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HOW BIGGER FISH ARE DEPENDENT ON THE SURVIVAL SMALLER ONES – THE CRITICAL ROLE FORAGE FISH PLAY IN THE REBOUND OF WILD COD FISH STOCKS IN THE GULF OF MAINE

I. INTRODUCTION

It is well known that we, as humans, stand at the crossroads when it comes to the health of our oceans. All across the world, ocean fish stocks over the last 40 years have been depleted and demolished. Issues that have come up are overfishing due to new technology, an increase in the overall demand for fish in both harvesting and consumption, and the use of fertilizer in agriculture. But there are other man-made causes, as well, like coastal development, pollution, and global warming. Drawing the exact influence of each, from a scientific viewpoint, is often difficult because a variety of factors contribute in different ways. There are also ecological factors like geographical location, climate, and the specific fish species being studied along with any other organisms involved in the natural habitat.

An important case study is the plight of the North Atlantic cod, whch is found in extensive numbers in the Gulf of Maine, a large body of oceanic water located off the coast of northern New England. Until the last half century, the Gulf of Maine had been one of the largest fishing areas in the world, with cod being one of its primary products. Since then, the cod fishing industry has been destroyed. This has not only had a distressing economic effect on local fisherman, whose families have made a

living fishing in this area for generations, but also has resulted in a collapse of the food chain. The cod had an important role in the ecosystem and is essential in supporting other marine life, including crustaceans, predator fish and sea mammals.

For the last thirty years the government has sought to facilitate and encourage the recovery of the cod fishing industry through strict catch limits and bans on commercial cod fishing during certain periods of time. Despite these drastic measures, the cod population has not rebounded. As a result, marine biologists have reassessed their method, and are focusing on the impact of "forage fish." Scientific studies have revealed that "forage fish" are a critical component to sustaining the marine ecosystem. This has led to what is called the "Ecosystem" or "Biodiversity" tactic to marine habitat restoration. This approach consists of a combination of methods that include catch limits, but one that is also aimed at fostering and renewing the food chain for cod that is crucial to its long term survival.

II. THE GULF OF MAINE AND THE CRUICAL ROLE THAT "FORAGE" FISH PLAY TO THE SURVIVAL OF THE COD FISHING INDUSTRY

To begin, it is important to understand the big picture. The Gulf of Maine is its own marine ecosystem. It is a "sea within a sea," geographically considered a semi-enclosed embayment with counter-clockwise currents. It consists of 7,500 miles of shoreline, covers 36,000 square miles of ocean, and provides a habitat for over 100 different species of fish. 54% of those fish are ground fish. There is a significant dilution of seawater that occurs because 60 different freshwater rivers flow into the

gulf. ("From the Bow Seat: Cod Excerpt" Video; Lenfest Forage Fish Task Force Report, "*Little Fish, Big Impact*," p. 44 (April 2012)).

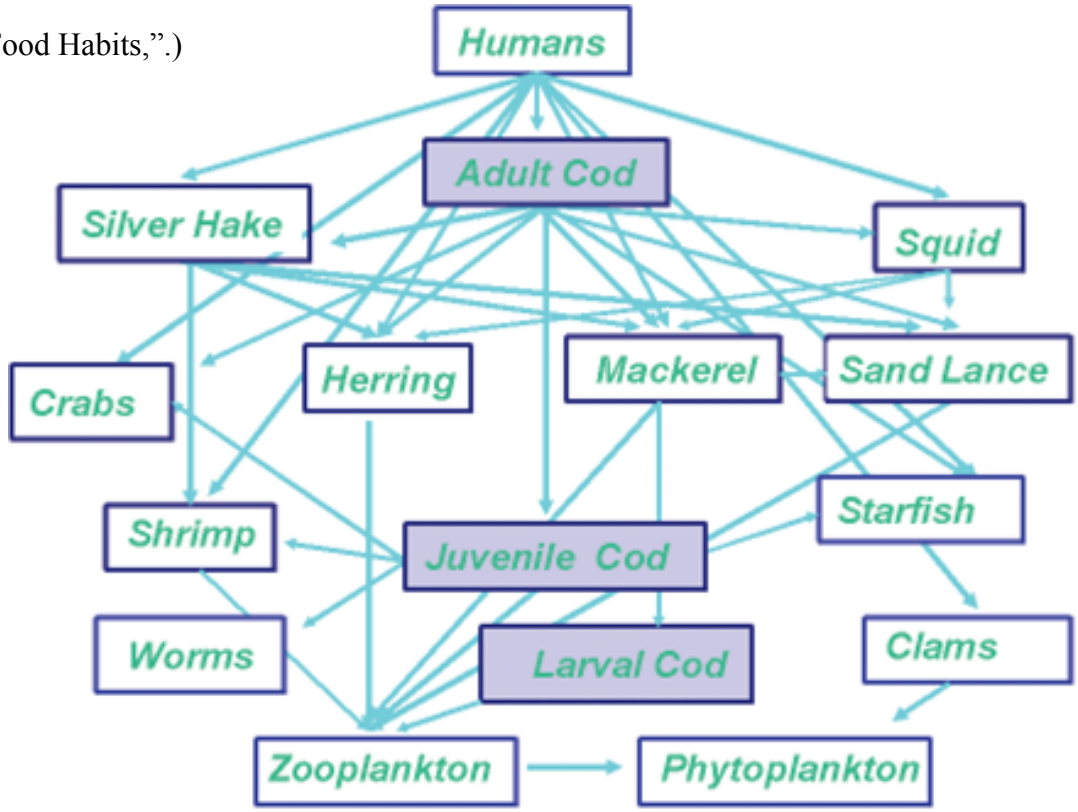
The multitude of geographic factors in The Gulf of Maine has made it a flourishing fishery, until the last 50 years. New England's economic development in colonial times and the 20th Century was attributable to the fishing industry, with cod forming the "backbone" of that industry. Cod was an ideal fish because it could be dried and cured very easily before refrigeration. There are even well known stories abound the abundance of cod in this region. For example, at one, time fisherman could just drop buckets into the water and catch tons of cod without having to use any form of force or labor.

Technological advances have permanently changed the fishing industry. The first was the introduction of "long lining," which increased the amount of cod that could be taken by ten-fold or more. Next was the use of nets, which, with the use of steam ships, exponentially increased the harvest of cod. Today, commercial fisherman use GPS and radar to pinpoint schools of fish. The result of technology and current commercial harvesting of cod has taken away the species ability to reproduce in adequate numbers to sustain its natural population size. For example, it is estimated that currently wild stocks of cod in the Gulf of Maine are only one percent (1%) of the species' 1965 levels. ("From the Bow Seat: Cod Excerpt" Video.)

Initial attempts to renew the species focused on fishing limits and bans on commercial fishing, but the cod stocks in the region have not been increasing. This has led scientists more recently to expand their search, to think of different causes to the quick decline, and to determine what other preservation and fish management

processes can be undertaken. One known alternate cause is the decrease of migratory, or forage fish, which the cod are reliant on as a food source over the same period as the cod decline.

The presence of the many rivers and freshwater estuaries that flow into the Gulf plays a crucial role in the transfer of nutrients essential to the sustainability of the marine ecosystem. The rivers and streams serve as "nutrient highways" by which smaller migratory "forage fish," such as river herring (alewives) and menhaden, function as the "vehicles" by which these nutrients are transported. These smaller forage fish eat zooplankton and phytoplankton - which are important sources of carbon, nitrogen, and phosphorous - that are later transferred to larger predator fish, like cod. Below is an illustration of this food chain, or pyramid, showing this complex connection created by this food web. ("Gulf of Maine Area, Census of Marine Life – Food Habits,".)



Studies show that a growing part of the world's commercial catch (37% by weight) is made up of small forage fish like herring, sardines, anchovies and menhaden. These forage fish are the main diet of larger predator fish, like cod. These oil-rich fish can be caught fairly easily because they travel in large schools. They feed on microscopic plants and animals, and then serve as the primary diet for larger fish like cod. (Opinion, "*Small Fish, Big Opportunity*," posted by Peter Baker (Pew Environment Group) on November 7, 2012)

Forage fish are harvested directly by commercial fisherman because of their great economic value. It is estimated one-third of all ocean species caught around the world are these forage fish. They are "ground up and used in all sorts of products, including feed for pets and livestock, nutritional supplements and salad dressing… and industrial fleets the world over are relentlessly 'harvesting' them with little awareness of the damage this is doing to the oceans' ecosystems." (New York Times Editorial, "*Big Warning on Little Fish*," April 8, 2012.) Most importantly, models created by the Lenfest Forage Fish Task Force show a direct relationship between declines in forage fish and declines in predator fish whose food source is dependent on them. (Lenfest Forage Fish Task Force Report, "*Little Fish, Big Impact*," pp. 56-58 (April 2012).). Thus, the importance of maintaining the quantities of forage fish, as well as their habitats, within this food chain is equally important as imposing catch limits.

In order to reach the goal of re-establishing adequate forage fish stocks, commercial fisherman must be convinced that it is in their economic interest to do so. If commercial fishing fleets believe that continuing to harvest forage fish is

more profitable, they will have no reason to change their actions. A recent study conducted may persuade them otherwise. The study measured and compared the total value of the forage fish catch to commercial fisheries, as a directly harvested product. It contrasted this data with the total value these stocks would affect the commercial catch of larger predator species. The finding was that the value in U.S. Dollars was $5.6 billion, while the forage fish value that supported other larger predator species, like cod, salmon, and tuna, was estimated to be $11.3 billion. (E. Piklich, *et al*., "*The Global Contribution of Forage Fish to Marine Fisheries and Ecosystems*," Fish and Fisheries (Sept. 2012 Blackwell Publishing).) In other words, the value of forage fish to the commercial fisheries for larger species was over twice the value of harvesting forage fish. However, the study did not take into account the added value resulting from sport fishing and tourism, which would further increase the discrepancy. The study is proof of economic reasons to scale back on the direct harvesting of forage fish.

III. ADOPTING AN "ECOSYSTEM" STRATEGY TO MANAGEMENT OF COD FISHERY HABITATS

In order to facilitate the renewal of wild cod stocks in the Gulf of Maine, marine biologists are encouraging what is called an "ecosystem" or "biodiversity" approach to fish management. The U.S. Commission on Ocean Policy has defined this approach as follows:

> *"U.S. ocean and coastal resources should be managed to reflect the relationships among all ecosystem components, including human and nonhuman species and the environments in which they live. Applying this principle will require defining relevant geographic management areas based*

on ecosystem, rather than political, boundaries."

In the past, fishery management has focused on a precise species instead of paying more broad attention to the symbiotic relationships between land, freshwater, and marine ecosystems. The realization that all are interconnected and have a bearing on the others should guide conservation and fish management efforts in the future. Today, conservative catch limitations or bans are not enough to protect forage fish populations from collapse which, in turn, result in the downfall of predator fish populations like cod in the Gulf of Maine. Since methods like limiting catches, banning certain calendar periods and seasons for cod fishing, or and restricting areas in which such fishing may take place, have proven to have little positive effect in increasing the cod population, the focus needs to address the basis of the problem. This approach involves the protection of the habitats of not only the cod, but also the habitats of migratory forage fish, such as the Atlantic herring, which make up their primary dietary source.

The goal is to increase the overall biomass needed to sustain the cod fisheries in the Gulf through a "bottom up" strategy, which includes a combination of measures (one of which includes keeping in place catch limits and seasonal bans on cod fishing).

- First, there is an immediate need to foster the ability of migratory forage fish to breed at levels necessary to support larger fishery stocks of cod. This can be accomplished through the elimination of migratory barriers (such dams) along the major rivers flowing into the Gulf to allow forage fish to swim upstream and spawn in greater numbers. For example, the removal of the Edwards Dam on Maine's

Kennebec River has opened up seventeen (17) miles of river habitat that had been blocked. (Andrew Goode, "The Plight and Outlook for Migratory Fish in the Gulf of Maine," Journal of Contemporary Water Research & Education, Issue No. 134, (July 2006).) An even more ambitious project being studied and planned is the restoration of the Penobcost River, which is the second largest river in New England. Until several man-made dams were constructed to bring electrical hydropower to the region, it served as the main route between land and freshwater ecosystems of Maine, to its coastal marine fisheries. The plan is to remove three of the dams in order to restore 11 species of sea-run fish, while improving access to almost 1,000 miles of inland habitat - including smaller streams and lakes - for these migratory forage fish. Marine biologists estimate the project will increase alewife runs from a few thousand to several million and American shad (river herring) from near zero to 1.5 million annually. (Penobscot River Restoration Trust Project; Internet).

- Another measure that should be used is the elimination of close shore searching of the sea bottom which degrades the natural habitats of important marine species called "benthos." Dredging of coastal areas and estuaries reduces many of these nutrient rich food sources necessary for the survival of forage fish which feed on the benthos. ("Gulf of Maine Area, Census of Marine Life – Food Habits,")

- A third measure is to convince fishing fleets that, in the long-run, it is more profitable to cut back on direct commercial harvesting of forage fish and eliminate mid-water searching, which results in the destruction of these fish populations. As discussed above, statistics show that, from an economic position,

commercial fisherman stand to gain from the reduction in direct commercial forage fish harvesting. The Gulf of Maine Research Institute is using underwater sound waves to measure the negative impact of mid-water seeking on Atlantic herring. ("*Using Acoustics to Examine the Possible Impacts of Trawling on Marine Forage Fish*," Acoustical Society of America 158th Meeting Lay Language Papers, presented October 28, 2009)

IV. CONCLUSION

It has become clear that forcing strict catch limits and seasonal fishing bans on cod has not succeeded in replenishing the abundant fish stock that was once so pervasive in the region. The time has now come to organize additional measures based on an overall "ecosystem" or "biodiversity" approach of fish management, which expands the focus beyond just the particular fish species sought to be protected and saved. Marine biologists are now realizing the interconnection between land, freshwater, and marine ecosystems, the role each has as part of a complex food web and chain, and the importance that each serves to maintain the health and sustainability of the cod fish stocks in the Gulf of Maine.

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