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Linking Management and Markets: The Northwest Atlantic Sea Herring Industry and the Case for "Regional" Quotas

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LINKING MANAGEMENT AND MARKETS:

THE NORTHWEST ATLANTIC SEA HERRING INDUSTRY

AND

THE CASE FOR "REGIONAL" QUOTAS

by
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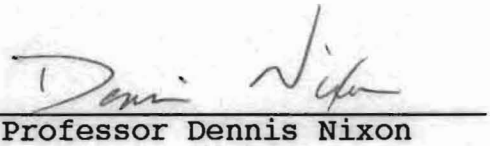
Approved 
Professor Dennis Nixon

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ABSTRACT

This review and characterization of the U.S. Atlantic sea herring fishery and industry analyzes opportunities for and constraints to developing the herring resource more fully.

Chapter 1 describes the herring resource, the existing fishery, and reviews current research into the international transboundary migrations of the Atlantic sea herring.

Chapters 2 and 3 describe the development of the herring fishery management plan in the context of the global herring market and the management complications that arise from the transboundary migrations of the stocks.

Examples of successful linkages between fisheries management and market development are described in Chapter 4 to illustrate the importance of incorporating these two elements into fisheries management plans. These management systems, largely drawn from other countries which encourage more local control and responsibility for sustaining fisheries resources, are summarized to illustrate options for inclusion in the draft U.S. Atlantic herring management plan.

A proposal and justification for regional and/or "community"-based allocations of herring is presented in Chapter 5. This proposal is grounded in the language of the draft Atlantic sea herring management plan currently under development, and draws on examples of similar management

schemes which have proved successful in linking management and marketing of fisheries resources.

In order to develop a current perspective on the U.S. herring industry, a representative cross-section of industry participants was interviewed for their opinions on opportunities and constraints to further utilization of the Atlantic herring resource. Summary results of the interviews are included in relevant chapters of the paper.

ACKNOWLEDGMENTS

Many thanks to the following individuals for their assistance and time with thoughts and access to materials used in this paper:

Dr. James Anderson, Univ. of Rhode Island, Dept. of Resource Economics
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Dr. Dave Stevenson, Maine Dept. of Marine Resources
Dr. Rob Stephenson, Canadian Dept. of Fisheries and Oceans, Scotia-Fundy Region

Thanks also to the numerous herring industry members and government officials who kindly took the time to be interviewed for this paper. They are listed in the **Sources** list, located at the end of this paper.

I appreciate Professor Dennis Nixon, my major professor, for reviewing and accepting this paper.

Most of all, I am grateful for the love and support of my wife and partner, Louisa, and for her patience and her resolve in defying the odds against married couples during our two years of graduate school.

TABLE OF CONTENTS

List of Tables

List of Figures

INTRODUCTION

The aim of this paper is to identify the prospects for and constraints to more fully utilizing the northwest Atlantic sea herring resource.

I first became interested in the Atlantic herring resource while studying Dr. Michael Sinclair's "member-vagrant" hypothesis[1] in preparation for a Biological Oceanography examination. This hypothesis attempts to establish a case for speciation by linking herring spawning areas and "larval retention zones" to sites in the northwest Atlantic where oceanographic conditions favor successful pairing of spawners and survival of their progeny.

Though widely accepted as a plausible hypothesis for herring stock recruitment, definition of discrete herring populations and the extent of stock interactions--U.S. and Canadian, coastal and offshore, winter and summer aggregations--continues to elude fisheries biologists and geneticists alike.[2]

This uncertainty remains one of the outstanding constraints to developing the fishery more fully. Definition of stocks and the extent of stock interaction are critical to developing a sustainable fishery.

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[1]Sinclair, M., 1988. Marine Populations: An Essay on Population Regulation and Speciation. Seattle: University of Washington Press, p.43.

[2]U.S.-Canada Atlantic Herring Science and Assessment Workshop, Portland, Maine, January 19-21, 1993, "Draft Conclusions and Recommendations".

Background

The northwest Atlantic sea herring resource, decimated in the 1970s by foreign fleets fishing on George's Bank stocks in what were international waters, has recently shown signs of recovery attributed to a cessation of fishing effort. The very success of the species in reestablishing itself has complicated management and development efforts and prompted U.S. and Canadian industry and resource managers to initiate a cooperative, international management planning process.

In addition to their inherent value as a human protein source, the role of sea herring and other pelagic species in the marine ecosystem is important, as well. These stocks serve as a carbon transfer link between the plankton biomass and higher trophic level species, including other commercially valuable finfish species.[3]

Striking a balance among these considerations--managing a food resource within the context of the supporting ecosystem--is increasingly at the core of modern fisheries

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[3]Daan, N., 1986. "Results of Recent Time-series Observations for Monitoring Trends in Large Marine Ecosystems With a Focus on the North Sea", in: Sherman, K. and L. Alexander (eds.), Variability and Management of Large Marine Ecosystems, 1986. Boulder, CO: Westview Press, pp.145-174.
---Sissenwine, M., 1986. "Perturbation of a Predator-controlled Continental Shelf Ecosystem", in: Sherman, K. and L. Alexander (eds.), Variability and Management of Large Marine Ecosystems, 1986. Boulder, CO: Westview Press, pp.55-85.

management, in the U.S. and abroad[4]. A third element--consideration of local and regional community dependence upon the proximate fisheries resources--has continued to gain in prominence in management decisions worldwide[5], as competition for scarce marine resources increases.

Scope of paper

This paper examines these issues in the context of the northwest Atlantic sea herring resource, as follows:

(1) how is management dealing with the inherent uncertainty of pelagic stock assessments while alleviating constraints on utilization of the resource?

(2) what techniques, if any, of managing the Canadian Atlantic sea herring fisheries are transferable to management of the U.S. Atlantic herring resource?

(3) what are the herring products produced by the U.S. and our competitors, what are their markets, and what

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[4]Platt, D., (ed.), 1993. The System in the Sea: Applying Ecosystems Principles to Marine Fisheries. Volume One: Conference Summary. Rockland, Maine: The Island Institute, 40 pp.

[5]In the U.S., recent allocations have explicitly favored fishing interests delivering to "shore-based" processors (notably, Alaska and Oregon) though the Secretary of Commerce recently remanded the Oregon allocation decision to the NMFS for further "cost-benefit" analysis). Furthermore, a portion of the pollock fishery in Alaska's Bering Sea has been dedicated for a four year period to Native Alaskan villages along the Bering Sea coast under the Community Development Quota program. In eastern Canada, "port quotas" have been discussed recently. The government of Norway has decreed that the settlements in northern Norway receive a percentage of the annual TAC. In the UK, the government has devolved management to the fishermen's cooperative level by granting "sectoral quotas" which are then allocated and managed according to local desires and custom. And, in Japan a similar allocation system for inshore fisheries, run by fishermen's cooperatives, has been in effect since the late 1940s. All these arrangements are motivated by a desire to capture the economic benefit of the fisheries resource for the proximate communities.

opportunities and constraints does the U.S. industry perceive for further development of the herring resource? And,

(4) are community or regional allocations of the sea herring Total Allowable Catch appropriate, or even desirable?

Research methods

The first two chapters of this paper describe the regional herring resource and fishery, and its evolving management plan. In order to understand the "state of the art" of management in the region, and to be current on the most recent stock assessment, the author attended a number of industry and management meetings during 1992-1993. In addition, the author interviewed managers and scientists representing federal, state and Canadian fishery management agencies in the northeastern U.S. and Atlantic Canada.

Finally, a review of past and evolving U.S. and Canadian management plans and literature concerning life history, stock assessment and management of the resource was conducted.

The third chapter of the paper examines constraints and opportunities to utilizing the herring resource. In order to gain insight into the underlying dynamics and fabric of the fishery, a survey was developed and administered--in-person when feasible, over the telephone when necessary--to over twenty individuals representing the herring harvesting, processing and marketing sectors.

The survey was designed to gather information about the relative economic importance of herring to the respondents' overall businesses; their opinions on product and market opportunities; current perceived constraints to their utilization of the herring resource; and, their attitudes toward a variety of management options. The geographic area covered by the respondents stretches from New Jersey to Newfoundland--nearly the full range of the herring resource in the northwest Atlantic. Summary results are included in relevant Chapters of this paper. A sample copy of the survey is included in the Appendix.

In addition to this primary research, an extensive literature search of current trade publications was conducted in order to determine current product forms and market structure, as well as harvesting and processing techniques practiced in other countries' herring fisheries.

For further information on market and trade issues, personal communications were conducted with representatives of U.S. and Canadian government trade agencies and embassies in the U.S. and in Europe, and U.S. and Canadian industry associations. In addition, a review of a number of relevant documents was conducted at the offices of the Maine Sardine Council.

The fourth chapter of the paper briefly examines selected examples of "community" or "regional" fisheries allocation schemes which have been sanctioned by various

federal governments as a means of retaining the value of the fisheries resource in the region of origin.

Material for this section was drawn from the literature, (where available), through correspondence and personal communication with managers and academics, and from the author's personal experience implementing Western Alaska Community Development Quota (CDQ) program in 1992-1993.

A "community" or "regional" allocation scheme for herring is then examined in the final chapter in the context of the current management plan development process and in the context of current U.S. herring industry opinion, as expressed in the survey responses.

Chapter 1
THE FISHERY

Background

Pelagic fisheries worldwide represent an abundant, renewable protein source for the growing world population[6], in particular for the less developed countries experiencing exponential population growth, as illustrated below.

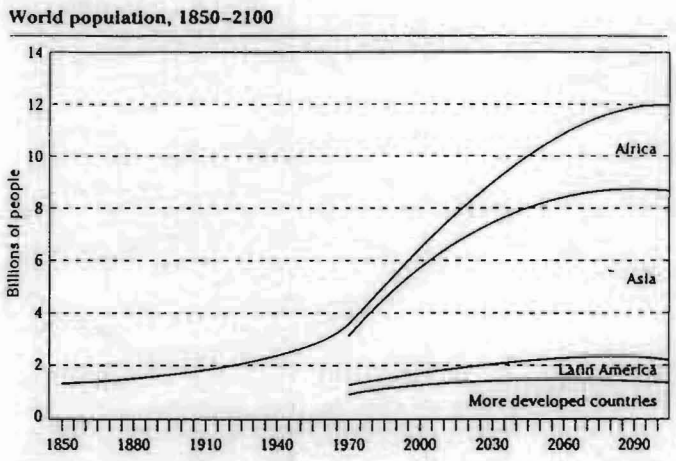

Figure I-1 World population, 1850-2100

Source: The World Bank

Stocks of these pelagic species--most notably the mackerels, anchovies, sardines, and herrings--are at high abundance levels in many of the world's oceans, even as stocks of many other species are overexploited by overcapitalized fleets. According to the most recent FAO

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[6]Kent, D. 1987. Fish, Food, and Hunger: The Potential of Fisheries for Alleviating Malnutrition, Part II. Boulder, CO: Westview Press, pp.65-164.

statistics[7], 1989 nominal catches of the Atlantic sea herring alone totalled 1.7 million metric tons. However, of an estimated U.S. northwest Atlantic stock abundance of 1.86 million metric tons, only 53,000 metric tons (or 3 per cent) was harvested in 1992 by U.S. fisheries.[8]

Northwest Atlantic Herring

In the northwest Atlantic, as in a number of other locations, this abundance is primarily attributable to extremely low fishing pressure[9] resulting from limited consumer demand for the resource. Figure I-2 below illustrates the state of the New England pelagic fishery resources relative to three other important species groups.

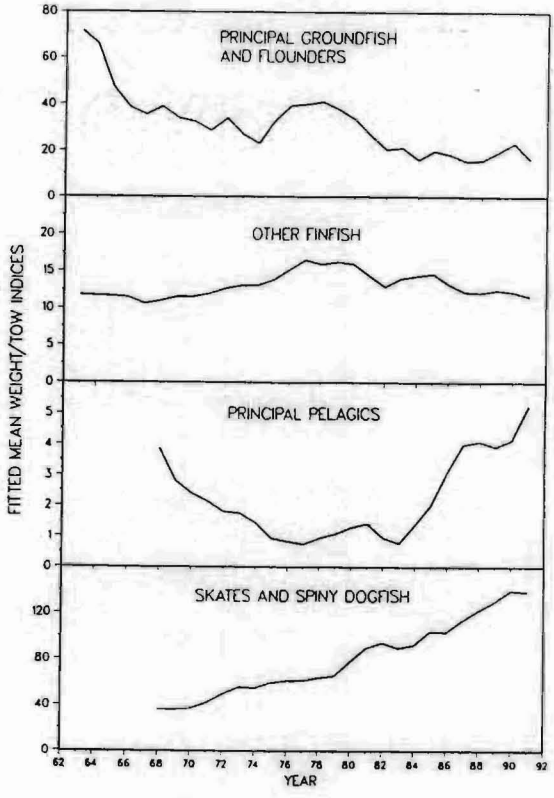

Figure I-2 Trends in indices of aggregate abundance for four species groups , reflecting the major changes in fishery resources, 1962-1992.

(Source: NMFS/NEFSC, 1992)

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[7]FAO Statistics Series No. 68-69, 1990. "Fishery Statistics: catches and landings". Rome, Italy: Food and Agriculture Organization of the United Nations, pp.209, 221.

[8]Pierce, D., April 23, 1993. "Memo to Atlantic States Marine Fisheries Commission Sea Herrring Board re: 1993 Sea Herring Assessment and July 1, 1993 Through June 30, 1994 IWP Recommendations", p.1.

[9]Pierce (1993), p.2.

Despite current abundance levels, management of herring resources is a notoriously imperfect science[10]. Due to their schooling habit, aggregations of herring can be fished at steady Catch Per Unit of Effort (CPUE) rates until, without warning, the resource is overfished. Their vulnerability to overfishing is magnified by the migratory nature of the species, exposing it to various regional and international political jurisdictions during its life cycle. This is in contrast to demersal species such as cod fish which are more sedentary in their life cycle and reflect overharvesting rates relatively quickly, allowing managers to rein in fishing effort (assuming the prevailing politics support conservation).

"U.S." Stocks

The northwest Atlantic sea herring resource is an anomaly among northeastern U.S. fisheries. Atlantic herring (*Clupea harengus harengus*), together with a handful of other species, are the only stocks of the 43 northeastern U.S. commercial species that are classified by the National Marine Fisheries Service (NMFS) as "underexploited". The overwhelming majority of species are classified as "overexploited"[11].

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[10]Beddington, J. and R.Rettig. 1983. Approaches to the regulation of fishing effort. Rome: FAO Fisheries Technical Paper 243, pp.26-27.
[11]Status of Fishery Resources off the Northeastern United States for 1992. 1992. NOAA Technical Memorandum NMFS-F/NEC-95, Woods Hole, MA.

Until 1989, NMFS divided the herring resource along the east coast of the U.S. into two stock complexes--Georges Bank and the Gulf of Maine, or coastal stock, complex--for management purposes[12]. There is genetic and tagging evidence that both supports and refutes this stock division[13]. Figure I-3 illustrates one researcher's widely accepted hypothesis[14] of how these stock complexes segregate during summer feeding and fall spawning periods and commingle while overwintering. One can see from the figure how extensive transboundary migrations and spawning during the herring's life cycle complicate management of the resource.

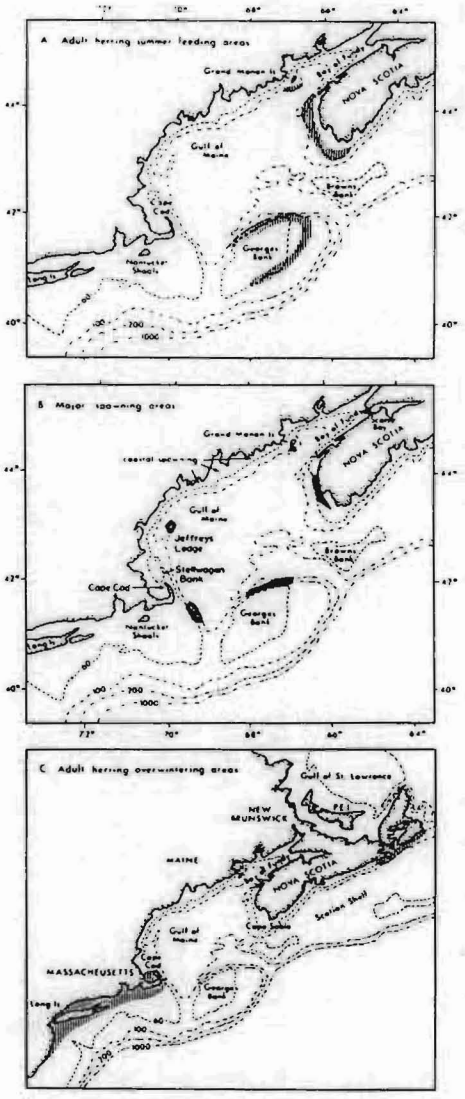

Figure I-3 Distributions of Atlantic herring in the Gulf of Maine and Scotian Shelf area during the summer feeding, spawning, and overwintering phases of the adult annual migration cycle.

Source: Reproduced from Sinclair (1988)

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[12]Status of Fishery Resources (1992), pp.91-92.

[13]Stephenson, R. and I. Kornfield. 1990. "Reappearance of spawning Atlantic herring (*Clupea harengus harengus*) on Georges Bank: population resurgence not recolonization", in: *Canadian Journal of Fisheries and Aquatic Sciences*, Vol. 47, No. 6, pp.1060-1064.

[14]Sinclair (1988), p.50.

The draft conclusion of a U.S.-Canada Herring Assessment Workshop held in January 1993 noted:

> "Although the issue of population structure in Atlantic herring has been studied for over a century, there remains great debate concerning the integrity, fidelity and discrete nature of herring spawning units. Regularity of spawning (both geographic and temporal), tag evidence of homing, differential population dynamics of neighboring groups, and larval retention all indicate that herring spawning units are distinct populations. On the other hand, the lack of demonstrable differences in genetic characteristics and weak results from traditional stock identification methods have been interpreted as indication of significant gene flow among neighboring spawning aggregations of a larger population.
>
> "A summary of arguments for and against discrete populations reaffirms that, while much of the evidence is inferential, it favors the discrete population concept. Demonstration of fidelity to natal spawning grounds and of mechanisms which may allow stock separation are critical to resolution of the discrete population debate."[15]

As a consequence of this unresolved debate, the herring from the Gulf of Maine and from Georges Bank have been combined for assessment purposes into a single stock complex. This approach has many advantages over the separate stock approach, but also poses a number of challenges for the future assessment and management of herring.

To better describe the overall stock complex and its importance to formulation of the management plan, the following descriptions illustrate the historic commercial significance of these two geographically distinct stocks.

"Coastal stock complex"

Nearly all the current domestic herring harvests are taken from the so-called "coastal stock" complex. Total

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[15] "Draft Conclusions of U.S.-Canada Herring Science and Assessment Workshop", Portland, Maine, January 1993.

catches from this complex have changed substantially over the past two decades. Catches averaged 50,149 mt during the years 1987 to 1991, whereas two decades ago they exceeded 300,000 mt.[16] The change in catch is widely attributed[17] to changes in migration patterns of juvenile herring, whereby juvenile herring have been far less available to inshore fixed gear, as well as to declines in export markets for adult herring.

The fishery in the Gulf of Maine consists of fixed gear (weirs and stop seines) and mobile gear (purse seines deployed from vessels) fisheries in coastal waters. Mid-water trawls have been deployed more recently in the winter fishery which has developed off Gloucester, MA. The bulk of these fish are landed in Gloucester and trucked to Maine and the Canadian maritimes for canning by sardine packers. Over the past five years, more than 90 percent of the catch of herring in Maine coastal waters has been taken with mobile gear, compared with less than 50 percent during the 1970s. The figures on the following page illustrate this shift in gear type and landings:

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[16]NOAA/NMFS Current Fishery Statistics No. 9012, 1992."Historical Catch Statistics: Atlantic and Gulf Coasts 1879-1991", p.11.
[17]Jeff Kaelin, Maine Sardine Council, personal communication, April 5, 1992.

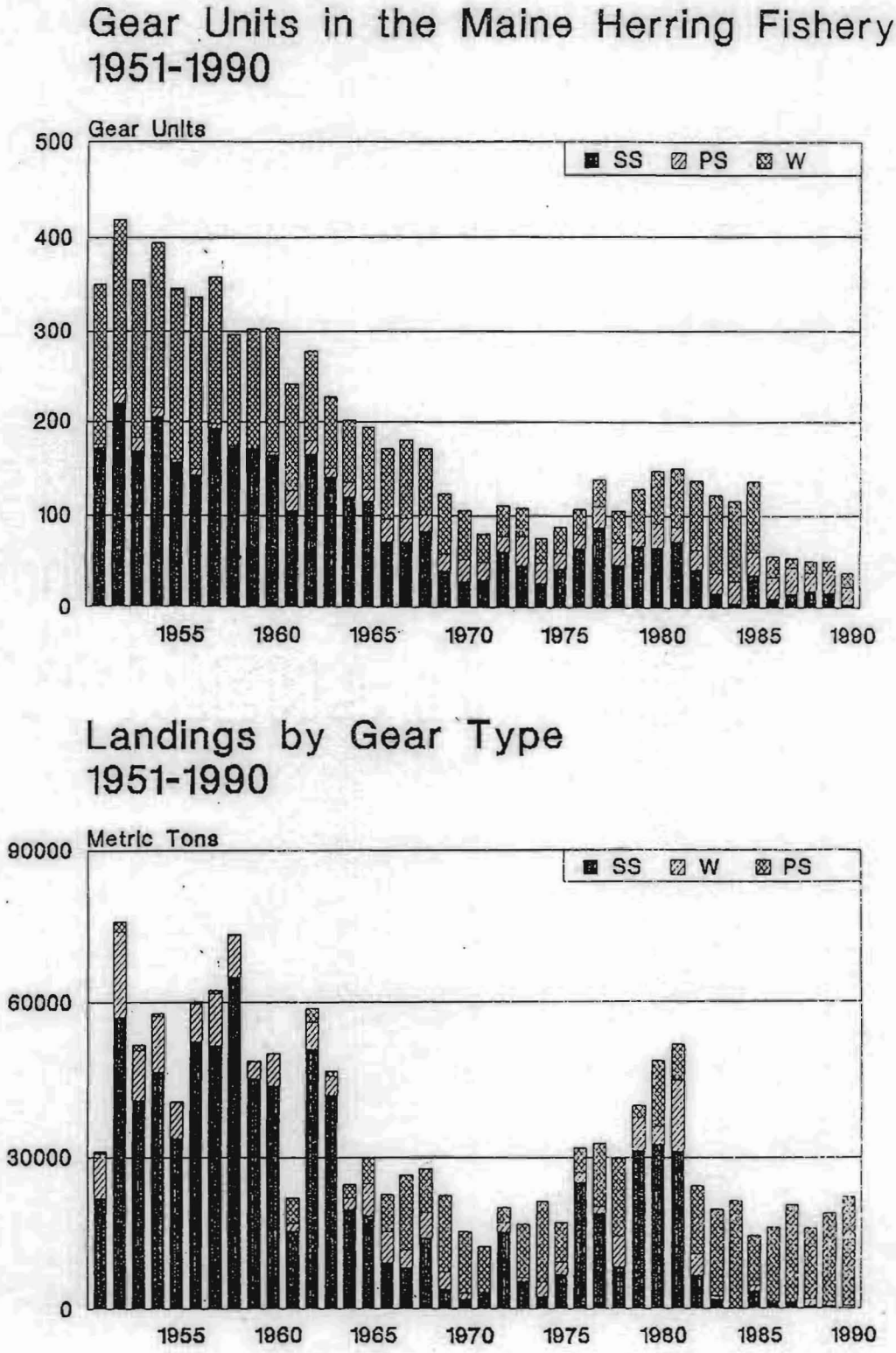

Figure I-4 Gear units and landings by gear type in the Maine herring fishery, 1951-1990

Source: Maine Sardine Council

"Georges Bank complex"

The herring fishery on Georges Bank was initiated by foreign fleets in 1961. Overharvesting of the Georges Bank herring resource occurred by the late 1960's and into the 1970's, with the influx of foreign factory fleets. Landings peaked in 1968 at 373,000 mt and subsequently declined to only 43,500 mt in 1976 as the stock collapsed. There has been no directed fishery--Canadian or U.S.--on Georges Bank since 1978[18].

The estimates of stock biomass (ages 2 and older) for the aggregate Georges Bank/coastal stock complex were in excess of 1 million mt before the collapse associated with the Georges Bank fishery. After the collapse, stock size estimates were less than 100,000 mt.[19]

"Combined stock complexes"

According to the most current preliminary stock assessment released in late April 1993 [20], stock abundance continues to rise and is now conservatively projected to be about 1.86 million metric tons. Estimated spawning stock biomass is also very high, at approximately 1 million metric tons (Note: these figures will be revised upwards once New Brunswick, Canada, "catch-at-age" estimates are calculated

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[18]Melvin, G.D. et al. 1992. "Georges Bank (5Z) herring 1992 update". CAFSAC Research Document 92/68.
[19]Status of Fishery Resources (1992), p.91.
[20]Pierce (1993).

and included in the estimates). The figures below illustrate the recovery of this fishery[21].

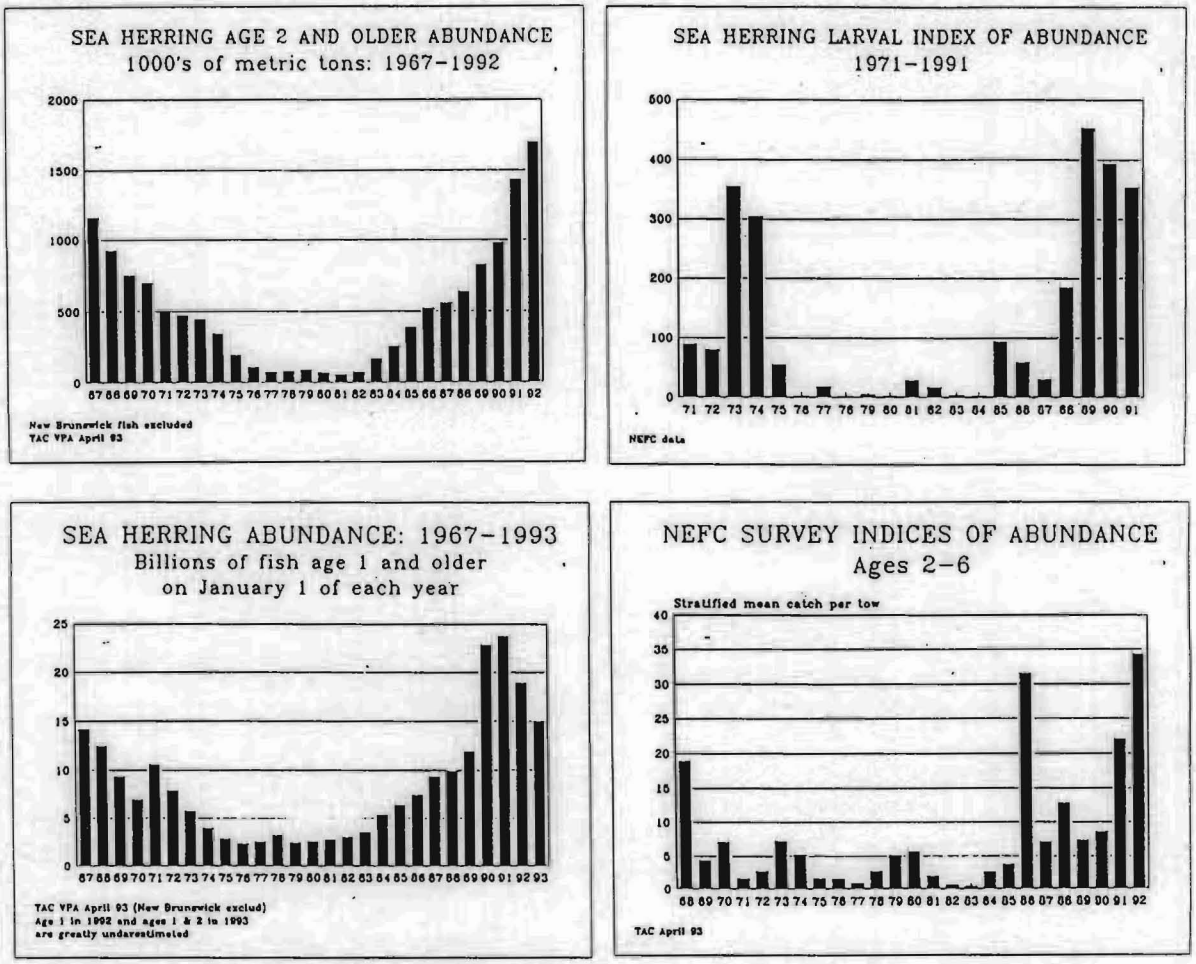

Figure I-5 Sea herring adult and larval abundance, 1967-1992

Source: MA DMF, NEFC

However, because no fishery is conducted in the offshore waters of the Georges Bank, these stock assessments are based

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[21]Pierce (1993), pp.4-7.

solely on abundance levels suggested by survey trawl catches[22] and larval herring densities[23]. As a result, NMFS scientists urge caution in accepting these stock assessments[24] at face value.

The Canadian fishery

This paper does not focus on the Canadian fishery. However, the reader must understand that due to the transboundary nature of the herring resource, Canadian harvesting activity, management techniques and controls on the harvest, and trade issues have major implications for the viability of the U.S. resource and industry. Stephenson et al. (1993) describe the history and management of the Scotia-Fundy herring fishery in a recent paper, *"Management of the 4WX herring fishery: an evaluation of recent events"*. The following information is drawn from this document in addition to several other relevant papers.

The herring fishery of the Scotian Shelf and Bay of Fundy regions of Canada (NAFO Divisions 4W and 4X, as depicted in Figure I-6 on the following page) is one of the oldest and is presently the largest in the western Atlantic,

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[22]NOAA/NMFS-Northeast Fisheries Science Center, "Cruise Results, NOAA R/V Albatross IV, Cruise No. AL 92-11, Autumn Bottom Trawl Survey", September-October, 1992.
[23]NOAA/NMFS-Northeast Fisheries Science Center, "Cruise Results, NOAA R/V Delaware II, Cruise No. DE II 92-14, Larval Herring/Sand Lance Study", December, 1992.
[24]Pierce (1993), p.4.

with recent landings of 100,000 mt annually[25]. Significantly, this is the only large Atlantic herring resource which has not suffered a major collapse[26].

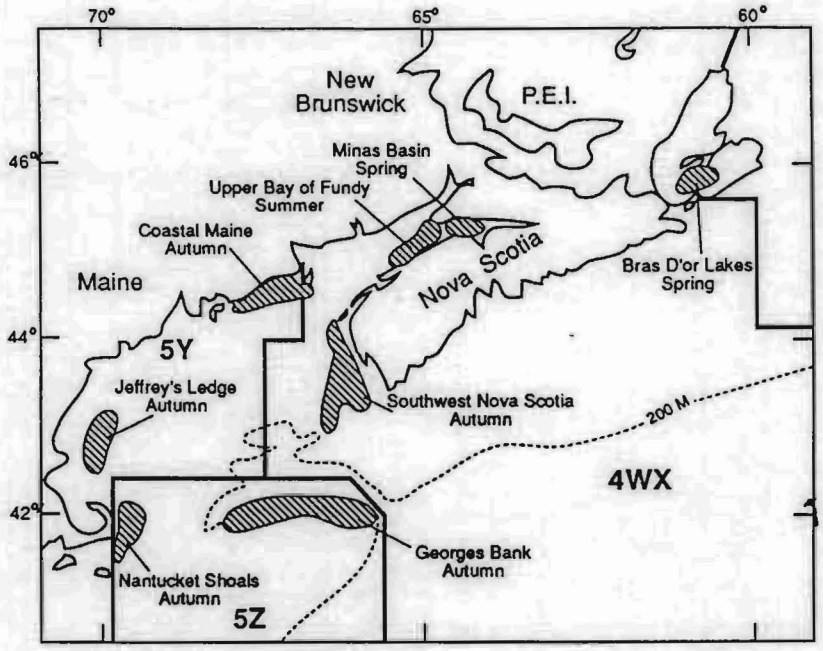

Figure I-6 Management units and major spawning areas of Atlantic herring in the Bay of Fundy, Gulf of Maine and Scotian Shelf.

Source: Stephenson et al. (1993)

Total Allowable Catch (TAC) for 1992 was set at 125,000 mt, a reduction from the 1991 TAC of 151,200 mt. Stock assessments have been hampered in the last several years by rampant under-reporting of landings[27]. Landings are made by

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[25]Stephenson, R.L., D.E. Lane, D.G. Aldous, and R. Nowak. 1993. "Management of the 4WX herring fishery: an evaluation of recent events", in: *Can. J. Fish. Aquat. Sci.* (accepted for publication, 4/93), p.1.
[26]Stephenson et al. (1993), p.2.
[27]Stephenson et al. (1993), p.47.

"mobile gear" (purse seine and drift gillnet), "fixed gear" (weir and set gillnet) and one permitted mid-water trawler.

The fishery was one of the first commercial fisheries to be regulated by limited entry (since 1970), and in 1972 it was the first fishery to come under nationally allocated annual total allowable catch (TAC) limits. Furthermore, in 1976, an individual vessel quota scheme for purse seiners was established and operated jointly by the regulatory and harvesting sectors.

A number of lessons, many relevant to the U.S. herring fishery, have been learned from the management of the 4WX fishery. These will be discussed more fully in Chapter 2, Developing a Fishery Management Plan.

It is widely accepted amongst industry and managers alike that the herring resource in the northwest Atlantic is transboundary between the U.S. and Canada[28]. In particular, the annual migrations of the Georges Bank and Gulf of Maine stock complexes take these stocks across the political U.S.-Canada boundary with regularity. The most notable of these migrations affected by a fishery is the annual influx of juvenile herring, considered to be U.S.-origin "migrants", taken in New Brunswick weir and shutoff fisheries. However, tagging results indicate that adult herring spawning off

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[28]Stephenson, R., Government of Canada, Dept. Fisheries and Oceans, St. Andrews, N.B., (personal communication, 1/93). And, Stephenson and Kornfield (1990), pp.2-3.

southwest Nova Scotia (late summer and autumn spawners) overwinter off eastern Nova Scotia (Cape Breton)[29].

The illustration in Figure I-6, above, from Stephenson et al. (1993) shows the proximity of Bay of Fundy/Scotian Shelf herring seasonal aggregations to "U.S-origin" stocks[30].

Current Landings and Values

U.S.

Total 1992 U.S. herring landings of 55,800 mt were a fraction of the target catch of 356,000 mt established by the ASMFC Herring Section for the entire stock complex (Gulf of Maine, Nantucket Shoals, southern New England and mid-Atlantic areas, and Georges Bank, but with New Brunswick weir fish excluded)[31]. These landings accounted for approximately 18.8 per cent by volume and 10 per cent by value of the nearly 298 million mt of all landed species in the region[32]. Landings by state in 1991 and 1992 are illustrated in Table I-1 on the following page.

These landings, all harvested by domestic fishermen and landed at U.S. shore-based facilities, are transformed into a limited number of products by both domestic and foreign

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[29]Stephenson et al. (1993), p.7.
[30]Stephenson et al. (1993), p.61.
[31]Pierce (1993), p.4.
[32]NOAA/NMFS Current Fishery Statistics No. 9012, (1992), p.18. And, personal communication with Bob Morrill, NMFS/Portland, ME, 6/4/93.

Table I-1 Atlantic herring landings by state, 1991-1992

	1992 Landings (MT)	1991 Landings(MT)
Maine	28,056	24,570
NH	255	340
Mass	22,980	21,600
RI	707	2,050
NY	9	40
NJ	3,745	370
MD	48	-
VA	0.5	-
Total	55,800	49,000

Note: Maine and Massachusetts landed 92% of the total 1992 harvest and 94.2% in 1991.

Source: MA DMF, NMFS

processors, as follows:

Canned herring

Of the total 1992 harvest, approximately 28,200 mt was utilized by Maine-based herring packers. These packers utilize juvenile herring (age 2-3) almost exclusively due to their smaller size. At an average ex-vessel price of $0.06/lb, Atlantic herring landings worth nearly $3.7 million to the region's fishermen were transformed by the Maine packers into 948,792 cases of sardines and steaks worth approximately $42.7 million[33].

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[33]NOAA/NMFS Current Fishery Statistics No. 9012, (1992), p.18. And, Food Institute Report, 2/8/93, p.18.

These six canning plants directly employ an estimated 1,000 full- and part-time people, and generate an annual payroll of approximately $13.1 million, including the cost of benefits paid to employees[34]. It is instructive to note that of the six remaining U.S. sardine packing plants, all located in Maine, one is 100 percent owned by Connors Bros., a Canadian corporation and the major competitor of Maine packers, while a second plant custom packs for Connors. Ownership and location of the packing plants is as follows:

Table I-2 Maine sardine packing plants - 1993

Company/ ownership	Plant location	Capacity/year (tons)	Employees (full/part)
Stinson Seafoods/U.S.	Belfast Bath Port Clyde	20,000	600/0
L. Ray Packing Co/U.S.	Milbridge	2,500	10/50-60
Lubec Packing/U.S. Note: custom packs for Connors Bros.	Lubec	2,500	15/135-150
Port Clyde Packing Co/ Canadian Note: owned 100% by Connors Bros.	Rockland	8,000	10/140

Sources: Personal interviews conducted by the author, December 1992-March 1993, and Maine Sardine Council

[34]Personal communication with individual company representatives, December-March, 1993. And, Letter from Jeff Kaelin, Maine Sardine Council, 9/30/92, to Office of the U.S. Trade Representative, p.1.

In its heyday of the early 1950s, the Maine herring fishery supported between 40 and 50 sardine packing plants employing approximately 4500 people, 200 weirs and 220 stop seines (fixed gear), and 10 purse seiners (mobile gear). By 1978, peak seasonal employment in the herring processing industry had fallen to 2300 people[35]. In 1950, production topped 3.8 million cases of canned sardines worth $21.2 million. By 1981, the value of the pack had risen to $54.9 million. An eight-fold increase in the value per case compensated for a three-fold decline in landings[36]. This increase in value was a direct result of the crash in the North Sea herring stocks due to overfishing.

Though technological advances in harvesting and processing of herring account for a portion of the employment reduction in much of the fishery, the overwhelming factor which has decimated the herring industry and eased fishing effort on the stocks has been an erosion of the domestic market for canned sardines (as small herring are called), and corresponding severe competition in domestic and overseas markets for both canned and frozen/pickled herring.

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[35]Acheson,J., A. Acheson, J. Bort, and J. Lello, 1978. The Fishing Ports of Maine and New Hampshire: 1978. Orono, ME: Univ. of Maine Sea Grant, p.265.

[36]Pack Statistics: Maine Sardine Industry 1875-1990. Published by the Maine Sardine Council, Brewer , Me, 1991.

Bait and "zoo food"

In addition to canned sardines and herring steaks, approximately 25,000 mt of adult herring (age 3 and older) are harvested by U.S. fishermen for lobster and longline bait and for "zoo food". In Maine alone, 1992 landings of herring for bait are estimated[37] at 13,431 mt. Maine landings of round herring for lobster bait are illustrative of the region's switch from groundfish racks, due to the decline in regional groundfish landings (see Figure I-7 following).

These harvests are delivered to domestic shore-based processors at approximately $0.06/lb., ex-vessel. No official figures of product mix for the bait vs. "zoo food" markets are available to the public. "Zoo food", according to industry participants interviewed for this paper, sells for approximately $0.20-0.22/lb., while bait wholesales at approximately $0.08/lb., both FOB East coast (Note: see Chapter 3, Market Opportunities and Constraints, for more detailed information on prices and volumes sold). According to industry sources, "zoo food" markets are notoriously particular about the quality and appearance of the product thus raising processing costs and reducing profits correspondingly.

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[37]Bob Morrill, NMFS/Portland, ME, personal communication, 6/4/93.

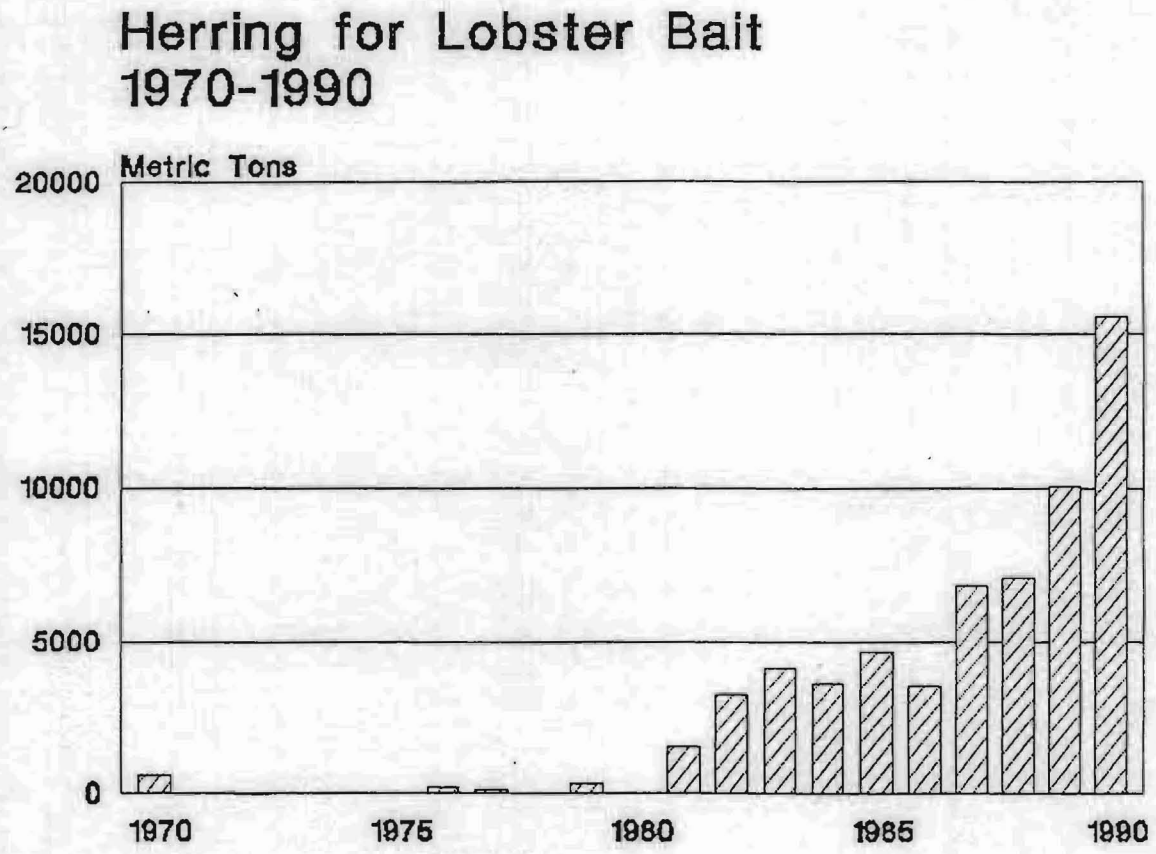

Figure I-7 Herring for lobster bait (round frozen), 1970-1990

Source: Maine Sardine Council

"IWPs"

In addition to the market provided by domestic processors, U.S. fishermen have another market outlet available to them, as well. Internal Waters Processing permits (IWPs), coordinated by the ASMFC but issued by the governors of the coastal states with an interest in the herring resource, allow foreign processing vessels to be stationed in designated anchorages within state waters in order to accept deliveries of herring and other permitted fish harvested by domestic fishermen.

Technically, these fish can be harvested within state waters or in federal waters. The Maine sardine industry has argued that harvesting herring in federal waters and then delivering them to foreign processing vessels in state waters is contrary to the intent of the enabling legislation[38]. This issue will be discussed in greater depth in Chapter 2 of this paper, Developing a Fishery Management Plan.

In 1991, IWP allocations for all states in the region (New England, New York, New Jersey) totalled 45,000 metric tons while removals totalled less than 5,000 mt. In Maine waters, of an allowable harvest of 11,000 mt available, a total harvest of only 2,918 mt. was taken. In 1992, region-wide allocations of 100,000 mt again yielded less than 5,000 mt[39].

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[38]Jeff Kaelin, Maine Sardine Council, personal communication, March 1993.

[39]Bob Morrill, NMFS/Portland, ME, personal communication, 6/4/93.

Industry participants attribute this low catch rate primarily to the difficulty of coordinating arrival of processing vessels of Eastern bloc and Russian origin to coincide with near shore availability of herring[40]. At an average ex-vessel value of $100-130 per ton, proceeds to fishermen totaled approximately $575,000. Allocations for 1993 IWP operations again total 100,000 metric tons.[41]

Current Landings and Values

Canada's Scotia-Fundy Fishery

The Scotia-Fundy herring fishery has had a parallel history to that of the U.S. fishery, and especially with the Maine sardine industry. Through the 1950s and into the 1960s, industry diversity, catch rates and product forms were similar.

Beginning in the 1960s, however, the Canadian processors began to diversify their product mix. Through major investment, subsidized by the federal government, fish meal and oil production began. By 1968, the peak of fish meal manufacture, 225,000 mt of herring was processed at six meal plants in New Brunswick and Nova Scotia[42]. A precipitous decline in landings and meal prices beginning in 1969 led to

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[40]Eric Reid, Deep Sea Fisheries Co., Pt. Judith, RI, and Tom Dowling, Resource Trading Co., Portland, ME, personal communications during interviews conducted specifically for this paper, 12/19/92 and 1/22/93.
[41]Pierce (1993), p.3.
[42]Stephenson et al. (1993), p.11.

marginal industry profitability and short fishing seasons through 1976 [43].

The fortunes of the Canadian herring industry (and of the U.S. industry, as well) were temporarily reversed in the mid-1970s with the collapse of the world's largest stocks of herring in the North Sea. In 1976, the Canadian government banned the rendering of whole herring for meal in an effort to preserve the herring resource and to encourage the development of product forms suitable for the higher priced European "food" herring market. This captive market came to an end by the mid-1980s with the recovery of the North Sea stocks[44].

Fortuitously, a new export market--in the making since 1978--blossomed in 1984. Increased demand for convenience foods in Japan resulted in the development of flavored herring roe, or *ajitsuke kazunoko*. This product was developed by a Japanese firm as a way to utilize broken and immature roe from the Soviet Union that was not suitable for the high-priced salted *kazunoko* gift-pack market[45]. Because of tremendous growth in sales of this product[46], a raw material supply relationship was developed with the Canadian east coast herring fishery.

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[43]Stephenson et al. (1993), p.11.
[44]Bengt Wallstrom, Percordia Seafoods, personal communication, 2/5/93.
[45]Anderson, J.L., J.T. Gledhill, Y. Kusakabe. 1989. "The Japanese Seafood Market: Herring Roe". J.L. Anderson and Co., Narragansett, RI, p.19.
[46]Anderson et al. (1989), p.19. From 1982-1987, consumption increased from 1,059 mt to 7,625 mt.

Figure I-8, below, illustrates the role of the roe fishery in overall earnings in the Atlantic Canadian herring fishery from 1984-1990.

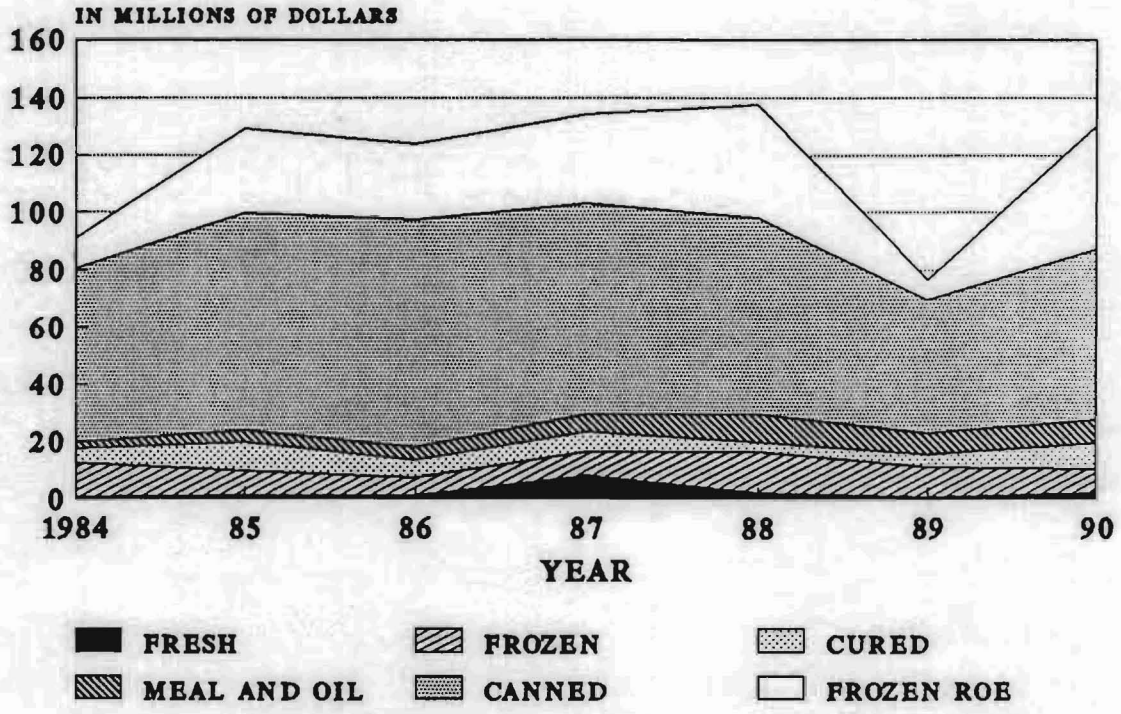

Figure I-8 Sales, Herring By Product Type, Scotia-Fundy Region 1984-90

Source: Stephenson et al. (1993)

This herring product never developed in the U.S. Atlantic herring fishery due to regulations effectively banning the taking of spawning herring in U.S. waters.

Despite this divergence in industry development, complimentary management and utilization of the resource is reinforced through industry-to-industry and joint management meetings.

One example of this linkage is the "significant" [47] percentage of the total U.S. herring harvest trucked from Gloucester, MA, to Canadian canning plants in New Brunswick. Ironically, many of these plants are in direct competition with U.S.-owned packers in U.S. and international markets[48].

This transboundary flow of herring works to the advantage of the U.S. industry, as well, according to the majority of industry respondents surveyed as part of the research for this paper[49]. Shortfalls in the U.S. fishery are frequently compensated for by shipments of Canadian fish to U.S. packing plants in Maine.

Summary

The northwest Atlantic herring fishery presents the U.S. and Canadian fishing industry--<u>private and public sectors together</u>--a unique opportunity to reverse the trend of mismanagement and overfishing which has plagued the region's fisheries[50]. Consider the following facts:

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[47]Bob Morrill, NMFS/Portland, ME, personal communication, March 3, 1993.
[48]Letter from Jeff Kaelin, Maine Sardine Council, to Office of the U.S. Trade Representative, 11/15/90.
[49]Personal communications with U.S. and Canadian herring industry members, December 1992-March 1993.
[50]<u>Status of Fishery Resources</u> (1992), pp.91-92.

· there is at present no Federal Management Plan (FMP) for sea herring in place for the U.S. EEZ

· the harvest of adults is currently limited in New England state waters during the spawning season through individual state regulation, coordinated through the Atlantic States Marine Fisheries Commission

· the resource has historically supported economically important regional and Canadian inshore fisheries and shore-based processing

· the resource is considered "underutilized"[51], has few "vested interests" to accommodate, and thus may be the least complicated fishery in the northeast on which to test alternative management models

· as noted above, historical use patterns are changing, especially in the U.S. fishery, in part prompted by anticipated cut-backs in groundfishing effort under Amendment 5 to the New England multi-species FMP.

Development of a fishery management plan, the subject of the next chapter, is underway and is to date an exemplary model of a co-management effort being driven by industry participation[52].

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[51] Status of Fishery Resources (1992), pp.91-92.

[52] Plante, J., "Herring plan mixes traditional, new ideas", in: Commercial Fisheries News, October 1992, pp.6B-8B.

Chapter 2
DEVELOPING A FISHERY MANAGEMENT PLAN

Background

Prior to 1976, the northwest Atlantic sea herring resource beyond territorial waters of the U.S. was managed by the International Commission for the Northwest Atlantic Fisheries (ICNAF). Figure II-1 on the following page illustrates the ICNAF fishery management zones that are the subject of this chapter (Zones 4X, 5Y, 5Z, 6A).

The Georges Bank herring fishery began in 1961 with the USSR fleet taking 68,000 mt. This fishery developed with the subsequent participation of the Poles, East and West Germany and catches increased to 374,000 mt by 1968, averaging 283,000 mt from 1967 to 1971. The international fishery for adult herring in the Gulf of Maine began in 1967. This was primarily a U.S. and Canadian fishery initially, with minor catches taken by East and West Germany[53]. Catches averaged 38,500 mt from 1969-1972, dropping to 16,000-24,000 mt through 1979 as a result of heavy exploitation of spawning fish in the Jeffrey's Ledge-Cape Ann area[54].

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[53]Sindermann, C.J., 1979. Status of Northwest Atlantic Herring Stocks of Concern to the United States, NOAA/NMFS Technical Series Report No. 23, p.313.

[54]"Outline of ASMFC Herring Management Plan", 9/9/92, p.1.

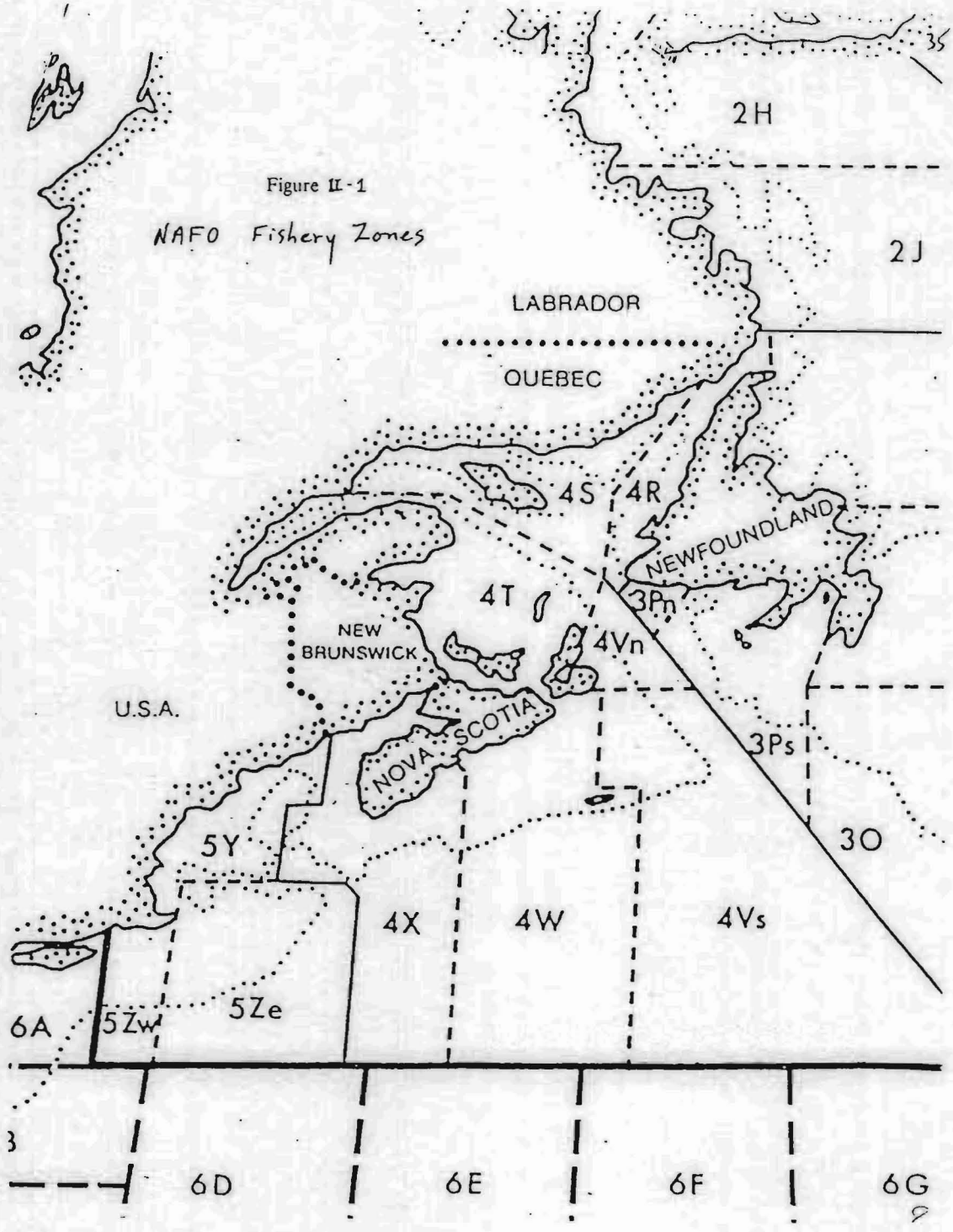

Figure II-1 ICNAF fishery management zones

Source: ICNAF Red Book, 1973

Difficulties in enforcing ICNAF quota limits resulted in catch overages and a depleted resource, both on Georges Bank and in the Gulf of Maine, with the fishery becoming dependent upon the strength of recruiting year classes[55]. The Georges Bank fishery collapsed from overfishing in 1977 and the Gulf of Maine stock was subsequently reduced to an annual harvest of 7,000 mt.

With the advent of the Magnuson Act in 1976, the U.S. withdrew from ICNAF and proceeded to manage all marine fisheries within the U.S. Exclusive Economic Zone via fishery management plans (FMP) prepared by regional fishery management councils. The first such plan for Atlantic sea herring was approved by the U.S. Secretary of Commerce in December 1978, replacing an interim Preliminary Management Plan (PMP) which regulated the foreign fishery in U.S. waters from 1976-1978.[56]

The goal of this management plan was to manage the Gulf of Maine and Georges Bank adult herring stocks so as to achieve levels of spawning stock biomass providing continued and relatively stable recruitment. The second objective was to manage the Gulf of Maine juvenile herring resource to stabilize and rebuild the Maine sardine industry.

By the early 1980s, the difficulty of distinguishing discrete herring stocks and determining stock interactions

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[55] "Outline of ASMFC Herring Management Plan", 9/9/92, p.2.
[56] "Federal Management Plan for the Atlantic Sea Herring", New England Fishery Management Council, Saugus, MA, 1978.

for management purposes, alluded to in the Preface to this paper, resulted in irresolvable disputes over the nearshore herring resource between fishermen from adjacent New England states[57]. Fearing depletion of the herring stocks, the U.S. Department of Commerce withdrew the original New England Fishery Management Council sea herring Fishery Management Plan in September 1982, four years after its original adoption. As a result of this action, sea herring was designated a prohibited species which effectively eliminated directed foreign herring fisheries in the U.S. Exclusive Economic Zone. This recision gave rise to the development of an interstate herring management plan, completed in 1983 under the aegis of the states with an interest in the resource--Maine, New Hampshire, Massachusetts, and Rhode Island. For a number of reasons[58], this interstate plan is no longer adequate to manage the resource throughout its range in U.S. and Canadian east coast waters.

Current Plan Development

Development of a more responsive U.S. management plan

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[57]"Outline of ASMFC Herring Management Plan", 9/9/92, p.4.

[58]These developments include:

1) an expanding offshore herring population resulting in increased resource abundance in coastal waters, giving rise to increasing requests for U.S.-based Internal Waters Processing (IWP) requests, and to interest by the Canadian industry to pursue a limited fishery on George's Bank;

2) an increase in domestic landings;

3) a herring by-catch in the mackerel mid-water trawl fishery in the mid-Atlantic region; and,

4) the need for a broader regional management process involving a larger group of states and the New England and Mid-Atlantic Fishery Management Councils.

for the Atlantic sea herring resource is well underway, with a number of sections drafted. Due to the current backlog of New England's fishery management crises (groundfish, scallops, lobster), the New England Fishery Management Council has abdicated its responsibility for development of the draft plan to the Atlantic Herring Section of the Atlantic States Marine Fisheries Commission.

As commercial use patterns change in response to depletion of other fisheries resources, and to international market conditions, demand for access to the herring resource will grow--indeed, it has already as evidenced by the graph below.[59]

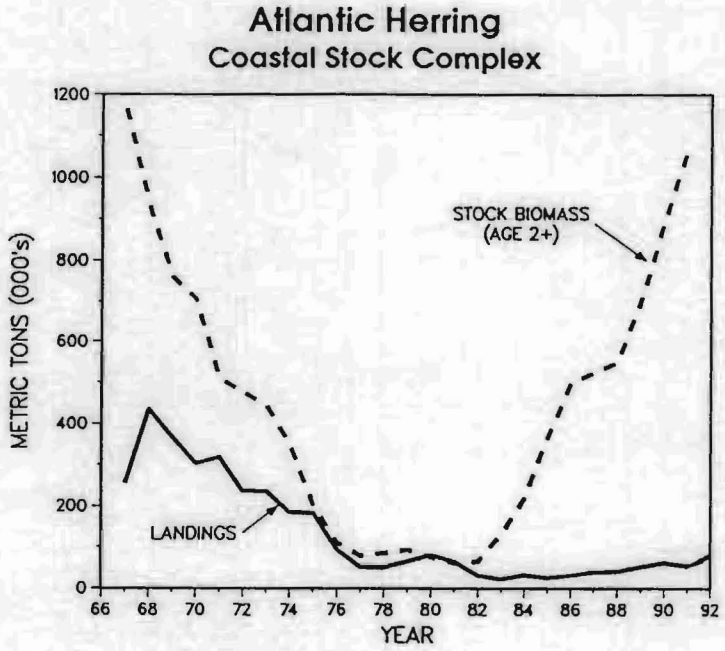

Figure II-2 Stock biomass and commercial landings, 1966-1992

thousand mt

Source: NMFS/NEFSC, 1992

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[59]Status of Fishery Resources (1992), p.92.

Management goal

Recognizing the inherent characteristics of the resource--its susceptibility to overfishing, its transboundary, migratory nature--and the likelihood of increased fishing effort in the future as changes in the New England Multi-species Fishery Management Plan (FMP)[60] take effect--the management plan development team (PDT) defined the following overall management goal:

> "...to manage the Atlantic herring as an interjurisdictional resource in U.S. Atlantic coast waters for sustained optimum utilization while conserving the resource through complementary management between between the New England and Mid-Atlantic Fishery Management Councils, the U.S. Atlantic coast states, and Canada in a manner which will provide the greatest benefit to the nation." [61]

Management objectives

This overall management goal is supported by the following objectives:

- to manage the resource on a sustainable basis through definition of overfishing;
- to establish complementary management of all components of the fishery throughout the range of the species in U.S. waters of the northwest Atlantic;
- to protect existing spawning areas and habitat from adverse fishing practices and other potential disturbances;
- to work cooperatively with Canada to research and manage this transboundary resource;

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[60]Amendment 5 to the NEFMC Multi-species FMP mandates a phased-in reduction in time-at-sea for vessels fishing groundfish in New England waters. It is a widely subscribed belief that this effort reduction will result in new fishing effort being applied to underutilized species such as herring.

[61]"Outline of ASMFC Herring Management Plan", 9/9/92, p.8.

· to establish a procedure by which to allocate fish;

· to promote the utilization of the resource in a manner which maximizes social and economic benefits to the nation.

Management plan specifics

The plan, as currently drafted, addresses many of these objectives. Specifically, it:

· establishes a target F value of 20% of MSP (maximum spawning potential);

· incorporates input from Canadian herring fishery managers and industry interests through regular consultations[62];

· designates three separate herring management areas which recognize the varying sizes and general distribution of discrete spawning and overwintering populations;

· establishes a harvesting regime for each management area which controls the ratio of juvenile vs. adult removals;

· defines a procedure for allocating harvests that embraces the concept that traditional interests have priority in herring allocations.

The figures on the following page illustrate the proposed herring management areas and the method for determining Optimum Yield and subsequent allocations to the domestic harvesters (DAH) and the foreign vessel internal waters ventures (IWP).

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[62]Transboundary management of the resource has been accomplished effectively for many years on an industry-to-industry, manager-to-manager basis without the involvement of high-level diplomats, according to Jeff Kaelin of the Maine Sardine Council (personal communication, 3/17/93).

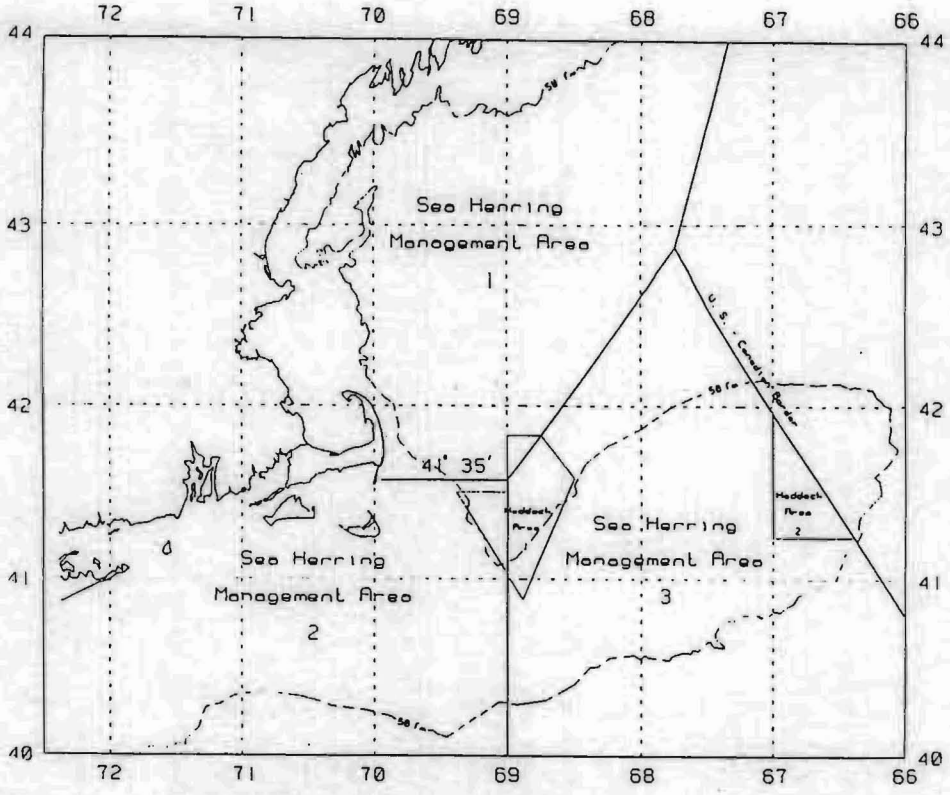

Figure II-3 Proposed Atlantic herring management areas

Source: ASMFC Draft Herring FMP, 9/92

Determination of Atlantic Herring Optimum Yield (OY)

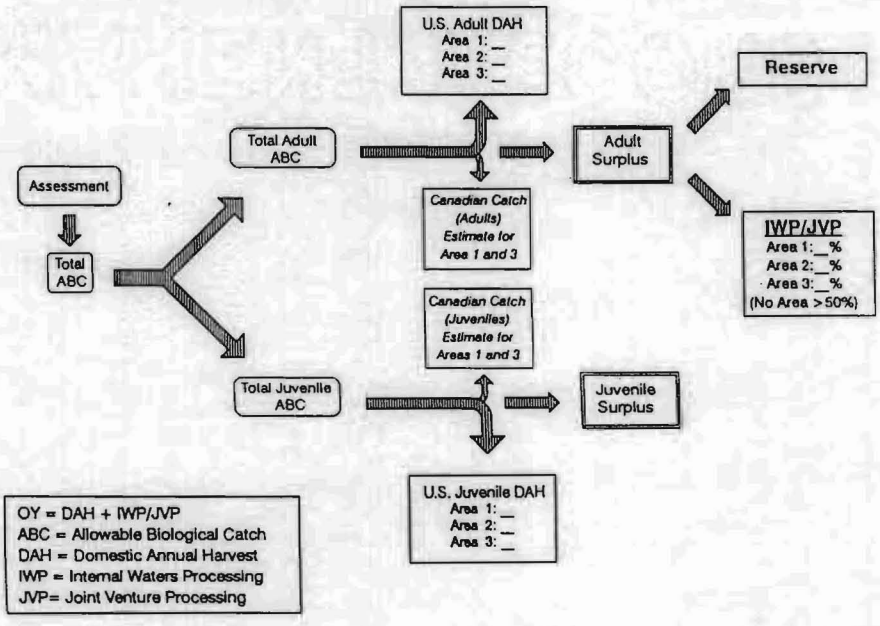

Figure II-4 Method for determining Optimum Yield in Atlantic herring fishery

Source: ASMFC Draft Herring FMP, 9/92

Management plan elements

The Plan Development Team, comprised primarily of state and federal fisheries biologists, has at its disposal current and historic stock assessment data with which to define target harvest levels and other stock protection measures. However, with the exception of overall U.S. herring landings and estimates of aggregated sardine industry economic performance provided by the Maine Sardine Council, very little data exists in the literature regarding utilization of herring by other industry participants.

The successful implementation of a management scheme depends partly on the quality of the data base. Essential data[63] includes the following: number of vessels and gear; effort, costs and earnings for major fishing methods; employment; income levels and distribution; cultural and social characteristics of the fishery; landings; end users of landings; methods and costs of processing and marketing; price analysis; foreign markets and imports of fish. For migratory species shared with neighboring countries, regional cooperation in the collection of resource and fishing statistics is critical.

Though an "Industry Advisory Committee" to the PDT is active in the development of the plan, detailed information on the aggregate herring industry has not yet been collected and incorporated into the draft herring FMP.

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[63]Lawson, R., 1984. Economics of Fisheries Development. New York: Praeger Publishers, pp.84-85.

Industry survey

To address this lack of information, a survey of approximately 22 companies and individuals active in the U.S. Atlantic herring fishery was designed and conducted by the author, in Winter 1992-1993, with the belief that current industry opinions and aggregated data on harvest levels and utilization patterns should be considered in development of the management plan[64]. It is the intent of the author to provide the PDT this information in a separate document.

This information may prove useful in fashioning a management plan which is responsive to one of the stated plan objectives, noted above:

> "to promote the utilization of the resource in a manner which maximizes social and economic benefits to the nation."

Overview of survey

The U.S. industry participants interviewed represent 100 per cent of the region's active sardine canners, approximately 75 per cent of the region's major bait and round frozen herring processors, and 100 per cent of the "trading companies" active in the herring fishery. An overview of the author's survey findings relevant to the development of the management plan follows:

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[64]An "Industry Advisory Committee" to the PDT was formed early in the process of developing a management plan and has been instrumental in providing the industry viewpoint to the PDT.

1) Maine sardine packers and other shore-based seafood and bait herring processors in the region were most skeptical of recent **stock assessments** indicating record high herring biomass, while trading companies and freezer-trawler companies were in general agreement with the predicted assessment levels. However, one of the trading companies maintained that past assessments had underestimated the stocks and had served to eliminate potentially lucrative herring IWPs requested for Maine waters in 1988 and 1989[65] ;

2) Development of a **roe fishery** on Georges Bank and/or Gulf of Maine herring stocks is strongly objected to by the Maine sardine packers. Other seafood and bait processors in the region were of mixed opinion, with half those questioned stating "conditional" support and half "strongly" agreeing to a carefully regulated fishery. All trading companies and freezer-trawler companies questioned "strongly" supported development of a roe fishery utilizing both stocks;

3) There was near unanimous agreement by all respondents that greater **federal and regional technical and marketing support** should be forthcoming in developing the herring fishery to its full economic potential. Concern was expressed by several sardine packers, however, that

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[65]Tom Dowling, Resource Trading Co., Portland, ME, personal communication, 1/21/93.

"historic" use be recognized in any future allocation schemes if the fishery becomes "overcapitalized";

4) Trading companies were the sole supporters of inclusion of directed foreign fishing (**TALFF**) in the management plan, so long as the TALFF allocations were conditioned on foreign purchases of a certain tonnage of U.S.-produced finished products ;

5) Freezer-trawlers and a limited number of shore-based processors "strongly" objected to provision for foreign over-the-side **joint ventures**, stating concern for erosion of progress in developing overseas markets. The majority of the industry interviewed favored continuation of J/Vs for harvesting surplus stocks as a means to maintain a robust domestic harvesting sector. However, until the New England Fishery Management Council adopts a herring management plan--the one under development by the ASMFC Herring Board or any other--no joint venture activities can be initiated in the the U.S. EEZ[66];

6) Support for continuation of **IWPs** was favored by half of the respondents, notably the sardine packers and trading companies. Sardine packers' support was conditioned upon provision for their annual pack needs as well as protection

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[66]"Outline of ASMFC Herring Management Plan", 9/9/92, p.13.

from localized depletion. Shore-based processors and freezer-trawlers were near unanimous in their agreement that IWPs should be outlawed, again due to concern of erosion of foreign markets;

7) Little support was expressed for individual fishermen or processing company allocations through issuance of **ITQs** or other quota shares. Those supporting the concept stated that if allocations were made, the shorebased companies with a history of reliance on the resource and evidence of investment in the fishery should be considered for shares on an equivalent basis as are those individual fishermen operating harvesting vessels or companies operating freezer-trawlers;

8) Little support was forthcoming for the concept of **community quota shares.** The majority of all respondents felt the concept lacked relevance to New England's fishing economies;

9) However, respondents were evenly divided on the question of **regional allocations**, with trading companies and shore-based seafood and bait processors favoring the concept while freezer-trawlers and sardine packers opposed it. Neither of the latter groups wishes the interstate/international flow of herring and the access to resources to be compromised;

10) Special **allocations for development of new product forms** also produced a nearly even split between those favoring and those opposing the concept. Sardine packers and seafood processors were generally opposed while trading companies and freezer-trawler interests were unanimously in favor of the concept;

11) In terms of **favoring the "status quo"** over all other management options listed above, all but the trading companies felt best served by this course of action, at least until further fishing effort or stock reductions called for restricting harvesting of the herring resource.

Current constraints to utilization of the herring resource, with relevance to development of the management plan, were expressed by industry respondents as follows:

1) **State fishery regulations** are regarded by two-thirds of the respondents as either supportive of the industry or not a constraint to their use and development of the herring fishery. Those claiming to be hampered by the state regulations are the freezer-trawlers and trading companies, both sectors being opposed to the region-wide ban on roe fishing;

2) The industry found less favor with **interstate (ASMFC) regulation** of the fishery. Approximately two-thirds of the respondents felt that the ASMFC process of interstate management was "moderately" to "very" constraining vis-a-vis their use of the herring resource. This majority was comprised of approximately even proportions of sardine packers, freezer-trawlers, and trading companies;

3) Even numbers of respondents felt that the lack of a **federal management** plan was either not a constraining influence, or was merely "moderately" constraining;

4) **Transboundary stock management** is considered by two-thirds of respondents to be either a supportive, positive influence or to not present a significant constraint to their use of the resource. The significant exception to this majority is the freezer-trawler companies which are wary of being excluded from a roe fishery in U.S. waters even if Canadian vessels are permitted a limited Georges Bank roe herring harvest, as has been proposed by Canadian industry and regulators alike;

5) Regarding **restrictions on gear type usage**, less than three-eighths of the respondents answered that use of mid-water and bottom trawls should be prohibited in the fishery, and that only purse seine, gillnet and weir harvests should be permitted. This was an objection raised solely by

several shore-based seafood processors and sardine packers who are skeptical about quality of the trawl-caught product, concerned with the lack of size and roe-content selectivity of a trawl compared to other gear types, and who believe that pair and mid-water trawls may be too efficient in harvesting schools of herring.

Survey update

Since this survey was conducted, and despite the record fishable biomass estimates noted in Chapter 1 of this paper, the domestic herring industry has suffered the worst winter fishery on record. This poor fishing has served to change the opinion of a number of sardine industry participants vis-a-vis the provision for IWPs in state waters and use of mid-water and pair trawls for harvesting IWP-associated herring[67].

Their concerns are summarized as follows:

· it may be impossible to regulate harvest of undersize herring when targeting adults;

· what will undersized herring be used for?

· these harvest techniques are highly efficient and competitive;

· localized depletion of the herring resource is a major concern for shore-based sardine packers because lack of nearshore herring reduces their processing efficiency;

These issues are especially troubling to the packers following the dismal winter fishery, one of the worst on

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[67]Jeff Kaelin, Maine Sardine Council, personal communication, 5/5/93.

record. In comparison to the 1992 pack, the 1993 pack was as follows in late April:

Table II-1 Maine sardine pack (cases) - 4/93 vs 4/92

As of 4/24/93 (# cases)		As of 4/24/92 (# cases)	
Sardines	52,557	Sardines	125,716
Steaks	54,025	Steaks	66,940
	106,582		192,656

Source: Maine Sardine Council

Canadian input

Though the U.S. herring fishery is presently in a relatively unexploited condition, it is instructive to understand the recent management history of the adjacent Scotia-Fundy herring fishery when fashioning a management plan for the U.S. portion of the northwest Atlantic herring stocks' range. To facilitate this, the Plan Development Team has solicited the participation and advice of the pelagic fisheries specialists within the Canadian Department of Fisheries and Oceans (Scotia-Fundy region) to assist in the ongoing effort to achieve complimentary management of the transboundary resource.

The Scotia-Fundy fishery, known locally as the "4WX herring fishery" after its NAFO management area designation, was one of the first to be regulated by limited entry (since 1970), and in 1972 it was the first fishery in Canada to come under nationally allocated total allowable catch (TAC)

limits.[68] In 1976, a joint industry-government sponsored and supported individual vessel quota scheme for purse seiners was established.

A recent "10-year review" of the management record for the "4WX" herring fishery[69] noted:

> "The Scotia-Fundy '10-Year Plan' was developed during a time of turmoil in the herring fishery. Problems including overcapacity, reduced stock size, depressed markets and overfishing indicated that the resource could no longer support the major purse seine sector as it was then structured.
>
> "The Plan attempted to bring about a rationalization (reduction) of the purse seine fleet, restoration and conservation of the stock, and economic stability of the fishery through a long term arrangement involving restricted entry (sector management and limited entry), a guaranteed fleet allocation (80% of TAC), and individual transferable vessel quotas."

The review revealed several key issues which may have relevance when fashioning the U.S. management plan, particularly if the implementation of transferable quotas is proposed by individual harvesters, processing or trading companies, or by communities or regional entities. The review identified the following issues:

· despite being designed to "rationalize", i.e. reduce the numbers of, the existing purse seine fleet, the anticipated consolidation has not occurred. This is attributed to the inappropriateness of a fleet reduction objective within the transferrable vessel quota management framework. As the authors note:

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[68]Stephenson et al. (1993), p.46.
[69]Stephenson et al. (1993), p.37.

"It is myopic to presume that a fleet configuration judged to be 'best' in 1983 should also be appropriate over an extended period of 10 years."[70]

Instead, they argue, it would be more effective to eliminate the current provisions restricting freely transferable quota shares (such as the "all-and-exit" and 4 percent maximum restrictions on quota transfers) and instead institute a more divisible transfer system with in-season transfers which would serve to attribute a more market-dictated price to quota and facilitate efficient trades[71] ;

· misreporting of catches (under-reporting, in particular, and to some degree discarding or dumping of substandard catches associated with roe fisheries) has been a central reason for the quota system failing to achieve its presumed economic benefits[72] ;

· the plan has been successful, however, in accommodating industry adaptation to new herring markets, such as the development of a roe fishery for the Japanese market. As a result:

"the viability of the fleet has improved over the Plan period...and herring abundance has not been adversely affected. Guaranteed quota shares coupled with increased demand for Atlantic herring destined for the Japanese roe market since 1984 greatly buoyed the economic position of vessels participating in the herring roe fishery."[73]

· however, the Plan was not designed to account for overcapacity, and rampant under-reporting of harvests ensued to overcome low initial vessel allocations made in 1983[74] .

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[70]Stephenson et al. (1993), p.42.
[71]Stephenson et al. (1993), p.40-41.
[72]Stephenson et al. (1993), p.37.
[73]Stephenson et al. (1993), p.41-42.
[74]Stephenson et al. (1993), p.37.

Thus, the goal of fleet rationalization was frustrated because there was no financial incentive to purchase additional quota (which would have served to retire some vessels from the fleet):

> "High prices in the roe market probably improved the lot of many seiners to the point that economic viability was sustained, where it may not have been otherwise, thus calling into question the explicit goal of fleet reduction. The availability of this market, together with the under-reporting which occurred under the quota system, continued to support even marginal operators through the period of the Plan since 1984.
>
> "It is not correct to associate this economic improvement with increased stability however. The recent downturn of the Japanese roe market, outside competition, and a fall in roe prices threaten to return the fishery to the economic crisis position of the early 1980s."[75]

Thus, the stated goal of stabilizing the economic viability of the fleet through rationalization and allocation of ITQs may be frustrated by market forces outside the control of the management plan;

· management plans by nature require that a long-term perspective be adopted coupled with a high degree of flexibility consistent with adopted principles. This would allow management to maintain a "proactive", forward looking perspective that incorporates regular performance evaluations into any plan modification;

· the development of management plans must include all participants in the fishery specifically in a consensus building atmosphere.

The review by Stephenson et al. (1993), cited extensively above, concludes that implementation of an ITQ

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[75]Stephenson et al. (1993), p.37.

system in the 4WX herring fishery is often cited to justify imposition of a similar scheme in other fisheries. The authors state that this rationale is ill-founded because the track record of ITQ management in any fishery is too incomplete to be able to evaluate its overall potential.

Summary

The central role of the fisheries biologists in the development of the U.S. Atlantic sea herring management plan places them under increasing scrutiny as interest in the resource develops. Encouragement of participation in the process by the Industry Advisory Committee and Canadian fisheries managers is seen as a positive development in a process fraught with uncertainty. Past criticism by industry participants of "extremely conservative" harvest allocations for IWP operations must be taken seriously.[76] As Greenwood (1984) notes:

> "If it [criticism of regulators] is accurate, then a fundamental presumption of American government--that through a combination of agency fact-finding and participation by interested parties in administrative proceedings, existing scientific knowledge relevant to an issue will be obtained, correctly analyzed, and made available to decision-makers when they need it--is placed in doubt. The issue of competence is critical to an understanding of the interaction between knowledge and discretion in regulation."[77]

As we shall see in the following chapter, Market Opportunities and Constraints, current market conditions are

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[76]Personal communication with Tom Dowling, Resource Trading Co., Portland, ME, 1/21/93, and "Outline of ASMFC Herring Management Plan", 9/9/92. pp.5-6.

[77]Greenwood, T., 1984. Knowledge and Discretion in Government Regulation. New York: Praeger Publishers, p.71.

serving as a brake on expansion of the U.S. herring fishery. However, the time-at-sea cutbacks which are the core of the proposed Amendment 5 to the New England multi-species fishery management plan may serve to divert effort to less utilized fisheries like herring, making development and implementation of a management plan which sustains the herring resource all the more timely.

Chapter 3
MARKET OPPORTUNITIES AND CONSTRAINTS

Background

The U.S. Atlantic herring fishery management plan, as currently drafted, makes provision for allocating the resource in such a way that recognizes the interests of historic users while encouraging development of new products and industry sectors. The following brief review of global products and markets, though not exhaustive, is illustrative of the range of herring products supplied by potential U.S. competitors in various markets worldwide.

World pelagic overview

World trade in fish and shellfish is in a phase of growth faster than that of any other agricultural commodity, according to the International Commodity Markets Handbook 1992.[78]

Over the past quarter century, trade of fish and shellfish has risen by a factor of 20, for a current total of $33 billion. This equates to some 1.5 percent of all world trade, or 10 percent of all agricultural trade.[79]

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[78]Chalmin, P. (ed.), 1992. International Commodity Markets Handbook 1992, pp. 127-128.
[79]Chalmin (1992), p.128.

However, the share of world trade of small pelagic species of herring, sardines, and anchovies, in the fresh and frozen forms, has declined significantly in both volume and value since 1980.[80] At that time, small pelagics accounted for 20 per cent of the volume and 9 per cent of the value of the total fresh and frozen fish traded worldwide. In 1989, that share dropped to less than 15 per cent of the volume and 4 per cent of the value. Of this total, the share of the small pelagic species of herring, sardines and pilchards accounted for 2.9 percent of this total, or approximately $957 million. Table III-1 on the following page illustrates the world market in small pelagics and the dominance of eastern Atlantic producers in the canned market export sector [note that the U.S. share of the fresh, chilled, or frozen herring market is dominated by Pacific roe herring (*Clupea harengus palliesi*) shipped frozen from Alaska to Japan and Asia for stripping of the roe].

Globally these species represent nearly half the total world maritime catch. Most of this catch is rendered into fishmeal and oil, destined for the animal feeds sector.[81] In volume terms, however, small pelagics account for only 4 percent of the world trade in fish and shellfish, but a quarter of canned fish preparations. Half of these

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[80]Bergesen, F., "World Pelagic Overview", a paper presented at The 15th International Seafood Conference, 11/1-4/92, Lisbon, Portugal, p.5.
[81]Tom Starkey, H.J. Baker Bro., personal communication, 4/12/93.

transactions are accounted for by sardines of various types, generally canned.[82]

Table III-1 The world market in small pelagics: market share by group and by major importers and exporters (percentage shares, basis 1989)

Species	% of world trade	Major exporters (% of market)	Major importers (% of market)
Small pelagics	4.0		
Herrings, sardines, anchovies	2.9		
Canned	1.4	Morocco (20.4) W. Germany (12.9) Portugal (10.5)	US (19) France (10)
Fresh, chilled, or frozen	1.1	US (22.3) Denmark (12.7)	Japan (38.6) W. Germany (13.7)
Dried, salted, or smoked	0.4	Iceland (17.5) Spain (15.2)	Italy (34.2) Spain (15.8)
Mackerel	1.1		
Fresh, chilled, or frozen	0.7	Korea (22.6) Norway (17) Holland (16.5)	Japan (27.4) Nigeria (14.6)
Canned	0.4	Japan (37.7) Thailand (11.1) Denmark (9.6) Portugal (9)	P.N. Guinea (37.4) Italy (19.3) Belgium (6.5)

Sources: FAO (1990), Bergesen (1992), Chalmin (1992)

The canned herring from Maine and Atlantic Canada, legally labeled as "sardines", represents a small fraction of this multi-million dollar industry, with annual landings of 50,000 mt in the U.S. fishery and 150,000 mt in the adjacent

[82]Chalmin (1992), p.140.

Scotia-Fundy region. This tonnage is miniscule compared to annual landings of Atlantic herring in the North East Atlantic fishery varying from 1.5 to 1.9 million metric tons.[83] As mentioned in Chapter 1, The Fishery, combined value of the 1992 Canadian and U.S. canned sardine pack was approximately USD $150 million. Because the world Atlantic herring market is largely dominated by European-origin herring, the discussion which follows focuses on those markets developed and dominated by European producers.

The Markets

The markets for pelagic fish are characterized by unstable demand. As a result, herring and mackerel are increasingly traded as bulk products in spot markets.[84] This trend is expected to continue, according to an industry expert, because of the continuous oversupply situation created by worldwide pelagic stock abundance and relatively low fishing effort.[85]

It is important to note that the Atlantic herring market is an extremely complex and differentiated market. Each herring "stock"--Norwegian, Baltic, Danish, Netherlands, Canadian and U.S.--is rated according to its perceived market attributes.[86]

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[83]Bergesen (1992), p.3.
[84]Bergesen (1992), p.2.
[85]Finn Bergesen, Managing Director, Norwegian Fishermen's Sales Organisation for Pelagic Fish, personal communication, 3/12/93.
[86]Bengt Wallstrom, Percordia Seafood, personal communication, 2/5/93.

As an example, Norwegian-origin herring are considered distinct from Danish and Dutch herring[87] due to their availability year round, their different fat content and size at maturity, their spawning condition and roe content, etc. Even within the Norwegian herring complex, distinctions are made between fish aggregations: Norwegian North Sea, fjord and coastal herring. Each has a market niche which is exploited on the basis of spawning cycles and timing, fish size, roe and/or fat content. Norwegian herring spawn in the winter months in contrast to the North Sea strains from the Netherlands and Denmark which do so in May/June. They are thus available in their highest fat content condition--the most desirable condition--before the more southerly stocks, and thus command a higher price in the market than they otherwise would. Large fish are preferred for the Japanese market, either as single fillets or pieces, with or without skin, but also whole with the roe or developing roe; medium size fish are popular raw materials for smoking and for fresh fillets; and, small fish are usually destined for the marinade industry.

Characterizing the subtleties of the entire market is beyond the scope of this paper. The point of the above example is to illustrate that U.S. herring producers seeking to enter the world market must either identify an appropriate existing niche or develop a new product suited to the raw

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[87]"Norwegian herring", in: *Fish International*, 12/92, pp.8-11.

material characteristics and production costs of their own herring resource.

The major markets for Atlantic herring are Europe (both west and east), Japan and the Far East, and Africa. Each is reviewed briefly below with special consideration given to the suitability of western Atlantic-origin herring for each market.

Western Europe

The general problem of oversupply of pelagic fish within western Europe is caused by the EEC's self-sufficient supplies of Atlantic herring and mackerel and their proximity to abundant external supplies from Norway, Iceland and Sweden.[88]

Holland, as an example, is one of Europe's major importers, producers and exporters of fish, handling about 600,000 tons of fish products per year. Of this total, 23 per cent are herring caught in Scandinavian and EEC-waters. Annual per capita fish consumption amounts to 14.5 kilograms, of which 2.5 kilograms are herring products.[89] Producers, feeling the limits to market expansion, are aware of the need to develop new products to fit the tastes of younger, less traditional consumers.[90]

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[88]Bergeson (1992), p.4.
[89]Carp, R., "Fish partner Holland", in *Fish International*, 4/92, p.16.
[90]Carp (1992), p.17.

Furthermore, consumer preferences have typically been for products based on locally-caught species.[91] Because of the oversupply situation, there have been depressed prices and very small margins in the European herring market.[92] Combined with additional transport and tariff costs, the prospects for entry into European markets by U.S. east coast herring producers is daunting indeed, especially considering that in most EEC countries tariffs applied to semi-processed products are higher than those on unprocessed products, while tariffs on processed products are higher still.[93]

Nonetheless, a European-based trade publication cited[94] a major Dutch herring processing concern which developed a process for utilizing "third class" Canadian round frozen herring as a low-cost raw material substitute for a heretofore high-priced product--*matjes* herring. By using herring with a fat content below the standard minimum 15 per cent, the processor is able to mass produce this firmer Canadian herring at low labor costs by using processing machines. The resulting product is sold to a wider market than the traditional hand-processed, high fat content *matjes* herring which is only sold fresh, in-season, in small quantities, at high prices.

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[91]Hallgarten, E., "Herring, the trademark of Holland", in: *Seafood Business*, Jan/Feb 1993 Vol. 12, No. 1, p.83.
[92]"Norwegian herring", in: *Fish International*, 12/92, p.11.
[93]OECD, 1989. Fisheries Issues: Trade and Access to Resources. Paris: OECD, p.70.
[94]"Dutch vis", in *Fish International*, 4/92, p.14.

This example of new product development to access a wider market is rare, however, in a trade characterized by tradition and ritual.[95]

Eastern Europe

Eastern Europe has historically been one of the most viable markets for European herring merchants,[96] particularly for herring purchased "over-the-side" from EC, Canadian, and recently U.S. fishermen, processed and salted in barrels on board eastern Bloc factory vessels (*klondykers*), and transported to ports in eastern Europe for further processing and distribution.

Beginning in 1992, currency shortages in east European countries eliminated many of these *klondyker* operations and slowed the increase of exports to the former Soviet republics. This has given rise to a shortage of herring in these markets and barter deals are slowly developing to take advantage of this situation.[97] In addition, temporary governmental guarantee schemes to promote trade are being discussed in governments and within the EEC.[98] However, until the republics resolve some of their outstanding economic

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[95]As an example, "Hollandse nieuwe" is a day in mid- to late-May that is reserved to celebrate the arrival of the first herring of the season in Holland.

[96]Bergesen (1992), p.9.

[97]Tom Dowling, Resource Trading Co., personal communication, 1/22/93.

[98]Finn Bergesen, Managing Director, Norwegian Fishermens Sales Organisation for Pelagic Fish, personal communication, 3/12/93.

difficulties they are unlikely to become major markets for imports nor to continue at historic import levels.[99]

The exception to this trend may be Poland which has a trade surplus. However, prices for herring products are down by 10 per cent since 1991, according to the Norwegian Fishermen's Sales Organization for Pelagic Fish,[100] making for a marginal sales opportunity.

Africa

Nigeria, Egypt and the Ivory Coast have all provided strong markets in the recent past for small pelagics, particularly for the eastern Bloc "klondykers".[101] It is forecast that these markets will open up more to western European suppliers with the withdrawal of the cash-poor eastern Bloc producers mentioned above.[102] However, prices have fallen constantly over the last few years,[103] reflecting the worldwide trend noted in the introduction to this chapter.

Japan and the Far East

The most interesting challenges for the pelagic industry may be in Japan, Korea and other Far East markets, according to an industry expert.[104] These markets demand top quality

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[99]Chalmin (1992), p.145.
[100]Bergesen (1992), p.10.
[101]"Pelagic dynasty", in: *Fish International*, 7/92, pp.58-65.
[102]Gerald Knecht, No. Atlantic Inc., personal communication, 5/26/93.
[103]Bergesen (1992), p.10.
[104]Bergesen (1992), p.11.

products but reward producers able to achieve these standards with high prices. Shipments of roe are the most important herring export from a value standpoint[105] and will be discussed more fully in the "Products" section which follows this "Market" overview. Large, whole smoked herring are also a very popular product in Japan and Korea.

Part of the marketing success of the European producers in the lucrative Japanese roe market can be attributed to their range of top quality products, particularly the large-sized mackerel and horse mackerel, which is in great demand in Japanese markets and which is used by European producers to leverage more market share for their herring roe.[106] This leverage using a combination of desirable products is a technique that U.S. Atlantic herring producers might consider, for example with sea urchin roe or monkfish livers which are both in high demand in some Asian markets.

U.S. and Canada

Primary markets for U.S. Atlantic herring are domestic: canned sardines and herring steaks; round frozen "zoo food" for captive marine mammals at aquaria; and, round frozen for longline bait in U.S. west coast and Alaska fisheries.[107]

In value, the approximately 51,300 mt of Atlantic herring landed in the U.S. in 1990 was worth approximately

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[105]"Fish in harmony", in: *Fish International*, 12/91, p.57.
[106]Bergesen (1992), p.12.
[107]Dan Flynn, Flynn Fisheries, personal communication, 5/26/93.

$5.7 million ex-vessel[108] and, in processed form, approximately $45 million: $40 million to the sardine industry and less than $5 million to the bait and round frozen processors.[109]

This is in contrast to the Scotia-Fundy region Atlantic Canadian herring industry, with landings of 140,000 mt worth approximately $140 million in 1990. Here, product diversity plays a major role in industry profitability as evidenced by the figure below.

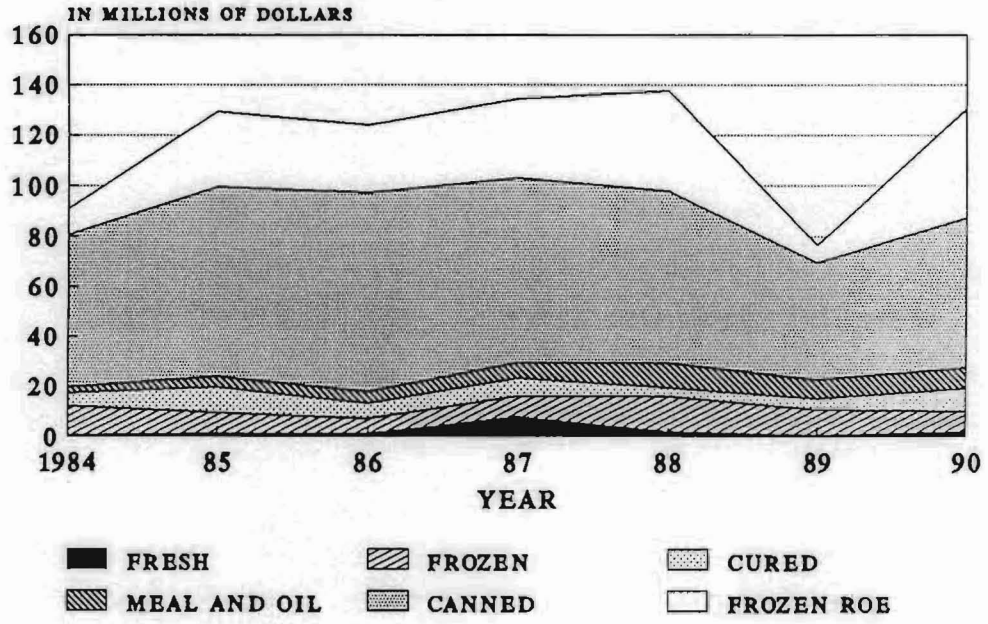

Figure III-1 Herring sales by product type, Scotia-Fundy Region, 1984-90

Source: Stephenson et al. (1993)

Markets for the Canadian products illustrated in the graph are as follows:

· fresh--domestic

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[108] Status of Fishery Resources (1992), p.18.

[109] Maine Sardine Council estimates, personal communication, 3/92.

- frozen--Europe
- cured--domestic and U.S.
- meal and oil--domestic, U.S. and E. Europe
- canned--domestic, U.S. and overseas
- frozen roe--Japan

The Products

According to NMFS statistics, export values of U.S. herring products (both fresh, frozen and canned) rose 25.3% from 1991-1992 while the import value of comparable products rose only 2.3%, as follows:

Table III-2 Value (million $) of Atlantic herring products (Northeast US region), 1990 and 1991.

Source: NMFS

	Exports		Imports	
Product category	1990	1991	1990	1991
Fresh, frozen	0.67	0.59	3.12	4.20
Salted herring	--	--	3.74	3.82
Canned sardines	11.06	14.11	30.38	30.07
Totals	11.73	14.70	37.24	38.09
Percentage change	25.3%		2.28%	

It is important to note, however, that these figures do not account for the true nature of U.S. "exports" to Canada. According to the Maine Sardine Council:

"Sardine exports to Canada are grossly inflated because Maine-packed goods, packed in Maine in three factories by a Canadian company but labeled and warehoused in Canada for eventual sale into the U.S., are counted as U.S. exports when, in fact, they are not...One Maine packer does have a very small market in Canada but it amounts to no more than 5 percent of the reported U.S. canned sardine exports to Canada."[110]

Canned herring

Maine is the only state in the United States that cans herring. This segment of the industry is comprised of five companies operating six factories along the coast, from Bath, east to Lubec, Maine.

The 1992 U.S. Atlantic herring landings totaled 55,800 mt. Of the total harvest, approximately 25,000 mt was utilized by Maine sardine canners. At an average ex-vessel price of $0.06/lb, Atlantic herring landings worth $3.1 million to the region were transformed by the Maine sardine packers into 948,792 cases of product worth approximately $42.7 million.[111]

According to the Maine Sardine Council, the influx of low-cost imported canned sardines into the U.S. market has served to reduce the Maine sardine producers' historic domination of the U.S. market to approximately a 35 percent share in 1992.[112]

One major U.S. sardine packer, however, has been developing export markets and now ships product to over 30

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[110] Kaelin letter (9/30/92), p.3.
[111] Food Institute Report, 2/8/93, p 18., and personal communication with Jeff Kaelin, Maine Sardine Council, 5/5/93.
[112] Kaelin letter (9/30/92), p.2.

countries, primarily in the Caribbean, Oceania, and Mexico.[113] Even so, the canning industry's primary focus continues to be the U.S. market with less than 10 percent of annual production exported.[114]

Round frozen

Determining an accurate estimate of round frozen herring production and sales figures is impossible. NMFS does not maintain records of U.S. round frozen production.[115] Because of lack of accounting for the transboundary transfers of herring trucked between the U.S. and Canada, referred to in Chapter 2, Developing a Management Plan, the total U.S. landings figures may not accurately reflect the amount processed into products other than canned sardines.

Herring roe

The Japanese market is the world's largest and most valuable herring roe (*kazunoko*) market. Minor markets utilizing Atlantic herring roe exist in Europe, mostly as a substitute for caviar and as a roe spread packaged in tubes.[116]

The traditional Japanese product comprising the majority of *kazunoko* consumption is salted herring roe called *shio*

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[113]Al West, Stinson Seafood Co., personal communication, 2/5/93.
[114]Kaelin letter (9/30/92), p.1.
[115]Bob Morrill, NMFS/Portland, ME. personal communication, 5/23/93.
[116]Eric Fleury, U.S. Consulate, Brussels, personal communication, 1/12/93.

kazunoko, according to "The Japanese Seafood Market: Herring Roe", a 1989 report prepared for the Government of Canada by J.L. Anderson and Co.[117] The raw material for this product has traditionally been supplied by Pacific herring producers from British Columbia, Alaska and Japan. Other herring roe products consumed in Japan include:[118] flavored herring roe, or *ajitsuke kazunoko* (in which whole herring skeins or pieces are the principal ingredient and are flavored with a variety of sauces including sake sediments, soy sauce, chili peppers, brandy); mixed seafood appetizers, or *chinmi* (in which herring roe is but one of several ingredients including dried squid, seaweed, vegetables, abalone); dried *kazunoko*; and, herring roe-on-kelp, or *kazunoko kombu*. The latter two products are specialty products and have limited, high-priced markets.

Consumption of herring roe products in Japan tripled in the 1980s with the introduction of flavored herring roe products, known as *ajitsuke kazunoko*. By 1987, nearly 20,000 mt of herring roe was consumed, up from 6,221 mt consumed in 1980.[119] Much of this growth is attributable to the popularity of *ajitsuke kazunoko* as an affordable "convenience" food available as a ready-to-eat product in supermarkets.

Ajitsuke kazunoko was developed by a Japanese herring roe processor in the 1970s as a way to utilize immature roe

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[117]Anderson et al. (1989), p.19.
[118]Anderson et al. (1989), pp.18-19.
[119]*Bill Atkinson's News Report*, (BANR), Issue 472 - 11/04/92, p.3.

from the Soviet Union that was not of sufficient quality for the salted *kazunoko* market. In response to growing demand for the product, this same company developed a roe supply relationship in the late 1970s with east coast Canadian herring producers. By 1987, Atlantic Canadian herring roe had nearly 100 percent domination of the *ajitsuke kazunoko* market.[120]

This domination changed in the late 1980s, however. In particular, Irish-origin herring roe has made in-roads into the *ajitsuke kazunoko* market. According to Anderson et al.,[121] availability, size and quality are the three attributes which led to this shift in market dominance. The Irish roe herring fishery is conducted from November to February which allows processing before the summer sales period for *ajitsuke kazunoko*. With regard to size, the fish are approximately 200 grams which produce roe of the size desired by the roe processors. Finally, and with regard to the most important parameter--quality--processors reportedly[122] favor Irish-origin roe over Atlantic Canadian roe because of the much firmer texture of the Irish roe.

These Japanese market developments and preferences present significant obstacles to U.S. processors contemplating entry into the Japanese market for Atlantic herring roe.[123] However, Anderson et al. in their 1989 survey

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[120]Anderson et al. (1989), p.22.
[121]Anderson et al. (1989), p.45.
[122]Anderson et al. (1989), p.43.
[123]Dick Goodwin, Seafreeze, Inc., personal communication, 12/19/92.

concluded that the "image problem" suffered by Atlantic Canadian herring roe in the Japanese market could possibly be overcome with effective promotion and improved handling and processing, depending on the natural characteristics of the roe itself.

Whether this diagnosis applies to development of an Atlantic U.S. herring roe fishery bears further research. It is interesting to note that a November 1992 issue of Bill Atkinson's News Report[124] noted that Japanese demand for frozen herring roe from the eastern Canada fishery was "surprisingly good".

Pickled herring

U.S. producers of pickled herring typically utilize brined Atlantic Canadian herring as a raw material due to its consistent quality and low price.[125] One U.S. company, requesting anonymity, stated that its annual purchases of brined herring total 2,000 tons and that they were the largest producer of pickled herring in the U.S.

Herring surimi

This product is currently being manufactured in Alaska for the first time,[126] using carcasses of both male and female

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[124] BANR (1992), p.3.

[125] Personal communications with principals of: Axler's Herring Products, Springfield, MA; Marshall's Smoked Seafoods, Johnston, RI; and, VITA Foods, Chicago, IL, 12/92-3/93.

[126] Welch, L., 1993. "Sex machines boost herring profits", in: *Pacific Fishing*, June 1993, p.27.

Pacific herring, following sex sorting and roe extraction from female fish. The herring surimi is reportedly of lower quality and darker color than surimi from white-fleshed fish and fills other, lower-value niches in the market where fish flavor is appreciated.

The Canadian Institute of Fisheries Technology in Halifax, Nova Scotia, has been experimenting with manufacture of Atlantic herring surimi using a Japanese vacuum leaching system which is intended to remove the residual odor, and thus taste, from the finished product.[127] Preliminary tests of the system in Japan using "sardines" and other "red-meat" fish species as a feedstuff were successful in producing an acceptable product which was sold as a fried surimi in a limited market in Nagasaki.

From a New England producers' perspective, the system may be of interest in its conservation of fresh water, usually a significant factor in the surimi manufacturing process. This process is reported to reduce water use three-fold over more typical systems while achieving an above average product recovery and functionality.

Chilean and Japanese processors are also producing "red meat" surimi from other pelagic species such as horse and jack mackerel.[128] This product was reportedly being formed

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[127]Dr. Kathy Spencer, Canadian Institute of Fisheries Technology, personal communication, 12/18/92.
[128]Dr. Kathy Spencer, personal communication, 12/22/92.

into *kamaboko* mushrooms, an analogue of the prized Chinese long stem mushrooms.

Formulated "meats" such as meat balls, salami, hotdogs, and pizza topping may hold promise for dark colored surimi or blends of dark/light surimi, depending on cost.

Meal and oil

Fish meal, historically a feedstock for livestock and poultry feeds, is now a primary ingredient in the burgeoning aquaculture feed business. Production of aquaculture feeds is estimated to consume 10 per cent of annual world fishmeal production.[129] That figure is forecast to rise to 30 per cent of total fishmeal production by 2000.[130]

World fish meal prices have been on a slow downward trend, somewhat in line with the general trend of the major world commodities.[131] The outlook for the rest of the year will be determined by soybean production and by the demand situation in key markets such as China, the Far East, Germany and West Europe.[132]

Fish oil is made primarily from fish such as pilchards, menhaden and capelin, and is chiefly used by the margarine industry.[133] Prices had strengthened in the second half of

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[129]Tom Starkey, H.J. Baker Bro., personal communication, 4/12/93.
[130]Chalmin (1992), pp.142-143.
[131]Tom Starkey, H.J. Baker Bro., personal communication, 4/12/93.
[132]Tom Starkey, H.J. Baker Bro., personal communication, 4/12/93.
[133]Chalmin (1992), p.141.

1992 to the point where they were approaching the price of vegetable oils.[134]

Summary

Markets for herring are global in scope, extremely competitive and often filled by producers with local knowledge using locally available raw materials. Product and market development costs are often prohibitively expensive[135] and U.S. government assistance is currently insufficient to compete with foreign companies which are supported by extensive government R&D networks, such as in Japan and Chile.

This inability to justify underwriting new process, product and market development is amplified by the fugitive nature of the herring resource and the lack of guaranteed access to quantities of fish which might otherwise justify investment in such R&D and infrastructure.

The next chapter of this paper examines several regional economic development mechanisms through which portions of various fisheries resources are allocated to community-based, regional organizations composed of fishing and processing interests. The intention of these industry-driven, government-mandated mechanisms is to secure local employment and infrastructure development through vesting of the

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[134]Bergesen (1992), p.14.
[135]Ron Hunter, Stinson Seafood, personal communication, 2/11/93.

valuable, proximate fisheries resource to the region. In theory, those individuals with a long-term "stake" in the resource will be better stewards and more willing and able to attract capital for investment in R&D than those with a shorter-term economic interest in the same resource.

Chapter 4
REGIONAL ALLOCATIONS:
SELECTED EXAMPLES WITH RELEVANCE TO NEW ENGLAND'S HERRING FISHERY

Background

The allocation schemes presented in this chapter introduce the concept of community or regional management control of offshore fisheries resources to benefit local economic development. This concept is in practice in several countries around the world. Four examples from temperate fisheries with potential application to New England's herring fishery will be reviewed. These examples are:

Japan--Fisheries Cooperative Associations

Norway--Regional Enterprise Share Quota system

European Community--Sectoral Quotas

U.S.--Western Alaska Community Development Quota program

These management systems have all "devolved" from regional or national control. Each has forsaken "open access" fisheries in favor of varying degrees of financial or residency commitment to the community or region controlling the quota.

Analyses of Regional Allocation Systems

JAPAN--FISHERIES COOPERATIVE ASSOCIATIONS

Concept

The Japanese system of fishery management seeks simultaneously to improve fishery production and to stabilize and "democratize" fishing communities.[136]

Background

The sustainable utilization of Japanese marine resources through democratic planning and cooperation among fishermen was an outgrowth of a pre-WW II period marked by competition for limited, common resources that proved destructive to fishermen's livelihoods and the viability of coastal communities.[137]

A number of fisheries management and coastal planning laws were enacted which were instrumental in providing the legal and societal framework for achieving rational marine resource development and management in Japan. Of these, the coupling of the Fisheries Resources Conservation Act and the Law of Fisheries Cooperative Associations has proven highly effective in the goal of stabilization of coastal communities through rationalization of the fisheries.

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[136]Asada,Y., Y. Hirasawa and F. Nagasaki, 1983. Fishery Management in Japan. Rome: FAO Fisheries Technical Paper 238, p.24.

[137]Saad, M. 1992. An Economic Study of Fisheries Management Through Fisheries Cooperative Associations In Japan: A Case Study of Salmon Fisheries In Northern Japan. Hokkaido University Thesis, p.52.

Features

All fishing activity in Japan is now licensed and effort is scaled to conform with the productivity of fishery resources. If fishing effort must be reduced to improve profitability in a specific fishery, the government facilitates reorganization of the fleet as necessary for this purpose, even when this involves the retiring of licenses for vessels representing investments made entirely at the owner's risk.[138] The remaining fishermen are obligated to make compensation to the exiting fishermen and often will obtain low-interest loans made available by the government in order to effect this rationalization.[139]

Fisheries management in Japan is directed primarily by fishermen's delegates elected on a "district" basis, together with knowledgeable experts and persons representing the public interest nominated by the prefectural governor.[140] Management of the near- and offshore resources is thus controlled at the local level among 66 coastal "districts" by participants with an immediate "stake" in the protection and enhancement of the resource. The role of the government is to provide resource assessments and set fishery quotas where appropriate. It is left to the delegates of each "sea-area" committee, one for each prefecture, to determine how the quota will be fished and managed. Joint sea-area fishery

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[138]Asada et al. (1983), p.25.
[139]Asada et al. (1983), p.25.
[140]Saad (1992), p. 46.

coordination committees negotiate claims of overlapping districts with the assistance of the government.

Delegates to the sea-area committees are sanctioned by the federal government through the Law of Fisheries Cooperative Associations, which was designed to promote cooperative organization among fishermen and fish processors.[141] In addition to the more universal functions of fishermen's coops, the special role of the Fisheries Cooperative Associations (FCAs) lies in their participation in fishery management by virtue of their legal authority over fishing rights.[142]

This legal authority could be vulnerable to non-compliance were it not for the coupling of the marketing function to the management authority granted to the Fisheries Cooperative Associations. Because of this dual function the FCAs, which levy a commission on all sales of 3-5 per cent of the sales value, build a sense of social cohesiveness within the FCA and the community.[143] This feeling of cohesiveness and common interest is the key to cooperation and consensus needed to implement and enforce district resource management policies.

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[141]Hirasawa, Y., 1991. "Japan's Fisheries Cooperative Associations as Marketing Channels", in: Fisheries of Japan. Rome: FAO Fisheries Technical Paper 452, p.11.
[142]Asada et al. (1983), p.9.
[143]Hirasawa (1991), p.26.

Summary

A 1991 economic analysis of the efficacy of FCAs as a management tool concluded that the profitability of the industry had improved significantly under the system, leading to employment stability in coastal communities and increased productivity in the fisheries resources.[144]

NORWAY--REGIONAL ENTERPRISE SHARE QUOTA (RESQ) MANAGEMENT SYSTEM[145]

Concept

The central tenet of RESQ is to allocate regional enterprise share-quotas (RESQ) as a long term user right for licensed local enterprises and regions, but not for vessels, in a manner which effectively ties the harvesting and processing of the resource to the region. This system does not grant property rights to fishermen although they are permitted to exchange quotas and use whatever capacity is necessary to catch and process their own share quota.

Background

The regional aspect of fishery policy is very important in Norway. The federal government is actively involved in efforts to secure employment and settlement in northern

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[144]Hirasawa (1991), p.2.

[145]The material for this section is drawn entirely from a draft discussion paper sent to me by the authors, as follows:
Trondsen, T., and J. Angell, 1992. "Regional Enterprise Share Quota (RESQ) Management System: The case of Norway", 21 pp.

Norway. Fishing and fish processing are the basic sources of income and employment in most coastal areas, especially in northern Norway. Therefore, the regional allocation of quotas and licenses has always been a critical issue.[146]

Recent events in the fishing industry and actions in the present Norwegian fishery management system have resulted in overcapitalization and a migration of vessels and processing plants to ports in the more populated westerly and southerly regions of the country.

In an effort to solve this overcapitalization and stem this migration, the regional enterprise share quota (RESQ) system proposal has been adopted as official policy by the regional authority of northern Norway and is currently under evaluation by the Norwegian Ministry of Fisheries.

Features

If approved by the Norwegian government, each region would receive a regional share quota (RSQ) where RSQ is equal to the sum of all RESQs in the region. Both RESQ and RSQ constitute long term user rights based on a legal contract (license) between the owner (Government) and the user. The license would not be transferable without governmental approval.

The licensed RESQ-holder would be free to choose how to harvest the quota without gear or vessel restrictions. He

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[146]Torbjorn Trondsen, fax communication, 11/4/92.

would also be permitted to exchange a certain percentage of his quota with other quota holders or use the same vessel to take different quotas.

Harvest of quotas would not be restricted to the region of issue but could be harvested anywhere in the Norwegian EEZ. However, RESQs cannot be moved from enterprises in one region to those in another region if the vessels are sold.

The RESQ itself cannot be sold but shares in those companies that are RESQ-holders can be sold. A recommendation has been made that at least 60 per cent of the shareholders in a company holding a RESQ license be active fishermen residing in the region of issue. This is the same restriction as is presently placed on ownership of Norwegian fishing vessels.

Summary

As an initial step in developing a fisheries policy which acknowledges the importance of the northern regions, the Norwegian legislature has dismissed privatization of the fisheries resource as contradictory to the longstanding principle that the fish stocks are common property.

RESQ may serve to stem the flow of fisheries industry activity from northern regions to more westerly ports by tying fishery access rights to the proximate ports. The goal of the system is to sustain a stable allocation of quotas in the various regions of the coast.

EUROPEAN COMMUNITY--SECTORAL QUOTAS

Concept

Sectoral quotas are a means of devolving management of fisheries resources from the national to the local level by granting portions of the Total Allowable Catch (TAC) to Producer Organizations (POs-- associations of licensed fishermen from a common port or region).

Background

The TAC and quota system is a central feature of the Common Fisheries Policy of the European Community. Overall TACs for most species are set annually. Individual country allocations are then made according to an "allocation key" which may vary in tonnage as the TAC fluctuates according to scientific advice. The relative percentages by country, however, remain fixed. This allocation system is referred to as the "principle of relative stability".[147]

Member countries are free to manage their shares of the EC fisheries as they see fit, provided their harvests do not exceed their total permitted quotas.

A recent assessment of the Common Fisheries Policy[148] concluded that the system has failed to achieve its management goals, with the notable exception of the United

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[147]Commission of the European Communities, 1991. Report 1991 From the Commission to the Council and the European Parliament on the Common Fisheries Policy. Brussels: Commission of the European Communities, Sec (91) 2288 final, p.22.

[148]Commission of the European Communities (1991), p. iii.

Kingdom's unique and successful experiment with the Shetland Islands fishery. In most other instances, the system has resulted in overfishing and a latent sectoral crisis.[149]

As a result of this crisis, more and more countries are looking to the UK sectoral quota system of which the Shetland Islands is the paradigm.

The Shetland Islands

Prior to the "Shetland experiment" in 1984, the UK, in common with most other EC member states, used to manage its available quotas by allocating shares to vessels on a weekly or monthly basis.[150] Regional disparities went unredressed because of the national focus of the system.

This disparity was particularly problematic for regions like Shetland, which are heavily dependent on fishery resources for employment in the harvesting and processing sectors and ancillary industries. Timing of the catch by species was critical for the Shetland Producers' Organization (PO) Ltd. to provide for year round harvesting and processing activity.

The allocation process prior to 1984 was not sensitive to the seasonal fisheries variability around the Shetland Islands and this led to a request by the local Shetland industry to the national fishery managers that it should obtain its 'regional' share of the UK quota on an annual

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[149]Goodlad (1992), p.2.
[150]Goodlad (1992), p.3.

basis, to be managed locally, according to local needs and circumstances.[151]

The Shetland 'experiment' of 1984 was granted, was deemed successful and the devolvement of quota management has since been expanded to other fisheries and other Producer Organizations (POs) in the UK.[152] In a noteworthy parallel to the Japanese Fisheries Cooperative Associations, advantages of the system include:[153]

· the reduction of government involvement and cost in quota setting, resulting in more resources available for effective enforcement and monitoring;

· day-to-day decisions on quota management taken at the most appropriate level - by the fishermen themselves through their representative POs;

· reduction of overcapacity and increased industry stability because of the POs ability to plan their annual fishing operations with relative certainty as to catch levels which can be tailored to individual PO member vessels.

These advantages have been recognized by other EC member countries such as the Netherlands.

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[151]Commission of the European Communities (1991), p.73.
[152]Commission of the European Communities (1991), p.73.
[153]Goodlad, J. 1992. "Fisheries Management by Sectoral Quotas - an Assessment of the UK System". Presented at the Annual Conference of the European Association of Fisheries Economists, Salerno, Italy, April 22-24, 1992, p.5.

The Netherlands

As is the case in other EC fishing nations, Holland is currently making efforts to reduce the size of her fishing fleet. Under the leadership of the former Dutch Prime Minister, the Dutch fish industry is trying to encourage individual fishing communities to move towards increased autonomy in the management of the quota framework.[154]

The group's plan[155] recommends the distribution of quotas among all Dutch cutters according to fishing capacity, allotting them to those ports in which the vessels are registered. Thus every fishing community would manage their own quota, divided up according to species, and assume the responsibility for managing and adhering to it.

The plan, developed jointly between the fishing industry and the fishing communities, reportedly has the support of the Dutch government and will be reviewed shortly for a final decision on implementation.[156]

Summary

Sectoral quotas in EC member states are proving successful due to the devolvement of management to the local level. In the UK, linkage of the allocation and marketing functions within the Producer Organizations approximates the

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[154] "Dutch vis", in *Fish International*, August 1992, p.12.
[155] "Dutch vis", in *Fish International*, August 1992, p.12.
[156] "Dutch vis", in *Fish International*, August 1992, p.12.

highly successful Japanese Fishermen's Cooperative Associations' framework.

Other EC member states, such as the Netherlands, are experimenting with vessel quotas tied to the port of registry as a means of stabilizing and devolving management. The national management authorities, freed from the contentious allocation process, are able to devote financial and human resources to stock research, quota enforcement and fleet monitoring.

WESTERN ALASKA COMMUNITY DEVELOPMENT QUOTA PROGRAM

Concept

This program is intended to provide the underpinnings of economic self-sufficiency to one of the poorest regions of rural Alaska through granting of exclusive harvest rights of a portion of the pollock TAC for a period of five years to consortia of Native Alaskan villages which border the Bering Sea.

These harvest rights may be fished by the consortia themselves, in partnership with existing fishing enterprises, or they may be leased in exchange for a resource fee. All proceeds accruing to the Native village consortia from the Community Development Quota (CDQ) fishery must be invested in the development of local fisheries (infrastructure, training and education).

Background

Beginning in 1987, the regional fishery management council was asked by the fishing communities of Kodiak and Dutch Harbor to divide the Alaska groundfish harvests between onshore and mobile offshore processors. The communities feared that the highly efficient, mobile fleet would outcompete the smaller, less efficient shorebased fleet leading to the demise of the coastal communities' economies.

Early proponents of CDQs for western Alaska villages were simultaneously advancing a similar case. Ultimately, though the inshore/offshore allocation proposal remains grounded in the federal court of appeals, the CDQ program was approved by the Secretary of Commerce. Fishing commenced in late 1992 for six Native village consortia and will continue through 1996.

Early estimates place the total contribution to the region's economic development from the pollock fishery alone at $100 million over five years.

Features

Under guidelines developed by the State of Alaska, assignment of CDQ pollock allocations are made annually on a competitive application basis. Applications are evaluated for the quality and economic viability of their Community Fisheries Plan and the competence and track record of their industry partner, if a joint venture arrangement is proposed.

No applicant group can receive more than one-third of the total available pollock allocation.

In order to qualify for award of a CDQ allocation, applicants must meet criteria intended to insure that the goals of the program--to provide for local economic development in impoverished Bering Sea coastal villages--are met.

The CDQ applicant must be a village-based or regional fishermen's organization or an incorporated economic development group with 75 per cent fishermen represented on its Board of Directors. The State encourages groups of villages to form regional alliances under one CDQ request. Only one application per village or region is accepted to encourage local cohesion.

Summary

The central tenet of the CDQ program--to view US fisheries as a tool for local economic development through direct allocation to individual communities--is precedent setting in the history of U.S. fisheries management. Whereas the inshore/offshore debate has focused on allocations to shorebased vs. offshore sectors, the CDQ program makes allocations to specific "community" groups. As such, many industry interests are opposed to the concept fearing it may set a precedent that could encumber the heretofore open

access fishery.[157] Other more local interests[158] advocate the linkage of resources to proximate communities as achieving the greatest net "national" benefit from the nation's fisheries resources, as required by the Magnuson Act.

Chapter Summary

The allocation schemes discussed above are premised on "local" control of varying degrees, depending on the extent of "devolved" management permitted or encouraged by the national governments involved. This "devolvement" of resource management by government to the local level is at the heart of the concept of "free market environmentalism", espoused by economists such as Baden and Stroup,[159] in Bureaucracy vs. Environment and Anderson and Leal[160] in Free Market Environmentalism.

Both sets of authors claim that a system of well-specified property rights to natural resources imposes a discipline on resource users because the wealth of the owner of the property right is at stake if "bad" decisions are made.

Whether these property rights are held by individuals, corporations, nonprofit environmental groups, community or

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[157]Richard Gutting, National Fisheries Institute, personal communication, 3/16/93.
[158]Bernton, H. 1992. "Harvest Time: Western villages get a share of the pollock, a brighter future and a host of corporate suitors", *Anchorage Daily News*, 9/20/92, pp. C1, C3.
[159]Baden, J. and R. Stroup (eds.), 1981. Bureaucracy vs. Environment. Ann Arbor: U. of Michigan Press, 189 pp.
[160]Anderson, T., and D. Leal, 1991. Free Market Environmentalism. Boulder, CO: Westview Press, 167 pp.

communal groups, the effect of "ownership" casts an entirely different, longer-term discipline to the management of the resource and the accrual of wealth from the resource. However, with fisheries, the government's role remains central in determining the total catch (TAC).

Application of the concept of "local control" of the New England herring fishery will be discussed in the following chapter in light of a recent industry opinion survey on constraints to development of, and potential allocation preferences in, the herring fishery.

Chapter 5
A PROPOSAL:
REGIONAL ALLOCATIONS IN THE NORTHWEST ATLANTIC HERRING FISHERY

Background

Vesting all or a portion of the proximate fisheries resource to local or regional entities can result in increased overall economic activity, community and regional stability, and more effective integration of harvesting, processing and marketing of fisheries products. Evidence of these benefits can be found in the four examples of community and regional allocations described in the preceding chapter.

This chapter examines the potential for allocation of the Atlantic herring resource as a means of resolving constraints to development of the U.S. herring fishery.

Relevance to the Management Plan

The draft ASMFC management plan discussed in Chapter 2, Developing a Fishery Management Plan, proposes a framework allocation scheme to be implemented in the event that the herring stock becomes over-exploited.[161] In this event, adult and juvenile catch limits will be imposed and allocated to each management area (see Figure II-3) according to the process outlined in Figure II-4.

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[161]Outline of ASMFC Herring Management Plan, 9/92, p.13.

This allocation scheme takes into consideration, among other factors:

- the seasonal distribution and availability of the fish
- regional differences in fishing effort and processing activity
- the "socioeconomic value" of different types of fishing and processing activities, and
- the importance of promoting the expansion of new or emerging fisheries or markets.[162]

The information cited above is crucial to the success of the management plan[163] but for the most part has not yet been researched by the Plan Development Team.

Constraints to Herring Fishery Development

A herring industry survey developed and administered by the author in Winter 1992-93 sought to address some of these issues and quantify the economic contribution of specific herring industry sectors. That information, summarized in Chapters 2 and 3 of this paper, will be submitted in full to the PDT in a separate document.

In addition, the industry respondents were asked to identify and rank the constraints to development of the herring resource.

The constraints identified as most significant were:

- instability of ex-vessel prices
- lack of a steady work force due to seasonality of the harvest
- currency fluctuations in foreign markets

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[162]Outline of ASMFC Herring Management Plan, 9/92, p.13.
[163]Outline of ASMFC Herring Management Plan, 9/92, p.17.

· lack of affordable financing

· a declining domestic market

· lack of new product development to create products which might appeal to the domestic market, and

· strength of world-wide herring stocks.

While a community or even regional allocation system cannot be expected to solve fishery development limitations caused by international currency fluctuations or a worldwide glut of herring stocks, such a system might encourage integration of the harvesting, processing and marketing sectors of the industry for mutually advantageous results.

This integration has been achieved in the Japanese and Shetland Islands' fisheries management systems with positive socioeconomic results, as discussed in the preceding chapter.[164] If applied to the New England herring fishery, such a system may serve to alleviate the following constraints identified by industry participants: stabilize the ex-vessel price; attract capital and investment in infrastructure and new products/markets by virtue of a guaranteed annual allocation of a percentage of the TAC; and, enhance profit sharing between sectors.

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[164]Saad (1992), p.54. And, Goodlad (1992), p.5.

Options for Management

In addition to determining the regional utilization patterns, economic contribution, and the constraints to further development of the herring fishery, the survey also sought to determine the opinions of the industry respondents about herring allocations based on the following general management alternatives:

- Individual Transferable Quotas (ITQs) for both fishermen and processors
- Internal Waters Processing permits (IWPs)
- Community Development Quotas (CDQs)*
- Regional allocations**
- Product development allocations
- Maintenance of the status quo

* Defined in the survey as "an annual harvest privilege granted to a consortium of community groups directed by fishermen and processors which demonstrate historic dependence on the herring resource".

** Defined in the survey as "an annual harvest privilege granted to a geographic region(s) which itself is a subset of the area under the jurisdiction of the regional Fishery Management Council".

As reported in Chapter 2, Developing a Fishery Management Plan, of all the management alternatives presented in the survey, industry respondents were most supportive of both regional allocations and product development allocations as means to limit effort in the herring fishery, should that become necessary. Furthermore, nearly two-thirds of those interviewed felt that the interstate regulation of the

fishery by ASMFC was "moderately to very constraining" vis-a-vis their use of the herring resource. In addition, few of the respondents felt that gear type restrictions were necessary so long as trawls were not deployed on spawning herring or spawning grounds.

In light of these responses, incorporating provisions in the draft management plan for regional allocations and "product development" allocations may have merit. The common theme among the community and regional management models presented in the previous chapter is the devolvement of management authority to the users--the fishermen and the communities or regions of which they are part--leaving the government regulators more time and resources to dedicate to stock research and enforcement of harvest quotas.

The role of regional and "product development" allocations

Allocations that conform to the management areas as proposed in the draft plan (see Figure II-3) could be tailored to the needs of the industry as they vary between regions. For instance, sardine canning is conducted exclusively in mid-coastal and eastern Maine. Because the product requires small fish, this fishery targets juvenile herring. On the other hand, bait processors target adult herring. Major bait processors are located in Rhode Island and Massachusetts. Other products, such as roe, surimi, smoked and pickled herring are also dependent on size of

fish. To be most effective, regional or "product development" allocations would consider these needs.

Furthermore, lack of a reliable work force due to the seasonal nature of the herring fishery was cited by a number of survey respondents as a significant operating problem. To remedy this, "product development" allocations could be granted to communities or regions, in tandem with existing processors or with investors, wishing to pioneer new products that may not be dependent on the seasonal availability of fresh herring.

Allocations made for new product development might also serve to boost employment and increase the viability of coastal communities. For example, since the development of the herring roe processing industry in Nova Scotia in the early 1980s, the local economy has been blooming:

> "Overall the expansion of herring fishing and fishing-related activities as well as the resulting increases in house construction, service firms, and wholesale and retail businesses and a proliferation of mink and fox ranching (which eat feeds made from herring) has had dramatic social repercussions.
>
> "Development of herring processing has massively increased participation of women in the workforce. Young people tend now to stay in the region rather than migrate to larger centres in search of work; even more surprising, more are returning...".[165]

Though Nova Scotia herring roe is processed as a fresh product, then frozen for shipment to Japan, the herring can

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[165]Giasson, M., 1992. "Capital and work-force adaptation in Clare", p.234, in: Apostle and Barrett eds., Emptying their nets: Small capital and rural industrialization in the Nova Scotia fishing industry. Toronto: Univ. of Toronto Press, 348 pp..

be round frozen for roe extraction in future,[166] as is done in Alaska. In Maine, the cost of construction and operation of cold storage facilities could be a major economic impediment to such a development unless other local seafood and agricultural products, such as lobsters, vegetables and blueberries, were processed in the facility as well.

The role of community allocations

In addition to the constraints noted above, a number of respondents stated that Canadian ownership of Maine sardine packing plants was of concern to them.

According to the Maine Sardine Council, the Canadian sardine industry is a true monopoly controlled by Connors Bros., Ltd., of Black's Harbor, New Brunswick. A series of acquisitions of Maine sardine companies and their plants by Connors Bros. in 1987 and 1988 resulted in Canadian control of about 40 per cent of Maine's sardine production along with seven brands with longstanding presence in U.S. markets.[167]

Though the State of Maine's Attorney General initiated a consent decree requiring Connors to operate one of the plants for eight years, and to purchase production from the other plant for five years (until 1993),[168] the impact of the acquisitions is becoming clear: one of the plants was closed

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[166]Bill Atkinson, BANR, personal communication 3/3/93.
[167]"Statement of Jeffrey Kaelin on behalf of the Maine Sardine Council before the International Trade Commission on the probable economic effect on the Maine sardine industry of accelerated elimination of U.S. tariffs on certain canned sardines from Canada", 9/11/90, p.2.
[168]Kaelin (1990), p.2

this year after its "protection" under the consent decree expired. With the plant closing went the scarce jobs and income which had contributed to the economy of the coastal village of Stonington for decades.

If allocations were granted to communities with historic dependence on the herring resource, those allocations possibly could be used as "collateral" to attract capital investment in the existing plants, foregoing the extinguishing of U.S. companies and the jobs that are dependent upon them.

National implications of allocations

Proponents of regional or community-based allocations have been fighting to achieve recognition as a legally justified tool in U.S. fisheries management since the mid-1980s.[169]

The first hint of this form of allocation came with the acrimonious debate over the so-called "inshore/offshore" allocation scheme in Alaska's groundfish fishery. As recently as November 1992, the management plan Amendment containing this provision was awaiting the Secretary of Commerce's approval, only to be remanded to the North Pacific Council by the new Secretary of Commerce for further analysis of the

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[169]The author recalls testimony by representatives of Trident Seafoods, a shore-based Alaska seafood processing plant, before the North Pacific Fishery Management Council in 1985, advocating the concept of groundfish allocations to shorebased processing plants as a means of guaranteeing regional employment (and thus guaranteeing raw material supplies at the same time).

economic implications, both regional and national, of such a split quota. [Note that the Western Alaska Community Development Quota (CDQ) program outlined in the previous chapter is regarded by many in the industry and management circles as a temporary program (officially only 4 years) to assist the villages in that part of Alaska only].

As the Alaska debate rages, a similar proposal for dividing the Pacific whiting quota off the U.S. west coast raises the same issues in a different geographic location.[170] In both situations, the conflict revolves around the issue of whether allocations to the shore-based processing sector, at the expense of the at-sea mobile processors, can be justified in terms of the "greatest net national benefit", as required by the Magnuson Fisheries Conservation and Management Act.[171]

Industry trade associations have made their positions clear on the issue of these allocations:

· the National Fisheries Institute, representing the broadest constituency of the industry (though for the most part a processors' and marketers' association) characterized the western Alaska CDQ program as a "dangerous precedent

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[170]Sylvia, G. and M.T. Morrissey. 1992. Pacific Whiting Harvesting, Processing, Marketing and Quality Assurance. OSU Sea Grant, Corvallis, Oregon, pp.13-14. And, Bragg, J. 1993. "Shoreside Suffers Setback on Whiting", in, *Pacific Fishing*, July 1993, pp.19, 59-61.

[171]Magnuson Fishery Conservation and Management Act (MFCMA) of 1976 [16 U.S.C. 1853(b)(6)].

using U.S. public resources to subsidize the development of a specific interest group's lifestyle";[172]

· in September 1992[173] the Maine Sardine Council proposed to the Atlantic States Marine Fisheries Commission that if the draft Atlantic herring management plan was to include allocations of herring to fishermen based on historical catch and investment in the fishery, the sardine industry should also be allocated shares of the total quota based on their historical participation and investment. This would amount to a de facto regional allocation because the sardine processors are located entirely within the state of Maine. However, as proposed, these allocations would not be vested to the communities themselves;

· in June 1993, commenting on the inshore/offshore debate over Pacific whiting allocations off Oregon, the Alaska Factory Trawlers Association Director, Joe Blum, asserted:

> "It's simply unfair to force the at-sea fleet to subsidize expansion of shoreside processing because of at-sea's efficiency."[174]

The "community" perspective

The perspectives reviewed above provide a "national" and a "regional" industry view on the topic of allocations of

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[172]Richard Gutting, National Fisheries Institute, comments made in a discussion during the 1992 Fisheries Policy Conference, an industry meeting held in Washington, D.C., in February 1993 to discuss issues related to reauthorization of the Magnuson Act.
[173]Letter from Jeff Kaelin, Maine Sardine Council, to William Brennan, Maine Dept. of Marine Resources and Head, ASMFC Herring Section, 9/4/92.
[174]Bragg (1993), p.61.

federally managed fisheries. What is missing is a "community" perspective which was not researched for this paper, perhaps an omission. Such a "community" view might be solicited from such diverse parties as a local or regional school board, a mayor or town council, or a fishermen's cooperative.

A recent analysis of opinions on U.S. fishery management from a broader spectrum of the industry than the NFI or Maine Sardine Council is summarized in The Magnuson Fishery Conservation and Management Act (MFCMA): Reauthorization Issues. Published in December 1992 by the U.S. Congressional Research Service, the study outlined responses of commercial harvesters, sport anglers, fisheries managers and scientists, fish processors and processing worker unions, and environmental groups to a survey of issues likely to be important in the 1993 MFCMA reauthorization discussions.

Despite the stated preference of industry spokesmen to secure individual quota shares for harvesters and processors should management of U.S. fisheries evolve to an allocation system, an equally concerned public voiced their preference for retaining ownership of the public's fisheries resource in the trust of the government:

> "Currently, respondents feel that the MFCMA provides no mechanism for compensating the public for use of these [fishery] resources. Concern was extreme that windfall profits not be conveyed to some users of these public resources through privatization, nor that quota allocations be permitted to congregate in large corporate entities if

privatization is pursued. Saleable quotas and the continued viability of of small family operators were perceived as antithetical..."[175]

Though not a "community" view, this survey reveals some interesting perspectives about the role of the "community" in the fishing industry.

In contrast to many other countries, the "community" perspective and the importance of the proximate fisheries resources to the economic and psychological vitality of coastal communities and their inhabitants is often addressed in a cursory manner, at best, in the development of U.S. fishery management plans. As Doeringer et al., in The New England Fishing Economy: Jobs, Income, and Kinship, note in their conclusion:

"In general, governments manage fishery resources in order to maintain fish populations and prevent overfishing. Typically, management policies have relied upon controlling fishing methods...It is generally assumed...that if these policies successfully reduce the resources in fishing, these resources will readily be employed elsewhere for more productive purposes.

"This focus on controlling fishing effort, to the neglect of the impact of regulation on jobs and income, implicitly assumes perfect mobility of resources into and out of the fishing sector. This study demonstrates that this assumption is often incorrect...The immobility of fisheries industry resources was previously thought to be confined to small, isolated, rural fishing communities. The presence of substantial labor and capital immobility in large fishing ports, involving the core of the industry, is a new finding."[176]

Bearing these findings in mind, perhaps a comprehensive public policy for the fishing industry should address the

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[175]Buck, E. 1992. The Magnuson Fishery Conservation and Management Act: Reauthorization Issues. Congressional Research Service, Environment and Natural Resources Policy Division, p.35.

[176]Doeringer, P., P. Moss, and D. Terkla. 1986. The New England Fishing Economy: Jobs, Income and Kinship. Amherst, MA: University of Massachusetts Press, pp.124-125.

complementarity between efficiency objectives of fisheries management policy and local economic development policies. If alternative employment prospects for fishing-industry labor are improved in ports suffering from quota cutbacks, the "opportunity cost" to remaining in the overcapitalized fishery increases and adjustment flexibility is enhanced.[177]

If the sophistication and patience is forthcoming from federal managers to consider the effects of fishery management schemes on coastal communities, the design of any allocation scheme must be done with extreme care. As noted in Chapter 1, The Fishery, the 10-year review of the Canadian 4WX herring fishery in the Scotia-Fundy region concluded that evaluation of the performance of the Individual Transferable Quota system in the 4WX fishery would be premature, though often cited in the rationale for implementing similar schemes elsewhere:

> "...there are too few summaries of the performance of this [ITQ] approach to be able to evaluate its overall potential. Clearly, further analysis...and especially empirical analysis is required to evaluate and understand the effectiveness of ITQs in modern fishery management systems."[178]

Summary

The draft U.S. Atlantic herring management plan contains provisions for allocating the herring resource in the event it becomes limited relative to the fishing effort exerted. However, the draft plan does not address the mechanics of the

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[177]Doeringer et al. (1986), p.125.
[178]Stephenson et al. (1993), pp.48-49.

proposed allocation process. That is, which entities would receive harvest "privileges": processors, fishermen, cooperatives, community or regional "consortia", or some combination of the above?

Though opposed in principle by some U.S. fishing industry trade associations, allocations of Atlantic herring to regional or community-based fishing consortia may have merit in securing the viability of the existing, U.S.-owned processing infrastructure and development of new herring products and markets; and, in securing the reliability of local employment opportunities. Each of these factors were identified in a survey conducted by the author of existing herring industry participants as "moderate to serious" constraints to the development of the U.S. Atlantic herring resource.

Unique partnerships between public and private entities have produced extremely positive fish stock stabilization and economic development gains in several fisheries management schemes around the world.[179] Similar management and development schemes for New England's herring fishery are worthy of governmentally sanctioned exploration.

Finally, and perhaps most importantly for the long-term viability of coastal communities, such allocations serve to retain ownership of the public's fishery resources in the federal government's trust while allowing regional and/or

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[179]Sylvia and Morrissey (1992).

community consortia to determine how best to develop those resources.

CONCLUSION

This paper has reviewed the prospects for, and constraints to, development of the U.S. Atlantic sea herring resource in the context of the global market for herring and other small pelagic species.

Opportunities and Constraints

In terms of estimated biomass, the sea herring resource is one of the few "underutilized" fishery resources in the Northeast. Stock abundance continues to rise and as of April 1993 was conservatively projected to be about 1.86 million metric tons. Estimated spawning stock biomass is also very high, at approximately 1 million metric tons.

However, as amply demonstrated in this paper, the constraints to product and market development are severe: foreign competition, both from overseas competitors as well as from our Canadian neighbors operating in Maine, continues to erode markets for U.S. herring and place U.S. jobs at risk; stocks of Northeastern Atlantic and North Pacific herring are at record highs and feed more local European, African and Asian markets; lack of coordination of U.S. management measures with product/market development, while improving, continues to be an impediment to greater utilization of the resource; uncertainty associated with stock assessment and discreteness of spawning stocks often serves to limit development options, particularly for

Internal Waters Processing ventures (IWPs) which involve coordination and justification of foreign vessel participation; and, product development and investment in new process technology is often not justified due to the fugitive nature of the resource and the lack of dedicated harvest allocations to specific entities.

The Need for Holistic Management

Development by our competitors of new products and markets for herring, as well as for other species, has been supported and encouraged by their governments both financially and in terms of regulatory flexibility.

This linkage of fisheries management and product development and marketing has often been accomplished through allocation of access "rights" to fisheries resources. In many cases, the most successful of these management arrangements have vested the allocations to community or regional fishing industry interests.

Examples cited in this paper demonstrate that when a fisheries resource is vested in a community or region, conservative management can be accomplished effectively by the true "stakeholders" in the resource--the fishermen, processors and their community interests. If such an allocation system is fashioned properly, a windfall of public financial and human resources can be redirected from allocation decision making and conflict mediation to

fisheries stock research, new product and process development, and overall monitoring of the resource.

U.S. fisheries management: 'cooperation' via regulation

With few exceptions, U.S. fisheries management and the markets for U.S. fisheries products have not been effectively integrated. Some authors have argued that this is the result of the regulation-driven approach[180] contained in U.S. resource management laws. Nor has U.S. law been supportive of providing special consideration for community and regional dependence on fisheries when formulating allocation schemes within fishery management plans.

Instead, by its very nature open-access "management", which has historically characterized U.S. fisheries, places a premium on the individual's "right to fish".[181] That "right" has resulted in overcapitalization and decimation of many of the U.S. fisheries.[182] Ironically, "open access" has led to the relatively recent imposition of a variety of limited entry and individual fishery quota schemes which, through license limitation, effectively eliminates new entrants who cannot afford the "entry" fee.

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[180]Anderson and Leal (1991).
[181]Townsend, R., 1985. "The Right to Fish as an External Benefit of Open Access", in: *Can. J. Fish. Aquat Sci.*, Vol.42, No.12, pp.2050-2053.
[182]Status of Fishery Resources (1992).

The Flaw in Individual Fishery Quotas

In the opinion of many industry participants,[183] including that of the author, any individual, freely transferable limited entry or quota systems are flawed because they create a "windfall" for qualifying participants from a public resource and subsequently concentrate the wealth of, and access to, a public resource in the hands of those who can afford the "entry" fee.

Compared to "regional" or "community" quotas, ITQs are isolated harvest rights, not necessarily integrated into the economy of the community or region where the fishery is prosecuted. ITQs will not, of themselves, serve to attract new infrastructure investment to a community's fishery. While processor allocations may serve this goal, at least in the short run, a processor holding an ITQ would also be free to sell their allocation to a competitor who might then close the only processing plant in the community.

Retaining the 'right to fish' through Regional Quotas

By contrast, management systems can be designed to retain the individual's "right to fish" while securing the wealth of the resource for the dependent communities. A fisheries allocation held by a region or community could be used as collateral to attract new investment, new processes,

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[183]Farris, P., 1993. "Can Clinton change things?", in: *National Fisherman*, June 1993, pp.4-5. And, Townsend (1985). And, Buck (1992), p.19.

new markets. It could be an inalienable collective asset of the community or region controlled by the fishing industry interests of that community or region.

Furthermore, these schemes have been shown to be more responsive to market signals than traditional systems,[184] yielding greater profits for fishermen and their communities.

Recommended Action

In the event the Atlantic sea herring resource becomes limited due to excess fishing effort, this paper recommends that allocations of herring be made on a "regional" or "community" basis. This recommendation is in keeping with allocation provisions of the draft Atlantic States Marine Fisheries Commission sea herring management plan currently under development.

For purposes of this proposal, "regional" allocations are defined as annual harvest privileges granted to a geographic region(s) which itself is a subset of the area under the jurisdiction of the regional Fishery Management Council. These regions could be equivalent to the management area designations contained in the draft sea herring management plan. "Community" allocations are defined as annual harvest privileges granted to consortia of community groups directed by fishermen and processors which demonstrate historic dependence on the herring resource. The allocations

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[184]Goodlad (1992), p.2. And, Saad (1992), pp.54-55.

would then be managed by a democratically appointed committee of qualified industry and community participants with direct participation in the fishery.

Based on experiences demonstrated by similar management schemes in other fisheries worldwide, regional and community allocations may help in resolving the constraints to development of the herring resource, as discussed in the previous chapter. Furthermore, such a "devolved" management system may prove more effective in countering these constraints to development of the resource, as identified by industry participants, than the Individual Transferable Quota (ITQ) systems currently in vogue in U.S. fisheries management circles.

Summary

The primary law regulating use of the fisheries resources of the U.S., the Magnuson Fisheries Conservation and Management Act of 1976, relies not on a property rights solution but rather on governmental regulation. From a "free market environmentalism" viewpoint,[185] this is an inherently flawed approach to resource management because the regulators do not own the resource and do not face economic incentives to manage it efficiently.

A 1986 study entitled The New England Fishing Economy[186] concluded that resource management policies must reflect the

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[185]Anderson and Leal (1991).
[186]Doeringer et al. (1986), pp.8-9.

economic and human impacts of "adjustments" to the fisheries. The study also emphasized the importance of taking local conditions into account when looking at the distributive consequences of regulatory policy. Both considerations argue for a special policy focus on local economic development in conjunction with more typical fisheries policies.

The concept of vesting the inherent wealth of public fisheries resources in the hands of a select few individuals or corporations will not guarantee the viability of the resources nor the communities dependent on the jobs generated by utilization of those resources. Nor is there any reason to believe that "open access" fisheries will be more successful in future than in the past in managing the fisheries resources for longer term gains. As described in this paper, however, the models which vest stewardship and development, not ownership, in the hands of dependent participants and their communities or regions have shown notable success in achieving linkage between rational resource management and successful market development.

The well-documented, dismal condition of U.S. fisheries[187] is tangible evidence that the current regulation-driven approach to U.S. fisheries management is not working and that alternatives should be considered. In the author's opinion, alternatives that serve to maintain the

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[187] Status of Fishery Resources (1992).

integrity of the communities dependent on the U.S. fisheries resources must be considered as priorities.

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APPENDIX

I Herring Industry Survey (sample document), 12/92

APPENDIX I

HERRING QUESTIONNAIRE

IDENTIFICATION

Date: _____

Respondent: _____ Position: _____

Firm: _____ Phone: _____

Address: _____ Fax: _____

_____ Brand/label: _____

_____ _____

1. When was this firm started? _____

2. Is herring your firm's primary source of income? Yes ____ No ____

3. What percentage of your firm's total income is represented by herring products? ____

4. What is your approximate annual total round weight production in tons of herring for the past five years?

1988	1989	1990	1991	1992	1993(est.)
_____	_____	_____	_____	_____	_____

5. What is the herring processing capacity of each plant or catcher/processor?

6. How many vessels deliver to you?

7. What are their approximate lengths and gross tonnage?

8. What herring products do you produce, in order of most to least significant in terms of your total annual sales?

1._____ 2._____ 3. _____

4._____ 5._____ 6._____

9. Do you export any herring products? ___

10. What percentage of your total production is exported? ____

11. Which products to what countries? _____ % of total ____ _____ % of total ___

_____ % of total ____ _____ % of total ___

12. How many people do you employ:

    Full-time_____ Seasonal full-time _____ Part-time _____

13. What is the average hourly wage paid to your employees?

    Packers _____ Management _____

14. What is your annual payroll, approximately? _____

15. Please classify your business:

    Sole proprietor ____
    Partnership ____ Family partnership? (Y/N) ____
    Joint Venture ____ With whom? _____
    Cooperative ____ Membership _____
    Corporation ____ Family corporation? (Y/N) ____
    Others ____ Describe: _____

16. What percentage of the business is owned by foreign interests?___% Country: _____

17. What is your primary method of financing?

    Bank loan _____
    Personal funds _____
    Venture capital _____
    Farmers Home Credit _____
    Others _____

18. What are your most significant costs?
    (labor, debt service, marketing, packaging, regulatory compliance)

    _____ _____ %

    _____ _____ %

    _____ _____ %

19. What was your gross sales of herring products in 1991? _____ In 1992 (est)? _____

PRODUCT POTENTIAL

Rank the market potential of the following herring-based products for both **(A) your firm** and **(B) the industry worldwide,** where:

-2 = greater than 5% decline in sales per year
-1 = 1-4% decline per year in sales
0 = unchanging or stable
+1 = 1-4% growth per year in sales
+2 = greater than 5% growth per year in sales
N/O = No opinion

	Signif. Decrease > -5%/yr	Slight Decrease 1-4%/yr	Stable ±1%/yr	Slight Increase 1-4%/yr	Signif. Increase >+5%/yr	N/O
	-2	-1	0	1	2	
SURIMI (raw/frozen)						
SURIMI (value-added, i.e. sausage)						
FROZEN ROE						
SALTED ROE (value-added)						
FRESH FILLETS						
FROZEN FILLETS						
MICROWAVABLE FILLET ENTREES						
FLAPS						
FISH MEAL						
FISH OIL						
FISH FEED						
PLANT FERTILIZER						
CANNED SARDINES						
CANNED CHUNKS						
PICKLED HERRING						

ZOO FOOD _____

BAIT _____

FROZEN WHOLE (for other than bait) _____

OTHER PRODUCTS?

_____ _____

_____ _____

CONSTRAINTS TO UTILIZATION

Rank the relative impact of the following subjects on your use of the herring resource (or, if a regulator, on the management of the resource).

Rankings
1. Supportive, positive influence
2. Not an important influence
3. Moderately constraining influence
4. Very constraining influence
5. Totally prohibitive influence
6. No opinion

POLLUTION						
Ocean	1	2	3	4	5	6 _____
Coastal	1	2	3	4	5	6 _____
OCEAN WARMING	1	2	3	4	5	6 _____
TRADE BARRIERS						
Imports to U.S.	1	2	3	4	5	6 _____
Exports from U.S.	1	2	3	4	5	6 _____
RESEARCH SUPPORT						
Product development	1	2	3	4	5	6 _____
Stock assessment	1	2	3	4	5	6 _____
FAT CONTENT	1	2	3	4	5	6 _____
PROXIMITY TO RESOURCE	1	2	3	4	5	6 _____
OVERFISHING	1	2	3	4	5	6 _____
CURRENT FISHERY REGULATIONS						
State	1	2	3	4	5	6 _____
Federal	1	2	3	4	5	6 _____
Interstate (ASMFC)	1	2	3	4	5	6 _____
TRANSBOUNDARY STOCK MGMT.	1	2	3	4	5	6 _____
OTHER						
_____	1	2	3	4	5	6 _____
_____	1	2	3	4	5	6 _____

STATEMENTS (inject new information and ask for opinion)

Recent stock assessment estimates by federal and state management agencies indicate a record sea herring biomass of OVER 1.2 MILLION MT exists in the NW Atlantic. Do you believe these estimates are accurate?

Strongly Disagree	**Mildly Disagree**	**Agree**	**Strongly Agree**	**No Opinion**

Atlantic Canada developed a herring roe fishery beginning in 1981 and now valued at $13 million (U.S.) annually. The U.S. should develop a herring roe fishery utilizing the Gulf of Maine stock.

Strongly Disagree	**Mildly Disagree**	**Agree**	**Strongly Agree**	**No Opinion**

The U.S. should develop a herring roe fishery utilizing the Georges Bank stock.

Strongly Disagree	**Mildly Disagree**	**Agree**	**Strongly Agree**	**No Opinion**

The state of Oregon and NMFS research supported the Oregon shorebased harvesting and processing sector's efforts to develop the Pacific whiting fishery into a surimi, fillet and by-products industry (including fish meal) in three years. New England states and NMFS/Northeast region should support a similar effort for herring.

Strongly Disagree	**Mildly Disagree**	**Agree**	**Strongly Agree**	**No Opinion**

The U.S. Congress and the President recently approved a GIFA (Governing International Fishing Agreement) for the Estonian directed harvest of mackerel. Should there be a directed foreign fishery on herring as well? (TALFF)

Strongly Disagree	**Mildly Disagree**	**Agree**	**Strongly Agree**	**No Opinion**

Should foreign joint ventures be permitted in the herring fishery?

Strongly Disagree	**Mildly Disagree**	**Agree**	**Strongly Agree**	**No Opinion**

Should IWPs be permitted in the herring fishery?

Strongly Disagree	**Mildly Disagree**	**Agree**	**Strongly Agree**	**No Opinion**

In terms of improving your business(or the effectiveness of your agency, if a regulator) what are the areas you would most focus additional funds on, if available?

Unassisted Response:

Assisted Response:

R&D
- Product development _____
- Market research _____
- Promotion _____
- Fishing and harvesting technology _____
- Quality assurance training programs _____

Stock assessments _____

Business loan guarantees _____

OPTIONS FOR MANAGEMENT

The Federal Management Plan for sea herring is currently under revision. Industry advisory group discussions have included whether portions of the herring resource should be allocated to various sectors of the fishing community. Do you favor, oppose or have no opinion about the following allocation arrangements (I will describe each if necessary):

	Firm/Agency			**Harvester**		
	Favor	Oppose	N/O	Favor	Oppose	N/O
ITQ						
Fishermen allocation						
Processor allocation						
INTERNAL WATERS PROCESSING ALLOCATION						
COMMUNITY DEVELOPMENT QUOTA						
REGIONAL ALLOCATION						
STATUS QUO						
PRODUCT ALLOCATION						
COMBINATION						
_____						
OTHER						
_____						
_____						

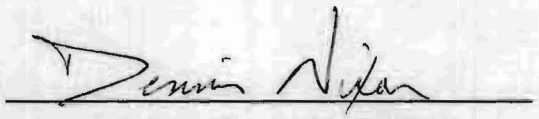
Nonpoint Source Pollution From Agricultural Runoff: An Analysis of Problems, Solutions, And The Remedial Action Plan Process For The St. Louis River Basin

By
Thomas V. Giddings

A Paper submitted in partial
fulfillment of the requirements for the degree of
Master of Marine Affairs

University of Rhode Island
1993

Major Paper
Master of Marine Affairs

Approved 
Professor Dennis Nixon

University of Rhode Island
1993

Table of Contents

List of Tables

List of Figures

I: Introduction:

Agricultural nonpoint source pollution is the pollution coming from agricultural production, which has no clear origin. It comes from a diffuse source, such as a farm field or an animal holding area. It is not a new problem, yet nonpoint source pollution from agricultural related activities has not been given the necessary attention it deserves. While programs and studies probe every facet of point sources and extol the efforts of point source clean-up, the relatively more difficult task of identifying nonpoint sources and the process of proposing to do something about them has been largely ignored. The question must be asked, *is the nonpoint source pollution problem that difficult to solve?* While this may be an overly broad question, in the case of nonpoint source pollution from agricultural activities, the answer, and certainly the work necessary to produce better answers may not be as difficult as some would believe.

Reducing the adverse impacts on the environment from farm related activities requires knowledge of the various pollutants and how pollutant pathways can be interrupted. To what degree is agricultural nonpoint source pollution a problem? A study of "nonpoint-source loading" by the National Commission on water quality projected nonpoint sources (mainly agriculture) will produce 72,500 tons per day of suspended solids, 14,150 tons per day of nitrogen, 965

tons per day of phosphorus, as well as most of the remaining fecal coliform pollution, even after all point sources are remedied.[1] Nonpoint source pollution in Minnesota has seriously affected many lakes and rivers. Considering only waters not supporting designated uses, 2,107 river miles are affected by nonpoint source pollution as opposed to 783 river miles affected by point sources; in lake acres, 172,449 acres are affected by nonpoint sources as opposed to 64,396 affected acres attributed to point sources.[2] Nutrients, sediment, and pesticides enter surface water through runoff. Nutrients, and pesticides leach through the soil contaminating ground water supplies. Animal waste adds nutrients and bacteria to the water column, and erosion carries with it what runoff doesn't wash away. Even so, little effort is made to identify the problem and even less is done to implement best management techniques that would mitigate the problem. This is especially true along the Minnesota-Wisconsin coast of Lake Superior, and in particular the St. Louis River basin. While tremendous work has been

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[1] United States Department of Agriculture and the United States Environmental Protection Agency, The Rural Clean Water Program: A Report (Washington GPO, 1989)

[2] Minnesota, Pollution Control Agency, Agriculture And Water Quality. Best Management Practices For Minnesota (St Paul: Pollution Control Agency, 1989;1991) 2-3.

accomplished in identifying and cleaning up point sources, very little has been done to identify nonpoint source pollution from agriculture, or to implement best management practices in an overall water quality plan.

II: The St. Louis River:

Particular concern must be given to protecting the Minnesota-Wisconsin coast of Lake Superior, specifically the St. Louis River basin. The St. Louis River is the second largest tributary to Lake Superior. The area supports a wide variety of activities both recreational and commercial. The river's 66 cubic meter per second mean annual discharge is exceeded only by the Nipigon River.[3] Its watershed consists of 3,634 square miles in northeastern Minnesota, and 263 square miles in northwestern Wisconsin.[4] From its headwaters at Seven Beaver Lake, the river flows 179 miles in a southwesterly direction to Lake Superior. As the River approaches the city of Duluth and Superior, it takes on the characteristics of a freshwater estuary. The upper portion of the St. Louis River is characterized by narrow, deep channels with depths ranging from 10 to 30 feet. As the river flows westward across St. Louis County, it passes through forested areas of sand, gravel, clay glacial till and outwash deposits. From the town of Floodwood to Thomson, the river passes through very hilly wooded glacial moraine. The soils in this area are course-loamy fine sands, loamy

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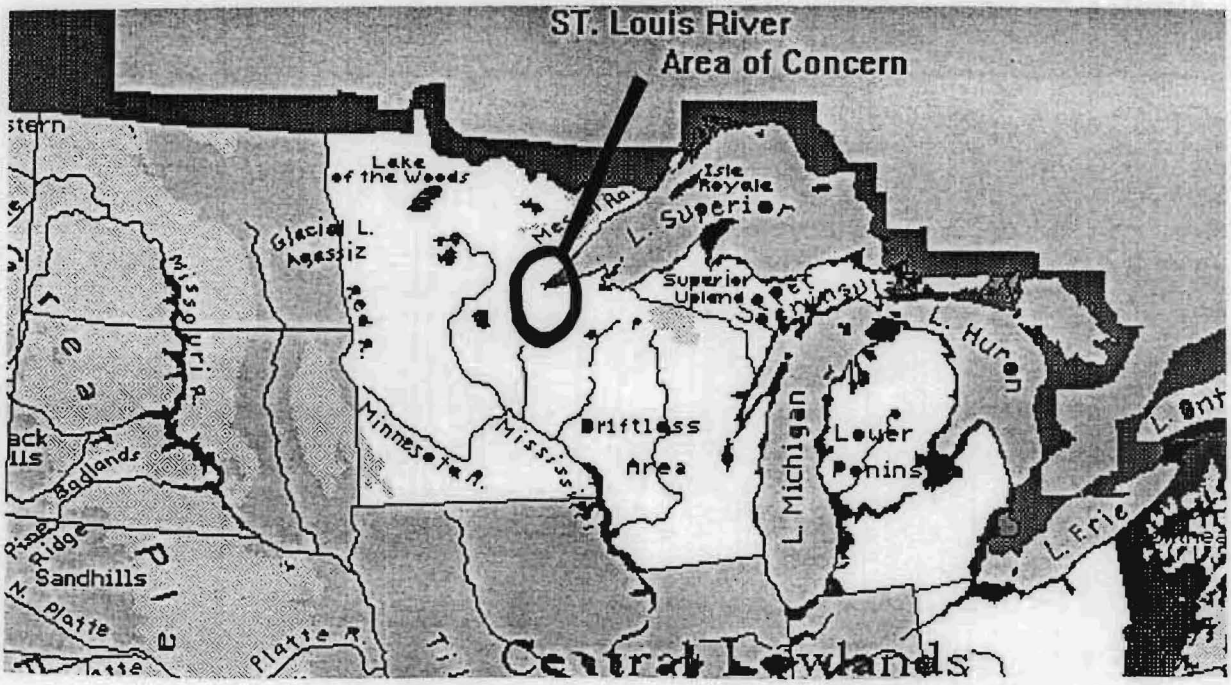
[3] Minnesota Pollution Control Agency; Wisconsin Department of Natural Resources, The St. Louis River System Remedial Action Plan Stage I, Minnesota Pollution Control Agency; Wisconsin Department of Natural Resources, 1992) III-1.

[4] Remedial Action Plan III-1.

mantles, and sands and gravel interspersed with some fine loam.[5] In this area valley slopes increase in size and steepness along the river banks. Below Thomson, the River abruptly changes as it flows through the deep narrow gorge of Thomson slates and conglomerate rounded pebble and sand rock formations of Jay Cooke State Park in lower Carlton County.[6] The final reach of the St. Louis River drains through the red clay deposits of glacial Lake Duluth and enters the St. Louis Bay estuary.

Figure 1



Source: The Software Toolworks U.S. Atlas, version 3.1.0, computer software, The Software Toolworks, Inc.,1991-1992, MS-DOS, disk.

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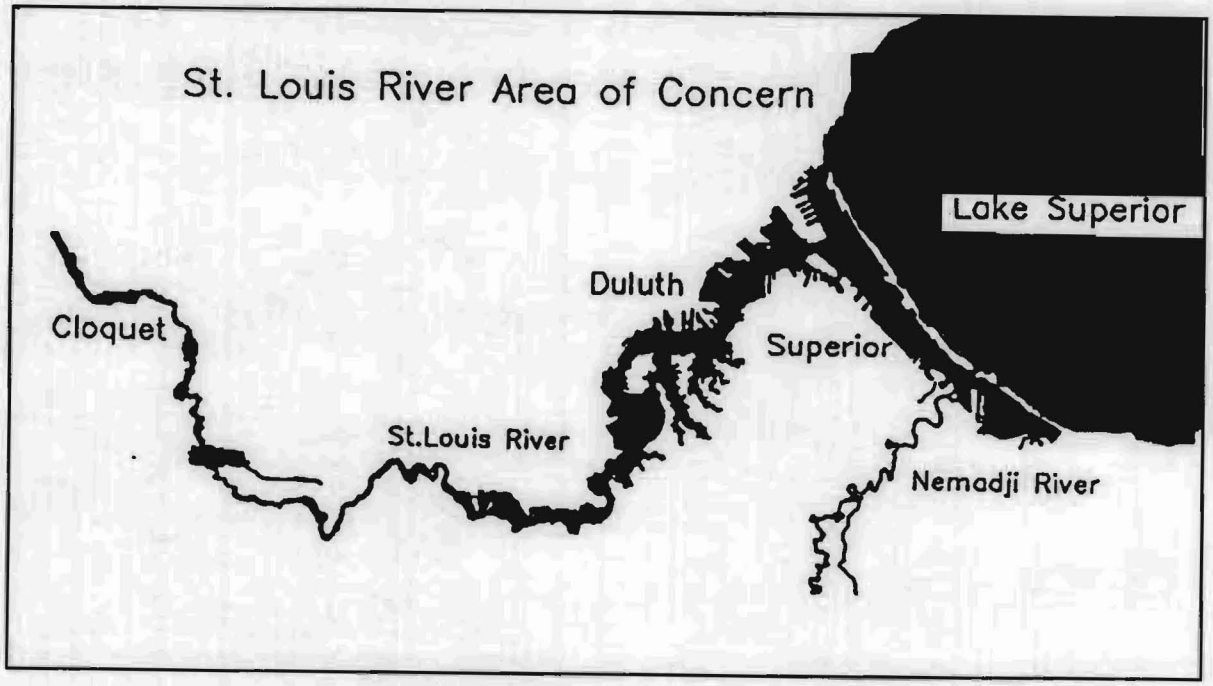
[5] Remedial Action Plan III-3.

[6] Remedial Action Plan III-3.

Figure 2



Source: Minnesota Pollution Control Agency; Wisconsin Department of Natural Resources, The St. Louis River System Remedial Action Plan Stage I, Minnesota Pollution Control Agency; Wisconsin Department of Natural Resources, 1992.

The Nemadji River, which also drains into Superior Bay, and is part of the St. Louis River watershed, encompasses 360 square miles.[7] The Nemadji River system starts five miles east of Moose Lake and flows north to the Atkinson area and east through southeastern Carlton County, Minnesota. It then flows northeast in to Douglas County, Wisconsin where it enters Superior Bay. This area, and Lake Superior itself are among Minnesota's most valuable resources, and represent in clear terms the net effect of considerable attention to point sources, and neglect of nonpoint sources from agriculture.

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[7] Remedial Action Plan III-4.

An examination of land use and the possible sources of nonpoint source pollution contributing to the water quality degradation of the St. Louis River and Lake Superior indicates that agriculture may be among the most significant contributors in the St. Louis River basin. While the northeastern portion of Minnesota and Wisconsin are not as agriculturally intensive as other portions of the State, a significant amount of acreage is devoted to agriculture. Total cropland acreage in the St. Louis River basin is divided primarily between three counties; Carlton County which has 66,492 acres devoted to agriculture, St. Louis County which has 93,438 acres, and Douglas County Wisconsin which has 26,826 acres.[8] A more quantifiable, and perhaps more telling statistic is the number of dairy farms in lower St. Louis County; 69, and their location; 95 percent are located directly on the St. Louis River or its tributaries.[9]

The St. Louis River Basin, including the Nemadji River, has a long and documented history of degradation and neglect as a result of point source pollutants impacting water quality. A 1928-1929 investigation by the Minnesota State Board of Health classified the portion of the river which runs from the city of Cloquet to Lake Superior as

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[8] Remedial Action Plan V-36.

[9] Remedial Action Plan V-36.

"pollutional".[10] A follow-up study in 1948 reaffirmed the findings of the earlier study, and further added that, in the ensuing 20 years that had elapsed, there had been a significant increase in waste discharges with no corresponding increase in treatment.

Figure 3

Source: The Software Toolworks U.S. Atlas, version 3.1.0, computer software, The Software Toolworks, Inc.,1991-1992, MS-DOS, disk.

Complaints of tainted fish flavor and fish kills continued through the 1970's. Waste water treatment improvements in the 1980's helped ease the heavy pollutant

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[10] Remedial Action Plan ii.

load, particularly total phosphorus. Problems with toxic residues in fish, however, persisted as late as 1985. In addition to historical discharges that have contributed mercury, PCB's, dioxins, and polynuclear aromatic hydrocarbons (PAH's) that now contaminate sediments, there are continuing contributions from industrial and municipal discharges, as well as a significant number of landfills.

Prior to settlement in the nineteenth century, the St. Louis River watershed was dominated by coniferous boreal forest, consisting mainly of white pine, spruce, fir, and red pine. Extensive clear-cut logging in the late nineteenth and early twentieth century significantly altered the hydrology of the watershed. Subsequent fires eliminated the 2-4 inch "duff" top soil layer important in retaining moisture, and further changed watershed hydrology. The area was eventually cleared for agricultural use, and remaining woodlands grew back as an aspen, maple, spruce, and fir cover. This change dramatically increased the runoff associated with storm events, and seasonal peak flows. Further land smoothing and drainage activities associated with agriculture and urbanization have increased runoff rates.

While the many point source inputs are well defined, little quantitative information exists for the significant accumulation of nonpoint source pollution delivered to the St. Louis River. No systematic attempt has been made to identify or address groundwater contamination despite the

existence of a number of contaminated sites. Where action has been taken, it has been of a highly localized nature. The significance of surface runoff as a transport mechanism is poorly identified within the watershed despite serious sediment loading problems where the River forms Superior Bay and empties into Lake Superior. The significance of the sediment loading is demonstrated by the 150,000 to 200,000 cubic yards dredged from the Duluth-Superior Harbor each year at a cost of $7.00 per cubic yard.[11] Nutrient content has been analyzed in relation to waste water treatment plant discharges, however information on nutrient input from agricultural activities which are much more concentrated is lacking. In addition, while information concerning pesticide and insecticide characteristics is available, correlation with those in use within the area has not been addressed.

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[11] Remedial Action Plan iv.

III: Identifying the problem:

A critical first step in identifying the process of generating nonpoint source pollution is a potential pollutant's means of detachment, and the means by which a pollutant is transported to the water body. Detachment is the release of a pollutant which may be either chemically or physically bonded to the soil particle. In some cases the pollutant is dissolved in water, and detachment will be from the point of application where it becomes dissolved. In other cases soil particles are detached as erosion. Transport of a pollutant is the movement of a pollutant from its origin to a water body. The pollutant need not have reached its end point or point of integration to begin having an adverse effect on a water body. It may be a pollutant in the transport system which will have a negative impact on the aquatic environment. When a pollutant finally becomes integrated into an ecosystem, it may be as an attached pollutant to a sediment particle, or dissolved into the water column.

The availability of a potential pollutant, and its detachment and transport will depend on a number of characteristics. Generally these characteristics are: (1) physical properties, (2) chemical properties, and (3) reactivity and biological properties of the pollutant. Pollutants which are strongly adsorbed by the soil are more susceptible to detachment and transport with the soil. Those

pollutants which are less adsorbed, and more soluble are much more likely to leach through the soil affecting ground water supplies. Examples of this are biological denitrification of nitrate to nitrogen gas which can reduce the nitrate concentration of a stream or lake, nitrification of ammonium (NH_4) adsorbed on a soil particle which will increase nitrate levels in the water body, and phosphates adsorbed on a soil particle which can be released into solution when it enters a lake with a low dissolved phosphate concentration.

For a management practice to be effective in interrupting the pathway of pollutants from a diffuse source, it must be able to interfere with the availability, detachment, and transport of a pollutant. A practice must be able to decrease availability, prevent detachment, or interrupt the transport process in order to decrease the pollutant load. In selecting a means to accomplish this both the degree of capital investment and the overall management practices required of an agricultural producer must be considered. Practices that require a high degree of capital investment will be unattractive to the producer, and therefore will, in most cases, not be implemented. Low cost methodologies may be more attractive but may require a much more time intensive effort than the producer is willing to commit to. It is also important to realize that not all practices are right for every water quality problem. If a practice fails to control the target pollutant than it can

hardly be considered a "best management practice". Selecting the best management practice then is as important as identifying the pollutant or establishing the pollutant's pathway.

The primary nonpoint source pollutants from agriculture can be grouped into the following categories: nutrients, sediments, animal waste, and pesticides. A possible fifth pollutant which will not be addressed are salts. Each present their own set of effects within the water column, and unique best management practices.

Nitrogen and phosphorus are the two major nutrients from agriculture that contribute to decreased water quality. Background levels in an aquatic environment are approximately 0.3 mg/l for nitrogen and 0.05 mg/l for phosphorus.[12] When nitrogen and phosphorus are introduced into an aquatic ecosystems, plant productivity can dramatically increase. Increased plant productivity results in additional organic matter being added to a water body. As plant material eventually dies, the decay process depletes the oxygen level, and can potentially produce unpleasant odors. Depleted oxygen levels, especially in colder bottom waters will change fish and aquatic plant habitat, often resulting in algae blooms and consequently increased turbidity.

A water body is classified by the nutrient level it

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[12] United States Department of Agriculture Soil Conservation Service, Water Quality Field Guide (Washington:GPO, 1983) 7.

contains. This classification is referred to as the trophic level. Oligotrophic water bodies exhibit the least degree of biological productivity, with the primary limiting factors being nitrogen and phosphorus. They are characterized by clear water (high degree of transparency), relatively uniform distribution of dissolved oxygen, and small amounts of decomposed organic matter. Lake Superior is presently classified as Oligotrophic.

Eutrophic water bodies represent the opposite end of the spectrum. They are characterized by a high degree of biological productivity, an over abundance of nutrients, and dissolved oxygen levels that are subject to wide variation. The excess biomass generates abundant dissolved oxygen during the photosynthetic process. When the process is interrupted, dissolved oxygen levels may fall to nearly zero as oxygen is used.

Eutrophic conditions represent only one possible result of excess nitrogen. Dissolved ammonia at concentrations above .2mg/l can be toxic to fish populations. Ammonia (NH_4^+) in the soil readily breaks down into nitrites (NO_2^-) and ultimately into its most useable plant form, nitrates (NO_3-). Nitrates in drinking water pose a serious health threat to humans, particularly infants. Nitrates are converted back to nitrites in the digestive tract, reducing the oxygen carrying capacity of the blood (methemoglobinemia). This can result

in brain damage or even death. The Environmental Protection Agency has set a maximum safe limit of 10mg/l nitrate-nitrogen for water used for human consumption.[13] Those water bodies that exhibit characteristics that indicate that it is in an intermediate stage are classified as Mesotrophic.

There are three microbial processes important to nitrogen transformation as it relates to nonpoint source pollution from agricultural runoff. The first two are part of the mineralization process, which makes nitrogen available for plant use. Ammonia is the initial product of organic matter decomposition. When ammonia is oxidized, nitrites (NO_2-) are formed which are readily converted to nitrates (NO_3). Nitrates are an important plant nutrient, however they are mobile in water and easily leach through the soil, readily moving below the root zone, particularly in sandy soils. It is also transportable as surface runoff, but usually in relatively small quantities. Ammonia itself is strongly adsorbed by the soil and is lost primarily with eroding sediment. The process of denitrification causes nitrogen to be lost to the atmosphere, working against the producer trying to maximize availability and retention. This benefits water quality by limiting the nitrogen available for leaching or for surface runoff, but may encourage producers to increase application. Some areas of the St. Louis River

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[13] Water Quality Field Guide 7.

basin, because of its geology, are susceptible to ground water contamination from nitrates; which create a serious pollution problem when occurring in sandy or shallow soils, or areas of fractured limestone.[14]

Phosphorus is the nutrient of concern in most Minnesota waters because it is the limiting nutrient for aquatic plant growth. It, like nitrogen, must be in the dissolved form to be readily used. Phosphorus content in most soils is low, ranging from between 0.01 and 0.2 percent by weight.[15] Manure and fertilizers are used to increase available phosphorus for plant growth and root formation, hastening maturity, and stimulation of seed formation. Applied phosphorus reaches the water column primarily through runoff and erosion. Phosphorus is found in both dissolved form, and colloidal or particulate. It is largely particulate, inorganic phosphorus which is associated with eroding sediments. In many lakes, organic phosphorus comprises as much as 95 percent of the total phosphorus, and is largely tied up in living aquatic plant life.[16] Dissolved inorganic phosphorus, orthophosphate phosphorus (H_2PO_4-), is most likely the only form directly available to algae. Algae consume dissolved inorganic

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[14] Agriculture and Water Quality. Best Management Practices for Minnesota 6.

[15] Water Quality Field Guide 33.

[16] Water Quality Field Guide 8.

phosphorus and convert it to the organic form.

Inorganic phosphorus can either be dissolved in surface or subsurface waters, or attached to sediments. Although much of the sediment held portion acts as if it were permanently attached (highly adsorbed) to the soil particle, it can contribute as a source of the dissolved form. The portion of the phosphorus that is subject to change, that is, the available part of the sediment phosphorus, is referred to as the labile fraction. Although dissolved phosphorus is the plant available form, particulate phosphorus forms also contribute to the water quality problem due to the labile phosphorus. The equilibrium between the labile and dissolved inorganic phosphorus is dependent upon the chemical and biological characteristics of the water regime in the soil and the water body.[17] Elemental phosphorus is seldom a toxicant, however it can become bioconcentrated in much the same way as mercury. A criterion of .10mg/l has been set by the U.S. Environmental Protection Agency for marine estuary waters.[18]

Sediment is the result of erosion. It is solid material, both organic and mineral, in suspension, being transported from its site of origin. It is the major

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[17] Water Quality Guide 8.

[18] Water Quality Field Guide 7.

pollutant by volume in Minnesota surface waters.[19] There are four basic types of erosion that produce sediment: splash erosion, sheet erosion, rill erosion, and gully erosion.[20] Splash erosion results from water droplets such as rain drops or irrigation water striking the soil surface and breaking the soil into fine particles that can be readily transported. Sheet erosion refers to water movement across the surface of the soil that removes thin sheets of soil. Rill erosion is the process by which water moves across the surface of the soil and cuts many small ravines a few inches across. When rills aggregate into small concentrated channels, the velocity is usually higher and additional instream sediment can be carried. Gully erosion takes place when water flows across a single site long enough to cut large gullies or ditches. Sediments from the different sources will vary in the amount of pollutant adsorbed to the soil particle. Sheet and rill erosion are most responsible for removing soil particles from the surface or plow layer of the soil. It is significant because the soil with the highest pollutant potential will be surface soils. Topsoil is richer in nutrient content, and will contain more chemical fertilizer and pesticides. In addition, topsoil is most active in

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19 Agriculture And Water Quality. Best Management Practices For Minnesota 5.

20 Charles D. Sopher and Jack V. Baird, Soils and Soil Management (Reston:Reston Publishing Co, 1982),250.

nutrient cycling and is highest in biological activity.

Detached sediment usually contains a higher percentage of finer and less dense particles than the soil from which it originates. Large particles are more readily detached from the soil because the particles are less cohesive. They will also settle out of suspension more quickly. Organic matter is not easily detached because of its cohesive properties, however, once detached, it is easily transported because of its low density. Clay particles and organic residues will remain suspended for longer periods of time and at slower flow rates. Small particles have a much greater adsorption capacity per mass than larger particles. As a result, eroding sediments generally contain higher concentrations of phosphorus, nitrogen, and pesticides than the original soil. Table 1 gives typical times for different soil materials of varying sizes to settle.[21]

Table 1

Material	Sediment Size	Time
Fine Sand	0.1mm	34 seconds
Silt	0.01mm	.94 hours
Clay	0.001mm	3.9 days
Colloids	0.0001mm	1.1 years

[21] Leo Preston, "Water Quality And Pollution Identification" background paper, VI-2

Suspended soil particles can cause increased turbidity in the water body. The effects of excessive turbidity are decreased light penetration (which effects plant growth), increased water temperature through the absorption of solar radiation, and negative impacts on fisheries. The small mouth bass, which is a sight feeder, is an example of a fishery which is degraded by increased turbidity.[22] Fisheries may also be affected by suspended solids covering spawning areas and clogging the gills of fish.

Animal waste is the most commonly perceived agricultural pollutant contributing to decreased water quality. Animal waste includes defecation of livestock and poultry, process water such as that from a milking parlor, and mixtures of feed, bedding, and soil. Animal wastes contribute nutrients as well as organic materials, and pathogens to the receiving water body. Manure, commonly used as a resource to add nutrients, organic matter, and even moisture to the soil is easily removed in runoff when applied to the soil surface. Autumn application of manure on a frozen field, as an example, will often result in high concentrations of nutrients being transported from the field during rainfall or snowmelt.

The problems previously addressed regarding nutrient loading in the water column also apply to animal wastes. If

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[22] Agriculture and Water Quality. Best Management Practices for Minnesota 4.

sufficient manure is applied to meet the nitrogen needs of a crop, phosphorus will be in excess. This in turn gives rise to the problems discussed concerning excess phosphorus. Generally, one pound of phosphorus which might likely come from manure can produce 500 pounds of aquatic plant growth, and concentrations as small as 30 parts per billion can cause nuisance levels of aquatic plants. [23]

The nutrient value in manure comes from its organic nature. Organic matter consists of carbon in combination with one or more elements. All substances of animal or vegetative origin contain carbon compounds. When manure or other natural organic matter is added to the water column, the decay process occurs just as it would on land, producing simpler compounds such as nitrates, ortho-phosphates, and gases such as nitrogen gas (N_2) and hydrogen sulfide (H_2S).

The organisms primarily responsible for the decomposition of organic matter are bacteria. If a large amount of organic matter/manure is added to a water body, the bacterial population will begin to grow, with the rate of growth expanding exponentially. The generation time, that is, the time it takes for each division, may vary from a few days to as little as twenty minutes. Because the bacteria demand oxygen, the available dissolved oxygen in the water column can be depleted quickly as the population explodes.

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[23] Minnesota Pollution Control Agency, Running your feedlot (St. Paul: Minnesota Pollution Control Agency, 1988,1991) 2.

With sufficient organic matter added, and the subsequent action of bacteria, the dissolved oxygen level can approach zero. The area where oxygen depletion is most significant may be far from the point where the organic matter enters the water column. The level of depletion will also depend on the water volume, turbulence, and velocity of the water body. Although turbulence will generally keep sediment suspended for a longer period of time, and can itself cause water quality problems, increased turbulence can have a positive effect in that it brings air into the water helping to replenish the dissolved oxygen. Thus a turbulent, fast moving water body can assimilate more organic waste than a slower more placid water body.

An adequate supply of dissolved oxygen is essential for a good fishery and long term health of a water body. Warm water fish species can survive for much longer periods of time with relatively low dissolved oxygen levels (1 to 5 ppm) than cold water species.[24] Most cold water species require dissolved oxygen levels well above 5 mg/l for successful growth and reproduction.[25]

The ability of an organic pollutant such as manure to deplete the oxygen level in a water body is often measured in terms of its biochemical oxygen demand, or BOD. The BOD test

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[24] Water Quality And Pollution Identification VIII-4

[25] Water Quality And Pollution Identification VIII-4

measures the amount of oxygen required by bacteria to consume organic matter over a five day period. Table 2 compares the BOD_5 values for agricultural waste and treated and untreated municipal waste water.[26]

Table 2

Source	BOD_5 (mg/l)
Milking Center Waste	1,500
Influent to a lagoon from:	
Dairy Cattle	6,000
Beef Cattle	6,700
Swine	12,800
Poultry	9,800
Effluent from a lagoon for:	
Dairy Cattle	2,100
Beef Cattle	2,345
Swine	4,480
Poultry	3,430
Raw domestic sewage	200
Treated sewage from a secondary treatment facility	20

BOD_5 values for the untreated and treated municipal waste water are lower due to greater water content than that found with agricultural waste. In total volume, an average dairy operation of 40 cows and their youngstock generates a

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26 Water Quality And Pollution Identification VIII-5.

waste load equal to that produced by 750 people.[27] Many poultry operations produce waste loads equal to cities with populations over 10,000.[28] Table 2 clearly demonstrates that while the total volume of organic livestock waste may be smaller in volume relative to municipal waste water discharges, it is much more concentrated, and is capable of causing severe damage to a water body.

Pesticides, which include insecticides, herbicides, and fungicides, are used extensively in production agriculture to control pests. The use of these chemicals increases yield, however they also pose a potential threat to water quality. A study by the Minnesota Department of Health and the Minnesota Department of Agriculture found that of 500 wells sampled throughout the state, 39 percent were found to have traces of pesticides in them.[29] Although the sampling took place in geologically sensitive areas, and was not intended to be representative of all aquifers, this study does point to an alarming amount of pesticides pollution from leaching and possibly runoff.

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[27] Minnesota, Pollution Control Agency, Protecting Minnesota's Waters... The Land-Use Connection (St Paul: Minnesota Pollution Control Agency, 1986) 27.

[28] Protecting Minnesota's Waters... The Land-Use Connection 27.

[29] Agriculture And Water Quality. Best Management Practices For Minnesota 6.

Pesticides are lost from agricultural land through four primary processes. These are volatilization, degradation (both chemical and biological), adsorption, and solubility. Volatilization does not appear to be a serious threat to water quality, therefore only the latter three will be discussed. Degradation is the time it takes a pesticide to breakdown to other forms. A pesticide which does not breakdown quickly can be a serious hazard as it moves into a water body. In addition, the breakdown products can also present a toxic hazard. The pesticides or their breakdown products can accumulate in the water body, negatively effecting the entire food chain. Sublethal effects include the behavioral and structural changes of organisms in the water body that in some way jeopardizes their chances for survival. Factors that determine pesticide degradation rates and persistence include soil type, soil-water content, pH, temperature, clay content, and organic matter content. Increasing soil pH will generally increase the degradation rate. The most dynamic and unpredictable factors in degradation are the soil microbial population and the environmental variables that control microbial activity. Increased microbial activity and decreased pesticide adsorption associated with higher temperatures generally enhance pesticide degradation. Pesticide degradation below the root zone is often limited because of the absence of organic matter. The persistence of a pesticide in a soil

system is measured in the time it takes for one-half of the applied material to disappear (half-life). The time required for 75 percent to disappear would be two half lives and so on.

Adsorption is the ability of a pesticide to bond with the soil. Some pesticides stick very tightly to soil particles while others are more easily partitioned. Adsorption is measured by the partition coefficient. The larger the partition coefficient, the greater the quantity of pesticide adsorbed to the soil. The extent to which a pesticide is adsorbed by soils (or sediment) is determined by several physical and chemical properties of both the soil and the pesticide. Regression analysis of the partition coefficient with several soil physical and chemical properties suggests that soil organic matter or organic carbon may be the single best indicator of pesticide adsorption coefficients for many pesticides.[30] It also appears that the partition coefficient when adjusted to reflect organic carbon content of the soil or sediment is essentially independent of soil type.

Solubility is the ability of a pesticide to dissolve in water. The greater the solubility, the greater the potential for a pesticide to leach through the soil, or to be lost in runoff water. In general, the greater the water solubility

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[30] Water Quality Field Guide 11.

of a pesticide, the lower the value of the partition coefficient. The amount of field-applied pesticide that leaves a field in the runoff and enters a water body is primarily a function of the intensity and duration of a rainfall, and the length of time between pesticide application and rainfall occurrence. Analysis indicates that greater than 90 percent of the pesticide is lost in the water phase of surface runoff, except for highly adsorbed pesticides and for large sediment loads. Pesticide concentrations in the sediment phase are generally much higher than those in the water phase because of the larger volume of water in the runoff event compared to the sediment mass. The total pesticide loss, however, is greater in the water phase of surface runoff.[31]

While there is a potential for pesticides to become a serious pollution problem, it is not realistic to conclude either that pesticides are not going to be used, or that they should not be used. It is imperative, however, that agricultural producers and water quality managers know the properties and characteristics of the pesticides that are used. It is also imperative that this information be used as part of an effective water quality plan.

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[31] Water Quality Field Guide 13.

IV: Best Management Practices:

The problems associated with nutrients, sediments, animal wastes, and pesticides are not without solution. A system of practices can reduce nonpoint source pollution from agricultural related runoff. Once a water quality problem has been identified, and the pollutants contributing to decreased water quality have also been identified, best management practices can be applied to achieve a water quality goal.

Selecting a best management practice will depend on the pollutant's availability, detachment, and means of transportation into the water column. The following considerations should be evaluated in deciding which practices are necessary to correct a water quality problem: (1) ability of the practice to achieve a specified water quality goal, (2) economic feasibility of the practice, (3) effect of the practice on ground water and/or surface water, (4) suitability of the practice for a particular site.[32] In assessing the economic feasibility of best management practices, several additional factors must be considered: (1) the probable cost of the practice, (2) the limitations of the soil, (3) any effect on yields, (4) the effect on production and labor costs, (5) the market for the crops to be grown,

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[32] Agriculture and Water Quality. Best Management Practices for Minnesota 12.

either in the market place, or through livestock.[33] With regard to suitability, a best management practice that is not well suited to a particular site will not have support from the producer, and will likely mean being discontinued. Factors such as the terrain, the equipment that the producer has, and possible effect on field conditions as well as past success under similar conditions will be important in the decision making process.

The relative potential of a nutrient as a pollutant depends on its availability for loss, which involves not only the amount of the nutrient present, but also its position in the soil. The agricultural producer can decrease nutrient availability by managing rates of nutrient application, monitoring the levels of nutrient buildup in the soil, particularly phosphorus, and by incorporation of the nutrients into the soil. Also important is the timing of nutrient application and the type of nutrient used. The rate at which a nutrient is applied is significant in controlling nutrient pollution. While a proper balance of nutrients is in many cases essential to healthy plant growth, over application can be damaging to a crop, and dramatically increase the potential for excess nutrients to enter the water column. Some of the factors that should be considered in rates of application are the yield goal for a specific

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[33] Agriculture and Water Quality. Best Management Practices for Minnesota 13.

crop, history of manure or other nutrient application, previous crops, soil type, and the method of nutrient placement.

A conservation cropping system can be an affective way to improve water quality and improve agricultural production. It improves soil structure, which improves infiltration, reduces runoff, and increases soil aggregate stability. Continuous one crop cropping systems with heavy annual fertilizer application will often result in nitrogen buildup creating a likely source of nutrient pollution. By rotating crops with low nitrogen demands such as soybeans with crops of higher demands such as corn, nitrogen will have less potential to either leach or be lost through surface runoff. Crop rotation is also effective in reducing losses of solid phase nitrogen and phosphorus by reducing the sediment to which these nutrients are attached.

Grasses and/or legumes in rotation can reduce nutrient loss, and provide substantial amounts of nitrogen for use by succeeding crops. A deep root crop such as alfalfa or a perennial grass can utilize nitrates below the normal root zone of many other crops, and therefore reduce leaching. Legumes are host plants for nitrogen fixing bacteria that take nitrogen from the atmosphere. Annual nitrogen fixation by red clover and alfalfa is generally in the range of 30 to

100 lbs/acre.[34] If left in the rotation for two or more years, significant amounts of nitrogen can be available in the soil. Nitrogen loss from corn can be as great as 10 times that of sod pasture. The use, therefore, of sod pasture rotations can significantly reduce losses of solid phase and dissolved forms of nitrogen and phosphorus. Cover crops or green manure crops such as small grains, sorghum, millet, and legumes protect the soil during the period when it is normally bare, or has little crop residue cover. If there is a vegetative cover when an erosion event occurs, either rain, snow melt, or wind, the amount of erosion will be greatly decreased and nutrients that would otherwise be lost are kept in the field and used by the crop.

Conservation tillage is another inexpensive yet effective way to prevent nutrient loss and soil loss by erosion. Conservation tillage is defined by the Soil Conservation Service as any tillage method which leaves at least 30 percent of the soil surface covered with crop residue after planting. The soil is tilled only to the extent required to prepare an adequate seedbed, incorporate chemicals, control weed growth, and plant the crop. Conservation tillage can be an entire field surface, or may involve only strips where a crop is planted. The aim of strip tillage is to provide a favorable seedbed, while

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[34] Water Quality Field Guide 34.

leaving the untilled row middles as a hostile environment for weed growth, and as a means to reduce erosion from surface runoff. The width of the strip can vary from 2 to 12 inches with typical reduction in soil loss ranging from 40 to 95 percent.[35] For full width conservation tillage, soil loss is reduced between 40 and 90 percent, and with wide strip or "ridge" tillage, soil loss is reduced up to 60 percent.[36] Conservation tillage is effective in controlling soil erosion and also reduces the amount of nutrient and pesticide pollution entering the water column by trapping pollutants that are attached or adsorbed to the soil particle. It is important however to emphasize that reductions in soluble or adsorbed nutrient and pesticide pollution will also be highly dependent on the nutrient and pesticide management practices that are used in conjunction with conservation tillage.

Proper pesticide use must be based on practices that manage pesticide use in a manner that makes efficient use of the chemicals and prevents contamination of a water body. This is accomplished by mixing pesticides, and calibrating equipment accurately, following careful handling procedures, and by properly disposing of wastes.

Improper pesticide waste disposal can cause potentially

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35 Agriculture And Water Quality. Best Management Practices For Minnesota 30.

36 Agriculture And Water Quality. Best Management Practices For Minnesota 30.

serious surface and ground water contamination, as well as dangerous health hazards. The wastes of most concern are empty containers, excess pesticide, and materials containing pesticide residue. All empty plastic containers are required to be triple rinsed before they are discarded, and the rinse water added to the application solution. The greatest potential hazard comes from spills. Agricultural chemicals that are spilled can readily enter surface water, or leach into ground water. Even a small leak can create a significant concentration of chemical in a very small area. If a leak does occur, it must be treated quickly and properly. Diluting the pesticide does not solve a hazardous waste problem. Diluting 10 gallons of hazardous waste with 90 gallons of water makes 100 gallons of hazardous waste.

Other methods that have proven to be successful in reducing sediment loss, nutrient loss, and potential pesticide runoff are contour farming, strip cropping, use of a filter strip, and field borders. Contour farming simply refers to rows that run around the slope rather than up and down the slope. This method reduces erosion, and therefore nutrient loss and potential pesticide runoff, and increases infiltration. There is also an economic advantage to contour farming in lower fuel costs for the producer. The rate of reduction in erosion ranges from 40 to 50 percent on slopes

of between 2 and 7 percent.[37] If contour farming is combined with conservation tillage for these same slope values, erosion can be reduced by as much as 70 to 80 percent.[38] Because contour farming does increase infiltration, the potential for leaching agricultural chemicals is increased. Therefore contour farming should be used in conjunction with an effective pesticide management plan. Contour farming is most suitable on land that has a relatively uniform slope. There is little value in contour farming in fields that have varying slopes that break in different directions. Where odd areas are formed because of contour farming, correction strips of close growing vegetation can be used to eliminate point rows.

Strip cropping is a system of planting crops in systematic strips. This is particularly effective in controlling wind and water erosion. The crops are planted such that a strip of sod or close growing crop is alternated with a strip of row crops. Contour strip cropping on land with a slope of 2 to 7 percent can reduce erosion by as much as 75 percent.[39] When strip cropping is used with contour farming, grassed waterways, terraces, or some other diversion

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[37] Water Quality Field Guide 38.

[38] Water Quality Field Guide 38.

[39] Water Quality Field Guide 38.

should be used in order to direct runoff. When strip cropping is used to protect cropland from wind erosion, the strips should be laid out as nearly as possible at right angles to the prevailing winds. Width of strips will be dependant upon the type of vegetation used.

Filter strips are strips of grass or other close growing vegetation intended to remove sediment as well as prevent nutrient loss and reduce pesticide loss into a water body. Filter strips can be used on cropland that is adjacent to streams, rivers, and lakes, or cropland at the lower end of a field as part of a waste management system that reduces nutrient, sediment, and chemical runoff. They are most effective with sheet flow erosion. The vegetation slows the nearly uniform water flow over a field surface, and traps the solid material. Sediment reduction from between 30 and 50 percent can be expected with a well planned filter strip.[40] Filter strips are not effective in trapping either dissolved nutrients or pesticides, nor do they significantly reduce fine grained suspended sediment. It has also proven effective in construction and silviculture sites in reducing sediment delivered to receiving waters. A filter strip must be designed wide enough to trap eroded sediment as it passes over the strip. While filter strips are most effective in controlling sheet erosion, they can be used with limited

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40 Agriculture And Water Quality. Best Management Practices For Minnesota 34.

success to control more concentrated flows. An important factor in the construction of a filter strip is the outlet or sediment basin of the strip, which must be stable and planned so as not to cause further erosion problems.

Field borders are areas of permanent vegetation established on the edge of a field. Field borders are effective in reducing runoff from end rows, particularly when contour farming is used and end rows run up and down a field. A field border, like filter strips, provides some filtration of sheet erosion, reducing sediment and nutrients or agricultural chemicals from entering the water column. Like filter strips, consideration must also be given to the planning of sediment basins for the same reasons stated for filter strips.

Manure is a valuable resource as well as a necessary by-product of livestock production. If manure application and livestock holding areas are properly managed, few pollutants will be discharged into the water column. The most effective controls in managing animal waste from field application are those that limit availability. Availability is reduced by limiting application rates to what is necessary for adding nutrients and organic matter to the soil, timing the application so that it does not coincide with periods of high runoff, by incorporating the manure whenever possible, and by carefully choosing the application site. In assessing nutrient level, nitrogen and phosphorus content must be

determined. This can be done through soil testing or by contacting the local Soil Conservation Service representative. Guidance is also available regarding rates of application in the Soil Conservation Service Agricultural Waste Management Field Manual. Application should be set back from surface waters with setback distances that vary with the field topography, soil type, and time of application. Distances to surface waters may be reduced if runoff is restricted by filter strips, field borders, or natural topography. Table 3 gives separation distances from surface waters for surface application.[41]

Table 3

Slope	Soil Texture	Time of Year	Minimum Separation (feet)
0-6%	Coarse	May-October	100
0-6%	Course	November-April	200
0-6%	Medium to Fine	May-October	200
0-6%	Medium to Fine	November-April	300
Over 6%	Course	May-October	200
Over 6%	Medium to Fine	May-October	300
Over 6%	All Soils	November-April	Not Recommended

Agricultural waste management systems are used to store manure and other agricultural waste such as milk parlor wash until it can be applied to cropland. Waste storage facilities differ depending on the type of agricultural operation. Waste storage ponds are earthen structures which

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[41] Running your feedlot 10.

provide temporary storage. Other waste storage structures include specifically built pits or above ground structures of a more permanent nature. Whether an earthen structure or more permanent structure is appropriate will be dependant upon soil type, and the height of the water table.

Animal waste management can be extremely effective in reducing the amount of pollutant that reaches a water body. A properly designed system used correctly can reduce the amount of nutrient runoff, bacterial input, suspended solids, and organic material that would deplete oxygen supplies as part of the decomposition process, or introduce pathogens into a water body. Pollution reduction as a result of animal waste management systems has been as much as 50 to 75 percent state-wide, although 100 percent can be achieved from systems that totally control runoff.[42]

Animal access to surface water must also be restricted. Cattle in streams increases turbidity, increases sediment loading, and also increases bacterial and nutrient input. Livestock exclusion can result in a 50 to 90 percent reduction of suspended solids and total phosphorus originating in a stream reach.[43] Providing adequate shade and

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[42] Agriculture And Water Quality. Best Management Practices For Minnesota 40.

[43] Agriculture And Water Quality. Best Management Practices For Minnesota 48.

the proper use of livestock insecticides can eliminate the need for livestock to congregate in streams and tributaries for relief from heat or insects. It may also be necessary to develop alternative sources of drinking water, and restrict access by fencing.

V: Addressing the problem - Remedial Action Plans:

Incorporation of best management practices will be most effective if a vehicle exists for problem identification and solution planning. Ideally this vehicle would include the cooperation of all interested parties, such as producers, water quality specialists, other resource users that might impact on water quality and water use, and agricultural production specialists from the state such as Department of Agriculture and Extension personnel. A mechanism for moving forward on water quality issues does exists in the Remedial Action Plans outlined in the Great Lakes Water Quality Agreement of 1978 (as amended by Protocol, November 18, 1987).[44]

The Remedial Action Plan process is part of a long history of water quality agreements between the United States and Canada. In 1909 the Boundary Waters Treaty was signed between the United States and Great Britain. The Boundary Waters Treaty established the International Joint Commission, a bi-national organization entrusted with the responsibilities of regulation of Great Lakes water levels, to carry out studies as the parties might request, and act as

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44 International Joint Commission United States and Canada. "Revised Great Lakes Water Quality Agreement of 1978 as amended by Protocol". November 18, 1987, Annex 2.

arbitrator for international water resource disputes.[45] One of the first tasks of the International Joint Commission (IJC) was to study water quality problems in the Great Lakes resulting from the discharge of raw sewage. The IJC issued a report in 1919 that recommended the issue be addressed in a comprehensive treaty to counter water quality problems, and to protect water quality in the Great Lakes. The report however was largely ignored and no action was taken.

Decades of neglect and degradation of Great Lakes water quality ensued, reaching somewhat of a climax in 1972, when mounting scientific research and public opinion compelled the governments of the United States and Canada to enact The 1972 Great Lakes Water Quality Agreement. This Agreement required specific steps to reduce discharge of conventional pollutants, namely phosphorus, and more generally acknowledged a need to look at the serious water quality problems that existed throughout the Great Lakes ecosystem. Continued monitoring and research following the 1972 Agreement showed that while improvements in conventional pollutants as a result of efforts to create or upgrade waste water treatment facilities had improved water quality with respect to those pollutants, a serious problem still existed in chemical toxins. The Agreement was revised in 1978, retaining all the essential components of the 1972 Agreement,

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45 "Revised Great Lakes Water Quality Agreement of 1978 as amended by Protocol", Article VII.

and added new emphasis on "...maintaining the chemical, physical, and biological integrity of the water of the Great Lakes Basin Ecosystem", and the elimination or reduction " ...to the maximum extent practical the discharge of pollutants into the Great Lakes System". With regard to agriculture, the 1978 Agreement addressed related water quality impairment in Article VI 1 (e), outlining "Measures for the abatement and control of pollution from agriculture, forestry, and other land use activities". These measures include:

> *(i)* Measures for the control of pest control products used in the Great Lakes Basin to ensure that pest control products likely to have long term deleterious effects on the quality of water to its biota be used only as authorized by the responsible regulatory agencies; that inventories of pest control products used in the Great Lakes Basin be established and maintained by appropriate agencies; and that research and educational programs be strengthened to facilitate integration of cultural, biological, and chemical pest control techniques;
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> *(ii)* Measures for the abatement and control of pollution from animal husbandry operations, including encouragement to appropriate agencies to adopt policies and regulations regarding utilization of animal wastes, and site selection and disposal of liquid and solid wastes, and to strengthen educational and technical assistance programs to enable farmers to establish waste utilization, handling, and disposal systems;
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> *(iii)* Measures governing the hauling and disposal of liquid and solid waste, including encouragement to appropriate regulatory agencies to ensure proper location, design and regulation governing land disposal, and to ensure sufficient, adequately trained technical and administrative capability to review plans and to supervise and monitor systems for application of wastes

on land.[46]

Additional items of concern addressed were the need for measures to control soil loss, and the need for measures to both encourage and facilitate improvements in land use planning and management programs to account for impacts on Great Lakes water quality. Also suggested were advisory programs and measures to abate and control inputs of nutrients, toxic substances and sediments from agriculture, and the conduct of further non-point source programs in accordance with Annex 13 of the 1978 Agreement as amended.[47]

Following the 1978 Agreement, the IJC identified 43 areas in the Great Lakes Basin as having impaired beneficial uses of the water resource due to pollution. The 1978 amendments did not, however, outline a means of implementation. Therefore in 1987, the Agreement was again modified to include Remedial Action Plans as a means to implement provisions of the Agreement, and to address those geographic areas in the Great Lakes basin most severely impacted.[48] Remedial Action Plans were directed to be

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46 "Revised Great Lakes Water Quality Agreement of 1978 as amended by Protocol", Article VI(1)(e)(i)-(iii).

47 "Revised Great Lakes Water Quality Agreement of 1978 as amended by ,Protocol", Annex 13(1).

48 "Revised Great Lakes Water Quality Agreement of 1978 as amended by Protocol", Annex 2.

developed for each of the 43 Areas of Concern (AOC) identified, incorporating a comprehensive ecosystem approach, and encouraging citizen participation. The purpose of such plans is:

> ...(to) provide a continuing historical record of the assessment of Areas of Concern or Critical Pollutants, proposed remedial actions and their method of implementation, as well as changes in environmental conditions that result from such actions, including significant milestones in restoring beneficial uses to Areas of Concern or open lake waters. They are to serve as an important step toward restoring and maintaining the chemical, physical and biological integrity of the Great Lakes Basin Ecosystem.[49]

Remedial Action Plans are to be developed jointly emphasizing cooperation between Canadian Provincial Governments and the State Governments and will include definitions and detailed descriptions of the environmental problem in the Area of Concern. It will also contain a definition of the causes of known impairment, evaluation of remedial measures in place, additional alternative measures to restore beneficial uses, and selection of measures for restoring beneficial uses as well as a schedule for implementation. In addition to these activities, the Plan is to identify responsible agencies for implementation, and a process for evaluating implementation and effectiveness as well as a description of the monitoring methods used to track implementation and effectiveness.

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[49] International Joint Commission United States and Canada."Revised Great Lakes Water Quality Agreement of 1978 as amended by Protocol". November 18, 1987,Annex 2(2)(b)

Remedial Action Plan development proceeds in three stages: (1) problem identification, (2) action planning, and (3) implementation. Stage I, problem identification, identifies and describes the problem in the Area of Concern. Included is a review of the International Joint Commission's "impaired beneficial use" criteria for designating areas of concern. Stage II, the action plan, will proceed with the completion of transitional activities that were begun in Stage I, the development of action items to solve the problems identified as a part of Stage I, and a range of alternative actions will be proposed consistent with the Remedial Action Plan goals and objectives. Stage III, implementation, will actually execute actions recommended in Stage II. Rates of accomplishment will be dependant upon complexity of the problems identified. Stage III will also include monitoring to determine effectiveness of the actions taken, and to ensure that remedial actions restore impaired uses.

The 1978 Agreement was codified into Federal Law by enactment of the Great Lakes Critical Programs Act of 1990.[50] This added Federal "teeth" to the Remedial Action Plan process. The Act amended the Clean Water Act to embody the goals of the 1978 Agreement and, among other things, to

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50 Great Lakes Critical Programs Act Of 1990. 33 U.S.C.§ 1268 - 1329.

improve accountability for implementation of the agreement.[51] It also established the Great Lakes National Program Office within the Environmental Protection Agency which is tasked with cooperating with other Federal agencies, State, tribal, and international agencies in developing and implementing plans and actions to carry out responsibilities under the 1978 Agreement as amended by the 1987 Protocol.[52] With regard to Remedial Action Plans, the Great Lakes Critical Program Act of 1990 mandates submission to the Program Office, submission to the International Joint Commission, and inclusion into state water quality plans.

The St. Louis River was originally designated an Area of Concern by the IJC due to large loads of suspended solids, nutrients, and high levels of biochemical oxygen demand resulting from direct discharge into the river by various industries and communities. These pollutants had a severe impact on beneficial uses and created stress conditions for local fish populations. The IJC requested that the Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources develop a Remedial Action Plan which would identify strategies to control sources of pollution, abate environmental contamination already present, and restore

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51 Federal Water Pollution Control Act 33 U.S.C.§ 1268.

52 Federal Water Pollution Control Act. 33 U.S.C. § 1268(a)(3)(b) and § 1268(a)(3)(c)(1)

beneficial uses in the St. Louis River Area of Concern. Impairment of beneficial uses, as defined by the Water Quality Agreement, is a change in the chemical, physical, or biological integrity of the Great Lakes system. The St. Louis River basin Remedial Action Plan addresses the following concerns: (1) the environmental problems, including geographical extent of the area affected and research needs, (2) beneficial uses that are impaired, (3) the causes of the problems and sources of pollutants, (4) remedial measures proposed to resolve the problems and restore beneficial uses, (5) a schedule for implementing and completing remedial measures, (6) agencies and jurisdictions responsible for implementing and regulating remedial measures, (7) the process for evaluating remedial program implementation and effectiveness, (8) surveillance and monitoring activities that will be used to track effectiveness of the programs and eventually confirm that the AOC beneficial uses have been restored.[53]

An initial Remedial Action Plan draft was completed in 1985 (prior to the 1987 Protocol), and was submitted to the U.S. Environmental Protection Agency (EPA) by the Minnesota Pollution Control Agency (MPCA).[54] The Environmental Protection Agency's response was to suggest a more

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53 Remedial Action Plan I-5.

54 Remedial Action Plan II-1

comprehensive plan to address the problems associated with the St. Louis River basin, and to develop necessary solutions and actions.[55] To this end, EPA hired Science Applications International Corporation (SAIC) to put the available information and data into a suitable format. Minnesota and Wisconsin reviewed the SAIC document and concluded significant change, revision, and expansion of the Plan was necessary. It was at this juncture that it became evident that there was a need beyond simple IJC and Federal mandate for public input and involvement. To address public concerns, a 32 member Citizens Advisory Committee (CAC) was formed in June, 1989 to oversee the Plan development. The committee was tasked with identifying issues to be considered, set goals for remedial action activities, and act in an advisory position to the MPCA and the Wisconsin Department of Natural Resources (WDNR).

The CAC formed two subcommittees, a Steering Committee, and a Public Relations/Information and Education Committee. The Steering Committee functioned to guide the CAC by organizing, developing, and recommending activities or options that the CAC would then pursue. The Public Relation/Information and Education Committee, active in 1990, organized public meetings to report on the Plan's progress. In 1989, five Technical Advisory Committees (TAC's) were

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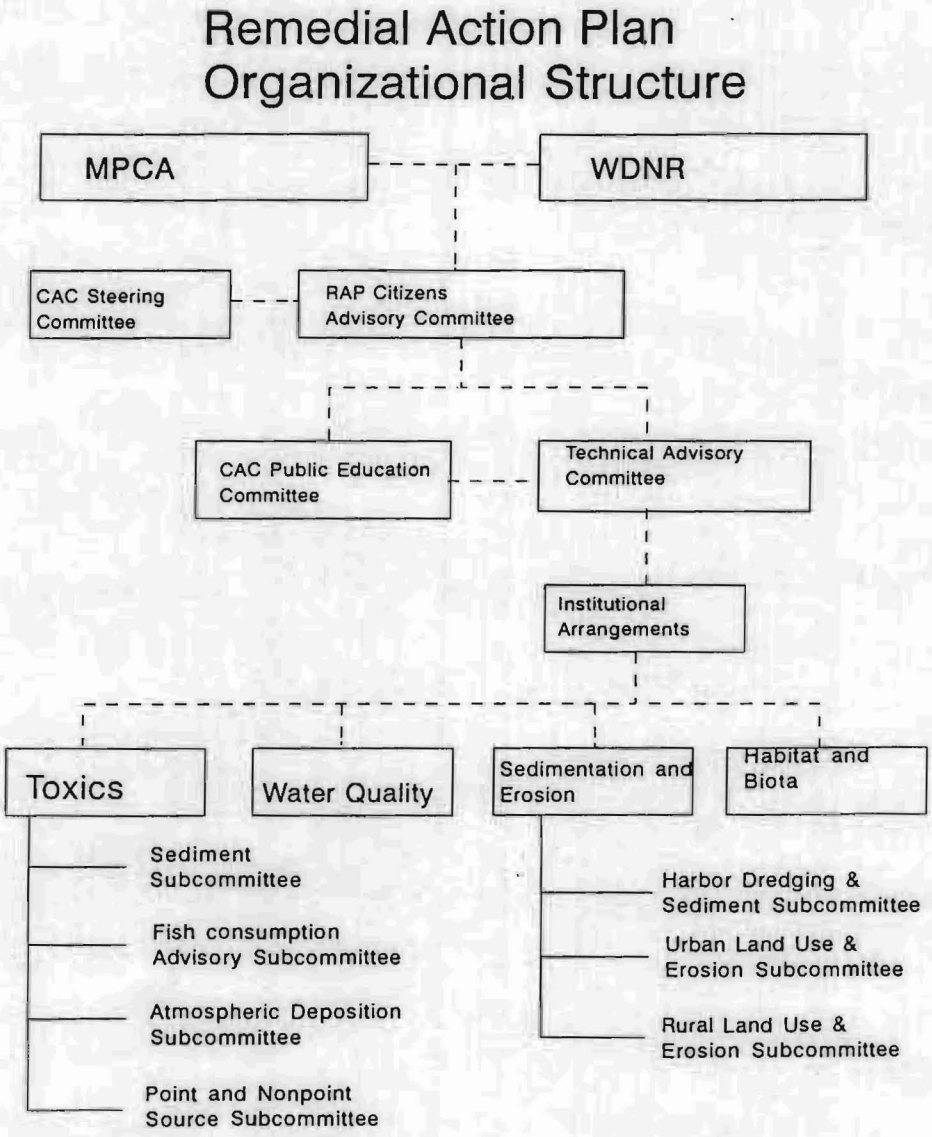
55 Remedial Action Plan II-1

formed to provide scientific and technical advice to the CAC. The TACs helped to analyze the complex water quality issues, and recommend a range of solutions. The five TACs established were Toxics, Water Quality, Sedimentation and Erosion, Habitat and Biota, and Institutional Arrangements. Toxics, Water Quality, Sedimentation and Erosion, and Habitat and Biota carry out functions in support of the CAC in identifying impaired beneficial uses and their causes, proposing goals and objectives to restore uses when degraded, and recommending solutions. The Institutional Arrangements TAC was assigned to work on how recommendations can be implemented giving consideration to economic, political, social, and policy factors. Institutional Arrangements also evaluates the advantages and disadvantages of the recommended actions, and identifies responsible parties required for implementation. Following the Institutional Arrangements TAC evaluation, recommendations are sent to the CAC which then produces final recommendations. Overseeing the entire process is the Remedial Action Plan coordinators from the MPCA and the WDNR. They, in turn, report back to the EPA. Figure 4 is an organizational chart of the St. Louis River system Remedial Action Plan organization.

Despite much detailed work by the CAC and involved agencies, several deficiencies in the St. Louis River Plan regarding the role of nonpoint source pollution exist, particularly nonpoint source from agriculture. Although

there has been substantial reduction in point source

Figure 4



Source: Minnesota Pollution Control Agency; Wisconsin Department of Natural Resources, The St. Louis River System Remedial Action Plan Stage I, Minnesota Pollution Control Agency; Wisconsin Department of Natural Resources, 1992

phosphorus loadings, the Remedial Action Plan stage I report completed April, 1992, concedes that phosphorus concentration in the estuary remains at levels that indicate a eutrophic condition might be expected. Algal blooms are lower, however, than would be expected given phosphorus concentrations. The Remedial Action Plan explains that several investigators have proposed that the limiting factor in algal growth in the estuary is poor light penetration caused by turbidity and color. The Plan states that in sampling conducted at 18 sites from Allouez Bay to Fond du Lac in 1984-1987, nutrients in the estuary were not fully expressed as phytoplankton biomass, perhaps due to high turbidity. Paleolimnological examinations of core samples indicate that the rate of sedimentation in the estuary has been increasing since 1900.

The rates of sedimentation, documented turbidity, and high phosphorus loading (despite the lack of algal blooms) all seem to suggest significant non-point source pollution problems. The Plan does draw a possible connection between phosphorus availability and transport through the system and the high sediment loading. The Plan references a 1972 National Eutrophication Survey that developed a nutrient budget for St. Louis Bay which estimated that 50 percent of the phosphorous inputs into the Bay were from non-point sources. In 1982, a study of nutrient loadings to the Bay

found that while point source loadings had decreased to one fifth of the previous input, non-point source inputs accounted for 90 percent of the nutrient loadings, and that overall loadings were similar between 1972 and 1982.[56] It is important to note that these studies did not include point source loadings from Wisconsin, and did not take into account the Lake Superior seiche. Despite the evidence of strong correlation between phosphorus loading and sedimentation, the possibility of a eutrophic condition, and data collected on the rates of sedimentation, little or no quantitative information on non-point source pollution exists for the St. Louis River AOC. The Remedial Action Plan plainly states this, while also conceding that although eutrophic conditions have not been noted within the St. Louis estuary in the last decade, nutrient loading from the system into Lake Superior is of concern.

An examination of possible causes of non-point source pollution contributing to the water quality degradation of the St. Louis River and Lake Superior indicate that agriculture *is* a significant factor. While the northeastern portion of Minnesota and Wisconsin are not as agriculturally intensive as other portions of the State, a significant amount of acreage is devoted to agriculture. Total cropland acreage in the St. Louis River basin in the three primary

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56 Remedial Action Plan V-32.

counties (Carlton, St. Louis, and Douglas County Wisconsin) totals 187,206 acres.[57] The Remedial Action Plan states that the main source of nutrients from agricultural operations is animal waste runoff from livestock and poultry operations, and fertilizer runoff, however no study to substantiate this is cited.

The lack of information on non-point source pollution from animal waste runoff is a problem which could be immediately addressed. Considerable attention has been given to nutrient loading reduction as a result of improvements in waste water treatment and the construction and consolidation associated with the Western Lake Superior Sanitary District treatment plant and upgrades to the Superior Waste Water Treatment Plant. A review of BOD_5 values from Table 4, however, again indicates that organic livestock waste, while consisting of less volume, is much more concentrated than municipal waste water discharges. With this in mind, given the high nutrient loading in the St. Louis River basin, it would seem that the need to address the problem of animal waste runoff is great.

A beginning point might be to identify herd and flock sizes of dairy and poultry operations in the three county area. Once dairy herd sizes have been established, dairy herd records can be used to accurately estimate the weight of

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57 Remedial Action Plan V-36.

each dairy cow. This information, along with the size and type of poultry flocks in the region can then be used to estimate total manure production and the resultant nutrient content. Although this information will not indicate the quantity actually reaching the water body, it will give an estimation of the amount of nutrient from animal waste which is available. Further measurement of dissolved oxygen levels and water samples can then provide an indication of how much nutrient is in the water column and a correlation can be drawn. In addition, information on compliance with rules on controlling feedlot pollution based on State law (Minnesota Rules, Chapter 7020) needs to be examined for actual compliance. Quantitative data also should be collected to determine the amount of manure that is applied to cropland, and the timing of manure applications. This, in conjunction with erosion data, will aid in determining if manure application is contributing significantly to the water quality problems already being caused by animal waste runoff from feedlots. The information gathered can then be used in determining best management practices for manure application and storage, and controlling sediment transport from erosion that may be carrying nutrients from field applied manure into the water column.

The same process should be employed for application of commercial fertilizers. Data on types of erosion and transport into the water column should be collected, and

fertilizer content (percent nitrogen, phosphorus, and potash) analyzed. Information on types of fertilizer used can easily be solicited from agricultural producers either by the county extension agent, or Soil Conservation Service representative. Given application rates, timing, and method of application (*i.e.* top dress, side dress, incorporation, or broadcast), combined with data on sediment transport, adsorption of fertilizer to the soil particle, and knowledge of the types of erosion most prevalent, accurate estimates can be made regarding the role of commercial fertilizer in nutrient loading.

Turbidity in the St. Louis River indicates that an erosion problem exists. Continued sedimentation in the St. Louis River and in particular Superior Bay and the harbor area suggests that much of the turbidity is from new erosion rather than sediment staying in suspension for long periods of time. The erosion and subsequent turbidity presents a problem not only from a transport of nutrients standpoint, but also its effect on water quality and the negative impact on fisheries. Sediment volumes and statistics on the amount of annual dredged material suggest that fishery quality is impacted, and that suspended solids may well be in the range of 80-400 mg/l or ppm. Although much of the focus on fisheries in the St. Louis River basin has been in regard to toxins and dissolved oxygen levels, the turbidity caused by erosion and suspended material and its effect on fisheries

should not be overlooked. While not all of the sedimentation is caused by agriculture, there does not seem to be any data indicating the estimated impact of erosion, or types of erosion caused by agriculture located in the Area of Concern. A lack of data makes it difficult to implement best management techniques. Even if the type of best management technique(s) could be identified, questions regarding the width of filter strips or field borders for example cannot be answered. Although not as significant, the impact of sediment already in suspension should also be examined. While sandy soil particles stay in suspension as little as 34 seconds, clay and organic colloids common to the region remain in suspension much longer; 3.9 days and 1.1 years respectively (Table 1). Once field evaluation has determined the type of erosion, a solution incorporating previously discussed best management practices can be implemented.

In addition to animal waste, fertilizer problems, and sedimentation, the Remedial Action Plan also identifies pesticide runoff as a result of surface runoff and/or seepage to ground water as a potential nonpoint source pollution problem resulting from agricultural activities. Table 4 lists some of the most common pesticides and insecticides in the St. Louis River Area of Concern.[58]

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58 Remedial Action Plan V-36.

Table 4

Pesticide	***Trade Name***
Atrazine	AAtrex, Atratol
Cyanazine	Bladex
EPTC	Eptam, Eradicane
Glyphosate	Accord, Roundup, Lorox, Ranger
2,4-D Sol Amine	Weeder
Insecticide	***Trade Name***
Aldicarb	Temik
Diazinon	DZN, Knox-Out
Malathion	Cynthion

The Remedial Action Plan lists the total acreage to which agricultural chemicals were applied for Carlton, Douglas, and St. Louis Counties. These are listed in Table 5.[59]

Table 5

Chemical Use	***Carlton County Mn***	***Douglas County Wi***	***St. Louis County Mn***
Fertilizers	9,603	4,994	14,738
Insect, nematode, disease and weed control	4,531	1,800	6,393
Defoliation and crop control	104	-	90

Beyond identifying these most common pesticides and

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59 Remedial Action Plan V-37.

insecticides, the Remedial Action Plan fails to address potential problems that these chemicals can cause in the water column. Of the pesticides, Atrazine, Cyanazine, EPTC and 2,4-D-Sol Amine all have either medium or high surface loss potential, and medium or high leaching potential. Glyphosate has a high surface runoff potential, but a low leaching potential. 2,4-D Sol Amine has an extremely high solubility factor. Glyphoste has an extremely high partition coefficient value indicating it is strongly adsorbed to the soil particle contributing to a high surface runoff loss potential. Atrizine has a half-life in the soil of approximately 60 days making it extremely susceptible to runoff following rainfall or other erosion events that would carry it into the water column. EPTC and Glyphosate also have relatively long half-lives, each measuring approximately 30 days. With respect to the insecticides, Aldicarb, while having a low surface runoff loss potential, has a high potential for leaching, as does Diazinon. Diazinon has medium potential for loss to surface runoff. Malathion has both a low potential for loss to surface runoff and a low potential for leaching. While information on pesticides is readily available, there has been no attempt to address potential loss to the water column, detachment or transport as a result of surface runoff, leaching, or the effects on water quality.

Indeed all of the potential sources of nonpoint source

pollution from agricultural runoff need to be examined as possible contributors to the water quality problems in the St. Louis River basin. In many instances the field work required has already been done by the Technical Advisory Committees, or is available from state agencies or the Soil Conservation Service. With adequate problem identification, Stage II of the Remedial Action Plan process can then propose the best management practices most appropriate to controlling the pollution problem. Many of the best management practices mentioned earlier have proven records of effectiveness in other parts of the Midwest and the Great Lakes region, and data on their effectiveness is available from the State Department of Agriculture.

The Remedial Action Plan process itself must be examined in terms of how it addresses nonpoint sources, specifically nonpoint sources from agricultural runoff. A list of participants of the Citizens Advisory Committee reveals that not a single agricultural producer, nor any related industries are included among the many industrial, commercial, environmental, or tribal groups. Among the County/City, State, and Federal agencies, departments, and services represented, the State Soil and Water Conservation Districts, and MPCA are the only link between agriculture and the Remedial Action Plan process. Noticeably absent are either Minnesota or Wisconsin State Departments of Agriculture, or representatives from the vast University of

Minnesota or Wisconsin Agricultural Extension network which has agents in each county of both states. Certainly extension agents from Carlton, St. Louis, and Douglas County would bring a wealth of information regarding current production methods that may be degrading water quality, as well as information on best management practices, including practices that are economically within a producers means, and those which will incur a cost greater than what the producer is willing to bear. While the USDA Soil Conservation Service (SCS) is listed as a participant, the extent to which they have participated is vague, leaving the impression that much of the information that the SCS could have brought to bear on problems of nonpoint sources pollution from all sources has not been included in the Stage I report.

Another trouble spot surfaced at a 29 December, 1992 meeting in the announcement by a representative from the MPCA that there was uncertainty whether the Wisconsin Department of Natural Resources would continue to participate in the Remedial Action Plan process.[60] MPCA representatives did not have concrete underlying reasons behind the move, but speculated that it may be connected to lack of cooperation with the State of Michigan in solving common water quality problems. This seems to indicate that States themselves may

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60 Meeting of the Citizen's Advisory Committee, St. Louis River Remedial Action Plan, City of Duluth, Minnesota, 29 December, 1992.

find it hard to coordinate water quality goals and Plan implementation. If cooperation between States, or differences in commitment between States cannot be solved, the many positive benefits of having a water quality plan which includes diverse interest groups will certainly be lost. Problems between States themselves or States and Provinces will only serve to preserve water quality status quo at best.

There are reasons that might explain why nonpoint source from agricultural runoff has received so little attention despite the obvious indicators, and why other instrumental agencies and services have not been involved up to this juncture, but none offer a reasonable rationale for ignoring nonpoint source pollution from agricultural runoff. The IJC did a complete review of the Stage I Plan for the St. Louis River basin in March, 1993. The overall evaluation of the Plan to this point by the IJC was very favorable.[61] Despite IJC review, little attention has been focused on Articles VI (e)(i) through (ix) of the Great Lakes Water Quality Agreement of 1978, which speak specifically to agriculture, or the pertinent sections of the Great Lakes Critical Programs Act. In the absence of a focusing event, nonpoint source as a whole, and certainly nonpoint source pollution from agriculture has been left to the back burner.

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[61] Mr. Brian Fredrickson, Minnesota Pollution Control Agency, personal interview, 6 May, 1993.

VI: Conclusion:

The problem of nonpoint source pollution clearly exists in the St. Louis River basin. While no single program is the sole solution to pollution abatement, the Remedial Action Plan process, given strong leadership, clearly defined roles, and a commitment to community input that gives all interests a stake in the outcome is an ideal beginning. It certainly provides the kind of framework necessary for solving nonpoint source pollution problems from agricultural related runoff, and can address best management practices for individual producers.

The Remedial Action Plan process does, however, involve a great deal of coordination between states, states and provinces, and the U.S. and Canadian governments. Because of the many governmental linkages, added to the involvement of interest groups participating as part of the Citizen's Advisory Committee to the Remedial Action Plan process, stronger leadership may be required. The type of leadership necessary would need to come from the EPA, particularly if state governments cannot resolve differences in meeting Remedial Action Plan objectives. Stronger EPA leadership would also entail closer liaison between the IJC and the EPA in positively and affirmatively resolving conflicts, and facilitate meeting goals within individual Areas of Concern.

While the many players involved admittedly complicate the Remedial Action Plan process, this provides an

opportunity to draw on a wide variety of expertise. The opportunity is lost, however, when problem identification becomes too focused on a particular source, and key contributors are left out. This would appear to be the case in the St. Louis River Area of Concern in regard to nonpoint source pollution from agriculture. By not actively engaging such groups as the Minnesota or Wisconsin Departments of Agriculture, Agricultural Extension Service, or agricultural producers, much valuable information regarding a significant cause of nonpoint source pollution has been omitted from the Remedial Action Plan process. By their exclusion, producers become separated from water quality issues of which they have an interest, and an impact. If best management practices *are* identified and imposed upon agricultural groups which have been previously ignored or overlooked, they will likely be met with hostility, defeating any goal of improved water quality.

Along the Minnesota-Wisconsin coast of Lake Superior, the second largest tributary, the St. Louis River, with its high rate of sedimentation and turbidity, and high nutrient loading, continues to be plagued by symptoms of nonpoint source pollution, a good portion of which may be attributable to agricultural related activities. Reducing the adverse impacts on the environment from those activities requires knowledge about the various pollutants and how pollutant pathways can be interrupted. The problem is not new, nor is

it insurmountable. Much of the work necessary for identifying agricultural nonpoint source pollution, and the work needed to provide better management answers *is* available. While tackling a diffuse source presents a relatively more difficult task, the ability to do so exists. By addressing the problem and identifying solutions, the water quality of Minnesota's greatest water resource is improved, and preserved. Nonpoint source pollution from agricultural runoff must not be addressed in passing, but rather given the same level of attention as identified point sources.

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