the cooperative game with side payments. In the context of fisheries, side payments can be explained as follows. In a two-player cooperative fisheries "game" without side payments, the benefits or the payoffs enjoyed by a given player will depend strictly upon the harvests taken by that player's fleets, and within that player's waters. If side payments are used, the payoffs are not so strictly determined.[23]

Side payments are not extensively used, but one can point to a few fisheries "games" where they have been applied to great effect. One example was provided by the fur seal fishery of the northeast Pacific and the Convention for the Preservation and Protection of Fur Seals, 1911–1984. Fur seals were exploited in the northeast Pacific by four countries; Canada, Japan, Russia, and the United States. The fishery became significant in the late 19th century. The resource was managed non-cooperatively and the "Prisoner's Dilemma" played itself out, heavily depleting the seals. Fearing a collapse of the resource, the four countries came together and transformed the competitive game into a cooperative one. The aforementioned Convention was brought into effect in 1911. Russia and the United States were lower-cost harvesters than were Canada and Japan.[24] Under the terms of the agreement Canada and Japan reduced their seal harvests to zero. In return, Russia and the United States gave Canada and Japan a certain fixed percentage of the annual harvested skins. The fixed percentages given to Canada and Japan were straightforward side payments. The Convention, the cooperative game, was profitable for all four players and also proved to have powerful resource conservation benefits. It is estimated that the size of the seal herds increased eighteen-fold between 1911 and 1941 when the Convention was interrupted by the outbreak of World War II in the northern Pacific.[25]

Two further comments are in order. Thus far we have talked in terms of two-player cooperative games. If there are three or more players, then we must allow for sub-coalitions to form. Then, for there to be a solution to the game, it must be sub-coalition proof as well. It must not be possible for a sub-coalition to do better by going off on its own. Furthermore, we must allow for the possibility that sub-coalitions may break apart and new ones form. Secondly, and of utmost importance, the diagrams we have employed are really a description of static or timeless games. This is adequate only as a starting point. In most games, and certainly in fisheries games, time does indeed matter. The solution to a cooperative game must be "time consistent."[26] Conditions may change through time with the consequence that what appeared to be a sound basis for cooperative management in the initial stages of the game may cease to be so through time, and thus the solution to the game may fail to be "time consistent." Cooperative arrangements which lack scope for bargaining and concomitant flexibility to adjust to changing circumstances invite collapse.

IV. THE CANADA-U.S. PACIFIC SALMON TREATY: BACKGROUND AND ORIGINS

Canadians and Americans recognized at an early stage the transboundary nature of Pacific salmon fishery resources and the desirability of cooperation. The initial attempts at cooperation focused on the Fraser River, which has been described as the western hemisphere's most important salmon river.[27] We have already noted that the Fraser River system sockeye and pinks normally pass through the Strait of Juan de Fuca on their return journey and thus become subject to American interception. We have also observed the heavy dependence of Washington/Oregon sockeye and pink fisheries on the Fraser River system runs.

The first attempt to establish cooperative management of the Fraser River salmon occurred in 1908, but it proved to be abortive.[28] Further efforts at cooperation were made as the effects of non-cooperation became increasingly evident. In 1930 a treaty formally known as the Convention for the Protection, Preservation and Extension of the Sockeye Salmon Fisheries in the Fraser River System was signed, but difficulties in the American senate delayed ratification until 1937. While the treaty was initially focused on the relatively high-valued sockeye salmon, it was later amended (1957) to include the less valuable pinks as well.

Under the treaty the Fraser River sockeye (and later pink) salmon were to be managed by an International Pacific Salmon Fisheries Commission (IPSFC) on which the two countries were to be equally represented. The management control extended over a specified Convention Area which essentially comprised the approaches to the Fraser River commencing at the southern end of Vancouver Island. The division of the net economic returns from the Fraser River fisheries was determined by a simple, and seemingly equitable, formula. The two countries would share equally the costs of maintaining the IPSFC and the costs of enhancing the Fraser River system's ability to produce and nurture salmon, for example, by the removal of obstructions confronting salmon on their way to the spawning grounds. The allowable salmon harvests were to be divided equally between the two countries. For the first twenty to twenty-five years the treaty appeared to work as well as a conservation device and, concomitantly, as a method for enhancing the economic returns from the fisheries to the two countries. In the late 1950s, near record runs of Fraser River sockeye and pink salmon were reported.[29]

What one actually had under the treaty during its first twenty to twenty-five years was an unadorned two-player game involving Washington State (or perhaps more accurately Washington/Oregon) and Canada (British Columbia to all intents and purposes). The existence of a substantial cooperative surplus was manifest. Equally manifest was the fact that each "player" was enjoying a payoff well in excess of its non-cooperative gains. Furthermore, the division of the economic returns from the cooperatively managed fishery appeared to be equitable. There were, it is true, no side payments. Each player's gross return from the fisheries was determined solely by the harvests of that player's fleet. But then, side payments did not appear to be required for a stable cooperative arrangement and would have seemed pointless at best.

Then conditions changed. By the early 1960s the Canadians, and the British Columbia fishing industry in particular, began reassessing their payoffs. They concluded that their 50 per cent share of the net economic benefits from the Fraser River fisheries was an illusion. While the harvests and direct costs of management were apportioned equally, there were indirect costs that needed to be considered as well. Canada had forgone power developments on the Fraser and had instituted pollution control programs, all for the benefit of the salmon. Canada bore these indirect costs in their entirety. From this point of view Canada was in fact enjoying significantly less than 50 per cent of the *net* economic benefits from the salmon fisheries. The Canadian government came under increasing pressure from the British Columbia fishing industry to re-open treaty negotiations to achieve a more "equitable" division of the aforementioned net benefits.[30]

During the bargaining, Canadian pressure on the United States took the form of harvesting Fraser River salmon outside of the Convention area,[31] and of intensifying Canadian interception of Columbia River system chinook and coho, particularly off the west coast of Vancouver Island. From the early 1960s to the early 1970s, Canadian harvests of chinook and coho from this sector increased by roughly 150 per cent in terms of weight.[32] In fact some 90 percent of these harvests were accounted by Columbia River-produced salmon.[33]

If Columbia River system chinook and coho only passed through Washington/Oregon waters, the high seas, and British Columbia waters in their migration, the Canadian strategy of intensifying interception would have made eminently good sense. But we

have already seen that this is not the nature of the migratory pattern of the chinook and coho. A significant portion migrate through Alaskan waters and are subject to Alaskan interception before moving into British Columbia waters. The Alaskan interceptions had long been a source of tension between Washington/Oregon and Alaska which worsened during 1970s and 1980s.[34] As Miller notes, the growing Canadian harvest of Columbia River chinook and salmon meant that the Washington/Oregon–Alaska dispute could not be treated as an internal United States issue. Canada would have to be drawn into the negotiations.[35]

In Canada, the management of marine fishery resources is the sole prerogative of the federal government. If the same were true in the United States, then Canada's interposition between Washington/Oregon and Alaska would have introduced complications but would not have altered the fact that it was basically a two-player game. Yet such is not the case. In the American system the individual states have yielded substantial control over fishery resource management to regional fisheries management councils. In the Pacific Salmon Commission that surfaced under the Canada–U.S. Pacific Salmon Treaty, the American section is a coalition among three players: Alaska, Washington/Oregon, and the 24 Treaty Native-American tribes of Washington, Oregon, and Idaho.[36] The three must reach a consensus among themselves before talks with the Canadian delegation.[37] During intra-U.S. disputes over Columbia River chinook and coho, the Native-American Treaty tribes and Washington/Oregon have normally found themselves in an alliance against Alaska. The fact that Canada was now firmly interposed between Alaska and the American Pacific Northwest did, in fact, alter the cooperative game in a fundamental manner. What had hitherto been a straightforward two-player game was moving inexorably towards a complex multi-player game.

In 1970 the two countries announced that they would enter into comprehensive salmon negotiations which would cover *all* transboundary salmon fishery resources produced in British Columbia, the Yukon, Oregon, Idaho, Washington, and Alaska. Given the substantial Canadian interception of Washington/Oregon-produced chinook and coho which had first passed through Alaskan waters, a comprehensive agreement was required. Moreover, by now Alaskans and British Columbians intercepted significant shares of each other's salmon. Added to these concerns was the impending United

Nations Third Conference on the Law of the Sea, which raised the spectre of other players becoming involved. The desire to control or to prevent any future penetration of the Pacific salmon fisheries by distant water fishing nations drove both Canada and the United States to put their own houses in order.[38]

Initially, the treaty negotiations could have been characterized as a three-player game involving Canada, Alaska, Washington/Oregon. The 1974 Boldt decision of the American federal court,[39] which guaranteed 50 per cent of the salmon available for harvesting off Washington/Oregon to the Pacific northwest Treaty/ Tribes, ultimately altered the relationship to a four-player game with the Treaty Tribes constituting the fourth player.

The negotiators of a renewed Pacific regime could be seen to have had two fundmental objectives:[40] (1) minimizing interceptions while at the same time not disrupting "existing" fisheries, and (2) achieving a mutually acceptable division of the benefits, however they might be defined, that arose from the existing set of Pacific salmon fisheries. Avoidance of the disruption of "existing" fisheries (that is, the American harvesting of Fraser River sockeye) meant accepting implicitly that there would be, to all intents and purposes, an irreducible level of interceptions. It seemed obvious that, if the second objective was to be achieved, one had first to measure the value of both American and Canadian interceptions. The measurement problem proved to be intractable and has yet to be resolved. Ongoing disputes arising from this difficulty threatened more than once to collapse talks.[41]

Still, the negotiators persevered, driven onwards by at least two manifestations of the Prisoner's Dilemma. The first took the form of a "fish war" which can be described as the deliberate overexploitation of a fishery resource by one party, or player, in order to deny harvesting opportunities to another.[42] The Fraser River sockeye and pink stocks within the Convention area were subject to cooperative management and were protected. All other Pacific salmon stocks were not similarly protected and so became the focus of the "fish war." Shortly after the ratification of the treaty in 1985, Thomas Jensen had concluded that the agreement was not just about fisheries management but actually a "peace treaty memorializing the end of the Pacific salmon war."[43] Nevertheless, as chinook stocks in particular declined, it soon became apparent that the "peace treaty" of 1985 had become little more than a brief armistice.

The second manifestation of the Prisoner's Dilemma focused on salmon enhancement programs. One can enlarge salmon stocks by reducing harvesting, and/or through enhancement programs such as hatcheries and the removal of obstacles to salmon spawning up river. Both the United States and Canada had significant opportunities to implement enhancement facilities. But there is evidence that both countries deliberately refrained from doing so for fear that the benefits would accrue to the other country's fishers rather than to their own.[44]

In the negotiations over the division of the benefits from the fisheries, the Canadian delegation was successful in insisting upon the adoption of the "equity" principle which was to be a source of great controversy in later years. The principle owes its origins to the U.N. Third Conference on the Law of the Sea (1973–1982). At the conference, Canada, along with the United States, promoted salmon as a species requiring special treatment. The common policy was that "states in whose rivers anadromous stocks originate shall have primary responsibility for such stocks" (U.N., 1982, Article 66). The principle referred to as the "state-of-origin" was directed primarily at distant water fishing nations such as Japan. But it can be argued that in order for the principle to be credible, Canada and the United States had to implement the state-of-origin approach in their own bilateral Pacific salmon negotiations.[45] At Canadian insistence, this was done and appeared in the guise of the "equity" principle.

One issue raised by the state-of-origin/equity principle is the extent of the claim which a state has over salmon produced in its waters when those fish are resident in the waters of a neighboring state. The issue is complicated by the concept of the 200-mile Exclusive Economic Zone (EEZ) brought forth by the new International Law of the Sea (U.N., 1982). Both Canada and the United States implemented EEZ regimes in 1977.

Under the U.N. Convention on the Law of the Sea, coastal states such as Canada and the United States have "sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living ..." within the EEZ .[46] The exclusive sovereignty over living resources in the EEZ (U.N., 1982, Article 56) appears to conflict with the state-of-origin principle (U.N., 1982, Article 66). But in a coastal state's own waters, that country's fishers can intercept salmon from another country. While the state-of-origin principle applies to transborder waters, the imple-

mentation of the principle is left to cooperation between the states involved.[47] Thus, although a special regime covers anadromous species, the state-of-origin principle (Article 66) yields to the exclusivity of the EEZ regime (Article 56). Article 56 is superior to Article 66.[48]

In any event, one can interpret the state-of-origin principle — U.N. Convention on the Law of the Sea, Article 66 — as implying that the economic benefits arising from the harvest of salmon belong to the state in whose waters the salmon are produced. On this basis, Canada pressed for the adoption of the "equity" principle in the salmon treaty in a form which maintains, in effect, that each state should receive the *equivalent* of the economic benefits of the salmon produced in its rivers and streams. The principle, thus stated, recognizes that interceptions cannot be eliminated but maintains that each nation should receive economic compensation for its own salmon intercepted by the other. Since it was well-known that American interceptions of salmon exceeded Canadian interceptions, the American delegation accepted this principle only with the deepest reluctance.[49]

The economic benefits with which the equity principle is concerned can be thought of as having two components. First there are the benefits that would accrue from post-treaty enhancement and conservation measures which would be implemented, in turn, once the curse of the Prisoner's Dilemma was lifted. The second component consists of the residual gains which might be called "baseline" benefits.[50] There was no dispute over the first component. The benefits should be enjoyed solely by the country implementing the measures. Thus, for example, if in the post-treaty era enhancement and conservation measures were implemented in the Columbia River system, all of the resultant benefits should accrue to the United States.

The "baseline benefits" were quite another matter and brought with them the return of the interception measurement problem. In the end, the negotiators finessed the problem by including in the treaty a memorandum of understanding stating that the "baseline benefits" required several years of further study, and that the equity principle was to be fully implemented in "due course." Postponing resolution of these issues made it possible to adopt the treaty.[51]

Driven by the growing crisis in the chinook fisheries, the negotiators pressed forward and by late 1982 had drafted a document

ready for approval. The Canadian government indicated its willingness to ratify the treaty immediately. But the Alaska delegation effectively blocked ratification in the U.S. senate, and a year later the proposed treaty appeared to be stillborn.

In this four-player game, three strongly supported the treaty, but the fourth player (Alaska) did not for an obvious reason. Alaska had little or nothing to gain from cooperation; that is, its Individual Rationality Constraint was not satisfied. Alaska was faced with only limited interception of its own salmon, while it could continue harvesting significant amounts of Washington/Oregon and British Columbia salmon. Alaskans believed they were being asked to incur substantial sacrifice and dislocation to help re-build Columbia River chinook stocks, with all the benefits accruing to Washington/Oregon and British Columbia fishers.[52]

The Canadian government responded in two ways. First, it offered to ratify the treaty as it stood. Secondly, it reverted to competitive behavior, employing a particular strategy which one could term "punishing one's friends." The Canadian authorities encouraged their fleet to increase harvesting of the already endangered Columbia River coho and chinook stocks.[53] This strategy appeared to prove effective when a Pacific Salmon Treaty Coalition emerged in Washington/Oregon, lobbying hard for a resumption of negotiations.[54]

If one player's Individual Rationality Constraint is being violated, then no progress will be made unless the scope for bargaining can be enhanced. One can attempt to enhance the relevant player's returns from cooperation through side payments. It may also be possible to alter the player's expected threat point payoff. The Treaty Native-Americans took the latter approach. They commenced litigation which, if successful, would have extended the 50-50 sharing rule arising from the Boldt decision to Pacific northwest salmon (chinook) primarily harvested in Alaska waters. This could have led to an enforced 50 per cent reduction in the Alaskan chinook harvest.[55] At the same time, the Native-Americans offered to terminate their litigation if Alaska agreed to cease blocking the treaty.

Treaty negotiations re-commenced in 1984, and the Alaskans and the Treaty Native-Americans entered into a side agreement foregoing litigation against Alaska so long as the Pacific Salmon Treaty remained in force.[56] These talks were completed in December, 1984. In March 1985, the articles of ratification were exchanged and

the Canada-U.S. Pacific Salmon Treaty was promulgated.[57] Figure 6 indicates the area covered by the agreement.

V. THE STRUCTURE OF THE TREATY AND THE EARLY YEARS OF PROMISE

The treaty establishes a Pacific Salmon Commission which is concerned with both the conservation and allocation of harvests from jointly exploited stocks. The commission is assisted by three panels. The two countries have equal representation on the commission and on each of the three panels. Decisions are reached by consensus (Treaty, 1985, Article II). One group, the Fraser River panel, effec-

Figure 6

Source: Canada (1997), Department of Fisheries and Oceans, *Pacific Salmon Treaty: Moving Towards Equity and Conservation,* paper prepared by Bud Graham, Director of Fisheries Management, Department of Fisheries and Oceans, Pacific Region.

tively takes over the duties of the IPFSC.[58] The other two, a northern and a southern panel, together cover all remaining salmon fisheries. The treaty contained short-term management plans for six specific sets of fisheries, namely: Fraser River sockeye and pink salmon fisheries; transboundary river fisheries, where a "transboundary river" is essentially one which rises in the Yukon/British Columbia and flows to sea through Alaska; fisheries based on salmon in the boundary area between British Columbia and Alaska; chinook fisheries; coho fisheries; and chum fisheries of southern British Columbia and Washington State.[59] With the assistance of the panels the commission was responsible for negotiating new management plans as the old ones expired, and it did so until 1991.[60] But commission members have been unable to reach a consensus on the allocation of salmon harvests since 1993.

The work of the commission is governed by fundamental principles set forth in Article III of the treaty. "Each Party shall conduct its fisheries and salmon enhancement programs so as to (a) prevent overfishing and provide for optimum production and (b) provide for each Party to receive benefits equivalent to the production of salmon originating in its waters."[61] Article III [1(a)] is seemingly straightforward and was not subject to argument when the treaty was signed. Article III [1(b)], the Equity Principle, became a source of ongoing contention. Article III then adds several qualifications which fueled debate and controversy. It states that, in honoring the two fundamental principles, "... the Parties shall take into account (a) the desirability in most cases of reducing interceptions, (b) the desirability in most cases of avoiding undue disruptions of existing fisheries, (c) annual variations in abundance of stocks."[62]

There were two key aspects of the original treaty. First, the Americans gave up their claim to 50 per cent of the all important harvests of Fraser River sockeye and pinks. Instead they accepted a ceiling which would be subject to reconsideration. Correspondingly, Canada accepted ceilings on its harvest of American-produced coho and chinooks. The implication of these provisions was that, if Canada set up successful enhancement programs on the Fraser, the benefits would accrue solely to Canada. Conversely, if the United States imposed successful enhancement programs on the Columbia, the benefits would accrue solely to the United States. Secondly, there was a commitment to rebuild the beleaguered chinook stocks from the Columbia northward to southeastern Alaska by restricting harvesting. The target stock levels were to be achieved by 1998.[63]

In retrospect, the aims and hopes of the negotiators were reasonably clear and straightforward at the time of the ratification of the treaty. With the curse of the Prisoner's Dilemma removed from the salmon enhancement programs, it was hoped that benefits which would flow from these programs would overwhelm the "baseline" benefits. Furthermore, the chinook and coho stocks would be restored to the satisfaction in particular of Washington/Oregon and the Treaty Native-Americans. Alaska would remain content as a result of being freed from the threat of litigation.[64]

The Fraser River continued to be seen as the key. At the time of the signing of the treaty, the Canadian Department of Fisheries and Oceans maintained that 80 per cent of American interception of Canadian produced salmon was accounted for by Fraser River sockeye and pinks.[65] Shortly after the treaty came into operation, a senior Canadian member of the Pacific Salmon Commission argued that the treaty would stand or fall on the Fraser River.[66] Under the terms of the treaty, the Americans continued to be assured of a share of the harvest of Fraser River salmon. At the same time Canada was assured that all additional benefits from post-treaty Fraser River enhancement projects would flow to Canada alone.[67]

In spite of the concern that the Americans were, and would remain, overall interception debtors, there was a belief on the Canadian side that the Canadian interception of coho and chinook allowed under the treaty would provide a rough, albeit imperfect, balance to American interception of sockeye and pinks.[68] Munro and Stokes (1989) urged that, if the rough balance was seen to be maintained, the two sides, and Canada in particular, should accept the balance and not allow the best to become the enemy of the good by seeking a precise accounting.[69]

In retrospect, the treaty did contain one serious weakness; namely, a lack of flexibility. The "equity" principle, which could not be finessed forever, was based on what might be termed a "fish-for-fish" rule. In the early 1990s the Canadian Minister of Fisheries and Oceans had stated that the "equity" principle meant giving each nation "the opportunity to harvest the fish produced in its rivers, or failing that, to harvest an equal amount of the other nation's fish."[70]

Put to one side the problem of devising an exchange rate between, say, sockeye and chinook. The implication of the minister's statement was that, if an imbalance should emerge (e.g. American interceptions are found to exceed Canadian interceptions to a signifi-

cant degree, and in a persistent manner), the imbalance could be dealt with only by (1) Canada increasing its interceptions, or (2) the U.S. lowering its harvesting activities in order to reduce, in turn, its interceptions. Option (1) is in direct conflict with Article III 3(a) of the treaty, which emphasizes the desirability of reducing interceptions where possible. The Americans would be able to argue that option (2) could prove to be counter to Article III 3(b), which stresses the desirability of avoiding undue disruption of "existing" fisheries.[71] To all intents and purposes, one was confronted in the treaty, and in its initial implementation, with a classic example of a cooperative game without side payments.[72] The subsequent years were to reveal the severe limitations of such a game in the context of Pacific salmon.

Be that as it may, the first few years of the life of the treaty encouraged at least cautious optimism. The Washington/Oregon harvests of coho and chinook showed a gratifyingly strong improvement over the years 1986-1988, providing reason to hope that a restoration of these beleaguered stocks was indeed taking place.[73] In addition, the seemingly all-important Fraser River component of the treaty appeared to work well. After the signing, Canada implemented its Fraser River sockeye rebuilding program and the river's sockeye harvest increased rapidly. Since all of the benefits of enhancement flowed to Canada, the Canadian share of the Fraser River sockeye harvest rose to 80 per cent. The American harvest of the Fraser River sockeye in Washington State waters was protected in absolute terms.[74] Both sides were pleased with the outcome. Daniel Huppert, an American observer, argued that this component of the treaty had to be regarded as a success right up to his date of writing in 1995.[75] Finally, the treaty enabled Canada and Alaska to come together to resolve the disputes over the salmon fisheries based upon the so-called transboundary rivers, streams that rise in Canada and flow to the sea through Alaska (e.g. the Stikine River). The treaty resulted in a model of cooperation with respect to these fisheries. Scientific research and stock rebuilding programs were agreed upon, and a formula for the equitable sharing of the harvests was devised.[76] One should note in passing that the Fraser River and transboundary rivers' "successes" had one characteristic in common. In each case, they were like a two player sub-game: Canada and Washington State; Canada and Alaska.[77]

VI. YEARS OF TURMOIL

Commencing in 1993, the early years of promise were followed by years of increasing tension, impasse and breakdown. Two key reasons can be advanced for these unfortunate developments. The first is that the "equity" principle could no longer go on being finessed and had to be addressed head on. Secondly, and of even greater importance, was the fact that the rough balance which the Canadians thought that they had achieved between American interception of Canadian-produced sockeye and pinks and Canadian interception of American- produced coho and chinook was shattered. The apparent recovery of the Washington/Oregon coho and chinook stocks proved to be illusory. The good harvest years of 1986–1988 were followed by years of rapidly declining yields. In 1994 coho and chinook stocks off Washington/Oregon were deemed to be so low as to warrant an outright harvest moratorium.[78] Figure 7, which shows total volume of harvests in Oregon, illustrates the difficulties being encountered by the salmon fisheries in that part of the U.S.

The collapse of the Washington/Oregon coho and chinook fisheries has been accompanied by rapidly increasing salmon harvests off Alaska. Alaska harvests, which were at a low point in the mid-1970s, experienced a ten-fold increase over the next 20 years.[79] Consider Figure 8 which shows the steady increase of Alaskan harvests and the dominance of Alaskan fishers (in volume terms) by the mid-1990s. In 1994–1995, Alaskans accounted for 85 per cent of the harvest (capture) of North American Pacific salmon in volume terms and roughly 80 per cent in value terms.[80] Miller (1996) argues persuasively that the Washington/Oregon harvest depression and the Alaska boom are connected and reflect an underlying climatic shift, the origins of which can now be traced back to the mid-1970s. But Miller concedes as well that climatic shifts cannot be disentangled from management practices. The Alaskans insist that their boom is to be explained in part by their excellent management practices. The argument has also been made that developments on the Columbia (e.g. dams) which led, in effect, to many wild salmon runs being replaced by hatchery-produced fish, made the Washington/Oregon coho stocks particularly vulnerable to adverse climatic shifts.[81]

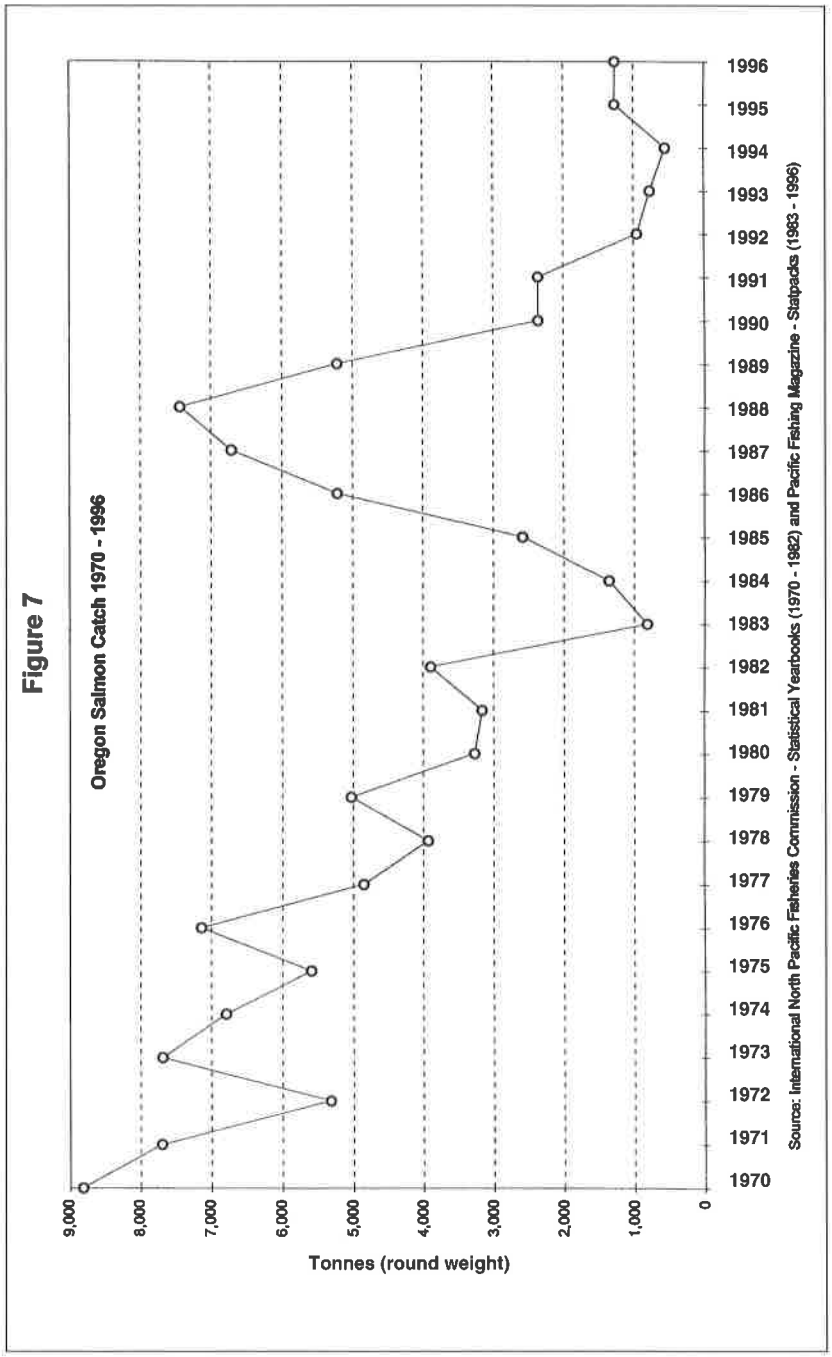


Figure 7
Oregon Salmon Catch 1970 - 1996
Tonnes (round weight)
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1996
1995
1994
1993
1992
1991
1990
1989
1988
1987
1986
1985
1984
1983
1982
1981
1980
1979
1978
1977
1976
1975
1974
1973
1972
1971
1970
Source: International North Pacific Fisheries Commission - Statistical Yearbooks (1970 - 1982) and Pacific Fishing Magazine - Statpacks (1983 - 1996)

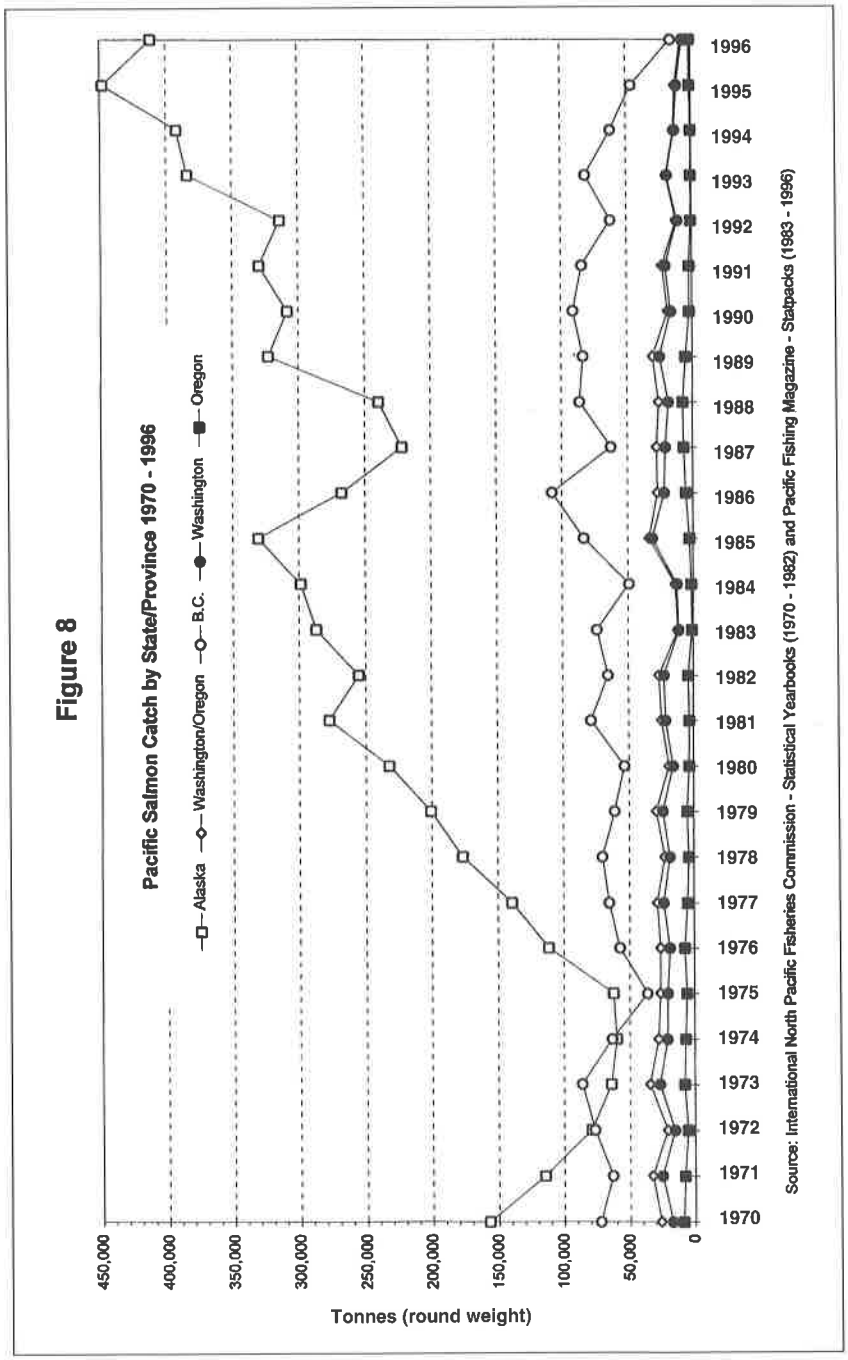


Figure 8
Pacific Salmon Catch by State/Province 1970 - 1996
Alaska
Washington/Oregon
B.C.
Washington
Oregon
Tonnes (round weight)
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1996
1995
1994
1993
1992
1991
1990
1989
1988
1987
1986
1985
1984
1983
1982
1981
1980
1979
1978
1977
1976
1975
1974
1973
1972
1971
1970
Source: International North Pacific Fisheries Commission - Statistical Yearbooks (1970 - 1982) and Pacific Fishing Magazine - Statpacks (1983 - 1996)

Two consequences were readily apparent. The first was that the treaty's goal of restoring the chinook stocks was not met except in Alaska.[82] A decade after the treaty had come into effect, it was estimated that only one-third of the chinook stocks were expected to achieve their targets by 1998.[83] Not surprisingly, there has been an insistence on the part of two players, Washington/Oregon and the treaty Native-Americans, that there should be a reduction of coho and chinook harvests in Alaska and British Columbia.[84] Secondly, there was a marked increase in Alaskan interception of Canadian-produced salmon. Given the intermingling of stocks, increased interception was inevitable as the Alaskans began to enjoy what they saw as the fruits of their good management. The increased Alaskan interception was also likely intensified by the fact that salmon runs in northern British Columbia rivers, such as the Nass and Skeena, were strong, due in part to the climatic shifts discussed by Miller (1996).

At the time that the treaty was signed, the Canadian authorities believed, as we have noted, that 80 per cent of the American interceptions of Canadian produced salmon were accounted for by Washington/Oregon, the American player which had a strong interest in seeing the treaty succeed. By the mid-1990s the same Canadian authorities estimated that *two-thirds* of the American interception of Canadian-produced salmon was accounted for by Alaska,[85] the American player whose support for the treaty in the past had been tepid, at the very best.

Finally, Alaskan willingness to reduce chinook harvests to accommodate Washington/ Oregon and British Columbia was weak. In contrast to those of Washington/Oregon and parts of British Columbia, Alaskan chinook runs were strong. Alaska saw itself being pressured to forego the benefits of its good management in order to support Washington/Oregon and B.C., which were being called to account for their common mismanagement.

Canada now found itself in a situation where its harvests of coho and chinook were declining, particularly because of the State of Washington/Oregon stocks, and where it was being pressured to reduce its harvests of these resources even further. At the same time, Alaskan interceptions of Canadian salmon were rapidly increasing. From the Canadian standpoint, the treaty was operating in a manner as to make complete nonsense of the "equity" principle. Canadian estimates of "net" salmon interceptions, measured in terms of number of fish, had put the "net" interceptions at roughly zero for 1989,

rising up to roughly 9 million fish in favor of the U.S. by 1996.[86] Canada maintained that, in 1996, the value of Canadian salmon intercepted by the Americans was 250 per cent greater than the value of American salmon intercepted by Canadians.[87] Prior to 1995, in any event, Canada expressed no interest whatsoever in reducing its interceptions unless the reductions were matched by a reduction of Alaskan, as well as Washington State, interceptions.[88] To Alaska, the Canadian demand for interception reductions meant that, yet again, Alaska was being called upon to bear a portion of the costs of Washington/Oregon and Canadian resource mismanagement.

In terms of game theory, these developments yielded two important implications. One player, Alaska, now had little or nothing to gain from the treaty. It was not necessary for it to announce formally its lack of confidence, or interest, in the treaty. All that it had to do was to refuse to make concessions permitting formation of a consensus. To Canada, another player, the treaty was yielding results that were manifestly inequitable. In essence, the cooperative game imbedded in the treaty proved incapable of adapting to major changes. The initially successful cooperative game had evolved into a new game devoid of a "core."

By 1993 negotiations on harvest allocations had effectively broken down. During the following year one player, Canada, reverted to competitive behavior, imposing a requirement for transit licences on American fishing vessels traveling from Washington State to Alaskan waters through Canadian waters (the inside passage between Vancouver Island and the Canadian mainland).[89] While American fishers denounced Canada as a "terrorist state," the Canadian Minister of Fisheries and Oceans complained that Alaskans were indulging in a "frenzy of greed."[90] A minor fish war erupted when Canadians began to fish aggressively for Fraser River sockeye off the west coast of Vancouver Island and in the Strait of Juan de Fuca in order to deny these stocks to their American counterparts.[91] When this strategy backfired, it was not repeated the following year.[92]

An interesting temporary shift in coalitions took place in 1995. Canada agreed with Washington State to reduce the Canadian harvest of coho and chinook in return for a reduction of Washington State harvest of Fraser River sockeye. Canada then lent its support to the treaty Native-Americans and Washington State in their successful attempt to take court action against Alaska, forcing that state to restrict, albeit on a temporary basis, its harvest of chinook.[93]

The year 1997 began with the promise of a "breakthrough" when "stakeholders" on both sides of the border would be brought together to overcome the impasse.[94] But this initiative proved futile and treaty harvest negotiations broke down in May. An attempt to restart the talks at the highest level the following month collapsed at the end of June when both sides accused the other of intransigence.[95]

Games analysis would suggest a reversion to competitive behavior; that is, the outbreak of a "fish war," and it did not prove to be lacking in predictive power. According to the Canadians, the treaty allowed Alaskans to harvest no more than 160,000 sockeye salmon per year. Now they were outraged to discover that aggressive Alaskan harvesting of sockeye salmon approached 470,000 fish, mostly at Canadian expense.[96] Canadian fishers responded by blockading the Alaska ferry when it called at Prince Rupert, B.C.[97] The incident provoked an angry White House comment. Several weeks later the government of British Columbia responded by promising to take the United States, Washington State and Alaska to court for their failure to implement the treaty.[98] Meanwhile, Ottawa and Washington moved to diffuse tensions by agreeing to appoint two eminent persons, one from each nation, who would work together to restart the "stakeholder" process which had commenced with such promise in the early spring of 1997.[99] By the end of the year the Pacific salmon treaty could be said to have become nearly a textbook example of a cooperative game devoid of a core. Return to Figure 5 and focus on the Pareto frontier without side payments. It was not an inaccurate description of the situation in which the two countries found themselves as 1997 drew to a close.

In January, 1998, the two eminent persons brought down their report.[100] It hints that the Alaskan harvest of fish bound for Canadian waters may have to be reduced and that Canada may have to re-think its position on the Equity Principle.[101] The report then puts forth three key recommendations:

1) that the stakeholder process should be abandoned;
2) that an interim two-year fishing agreement between the two countries should be established;
3) that during the two-year period, efforts should be devoted towards developing a "practical framework for implementing Article III of the treaty [the Principles Article] leading to the establishment of longer-term fishing arrangements."[102]

In essence the recommendations call for a two-year truce during

which time the relevant governments will re-work and re-think Article III of the treaty.

The obvious implication is that, in developing the aforementioned "practical framework," serious consideration must be given to the introduction of side payments broadening the scope for bargaining.[103] The authors are not the first to point to the importance of side payments. Schmidt (1995) does, in fact, argue for consideration to be given to side payments as a means for resolving intra-U.S. coalition differences. He argues that salmon issues might be linked to other issues of concern to Alaska.[104] The authors of this essay would only add that there is no reason why side payments should be confined to the U.S. coalition. Canada should be drawn in as well in the attempt to achieve a resolution of the impasse.

We have no easy solution and do not question the fact that producing acceptable side payments will be difficult and will demand careful thought and imagination. But the alternative is to see the current truce prove to be no more than temporary and to return to chronic "fish wars" at the cost of the resource and of the economies of Washington/Oregon, British Columbia, and Alaska.

VII. CONCLUSION

The Pacific salmon resource is currently of key importance to the fishing industries of Oregon, Washington, British Columbia, and Alaska. By its very nature, it is inherently a transboundary resource which requires management under a cooperative international regime. The *global* resource and economic benefits from cooperation are substantial and obvious. The consequences of non-cooperation are no less apparent.

Since the early years of this century, Canada and the United States have made several attempts to develop cooperative management policies. Some proved to be highly successful. The most ambitious attempt has taken the form of the Canada–United States Pacific Salmon Treaty of 1985. The treaty, initially hailed on both sides of the border as a triumph for the negotiating teams, appeared to live up to its promise. But the early successes were followed by years of frustration and breakdown resulting in a full-fledged "fish war," complete with lawsuits and angry public letters emanating from the White House.

We have argued that the treaty offered too narrow a scope for bargaining in the end and therefore remained insufficiently flexible

to accommodate major changes over time, some of which were due to unpredictable and uncontrollable climatic shifts. We are hopeful that the report by Messrs. Strangway and Ruckelshaus provides an opportunity to enhance the scope for bargaining. If the opportunity is not seized, the outlook for the future of the salmon fishery will be bleak indeed.

GLOSSARY

EZZ Exclusive Economic Zone

IPSFC International Pacific Salmon Fisheries Commission

OECD Organization for Economic Cooperation and Development

UN United Nations

NOTES

*The research for this paper was supported by the Social Sciences and Humanities Resources Council of Canada through its Strategic Grant program for the project: "Fisheries, Uncertainty and the Precautionary Approach to Resource Management," and by the United States National Science Foundation, through NSF Grant DBI-9708475. The authors would also like to express their gratitude to Mr. Gorazd Ruseski for his extensive research assistance.

[1] *Globe and Mail*, September 18, 1997, p.A.1.

[2] *Globe and Mail*, September 9, 1997, p.A.1.

[3] Strangway and Ruckelshaus, 1998.

[4] See for example, Miller, 1996; Schmidt, 1995.

[5] Huppert, 1995.

[6] Canada, Department of Fisheries and Oceans. *Statistical Highlights* (various issues): United States of America, national Marine fisheries Service, *Fisheries of the United States* (various editions); Pacific Fishing Magazine, *Statistical Yearbook* (various editions).

[7] Groot and Margolis, 1991.

[8] Pacific Fishing Magazine, *Statistical Yearbook.*

[9] Bjorndal, Asche and Steen, 1996.

[10]10 Bjorndal et al., *ibid.*

[11] Bjorndal et al., *ibid.*

[12] Bjorndal, et al., *ibid.*

[13] The trends were fitted by using the Microsoft Excel "Trendline" command and adopting the "Power Function" option. In each of the two trend-line equations, x = 1,2,3 ... corresponding to the years 1980, 1981, 1982 ...

[14] Bjorndal et al. *Ibid.*

[15] OECD, 1997.

[16] OECD, *ibid.*, pp. 139-143; 161-169.

[17] *The Economist* (1994), vol. 333, p. 96.

[18] Nash, 1951.

[1917] A.W. Tucker (1950).

[20] Clark, 1980; Levhari and Mirman, 1980.

[21] United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks, 1993—1995.

[22] Nash, 1953.

[23] Munro, 1990.

[24] Canada and Japan harvested the seals at sea, while Russia and the United States harvested the seals on land.

[25] FAO, 1992.

[26] Kaitala and Pohjola, 1998.

[27] Logan, 1974.

[28] Munro and Stokes, 1989.

[29] Johnston, 1965.

[30] Munro and Stokes, 1989.

[31] Huppert, 1995, p. 7.

[32] Source: Department of Fisheries and Oceans (Canada).

[33] Canada, 1982.

[34] Miller, 1996.

[35] Miller, *ibid.* p. 118.

[36] The United States federal government is represented on the Commission, but has no voting power. The American federal government has, through legislation (16 U.S.C. sec. 3631–3644 (1997), Public Law No. 99-5, 99 Stat. 7 (1985)) effectively abdicated responsibility over Pacific salmon to the three players which we have listed. Only where *direct* action by one of the three puts the United States in jeopardy of not fulfilling its treaty obligations may the federal government intervene.

[37] Miller 1996; Schmidt, 1995.

[38] Schmidt, 1995; Yanagida, 1987.

[39] United States v. Washington, 384 F. Supp. 312 (W.D. Wash, 1974). The presiding judge was George H. Boldt.

[40] Munro and Stokes, 1989.

[41] Munro and Stokes, *ibid.*

[42] Jensen, 1986, n.18.

[43] Jensen (1986, p. 372).

[44] Munro and Stokes, 1989.

[45] Johnson, 1977; McDorman, 1995.

[46] U.N., 1982, Article 56.

[47] U.N., 1982, Article 66 (4); McDorman, 1995.

[48] McDorman, 1995.

[49] Munro and Stokes, 1989.

[50] Munro and Stokes, 1989.

[51] Munro and Stokes, 1989.

[52] Stevens, 1986.

[53] Munro and Stokes, 1989.

[54] Jensen, 1986.

[55] Jensen, 1986, n.100.

[56] Miller, 1996.

[57] Treaty Between the Government of Canada and the Government of the United States Concerning Pacific Salmon, 1985.

[58] IPFS.

[59] Treaty 1985.

[60] Yanagida, 1987; Huppert, 1995.

[61] Treaty, 1985, Article III (1 (a) and 1 (b).

[62] Treaty, 1985, Article III [3(a), 3(b) and 3(c)].

[63] Treaty, 1985.

[64] Munro and Stokes, 1989.

[65] Canada, Department of Fisheries and Oceans (1985), *Information Bulletin*, No.1-HQ-85-1E, p.2.

[66] Munro and Stokes, 1989.

[67] Munro and Stokes, *ibid.*

[68] Munro and Stokes, *ibid.*

[69] Munro and Stokes, *ibid.*

[70] Cited in Huppert, 1995.

[71] Treaty, 1985, Article III. The qualifications set out in Article III 3(a) and 3(b) are, needless to say, not entirely consistent with each other.

[72] One could qualify this statement by arguing that the agreement between the Treaty Indians and Alaska constitutes an indirect side payment.

[73] Miller, 1996.

[74] Huppert, 1995.

[75] Huppert, 1995, p. 9. In the most recent discussions, even the Fraser River resources became a source of dispute.

[76] Huppert, 1995.

[77] Even in these early years of promise, however, there were commentators who (correctly) warned of possible future difficulties and dangers, arising, in particular, from the unresolved equity issue and the unstable American coalition. See, for example, Yanagida (1987).

[78] Miller, 1996.

[79] Miller, 1996

[80] See n. 1.

[81] Miller, 1996

[82] British Columbia's experience with the chinook stocks has been mixed.

[83] Huppert, 1995.

[84] Huppert, 1995.

[85] Canada, 1997.

[86] Huppert, 1995, p.27; *Globe and Mail*, February 6, 1997, p.A.8.

[87] Canada, 1997.

[88] Huppert, 1995.

[89] McDorman, 1995.

[90] Schmidt, 1995, n.4.

[91] Canada, 1995.

[92] Occasionally, the Fraser River sockeye, in their return, go around the northern end of Vancouver Island, rather than the southern. Such was the case in 1994. Hence the Canadian strategy was futile.

During that year, in excess of a million Fraser River sockeye "disappeared" en route to their spawning grounds. The Canadian federal government established a Fraser River Sockeye Public Re-

view Board to investigate. The Board argued that the aforementioned strategy, as well as being futile, contributed to the "disappearance" of the Fraser River sockeye. The Board also remarked, rather acidly, that the strategy relieved the Americans of any moral responsibility for conservation of the stocks (Canada, 1995, p.iii).

[93] Huppert, 1995.

[94] *Globe and Mail*, February 6, 1997, p.1.

[95] *Globe and Mail*, June 25, 1997, p.A.1.

[96] *Globe and Mail*, July 21, 1997, p.A.1;p.A.4.

[97] *Globe and Mail*, July 25, 1997, p.A.1.

[98] *Globe and Mail*, September 9, 1997.

[99] *Globe and Mail*, July 24, 1997, p. A1.

[100] Strangway and Ruckelshaus, 1998.

[101] Strangway and Ruckelshaus, 1998, pp. 5-6.

[102] Strangway and Ruckelshaus, *ibid.*

[103] For example, in finding means of implementing the Equity Principle, the "fish-for-fish" rule should come in for careful scrutiny. In its present form, it has proven to be not so much "unfair" as unworkable.

[104] Schmidt, 1995ce.

REFERENCES

Bjorndal, Trond, Frank Asche and Frode Steen (1996), "Fresh Salmon Prices in the EU Market", Norwegian School of Economics and Business Administration, SNF-Report No. 55/1996.

Canada (1982), Commission on Pacific Fisheries Policy, *Final Report*, Ottawa, Ministry of Supply and Services.

Canada (1995), *Fraser River Sockeye 1994, Problems and Discrepancies: Report of the Fraser River Sockeye Public Review Board*, Ottawa.

Canada (1997), Department of Fisheries and Oceans, *Pacific Salmon Treaty: Moving Towards Equity and Conservation*, paper prepared by Bud Graham, Director of Fisheries Management, Department of Fisheries and Oceans, Pacific Region, Vancouver.

Canada, Department of Fisheries and Oceans, *Fisheries Statistical Highlights*, Ottawa.

_____, _____ (1985), *Information Bulletin*, No. 1-HQ-85-1E, Ottawa.

Clark, Colin W. (1980), "Restricted Access to Common Property Fishery Resources: A Game Theoretic Analysis," in P. Liu (ed.), *Dynamic Optimization and Mathematical Economics*, New York, Plenum Press, pp. 117-132. *The Economist*, vol. 333.

Food and Agriculture Organization of the United Nations (1992), *Marine Fisheries and the Law of the Sea: A Decade of Change*, FAO Fisheries Circular No. 853, Rome.

The Globe and Mail. Groot, C. and L. Margolis (eds.) (1991), *Pacific Salmon Life Histories*, Vancouver, University of British Columbia Press.

Huppert, Daniel D. (1995), *Why the Pacific Salmon Treaty Failed to End the Salmon Wars*, School of Marine Affairs, University of Washington, SMA 95-1, Seattle.

International North Pacific Fisheries Commission, *Statistical Yearbooks.*

Jensen, Thomas C. (1986), "The United States–Canada Pacific Salmon Interception Treaty: An Historical and Legal Overview," *Environmental Law*, vol. 16, pp. 365-422.

Johnson, Barbara (1977), "Canadian Foreign Policy and Fisheries," in Barbara Johnson and Mark Zacher (eds.), *Canadian Foreign Policy and the Law of the Sea*, Vancouver, University of British Columbia Press, pp. 52-99.

Johnston, Douglas M. (1965), *The International Law of Fisheries: A Framework for Policy- Oriented Inquiries*, New Haven, Yale University Press.

Kaitala, Veijo and M. Pohjola (1988), "Optimal Recovery of Shared Stock: A Differential Game with Efficient Memory Equilibria," *Natural Resource Modeling*, vol. 3, pp. 91-119.

Levhari, D. and L.J. Mirman (1980), "The Great Fish War: An Example Using a Dynamic Courant-Nash Solution," *Bell Journal of Economics*, vol. 11, pp. 649-661.

Logan, R.M. (1974), *Canada and the United States and the Third Law of the Sea Conference*, Montreal, C.D. Howe Research Institute and the National Planning Association.

McDorman, Ted L. (1995), "The West Coast Salmon Dispute: A Canadian View of the Breakdown of the 1985 Treaty and the Transit License Measure," *Loyola of Los Angeles International and Comparative Law Journal*, vol. 17, pp. 477-506.

Miller, Kathleen A. (1996), "Salmon Stock Variability and the Political Economy of the Pacific Salmon Treaty," *Contemporary Economic Policy*, vol. XIV, pp. 112-129.

Munro, Gordon R. (1990), "The Optimal Management of Transboundary Fisheries: Game Theoretic Considerations," *Natural Resource Modeling*, vol. 4, pp. 403-426.

_____ and Robert L. Stokes (1989), "The Canada–United States Pacific Salmon Treaty," in Donald McRae and Gordon Munro (eds.), *Canadian Oceans Policy: National Strategies and the New Law of the Sea*, Vancouver, University of British Columbia Press, pp. 17-38.

Nash, John F. (1951), "Noncooperative Games," *Annals of Mathematics*, vol. 54, pp. 289-295.

_____ (1953), "Two-Person Cooperative Games," *Econometrica*, vol. 21, pp. 128-140.

Organization for Economic Cooperation and Development (1997), *Towards Sustainable Fisheries: Economic Aspects of the Management of Living Marine Resources*, Paris.

Pacific Fishing Magazine, *Statistical Yearbook*.

Schmidt, Robert J., Jr. (1996), "International Negotiations Paralyzed by Domestic Politics: Two-Level Game Theory and the Problem of the Pacific Salmon Commission," *Environmental Law*, vol. 26, pp. 95-139.

Stevens, Ted (1986), "United States–Canada Salmon Treaty Negotiations: The Alaskan Perspective," *Environmental Law*, vol. 16, pp. 423-430.

Strangway, David W. And William D. Ruckelshaus (1998), "Pacific Salmon Report to the Prime Minister of Canada and the President of the United States, January 12, 1998."

Treaty between the Government of Canada and the Government of the United States of America Concerning Pacific Salmon, March 1985.

Tucker, A.W. (1950), "A Two-Person Dilemma," Stanford University, unpublished.

United Nations (1982), *United Nations Convention on the Law of the Sea*, U.N. Doc. A/Conf. 61/122.

United States Code, Sections 3631–3644 (1997), Public Law No. 99-5, 99 Stat. 7(1985).

United States of America, National Marine Fisheries Service, *Fisheries of the United States*.

United States v. Washington, 384 F. Supp. 312 (W.D. Wash., 1974).

Yanagida, Joy A. (1987), "The Pacific Salmon Treaty," *American Journal of International Law*, vol. 81, pp. 577-592..

CANADIAN-AMERICAN PUBLIC POLICY

Occasional papers on a wide range of issues in U.S.-Canadian relations

CAPP 1: April 1990 — **Canada-U.S. Relations in the Bush Era**
Joseph T. Jockel

CAPP 2: July 1990 — **Transboundary Air-Quality Relations: The Canada-United States Experience**
John E. Carroll

CAPP 3: October 1990 — **Canadian Culture, the Canadian State, and the New Continentalism**
Allan Smith

CAPP 4: December 1990 — **Forests, Timber, and Trade: Emerging Canadian and U.S. Relations under the Free Trade Agreement**
Thomas R. Waggener

CAPP 5: March 1991 — **Change and Continuity in Canada-U.S. Economic Relations**
William Diebold

* CAPP 6: June 1991 — **Trade Liberalization and the Political Economy of Culture: An International Perspective on FTA**
Graham Carr

CAPP 7: September 1991 — **If Canada Breaks Up: Implications for U.S. Policy**
Joseph T. Jockel

* CAPP 8: December 1991 — **Ogdensburg Plus Fifty and Still Counting: Canada-U.S. Defense Relations in the Post-Cold War Era**
Joel J. Sokolsky

* CAPP 9: March 1992 — **The Regulation of U.S.-Canada Air Transportation: Past, Present and Future**
Martin Dresner

* Out of print

* CAPP 10: June 1992 — **Emerging Issues in the U.S.-Canada Agricultural Trade Under the GATT and FTA**
Theodore H. Cohn

CAPP 11: September 1992 — **Settling U.S. - Canada Disputes: Lessons For NAFTA**
Annette Baker Fox

CAPP 12: December 1992 — **Canada-U.S. Electricity Trade and Environmental Politics**
William Averyt

CAPP 13: June 1993 — **Canadian Politics in a Global Economy**
Gordon T. Stewart

CAPP 14: September 1993—**The Intersection of Domestic and Foreign Policy in the NAFTA Agricultural Negotiations**
Theodore H. Cohn

CAPP 15: November 1993—**A New Global Partnership: Canada-U.S. Relations in the Clinton Era**
John Kirton

CAPP 16: December 1993 — **The Impact of Free Trade on Canadian- American Border Cities**
Peter Karl Kresl

CAPP 17: April 1994 — **North American Social Democracy in the 1990s: The NDP in Ontario**
Mildred A. Schwartz

CAPP 18: August 1994 — **The Politics of Health Care Reform in Canada and the United States**
Antonia Maioni

CAPP 19: October 1994 — **Public Policy and NAFTA: The Role of Organized Business Interests and the Labor Movement**
Henry J. Jacek

CAPP 20: December 1994-- **The Secret of Transforming Art Into Gold: Intellectual Property Issues In Canada-U.S. Relations**
Myra J. Tawfik

CAPP 21: January 1995--**Anticipating The Impact of NAFTA on Health And Health Policy**
Pauline V. Rosenau, Russell D. Jones, Julie Reagan Watson and Carl Hacker

CAPP 22: June 1995--**Regulation, Industry Structure, and the North Atlantic Fishing Industry**
Peter B. Doeringer, David G. Terkla and Audrey Watson

* CAPP 23: November 1995--**The Moral Economy of Health and Aging in Canada and the United States**
Phillip G. Clark

CAPP 24: December 1995--**Multilateralism or Bilateralism in the Negotiation of Trade-Related Investment Measures?**
Elizabeth Smythe

CAPP 25: February 1996--**The Abortion Controversy in Canada and the United States**
Raymond Tatalovich

CAPP 26: May 1996—**Health Care Reform or Health Care Rationing? A Comparative Study**
Joan Price Boase

CAPP 27: September 1996—**Resolving The North American Subsidies War**
Peter Morici

* CAPP 28: December 1996—**Calling Maggie's Bluff: The NAFTA Labor Agreement and the Development of an Alternative to Neoliberalism**
Stephen Herzenberg

* CAPP 29: April 1997—**The Long Journey to Free Trade in U.S.-Canada Airline Services**
Michael W. Pustay

* Out of print

CAPP 30: July 1997—**Are Canadian and U.S. Social Assistance Policies Converging?**
Gerard Boychuk

CAPP 31: November 1997—**Observing the Rules: Canada-U.S. Trade and Environmental Relations**
Annette Baker Fox

CAPP 32: December 1997—**Flights of the Phoenix: Explaining The Durability of the Canada-U.S. Softwood Lumber Dispute**
Ben Cashore

CAPP 33: February 1998—**Transboundary Fishery Resources and the Canada-United States Pacific Salmon Treaty**
Gordon Munro, TedMcDorman and Robert McKelvey

CONTENTS

CANADIAN-AMERICAN PUBLIC POLICY

Occasional papers on a wide range of issues in U.S.-Canadian relations

Rapidly growing commercial ties between Canadian and the U.S. are raising complex new policy issues in both countries concerning trade, investment, energy, the environment, resources management, cultural politics, and foreign affairs. Published four times a year on an occasional schedule, **Canadian-American Public Policy** will keep you abreast of these issues with informed, timely, and objective analysis by leading experts in both countries. Subscribe now to be certain not to miss any important issues.

Please enter my subscription to **Canadian-American Public Policy.** (Individuals must include payment or credit card authorization with order. Canadian checks and money orders in Canadian currency are welcome.) One year: $21.00 U.S.,$26.00 Canada and foreign. Two years: $39.50 U.S., $47.00 Canada and foreign.

Payment enclosed: $ _____ .

Please charge to _____ VISA _____
MasterCard.

Cardnumber: _____

Expiration date: _____

Signature: _____

Name (please print or type): _____

Address: _____

City / State or Province: _____

Postal code or Zip: _____

Please return to:

Canadian-American Center, University of Maine
154 College Avenue, Orono, ME U.S.A. 04473-1591
(207) 581-4220
ISSN 1047-107