Chile Litoral

DIÁLOGO CIENTÍFICO SOBRE LOS ECOSISTEMAS COSTEROS

Ronald G. Hellman
Rodrigo Araya
Editores

FLACSO-Chile

ACSS
Americas Center on Science and Society

Inscripción N° 141.549, Santiago de Chile.

577.51 Hellman, Ronald, ed.; Araya, Rodrigo, coord.
H477 FLACSO-Chile; Americas Center on Science and Society.
Chile litoral: diálogo científico sobre los ecosistemas costeros. Santiago, Chile, FLACSO-Chile, 2005.
406 p. Serie Libros FLACSO-Chile
ISBN: 956-205-194-3

AGUAS COSTERAS / MEDIOAMBIENTE / PUERTOS / SALMONICULTURA / ECOSISTEMAS / BIODIVERSIDAD / RECURSOS NATURALES / CHILE

Texto compuesto en tipografía *Palatino 11/13*

Producción editorial y diseño de portada: *Marcela Zamorano, FLACSO-Chile.*
Diagramación interior: *Marcela Contreras, FLACSO-Chile.*

Se terminó de imprimir esta
PRIMERA EDICIÓN,
en los talleres de LOM Ediciones,
Maturana 9, Santiago de Chile,
en febrero de 2005.

IMPRESO EN CHILE / PRINTED IN CHILE

ÍNDICE

TERCERA PARTE
CIENCIA Y POLÍTICAS PÚBLICAS

CUARTA PARTE
CONFLICTOS Y RECURSOS NATURALES

Examining Chile's Tenth Region and the tri-State Estuary as Models for Understanding Issues in the Management of World Fisheries

MARTIN P. SCHREIBMAN[1], JOSEPH W. RACHLIN[2], BARBARA E. WARKENTINE[3]

1. FUNDAMENTAL PROBLEMS

It is generally accepted that the biggest problems facing our world fisheries are based in overfishing and pollution. The oceans, once thought of as a vast unending cornucopia of resources that could never be exhausted, are now suffering from major degradation and over exploitation. Commercial fish stocks are in serious decline and it has been estimated that some 70 percent are now fully exploited, over fished, or collapsed, as in the case of the once abundant cod fishery off the grand Banks of Newfoundland. The depletion of natural stocks of fish is magnified by current poor management policies or by our inability to enforce the good ones. This depletion is exacerbated by ocean vessels outfitted with new technology that permits the indiscriminate vacuuming of the ocean floor gathering sought after stock in addition to unwanted bycatch, and in the process of trawling, scouring and degrading of the ocean floor. This latter point is a particular problem on banks, ridges, and the tops of seamounts, where the desired stocks tend to congregate. Urban, industrial and agricultural pollution from point and non-point sources challenge our estuaries, the primary spawning and nursery grounds for commercial and recreational fisheries. Some chemical pollutants that emanate from industrial plants behave as hormone mimics that interfere with fundamental reproductive processes and have impacts that are long term and multigenerational. Dramatic increases in urban populations, especially those in proximity to our coastlines (it is estimated

[1] Aquatic Research and Environmental Assessment Center (AREAC), Brooklyn College, CUNY.

[2] Laboratory for Marine and Estuarine Research (La MER), Lehman College, CUNY.

[3] SUNY Maritime College.

that 80% of the United States' population is within a one hour drive of a coast and this percentage is certain to increase in the next decades) are challenging our ability to adequately treat wastewater and is severely affecting our coastlines. This problem is exacerbated by the fact that many coastal communities and large coastal urban centers have combined storm and sewer systems. These systems become overwhelmed during heavy storm events and flush virtually untreated water into the coastal zone. In many cases the discharge of an overabundance of nitrogenous compounds leads to problems of eutrophication. In addition to these challenges there are the problems associated with, climate change and habitat alteration. These problems are currently global in scope and resolution will require international cooperation.

These issues are pertinent to Chile and to the tri-state (New York, New Jersey and Connecticut) estuarine systems, two study sites in the IACERE Program. Chile's Tenth Region, which encompasses the coastal and estuarine systems of Chiloé Island, is characterized by commercial fishing of wild stocks and extensive net-pen fish farming of non-native salmon species. While these activities contribute to the economic well being of the country, they are not without consequences. Fishery problems become magnified by at least four very obvious conditions. One is the escape of cultured stocks resulting in the alteration of natural populations (genetic dilution and reduction of biodiversity through competition with sensitive species). A second is the introduction of high levels of nitrates and phosphates into the estuarine environment from the net pen fish farms. This increase in nutrient loading is periodically responsible for generating red tides and other harmful algal blooms that can negatively impact the industry. A third concern is the increase in disease, especially parasitic disease due to overcrowding in net pen culture. This constitutes a reservoir from which the escape of these parasites, in large numbers, into the local environment, can potentially affect native stocks. The fourth concern is habitat alteration particularly deforestation. This can lead to extensive erosion and concomitant soil runoff from the land thus degrading the coastal estuaries with silt and chemical additives. Habitat loss from such practices will be exacerbated by increases in population and the expansion of ecotourism, a new form of economic development in Chile. It should be further noted that the competing problem of preserving the natural forest to enhance ecotourism, which on the surface is beneficial to the Chilean economy could, if unregulated, have a negative economic effect through degradation of coastal zones, through increased human activities and disturbance to this sensitive habitat.

In the tri-state estuarine system, we are confronted with similar ecological and economic challenges. In this northeastern region of the United States we have water quality issues, endocrine disrupting chemicals loading, increasing populations and habitat loss as major perturbations in a critical spawning and nursery site for world fisheries. In addition our aquaculture practices in this region, albeit not as extensive as those of Chile, do present similar concerns. In sum, the major challenges to world fisheries are:

a. Approximately 1/3 of national fisheries (2/3 of the world) were over fished or are experiencing over fishing.
b. Although single species regulation has improved conservation somewhat in recent years, current levels of fishing have resulted in significant ecological and economic consequences.
c. The combined effects of over fishing (including recreational fishing), bycatch (27 million tons world-wide), coastal zone habitat degradation (loss of wet lands), and fishing induced food web changes alter the composition of ecological communities and the structure, function, productivity, and resilience of marine ecosystems.

2. PRACTICED AND PROPOSED REMEDIATION AND PROGRAMS OF ACTION

It has become apparent that there is a profound need to respond constructively and immediately to these challenges to insure marine ecosystems and world fisheries stability. Just as the challenges are similar in Chile and the tri-state area, so are the proposed and practiced remediations. Examples of courses of action are as follows: - legislated regulations, management plans, technology development, assessment and restoration, scientific studies involving inventory and monitoring of population dynamics, combined comparative laboratory and field studies, multiple use remediation, education and community outreach, and the establishment of no fishing marine reserves.

a. LEGISLATED REGULATIONS.

The most effective programs for dealing with the issue of water pollution have been to control effluent discharge to our aquatic ecosystems. The Clean Air and Water Acts of the 1970's was instru-

mental in restoring the waters of the New York Bight, the Hudson River, the harbors of New York and New Jersey and the Long Island Sound estuarine systems. An important effect of these acts was the gradual diminution of point source pollutants being discharged into the coastal estuaries. The result has been blatantly clear: striped bass and whiting are back in New York waters in large numbers not seen since prior to the initial degradation of these systems in the post second world war years. Fish from the East and Hudson Rivers can be consumed at New York State Departments of Conservation and Environmental Protection suggested rates that are on a par with fish caught from our "pristine" upstate reservoirs. Additionally, more recreational swimming is seen in the Hudson for individual enjoyment and competitive meets than ever before. In fact there has been increased recreational activity, including boating, in all these waters at levels not seen before.

Chile is the second largest producer of fish meal and fish oil with an industry based on small pelagic fishes like anchovy (anchoveta) and Pacific pilchard (sardenia) in the North and jack mackerel (jurel) in the central and the southern regions. Patagonian Toothfish (Chilean sea bass) fisheries management has been a major concern for Chile and other sea bass-fishing nations because of a rapidly depleting wild stock. The United States alone imports 10,000 tons of fresh and frozen Chilean sea bass, or somewhere between 15 to 20 percent of the worldwide Chilean sea bass catch. A 24-country commission for the Conservation of Antarctic Marine Living Resources is responsible for conserving fish within Antarctic waters, especially to conserve sea bass through strict catch limits. Chilean sea bass trade is regulated and a certificate verifying that the fish were legally caught must accompany the catch. Here is an example of sound legislation. However, lack of adequate enforcement has led to an estimated level of illegal captures running between 100 to 200% above the formal quotas.

Now, more than ever, the emphasis for effective fisheries management is for an *ecosystem-based management* approach suggested by NMFS in 1999 and enhanced by recent Pew Oceans Commission reports. Such an approach has its basis in four requirements: 1) knowledge of the total fishing mortality on targeted and incidentally caught species (which includes mortality from bycatch and regulatory discards); 2) Understanding through research and study, food webs and the nutritional links between species; 3) Understanding the dynamics of the habits of these organisms; and 4) Recognizing and understanding the tradeoffs to biodiversity and population structure within ecosystems

that result from excessive levels of extractions. At present, fisheries practices, for the most part, ignore these essential requirements.

The Pew Oceans Commission has a bipartisan membership that includes fishermen, scientists and elected officials. After several years of study, the Pew Oceans Commission report (2003) proposes the creation of marine ecosystems reserves. They recommend that marine resources can be better protected for future generations by creating vast "no-kill" reserves similar to national parks and by dividing the remainder of the ocean into economic zones for commercial and recreational fishing. This would lead to a halt in trying to protect a single species and switch to a comprehensive ecosystem approach. In order for this concept to work, as with all other regulations, there must be adequate support for law enforcement, regulation and monitoring. There is already a case study in place with encouraging results. In 2002, the California Fish and Game Commission designated 175 square miles of ocean around the Channel Islands as a no-kill marine reserve. This creation of a fully protected marine reserve in the United States serves well as a template for similar reserves in other regions of the United States and in the world at large.

In Addition, it has been proposed that in order to reduce fishing pressure on sensitive stocks by inefficient and subsidized fleets worldwide, that there be established strict regulations and stock quotas in the proposed zones that would be designated for commercial fishing. In this way, the owners of the less efficient fleets can sell their quota rights to the owners of the more efficient fleets, thus reducing the total number of boats hunting these sensitive stocks. This also would serve to positively change the economics of the industry and allow the owners of the inefficient fleets to gradually buy out of the system and prepare for alternative ventures for themselves and their crews over time, rather than continue an economically inefficient operation which results in continued financial loss and the concomitant damage to the sensitive stocks and bycatch.

b. Technology Development

The development of new technology has permitted the construction of super trawlers that are hundreds of feet long and can drag nets up to a quarter-mile wide. These ships are also equipped to process, pack and freeze fish directly on board allowing for quicker distribution to restaurants around the world. Newly developed acoustical equipment

and global positioning electronics have made fishing equivalent to "shooting goldfish in a bowl". On the other hand, technology has also been helpful to our fisheries. Sophisticated water quality monitoring, sensing devises to evaluate aquatic organism migrations and new mechanical and biological filtration to "purify" waste water before it is discharged into our ecosystems, has had far-reaching beneficial effects. Improvement in wastewater treatment has, in large measure, been responsible for the success of the Clean Water Act.

Recirculating Aquaculture System (RAS) technology developed in recent years, essentially through university research, has enabled us to construct water-reuse systems. It is especially useful in that it permits the duplication of a wide range of aquatic ecosystems by being able to set and regulate levels of salinity, temperature and photoperiod. This not only enables us to study and assess the health of an ecosystem, it also permits the growth of a wide variety of aquatic organisms in intensive, carefully monitored, friendly-to-the-environment systems, and within limited space. It is, indeed, the newest form of aquaculture that is capable of being conducted anywhere, including large metropolitan areas (as in, "urban aquaculture"). RAS has been adopted in water-deprived areas such as the Middle East and where excessive use of salmon net-pen culture has severely challenged or destroyed ecosystems, such as in Chiloé Island in Chile. In the latter case, RAS's are now being used for the smolt (freshwater) phase of the salmon life cycle to ease the pressure on natural systems. RAS is also being used more extensively in captive breeding programs, where challenged species are spawned and their offspring returned to their natural environment. Such programs are in place at the Brooklyn College Aquatic Research and Environmental Assessment Center (AREAC) for horseshoe crabs, winter flounders and bivalves. Thus, there is great potential for the application of RAS to study and evaluate perturbations to the environment, understand and regulate the physiological state of aquatic organism and for utilization of aquaculture processes to ease the drain on natural fisheries.

c. Assessment and Restoration

Our water ecosystems are complex and highly dynamic. They are never the same from year to year or even within one day. They are in constant flux from tides, uses/ abuses and from natural phenomena, such as storm events, erosion, sea level rise and temperature elevations. For these reasons constant inventory and monitoring are essential in order

to determine the "health" of our waters. Restoration of heavily impacted marine ecosystems, especially in urban regions, cannot take place without assessment. The question of "restoration" is also problematic - restoration to what? A return to "original" conditions is most often not wise and almost always wasteful because the ecosystems will respond to the same adverse conditions and are more than likely to revert to the same, unwanted, effects. It could be that this is the reason that the majority of restoration programs are unsuccessful and, revert within five years to the original problems for which restoration effects were first initiated. Dredging, a common component to "restoration", leads to enormous acrimonious discourses of resolving the questions of the dredged material, where from?, where to? Clearly restoration activities must consider the current multiuse activities of our coastal systems, and include the goals of all stakeholders in developing meaningful, efficient, and effective protocols and management plans. There are several major assessment and restoration projects in the New York City area. The JABERRT (Jamaica Bay Ecosystem Research and Restoration Team) was a major, multidiscipline, two-year study of 11 sites within Jamaica Bay (a more than 10,000 acre estuary in the heart of New York City). The information gathered by more than 20 science experts and their students will be utilized by the U.S. Army Corps of Engineers, New York Department of Environmental Conservation and Gateway National Recreation Area to "revitalize" these sites. This information is also available to the public on CD-ROM from one of the authors (Martin P. Schriebman).

Another case study in the NYC area is the restoration of the Bronx River and its contiguous coastline. This river, whose origin in the pristine waters north of the city, was impacted and water flow critically reduced by the construction of a dam and reservoir system north at White Plains NY in the late 1800s. Over the years neglect and abandonment of commercial establishments have led to a marked degradation of the shoreline of the Bronx River estuary. In addition, the same industrialization and construction of a major roadway essentially separated this river from local residents resulting in their abandonment of concern for its ecological condition. In recent years public awareness has been rekindled and as a result lobbying on the part of residents and policymakers has brought federal funds for restoration studies, habitat improvement, and community access. These studies are being spearheaded by Drs. Rachlin and Warkentine at the Laboratory for Marine and Estuarine Research (La MER) at Lehman College, CUNY, and involve collaborations with many local governmental and non-

governmental organizations (NGOs). The story of the Bronx River is repeated in other similar challenged estuaries of the city, as for example, the Gowanus Canal, Newtown Creek and the Coney Island Creek.

In Chile the proposed construction of the Chacoa Bridge was preceded by extensive studies on the environment and demographics. The information so derived has affected the decision to construct this connecter of Chiloé Island and the mainland.

d. Scientific Studies

In ocean and estuarine research it is valuable to combine comparative field and laboratory investigations in order to acquire and better evaluate the "big picture". From, understanding the impact of power plants on Hudson River fishes to the causes and effects of harmful algal blooms, it is important to do the environmental assessment in the field and then to dissect the various components and perturbations and reproduce and study them in controlled laboratory experiments. In this way we are in a better position to identify causative agents, understand their mechanisms of action and to institute practices for their elimination or amelioration.

The past decade has witnessed a growing awareness and level of concern regarding the effects of xenobiotic chemicals, such as pesticides, herbicides, and by-products or waste products of industry on the endocrine regulation of reproduction, growth and development in wildlife species and its possible subsequent impact on the human population. These chemical pollutants as a group, are known as endocrine disrupting chemicals (EDC) or hormone-mimicking agents. It is clear that these EDC's are having long-term negative effects, including decline in numbers and years classes of our fisheries by affecting reproductive system development and effectiveness and on gender determination and ratios. It is currently a central focus of the scientific community to identify environmental contaminants with potential endocrine disrupting effects through combined field and laboratory experiments, and to gain a fuller understanding of the impact that these chemicals have on ecosystems and on the multigenerational physiology of organisms within these ecosystems.

Similar experimental design could be applied to aid comprehension of other environmental puzzles, such as the major lobster die-off in Long Island Sound, over wintering mortality of bivalves (especially hard clams) on the eastern end of Long Island and food chain transfer

and impact of pollutants, such as heavy metals including mercury, PAH's, and PCB's.

Challenges to the integrity of our estuaries around the world will certainly lead to declines in world fisheries, for these estuaries serve as vital spawning and nursery grounds for important fisheries that include Atlantic Cod and Chilean sea bass (Patagonian tooth-fish). One such challenge occurs in the vital salt marsh islands in Jamaica Bay, N.Y. It has been estimated that 60 acres are lost each year and that by 2024 these foundations of an important estuary will be gone. To understand the causes of habitat loss and the methods for remediation, a complex multidisciplinary study of the entire ecosystem has been launched. This research is essential for, without understanding the causes of this demise any restoration efforts will be for naught.

3. CREATION OF MICRO-ECOSYSTEMS FOR REMEDIATION

With all the positive benefits of aquaculture, such as providing a safe, dependable and affordable source of food, there are a number of negative features. Not the least is environmental damage to our ecosystems that are being witnessed from Canada to Patogonia, regions known to harbor large and numerous net-pen cages. Methods need to be developed and tested to address organic pollution and eutrophication derived from discharges of fish wastes and uneaten feed that fall to the bottom of the water column beneath the cages. One approach to remediation is the creation of artificial reefs and concomitant co-culturing of organisms. These approaches are being studied in several countries, with Chilean marine biologists assuming a leading role. Artificial reefs constructed beneath net-cages and inhabited by a variety of organisms, including abalone and bivalves could serve to reduce the uneaten feeds and fish wastes. Another remediation approach, the use of marine plants placed in proximity to net-pen cultured animals is also showing promise in controlling excessive nutrient loading. Successful remediation from these measures will serve as a model for a global strategy to reduce the environmentally noxious effects of net pen aquaculture, and improve the quality of the estuarine resources that they now degrade.

4. EDUCATION AND COMMUNITY OUTREACH

A program of educating every level of society, from preschoolers to policymakers and land-users, could be effective in stemming the tide of the perils of over fishing, pollution and habitat destruction. Information based on problem identification and sound science to understand its causes, will be most instrumental in stimulating concerned, effective stewardship of our world fisheries. Even those whose economy is challenged, such as commercial and recreation fisherman, can be made to understand and support the long term benefits to all from creating marine reserves, improving water quality and development of responsible aquaculture practices. Comprehensive management plans of aquatic ecosystems that are being generated by an increasing number of communities, when explained to constituents in understandable terms, can only result in positive returns to our environment. Additionally, comprehensive, comparative programs of study, understanding and communication on a global scale through cooperative programs, such as those of the IACERE/FLACSO-Chile partnership, could serve admirably in this role (Fig.1).

5. SUMMARY STATEMENT

We are moving steadfastly forward in identifying, understanding and ameliorating the challenges to world fisheries. Having a better grasp of the massive dimensions of the problems allows us to more efficiently understand them. It also makes us more effective in communicating the negative impacts that challenged world fisheries and their ecosystems have on economics, social structure, habitat and quality of life. A more comprehensive understanding of the dimensions of the issues that cause degradation of our marine ecosystems and their fisheries places us in a better position to restore and protect them.

BIBLIOGRAPHY

BEACH, D. 2002, Coastal Sprawl: The Effects of Urban Design on Aquatic Ecosystems in the United States,Pew Oceans Commission, Arlington, Virginia.

BRICKER, S.B., C.G. CLEMENT, D.E. PIRHALLA, S.P. ORLANDO, and D.F.G. FARROW. 1999. National estuarine eutrophication assessment: Effects of nutrient enrichment in the nation's estuaries, National Oceanic and Atmospheric Administration, Silver Spring, Maryland.

CARLTON, J.T. 2001. Introduced Species in U.S. Coastal Waters; Environmental Impacts and Management Priorities, Pew Oceans Commission, Arlington, Virginia.

DAYTON, P.K., S. THRUSH, and F.C. COLEMAN. 2002. Ecological Effects of Fishing in Marine Ecosystems of the United States. Pew Oceans Commission, Arlington, Virginia.

GOLDBERG, R.J., M.S. ELLIOT, R.I. NAYLOR (2001). Marine Aquaculture in the US: Environmental Impacts and Policy Options Pew Oceans Commission; Arlington Virginia.

LIMBURG, K.E., MORAN, M.A., and MCDOWELL, W.H. 1985. The Hudson River Ecosystem. Springer-Vertag, New York, Belin, Heidelberg, Tokyo.

NMFS. 2002. *Fisheries of the United States*, 2001. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Silver Spring, Maryland.

NOAA. 2002. National Oceanic and Atmospheric Administration, U.S. Department of Commerce. 13 Feb. 2002. http://sfbay.wr.usgs.gov/access/urban.html.

O'CONNOR, J.M. and RACHLIN,.J.W. 1982. Perspectives on metals in New York Bight Organisms: Factors controlling accumulation and body burdens. P655-685. In: Mayer,G.F. (Ed.) Ecological Stress and The New York Bight: Science and Management. Estuarine Research Federation. Columbia, South Carolina.

PALUMBI, S.R. 2003. Marine Reserves: A Tool for Ecosystem Management and Conservation. Pew Oceans Commission, Arlington, Virginia.

PEW. Oceans Commission. 2003. Socioeconomic Perspectives on Marine Fisheries in the United States. Pew Oceans Commission Arlington, Virginia, America's Living Oceans./ Summary Report., Pew Oceans Comission, May 2003.

RACHLIN, J.W. and WARKENTINE, B.F. 1990. Reexamination of some population dynamics of the silver hake in the New York City Bight. Northeastern Environmental Science 9 (1/2): 66-68/.

RACHLIN, J.W. and WARKENTINE, B.E. Evaluation of Fin fish population dynamics and resource partitioning as a measure of the status of the NY Bight estuarine systems. Fifth Biennial Meeting. International Society for Ecological Economics. Santiago, Chile. November 1998.

SAFINA, C. 1994. Where have all the fishes gone? Science and Technology. 14 Jan.2003. *www.seaweb.org/bckground/safina3.html*

TANACREDI, J.T., SCHREIBMAN, M.P., FRAME, G. (2003). Jamaica Bay Ecosystem Research and Restoration Team (JABERRT) Final Report. Division of Natural Resources Gateway National Recreation Area and Brooklyn College Aquatic Research and Environmental Assessment Center (AREAC). Available on CD.