Sustainability of Marine Resources: Fisheries Utilization

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ABSTRACT

The Sustainable Water Resources Roundtable (SWRR) is one of several natural resource roundtables with government, corporate, and NGO participation. SWRR has been a subgroup of the Advisory Committee on Water Information (ACWI) since 2001, and operates under authority of OMB M-92-01 and the Federal Advisory Committee Act. The purpose of the Roundtable is to provide an open forum for exchanging ideas and information to foster collaboration on ways to manage water resources in such a way that the resource and its uses may be sustained over the long term.

Four earlier papers in this series described work leading up to the completion of the 2005 Preliminary Report. The present paper breaks new ground, and represents a challenge to the traditional disciplines of civil and sanitary engineering. Here we address the problem of sustainable marine fisheries, as exemplified by the work of the National Marine Fisheries Service and the Marine Stewardship Council. This is a new challenge that we begin to address by examining the idea of developing indicators for commercial fisheries resources. The goal is to help policy makers balance the economic benefits of commercial fisheries against the exhaustion of a finite resource of creatures that dwell in water. This "blue water" approach serves to connect creatures that dwell in water with the important economic benefits they bring to us all.

The journey toward Sustainable Water Resources Management begins by determining the most important water issues and indicators. The long-term goals of SWRR include the development of principles, criteria and indicators to support decision-making and identification of opportunities for collaboration on research needs. Sustainable Water Resources Roundtable participants are committed to interdisciplinary, inter-jurisdictional, and cross-ownership collaboration that identifies and supports national, state, and field-level activities to sustain water resources.

KEYWORDS: Sustainable development, water sustainability, indicator, water resources, water quality, sustainable water resources management, Sustainable Water Resources Roundtable, marine resources, fisheries.

INTRODUCTION

The Sustainable Water Resources Roundtable (SWRR) is one of several natural resource roundtables with government, corporate, and NGO participation while others deal with forestry, rangelands, and minerals. SWRR has been a subgroup of the Advisory Committee on Water Information (ACWI) since 2001, and operates under authority of OMB M-92-01 and the Federal Advisory Committee Act. The 2005 Preliminary Report completed by SWRR is available at http://acwi.gov/swrr/. The purpose of the Roundtable is to provide an open forum for exchanging ideas and information to foster collaboration on ways to manage water resources in such a way that the resource and its uses may be sustained over the long term. Roundtable discussions and activities will focus in part on criteria, indicators, and methods for assessing the sustainability of water resources, as well as exploring and improving how this information is used to promote sustainable water resource management.

Earlier papers in this series described work leading up to the completion of the 2005 Preliminary Report. The first paper in this publication series entitled "*Formulating Key Water Quality Indicators for Sustainable Water Resources Development*" at *WEFTEC'04* emphasizes the application of the water sustainability framework to the water quality field. The objective of the second paper, *"Part II: Scale Issues and Geographic Patterns"*, which was presented at *WEFTEC'05*, is to address the importance of scale issues and geographic patterns and how they may influence the formulation of key water sustainability indicators. The third paper, *"Our Journey Towards Sustainable Water Resources Management: Preliminary Report by the Sustainable Water Resources Roundtable,"* was presented at *WEFTEC'06*, which is a summary of the 2005 report which describes 17 indicators currently proposed as a way to characterize water sustainability. The paper also contrasts the 17 indicators with a possible short list of key water indicators that might be used for policy making. The fourth paper, presented at *WEFTEC'07*, is "*Evolution of Sustainable Water Resources Indicators,"* and introduces the set of national public policy issues that can act as drivers that cause the need for indicators to track them, and presents an eight-indicator framework that includes some indicators that are not covered in earlier documents.

The present paper breaks new ground. Earlier work has focused largely on freshwater and inland waters. However, how might water indicators relate to issues along the coasts and in the ocean? This is a new challenge that we begin to address by examining the idea of developing indicators for commercial fisheries resources. The goal is to help policy makers balance the economic benefits of commercial fisheries against the exhaustion of a finite resource of creatures that dwell in water.

METHODOLOGY

Sustainability has been defined as a property of a system that can be maintained in a certain state indefinitely. As used with regard to the environment, it refers to the potential longevity of human cultures that are supported by critical external factors, such as agriculture, forestry, and fisheries, all of which have a water component. History includes many examples of earlier societies that have eventually died out, sometimes as a result of their failure to successfully relate to their environment. In modern terms, we can see a case of use of resources by increasing demand, and a fixed supply provided by a single world. The challenge is to determine how to create long-term sustainability.

Water sustainability solutions are characterized by certain systems analysis properties that may indicate the overall stability of the system. It is important for sustainability

- that solutions to problems should be viable for long durations;
- that the system should not be required to undergo extreme change in short periods of time to reach the desired solution;
- that the solution sought is often a compromise of available options and not for some extreme case;
- and is not overly complex.

Even with these precautions, the most successful solutions often possess the additional property of reversibility. Only actual experience can tell us if we are on the right track, and if not we must be able to make changes. Whether the geographic scale is a local water problem or a national system, these rules tend to produce sustainable solutions.

Daly (1996) suggests the following three operational rules defining the condition of sustainability:

1. Renewable resources such as fish, soil, and ground water must be used no faster than the rate at which they regenerate.
2. Nonrenewable resources such as minerals and fossil fuels must be used no faster than renewable substitutes for them can be put into place.
3. Pollution and wastes must be emitted no faster than natural systems can absorb them, recycle them, or render them harmless.

Using these concepts, we now move into the coastal and marine environment to see what indicators might be developed. Note there is no real attempt to replicate complex and often unknown ecologies for the creatures under study. For policy making purposes we can focus on the economic demand for a water-related resource, and contrast it to what we know about the supply of the resource which is provided by the environment.

RESULTS AND DISCUSSION

Demand for Fish

Our economy has a substantial demand for fish of many species. Indeed, there are so many species involved that special terminology is used by fisheries biologists. Stocks and stock complexes refer to individual or closely related species of fish, usually those for which some commercial market exists. For those accustomed to water quality engineering, a good parallel would be the many hundred parameter codes that are used to describe water constituents. In the same way, many of these stocks are unfamiliar to the layman. Only some are intended for the food industry. There are many other uses. Consequently, many of the statistics used for indicators are in terms of aggregated stocks. A few better-known species have been selected as examples in the paper, but this is largely for illustrative purposes.

Figure 1 shows the trend of demand in quantity of fish consumed over time. Because of the large number of species, only some are shown here, as selected by the National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA). The agency can assess only a certain number of fisheries stocks per year, so the information tends to be focused on those species for which more recent and reliable data exist. We know that other things are happening, but determining exactly what is enormously difficult. The tentative conclusion is that this indicator shows a demand that is approximately level. At a national scale, this may be good news. However, we must also note that other nations may exhibit far different trends. In addition, there is a complicated relationship that involves fish caught by various nations, and how the catch is imported and exported among them. For these reason, Figure 1 is best looked upon as only a first approximation.

Impact on Commercial Fisheries

Among water resources public policy issues, the use of commercial fisheries is unusual in that there is a well-defined management approach, defined by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (MSRA). Under provisions of the act, the NMFS assesses fisheries stocks, collects data and maintains data systems, and submits an annual report to Congress. Figure 2 shows a summary of the 2006 status of fisheries stocks. Again there are specific definitions involved in describing the results. There are stocks that are classed as subject to overfishing, which means that the mortality rate is above a particular threshold. A more severe class is the overfished status, in which the stock biomass is below a particular threshold. Thresholds are determined for each individual species, in the same way that water quality parameters have their individual criteria and standards.

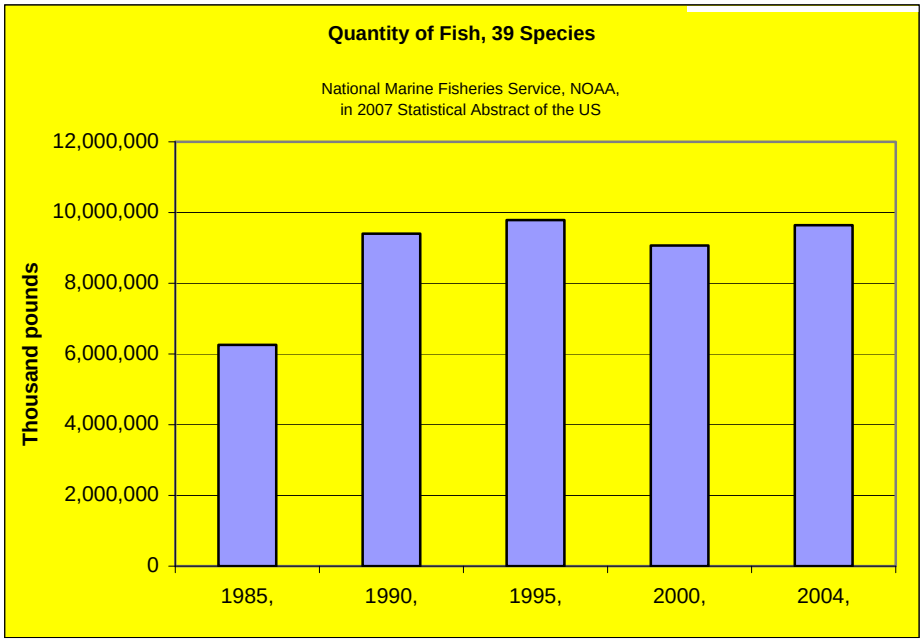


Figure 1. Quantity of Fish Landed (NOAA, 2005; U.S. Census Bureau, 2007)

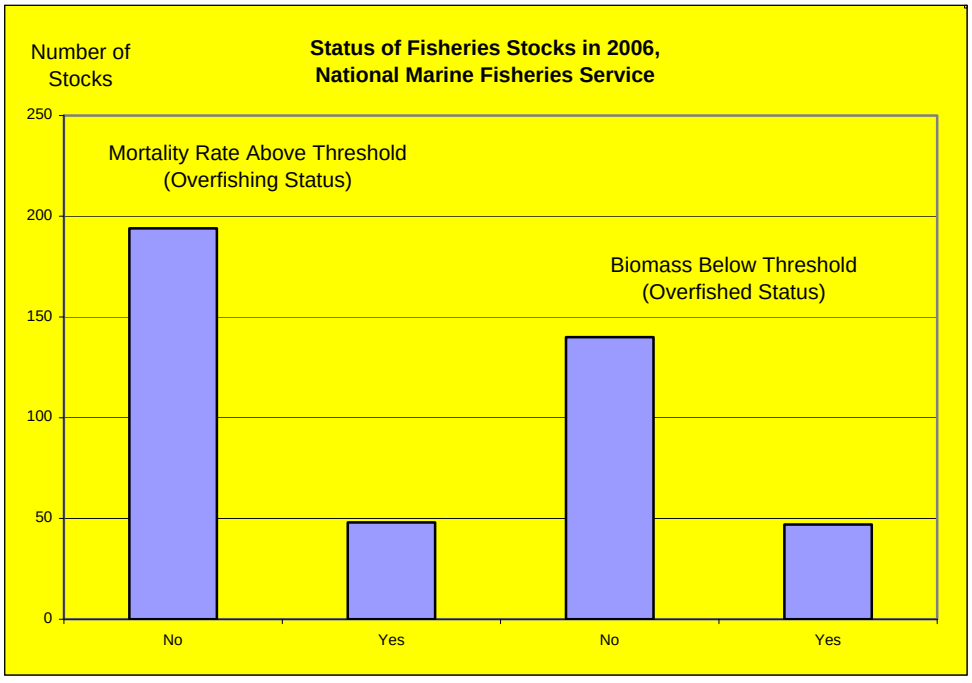


Figure 2. Status of Fisheries Stocks in 2006 (NOAA, 2006)

Overfished status is based on the amount of fish in the sea. A species is declared overfished when the population size is below a certain level determined by scientists to be healthy. Overfishing refers to the rate of harvest of a species. Overfishing occurs when more fish are being taken from a stock than the fish population can replace through reproduction or immigration from other populations.

To say "*seafood is sustainable*" is to say the population of that species of fish is being managed in a way that can provide for today's needs without damaging the ability of the species to reproduce and maintain abundant populations for future generations of consumers. The majority of fish and shellfish caught in federal waters of the U.S. are harvested under fishery management plans that must meet 10 National Standards to ensure that healthy fish stocks are maintained, overfishing is eliminated, and the long-term social-economic benefits to the nation are achieved. In the United States, fisheries managers are required to set harvest levels within a range of scientific recommendations to sustain healthy populations of fish and shellfish.

When a stock is determined to be overfished, management practices must be changed to increase the size of the stock back to the level that produces maximum sustainable yield, the largest average catch that can continuously be taken from a stock. If a U.S. federally-managed stock is overfished, it is required to be under a rebuilding plan with strict deadlines. This usually means that some reduced level of fishing may still take place to provide the market with fish. Even under strict rebuilding plans, it is intended that proper management is working to bring the stock back to sustainable levels so the fish can continue to be harvested and sold.

Mortality rate is from all causes, not just human action. In addition, biomass is estimated from complex models of ecology. This indicator seems to show a degree of optimism, even with the uncertainties. Among the stocks shown in Figure 2, there are a few familiar species: the Eastern Pacific Yellowfin Tuna is listed as subject to overfishing. The Pacific Halibut is listed as not overfished. As can be seen, there are many other stocks that are assessed. Another way to look at the results is to note what has happened since 2001. On the positive side, 13 stocks have been removed from overfishing status and 27 have been removed from overfished status. On the negative side, however, 19 have been added to overfishing status and 17 stocks added to overfished status. At a gross level, the sums are almost equivalent. Perhaps this means we are at best holding our own.

Some Examples of Commercial Fisheries

The NMFS covers an enormous number of fish species, many of which are unfamiliar to anyone not working in the field. To give some idea of how the process works, a few species have been selected by the authors to illustrate the problems and possibilities of sustainable fisheries, and to show that these concerns are far from just an academic exercise.

Atlantic Cod

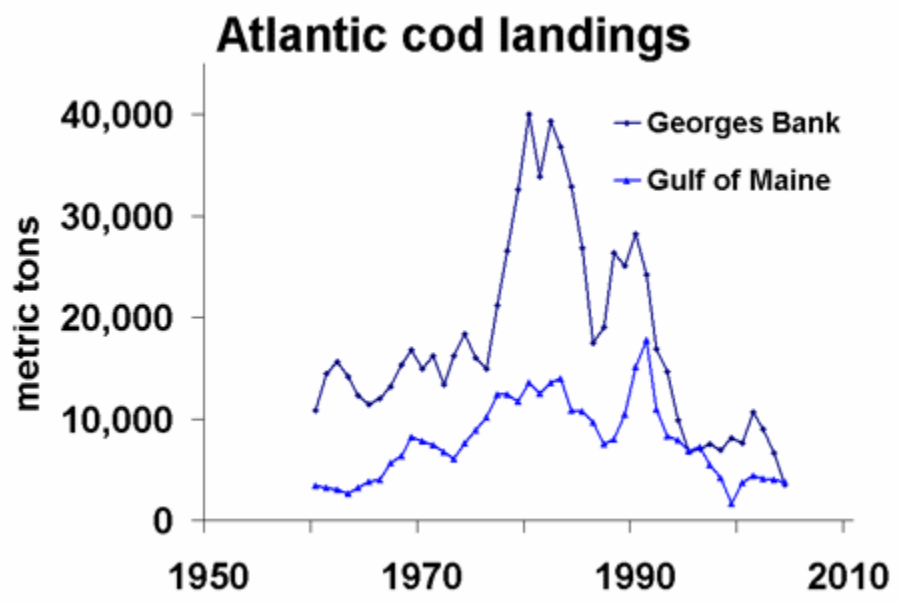


Figure 3. Atlantic Cod Landings Trends (NOAA National Marine Fisheries Service, 2006)

The NMFS states that Atlantic cod populations are low, and strict rebuilding measures have been implemented. Recent studies link the effects of climate change to decreases in cod populations in the North Atlantic. The biomass of both Georges Bank and Gulf of Maine stocks is well below the biomass needed to support maximum sustainable yield, at 10% and 23% of the target biomass, respectively. The species is listed as subject to overfishing and is overfished.

In U.S. waters, Atlantic cod are assessed and managed as two stocks: 1) Gulf of Maine and 2) Georges Bank and Southward. These stocks are managed under the New England Fishery Management Council's Northeast Multispecies Fishery Management Plan. Several other species share the same habitat as cod and are therefore managed concurrently. This plan has implemented closures, gear restrictions, minimum size limits, and other management measures to reduce fishing mortality to levels that will allow stocks to rebuild above minimum biomass thresholds and, ultimately, remain at or near the target biomass levels. Currently, biomass of both stocks remains at an extremely low level. The Georges Bank stock is under a 22-year rebuilding plan, and the Gulf of Maine stock is under a 10-year plan.

Landings refer to the amount of catch that is brought to land. Stricter management measures were enacted throughout the 1990s, contributing to the decline in domestic commercial landings in the past 15 years. It is worthy of note that the landings presented are domestic commercial landings.

Pacific Halibut

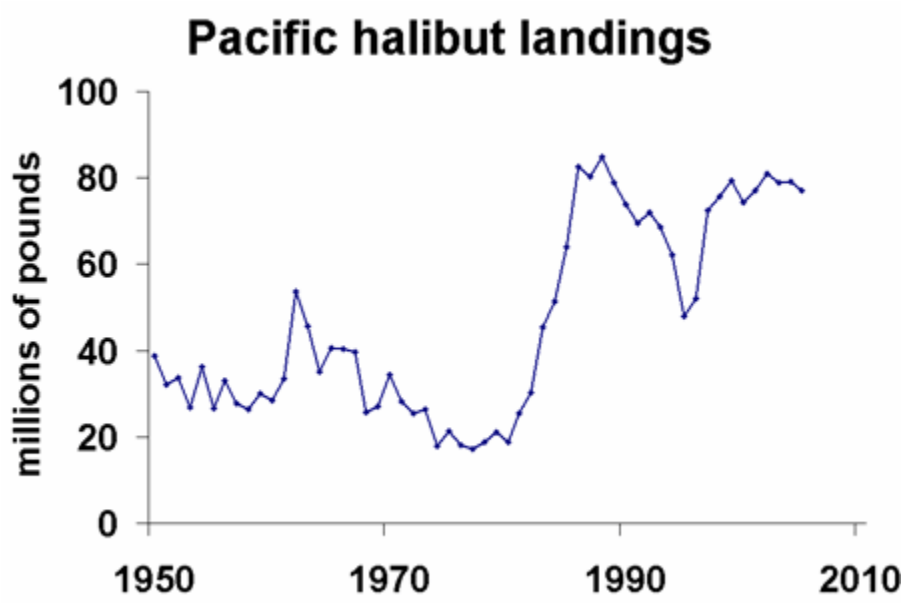


Figure 4. Pacific Halibut Landings Trends (NOAA National Marine Fisheries Service, 2006)

The NMFS states that Pacific halibut populations are healthy. They are not overfished, and overfishing is not occurring. Pacific halibut is managed by a treaty between the U.S. and Canada through recommendations of the International Pacific Halibut Commission (IPHC). A total of 97 percent of all halibut landed in the U.S. in 2005 were Pacific halibut. The 2006 estimated exploitable biomass was 382 million pounds (173,272 metric tons) for all regulatory areas.

The IPHC annually establishes total allowable catch levels for halibut that will be caught commercially in the U.S. and Canadian exclusive economic zones (EEZs) and assesses the abundance and potential yield of Pacific halibut using all available data from the commercial, subsistence, and sport fisheries, as well as from scientific surveys and observations of bycatch in non-target fisheries.

Landings refer to the amount of catch that is brought to land. Catch limits were drastically reduced in the 1970s and remained low for a decade, as evidenced by the lowest points in the graph. In the 1980s, the stock was declared rebuilt and a constant harvest rate policy was set. In the early and mid 1990s, both the Department of Fisheries and Oceans in British Columbia and Alaska adopted Individual Quota systems. Landings have been relatively steady since the late 1990s.

Atlantic Salmon

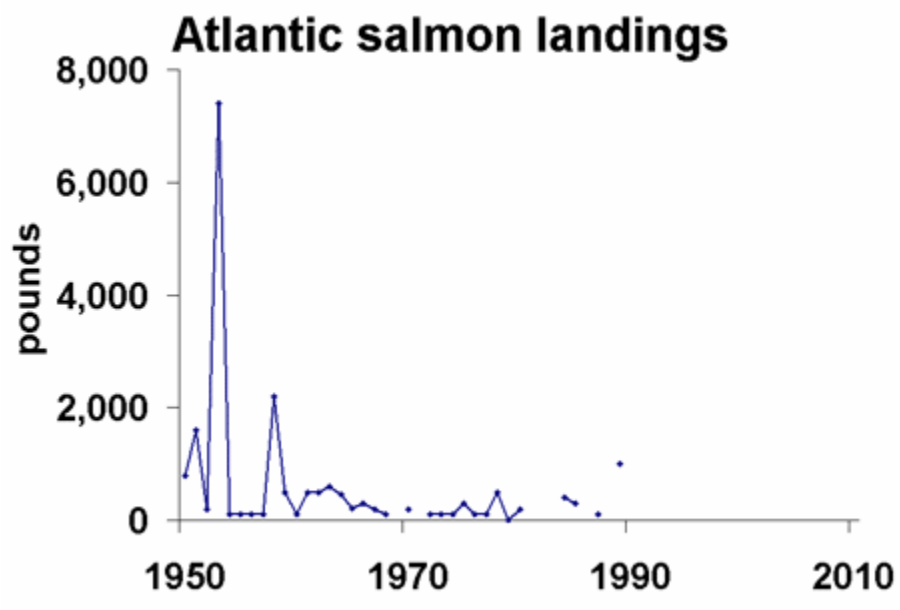


Figure 5. Atlantic Salmon Landings Trends (NOAA National Marine Fisheries Service, 2006)

The NMFS states that wild Atlantic salmon population levels are very low, and commercial fishing for the species is prohibited. Almost all of the Atlantic salmon sold in the United States comes from aquaculture operations. Salmon aquaculture in the United States meets high environmental and health standards and is involved in improving best practices for aquaculture worldwide. Atlantic salmon is currently produced in aquaculture operations in Maine and Washington State in the United States.

Atlantic salmon stocks are currently at perilously low levels. Commercial fisheries are prohibited. The species is now overfished, although commercial and recreational fisheries were permitted for much of the 20th century. There is currently no directed or incidental commercial fishery for Atlantic salmon in federal waters.

Atlantic salmon is managed by the Northeast Fishery Management Council through the Fishery Management Plan for Atlantic Salmon, originally implemented March 17, 1988. The FMP established U.S. management authority over all Atlantic salmon of U.S. origin. The FMP currently prohibits possession of Atlantic salmon and any directed or incidental (bycatch) commercial fishery for Atlantic salmon in federal waters. Effectively, this protects the entire U.S. population complex in marine waters and is complementary to management practiced by the states in riverine and coastal waters. However, distant water fisheries must be managed as well to conserve and restore U.S. salmon populations.

In 2000, NOAA's National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) listed the Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon as endangered under the Endangered Species Act.
In December 2005, the USFWS and NMFS, in coordination with the State of Maine, finalized the Recovery Plan for the GOM DPS of Atlantic salmon. The Recovery Plan identifies recovery actions needed to halt the decline of the species and lays out a process to minimize threats.

Landings refer to the amount of catch that is brought to land. Because no reporting requirements were established for the fishery, landings data are incomplete. In 1989, all state and federal commercial salmon fisheries in New England were closed by law. Recreational salmon fishing continues in the Gulf of Maine area under strict regulation. Only domestic commercial landings are shown in the graph.

Pink Salmon

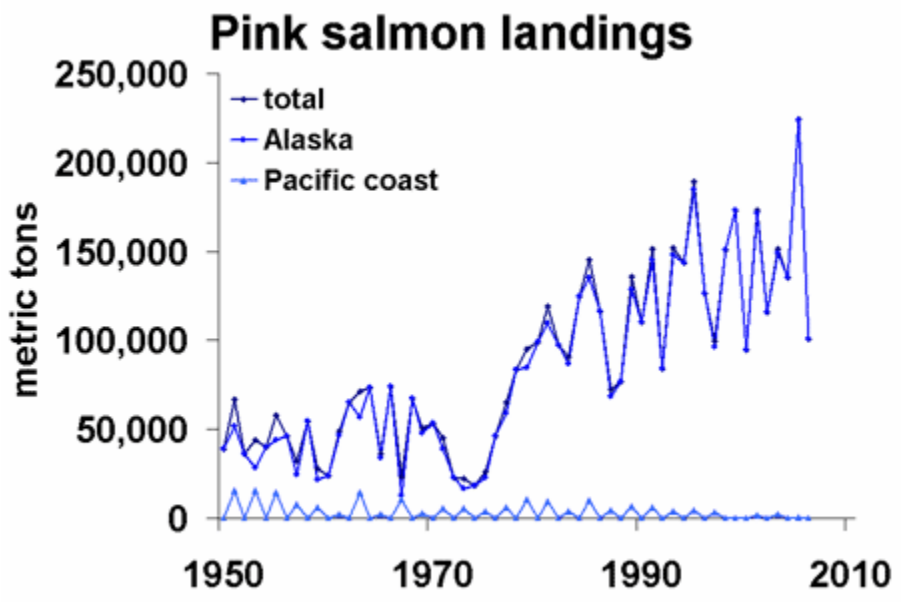


Figure 6. Pink Salmon Landings Trends (NOAA National Marine Fisheries Service, 2006)

The NMFS states that pink salmon are the most abundant salmon. However, biomass measurements are not used to describe the stock status of pink salmon. Instead, stock status is usually described using measures of spawning escapement, productivity, and recruitment. Management of pink salmon varies by location. A number of management controls are used to manage the ocean fisheries each season, including boundaries, seasons, quotas, minimum harvest lengths, fishing gear restrictions, and recreational daily bag limits. Commercial landings are worth about $50 million per year to fishermen in

Alaska. Pink salmon is most frequently marketed as a canned product, and pink salmon roe (eggs) is much more highly valued than the flesh.

The North Pacific Fishery Management Council manages the salmon fisheries in the exclusive economic zone (EEZ) off Alaska under the Fishery Management Plan for the Salmon Fisheries in the EEZ off the Coast of Alaska. The salmon fisheries in the EEZ off Washington, Oregon, and California are managed by the Pacific Fishery Management Council (PFMC) under the Pacific Coast Salmon Plan.

Pink salmon contribute about 40% by weight and 60% in numbers of all salmon caught commercially in the North Pacific Ocean and adjacent waters. Pink salmon populations in Alaska are abundant, with historic record catches over the past decade, exceeding 100 million fish statewide in several years. Farther south, pink salmon populations may not be at record levels, but are generally healthy.

Landings refer to the amount of catch that is brought to land. The majority of U.S. landings come from Alaska. Small numbers of pink salmon are also harvested off the West Coast.

North Atlantic Swordfish

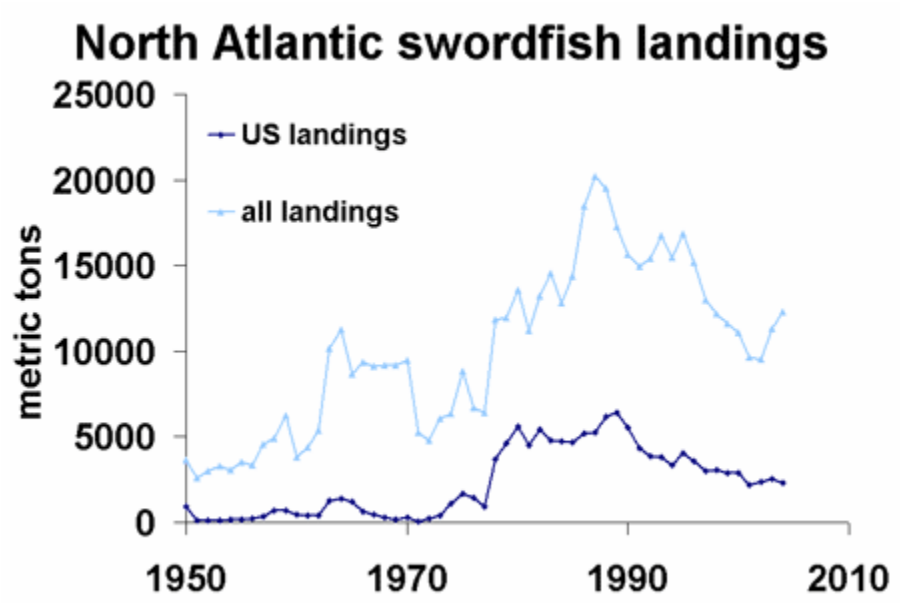


Figure 7. North Atlantic Swordfish Landings Trends (NOAA National Marine Fisheries Service, 2006)

The NMFS states that swordfish population levels are high and no overfishing is occurring. Strict federal fisheries management measures are improving the condition of the fishery, and a fishing industry/NOAA partnership is successfully reducing sea turtle

bycatch. About 37 percent of the swordfish sold in the U.S. comes from the Atlantic and Gulf of Mexico. The rest is Pacific swordfish, where population levels are also high.

Because swordfish is considered a highly migratory species (HMS), it is managed in the U.S. and at the international level. Atlantic swordfish management in the United States began with the 1985 Fishery Management Plan (FMP). The U.S. was concerned primarily with reducing the harvest of juvenile swordfish and foreign impact on the domestic fishery. The International Commission for Conservation of Atlantic Tunas (ICCAT) was established in 1969 to foster international cooperation for the management of Atlantic HMS, including Atlantic swordfish. Member countries include the U.S., Canada, the European community, and Japan.

Landings refer to the amount of catch that is brought to land. The United States harvests about 20 percent of the total North Atlantic landings. Several other nations (such as Japan, Spain, Portugal, and Canada) are also active in the North Atlantic swordfish fishery. With increased restrictions on the domestic fishery, U.S. landings remain low while international landings are on the rise.

Pacific Yellowfin Tuna

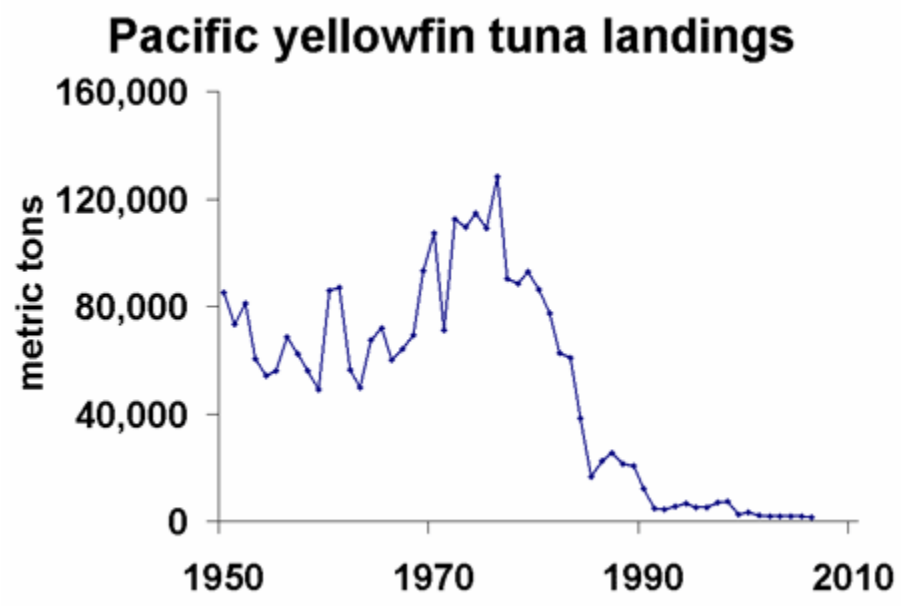


Figure 8. Pacific Yellowfin Tuna Landings Trends (NOAA National Marine Fisheries Service, 2006)

The NMFS states that yellowfin population levels are high, but the Eastern Pacific yellowfin stock is currently subject to overfishing. The tuna industry, through participating governments, works within the framework of the Agreement on the International Dolphin Conservation Program to minimize dolphin bycatch in the Eastern

Pacific Ocean purse seine fishery. About 25% of all yellowfin tuna sold in the U.S. comes from U.S. fisheries while the rest is imported.

Yellowfin tuna biomass (Eastern Pacific, or EPO) is 96% of the biomass needed to support maximum sustainable yield. Central and Western Pacific (WCPO) biomass is 17% above the critical biomass. The species is not overfished, and is subject to overfishing only in the eastern Pacific Ocean.

Yellowfin tuna is a highly migratory species (HMS). There are two stocks of yellowfin tuna in the Pacific Ocean, eastern Pacific Ocean (EPO) and western and central Pacific Ocean (WCPO). The Western Pacific Fishery Management Council has managed yellowfin since 1987 through the Western Pacific Pelagics Fisheries Management Plan. The WPFMC and the Pacific Fishery Management Council (PFMC) have taken steps to better coordinate management of pelagic fisheries, which led to the development and implementation of the PFMC's West Coast HMS Fishery Management Plan (FMP) in 2004. Both councils now collaborate in the management of Pacific yellowfin tuna, and the councils and NMFS science centers in both regions work together in the preparation of stock assessment and fishery evaluation reports as well.

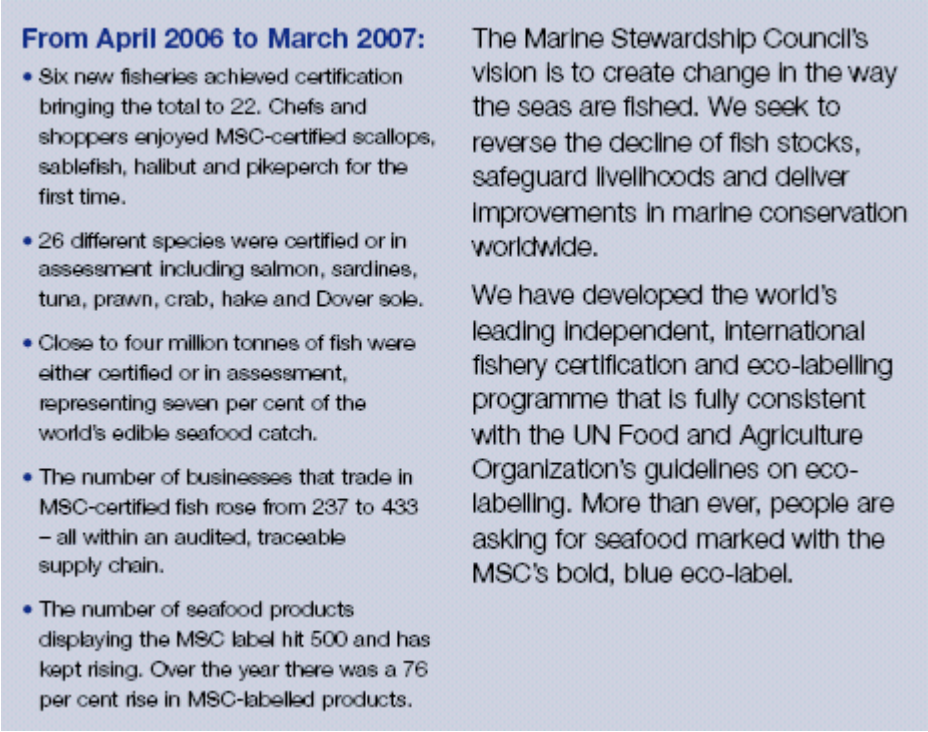
Management Action towards Sustainability

What can be done when stocks are identified as subject to overfishing or overfished? Government actions are in place, and often involve agreements among many stakeholders to change how fisheries operate. Such actions may take years to accomplish, and more years to observe results. However, this is not the only possible kind of action. The Marine Stewardship Council has been working internationally to address stock depletion problems, which are of increasing concern in many nations. This approach is of a different nature.

Recognizing that a long pathway exists between the fishing industry and the retail consumer, the Marine Stewardship Council has endeavored to put in place a chain of custody approach, which requires each organization involved from A to Z to follow some form of “green” approach, in order to be awarded a seal from the Council. Thus, the ultimate consumer knows whether or not the product has been subject to stewardship standards at the point of purchase, and can judge the effect of the process on the final price of the product. This kind of approach folds a market-based approach into the extraction of a natural resource. To the extent that it is successful, the Council offers at least a very useful supplement to government regulation and in some cases reaches into places where no government system exists. Figure 9 is from the Marine Stewardship Council and shows some of their more recent activities.

The Council has been working to include ever greater numbers of product species within their framework. For example, during the period 2005-2006 they certified more than 50 fisheries or had them in assessment. More than three million tons of seafood came from fisheries engaged in their program, including 42 percent of the global wild salmon catch, 32 percent of the global prime whitefish catch, and 18 percent of the global spiny lobster catch. More than 50 percent growth occurred in the number of seafood products

displaying the Council label, bringing the total to 332 products available in 25 countries in March 2006. Retail sales of Council-labeled fish grew 76 percent in 2005-2006, with more than 200 businesses trading Council-labeled seafood (Marine Stewardship Council Annual Report, 2005-2006).



From April 2006 to March 2007:

- Six new fisheries achieved certification bringing the total to 22. Chefs and shoppers enjoyed MSC-certified scallops, sablefish, halibut and pikeperch for the first time.
- 26 different species were certified or in assessment including salmon, sardines, tuna, prawn, crab, hake and Dover sole.
- Close to four million tonnes of fish were either certified or in assessment, representing seven per cent of the world's edible seafood catch.
- The number of businesses that trade in MSC-certified fish rose from 237 to 433 – all within an audited, traceable supply chain.
- The number of seafood products displaying the MSC label hit 500 and has kept rising. Over the year there was a 76 per cent rise in MSC-labelled products.

The Marine Stewardship Council's vision is to create change in the way the seas are fished. We seek to reverse the decline of fish stocks, safeguard livelihoods and deliver improvements in marine conservation worldwide.

We have developed the world's leading independent, international fishery certification and eco-labelling programme that is fully consistent with the UN Food and Agriculture Organization's guidelines on eco-labelling. More than ever, people are asking for seafood marked with the MSC's bold, blue eco-label.

Figure 9. 2006-2007 Activities of the Marine Stewardship Council (MSC, 2007)

CONCLUSIONS

This study shows that sustainable water resources efforts can be extended into the marine environment and can provide indicators useful to policy makers who must manage natural resources found there. It appears that even with the impressive array of public and private management initiatives that now exist, the combined efforts seem able to just barely keep abreast of the enormous problems facing the nation and the world. If anything, we must conclude that additional work is needed in all areas, for example basic science, data collection, economic investigation, and management of the resource.

Sustainable Water Resources Roundtable participants are committed to interdisciplinary, inter-jurisdictional, and cross-ownership collaboration that identifies and supports national, state, and field-level activities to sustain water resources. Several ongoing initiatives by SWRR include:

- Continue to refine investigations into water indicators, especially which indicators can best support the missions of agencies that have important policy responsibilities under public law. This paper is an illustration of extending the sustainability concept into a new arena.
- Recruit representatives from additional water interests, such as environmental groups and the corporate and industrial community. This paper attempts to do this.
- Continue work to establish and maintain relationships with the scientific community, to help build on the best ideas and practices in the water discipline.
- Encourage research into the nature of sustainability as it relates to water resources.
- Leverage efforts by continuing an aggressive outreach program with the professional water resources community.

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