有明海再生機構設立記念国際シンポジウム

～世界の閉鎖性水域の現状と再生への取組み～

PROCEEDINGS of
"Ariake Bay Rehabilitation Organization"
Opening Memorial Symposium

(DRAFT)

The Present Situation and Efforts of Rehabilitation of Enclosed Coastal Seas in the World

SAGA (HIGASHIYOKA), JAPAN
SEPTEMBER 19, 2005

■Memorial Lecture

Lecturer

Dr. William Cosgrove

Honorary Advisor of Ariake Bay Rehabilitation Organization

(President of the Bureau d'audiences publiques sur l'environnement, Quebec, Canada)

From 1973-1989, he employed by the World Bank initially as Water Resources, Energy and Telecommunications Specialist. He served as President of the World Water Council from October 2003 to January 2005. He was named President of the Bureau d'audiences publiques sur l'environnement in January 2005. He received the World Water Council Gold Medal for Service to World Water in 2000 and the Prix International de Cannes for Water and Economics in 2001. He was made Honorary Fellow of the UNESCO – IHE Training Institute in 2004.

■Panel discussion

Coordinator

Dr. Tetsuya Kusuda

Chairman of the Board of Ariake Bay Rehabilitation Organization

(Professor of Graduate School of Kyushu University, Japan)

He continuously researches the conservation of civil environment from the aspect of both technique and system. Especially, he is making efforts toward solving the problem of deterioration of environment of Ariake Bay. He was named Chairman of the Board of Ariake Bay rehabilitation organization in June 2005.

Panelists

Dr. Jonathan Grabowski

Research Scientist of Gulf of Maine Research Institute, USA

He is researching as a Marine Ecologist. And his research interests are benthic community ecology, fisheries ecology and oceanography, marine population dynamics, etc. Especially, he has lots of experiences in oyster reef restoration.

Dr. Dongsung Kim

The head of Marine Ecosystem Conservation Research Division, Korea Ocean Research and Development Institute, Korea

He is researching as a biological scientist. And his research interests are physio-ecology of meiobenthos, benthic food web, marine conservation and environmental assessment, etc. Especially, he has lots of experiences of research on tidal flats in Korea.

Dr. Ashish Mehta

Professor of University of Florida, USA

He is researching as a coastal and oceanographic engineer. And his research interests are coastal cohesive sediment transport, coastal processes, port and harbor engineering, etc. Especially, he has excellent achievements in sediment transport. He got Hans Albert Einstein Award in hydraulics and sediment transport, ASCE, 2000. Besides the award, he got many other awards.

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« Involving local communities in sustainable development »

Dr. William J. Cosgrove, President
Bureau d'audiences publiques sur l'environnement (BAPE), Québec, Canada

Water is essential to all aspects of human life and economic development. Yet human activity can destroy this essential resource. Like many other seas and rivers of the world exposed to intense human activities, the Ariake Bay ecosystem suffers from environmental changes that affect the welfare of the coastal communities and even impact the economy of Japan.

Engineering works to protect the population and cultivation against natural hazards such as rainfall-induced river floods and typhoon-induced high tides (both possibly enhanced by climate change), as well as growing urbanization and agricultural development and secular land reclamation have had serious impacts on the Ariake Bay and its coastal environment. With the deterioration of the marine ecosystem, fisheries have severely decline and seaweed cultivation is endangered. In 2000, red tides caused an unprecedented poor harvest of seaweed (Nori (*Porphyra spp.*). Nori is one of the most important foods in Japan and about 40% of the national product is cultivated in this region.

It is widely recognized that the active participation of non-government stakeholders and the public in the decision making process is a crucial element in mobilizing solutions for the restoration of impaired ecosystems. Information exchange and partnerships help the non-scientific community to better understand environmental issues and may provide a way to release individual capabilities and enlist community support for the benefit of the Ariake Bay Restoration Organization (ABRO).

Two ways to promote action by developing partnership with local communities for improved water resources management have been successful in Québec, Canada. Since 1988, the St. Lawrence Vision 2000 Action Plan, a federal - provincial effort to revitalize the St. Lawrence River, has reached concrete results through empowering local communities to participate in the process. Under the federal Oceans Act in 1997, the Marine Protected Areas Program provides a new approach to the integrated management of oceans based on partnership, prevention and sustainable development. This program is a useful tool for coastal communities, which are dependent on the health and productivity of marine ecosystems.

The Bureau d'audiences publiques sur l'environnement (BAPE), established in 1978, is a quasi-judicial government organization that encourages participative democracy. It informs and consults the public on questions related to the quality of the environment. The BAPE commissions examine proposed projects from a sustainable development perspective that encompasses the biophysical, social and cultural aspects. It transmits the concerns of citizens to the decision makers. In addition to conducting hearings on specific projects, the BAPE has carried out hearings throughout Québec on major national issues such as long-term waste disposal, water management, and sustainable hog-farming.

These three examples from Québec adapted to the local circumstances and culture, may provide some hints on how to approach the restoration of the Ariake Bay and its coasts.

Application of Integrated Water Resources Management to the Ariake Bay Restoration Organization (ABRO)

« *Involving local communities in sustainable development* »

Dr. William J. Cosgrove, President
Bureau d'Audiences Publiques sur l'Environnement (BAPE)
Quebec, Canada

Higashiyoka Town, Japan
19 September, 2005

The Global Water System

It is a truism that "without water, there is no life". Indeed all aspects of human life and livelihoods require water. The quantity of water on our planet has been the same since the origins of the planet four billion years ago. Until recent geological times the few humans who occupied the planet migrated to find water to meet their needs as the rainfall patterns shifted. In the past few hundred years the human population has multiplied, indeed three times during the past century. At the same time, humans have found new economic and social uses for water, so that human consumption of water has multiplied even faster than the population - six times during the past century.

Runoff from rainfall is equal to over 40,000 cubic kilometres per year. And humans withdraw only about 3,000. So why is there a water problem? It is because the rainfall is distributed unevenly over the planet, and certainly not in patterns that match those of population distribution. Indeed most precipitation falls on parts of the planet that are uninhabited. In some areas the runoff from rainfall is not sufficient to meet the basic needs of humans to feed themselves. Other regions are coming to this state as their populations continue to grow and the demand per capita for water increases to provide a higher standard of living.

The water cycle, locally and globally, is not only a process of precipitation and evaporation, but includes interacting biological and biogeochemical, physical and human impacts. Human activity is becoming the major disrupter, without our even being aware of the consequences of our activities. For example[1]:

- Emissions of greenhouse gases may accelerate the hydrological cycle with resulting increased frequency of extreme events; loss of snow cover and mountain ice and other consequences.
- Deforestation, wetland drainage, irrigation and evaporation in reservoirs may result in withdrawals exceeding available supplies resulting in the need for reuse (with accompanying public health and pollution problems) and groundwater mining.
- Dams, interbasin transfers, stream canalisation and human settlement of floodplains change the residence time of runoff and may change migration paths of aquatic organisms.
- Increased erosion from deforestation, grazing, agriculture and construction may cause reduction in agricultural fertility upstream, habitat destruction, loss of reservoir investments through silting and property loss on eroded shorelines.
- Inadequately treated wastes from industry, mining, urbanisation and agriculture may accelerate eutrophication, create coastal zone anoxia and result in harmful algal blooms and fisheries loss as well as posing a public health threat.

[1] Humans Transforming the Global Water system; C. Vorosmarty et al; Transactions American Geophysical Union, Vol 85, No. 48, 30 November 2004.

Local systems – the Saga Plain and the Ariake Bay

The morphology of the Saga Plain is characterized by a vast and flat lying landscape widely below sea-level that has been one of the greatest breadbaskets in Japan for centuries, mainly for rice cultivation. With time, a unique irrigation system was developed to retain water for agricultural purposes, thus creating a shortage of water for other uses downstream and leaving a hydrological regime greatly altered, both in quantity and quality, by human activity. The Saga Plain drains itself through many rivers into the Ariake Bay, a semi-enclosed sea, 80 km in length and 45 km in width with a average depth of about 15 m. The Ariake Bay forms one of the most important shallow water regions for fisheries in western Japan. Strong tidal mixing induced by a very large tidal range and high turbidity prevented red tide occurrences in the past, but in 1980s red tide began to occur more frequently.

Engineering works to protect the population and cultivation against natural hazards such as rainfall-induced river floods and typhoon-induced high tides (both possibly enhanced by climate change), as well as growing urbanization and agricultural development and secular land reclamation have had serious impacts on the Ariake Bay and its coastal environment. With the deterioration of the marine ecosystem, fisheries have severely decline and seaweed cultivation is endangered. In 2000, red tides caused an unprecedented poor harvest of seaweed Nori (*Porphyra spp.*). Nori is one of the most important foods in Japan and about 40% of the national product is cultivated in this region.

It is widely recognized that the active participation of non-government stakeholders and the public in the decision making process is a crucial element in mobilizing solutions for the restoration of impaired ecosystems. Information exchange and partnerships help the non-scientific community to better understand environmental issues and may provide a way to release individual capabilities and enlist community support for the benefit of the Ariake Bay Restoration Organization (ABRO).

Participative approach in Canada

As a maritime artery and a recreational and economic resource, the St. Lawrence River has always fuelled Quebec's growth and vitality. More than 80% of the population live along its banks, and 50% draw their drinking water from the river. Many Quebecers rely on the river's fisheries for a living. But this major river ecosystem, the largest in eastern North America, is in danger. The river is being strangled by the economic development it made possible. Drinking water is in jeopardy, swimming has been out of the question for many years, the St. Lawrence beluga, a marine mammal at the top of the food chain, and other species are threatened, habitats have been destroyed or have severely deteriorated, sports' fishing has suffered and commercial fishing is in crisis. Public concern about this situation has been growing. Specialists who monitor the changing quality of the ecosystem unanimously agree that toxic pollution from industrial sources is having a negative impact on the environment. There are biological indicators that attest to this situation, including diseases of belugas and contamination of shellfish. It has become increasingly clear that the entire food chain is tainted by toxic pollution. It was important to act, if we wanted to pass on this living heritage, the St. Lawrence River, to future generations. Most threatening was the problem of industrial pollution caused mainly by the many industrial plants, located along the river and on the Great Lakes upstream.

The St. Lawrence Action Plan

The St. Lawrence Action Plan (SLAP) involves the government of Canada and Québec which **have** co-ordinated their activities to clean up the St. Lawrence River during a three five-year successive phases for the 1988 and 2003 period. The forth phase is pending but an agreement will be signed during the fall of 2005. In June 1988, they announced the implementation of a vigorous clean-up and protection plan for the St. Lawrence River. Phase I (1988-1993) is based on the principles of sustainable development and aims to implement the four following components: restoration, protection, conservation and state of the environment.

The beginning of a solid partnership

Right from the start, all stakeholders capable of contributing to the success of the SLAP are rallied. It is believed that it is essential to create a harmonious partnership of all parties from other levels of government, universities and the private sector. Environmental groups are also called upon to collaborate closely in the proposed activities, particularly with respect to the protection of wildlife habitats.

After five years of a first action plan for the protection, conservation and clean-up of the St. Lawrence ecosystem, both the Canadian and Quebec governments signed once again a second agreement under the new name St. Lawrence Vision 2000 (SLV 2000), this agreement ran until 1998 after stimulating and harmonizing the efforts of as many partners as possible. SLV 2000 (1993-1998) not only carries on the work of the SLAP, it also seeks to address new issues and follows a different approach in that the focus is now on partner participation and a larger field of action. For a more comprehensive, integrated approach, SLV 2000 expands its activities into new areas of action to reach seven areas of action: biodiversity, agriculture, community involvement, decision support, health, protection and restoration. The plan also addresses non-point-source pollution from seven of the major St. Lawrence's tributaries. SLV 2000 also encourages the active participation of partners from the private sector, universities, environmental groups, research centres and local organizations.

The community involvement

SLV 2000 calls for more public participation with the ZIP Program (figure 1). Local advisory committees are being established for each ZIP and public consultations are being held to prepare Environmental Remedial Action Plans (ERAPs). SLV 2000 also offers financial assistance to organizations wishing to carry out local protection and restoration projects with the Community Interaction Program. The ZIP Program is the result of a partnership between the federal and provincial governments and *Stratégies Saint-Laurent* (SSL), a nongovernmental organization which works at the local level with riverside communities. SSL provides support to all the ZIP Committees and co-ordinates their creation, ensuring that they are representative of the different segments of society. ZIP Committees are majority members in SSL, representing a broad range of environmental groups, socio-economic and socio-community groups, municipalities, industries and citizens in each study area. They are truly the cornerstone of the program's implementation. Under Phase II, and by virtue of the ZIP Program, riverside communities were able to take an active part in protecting, restoring, and reclaiming the St. Lawrence River.

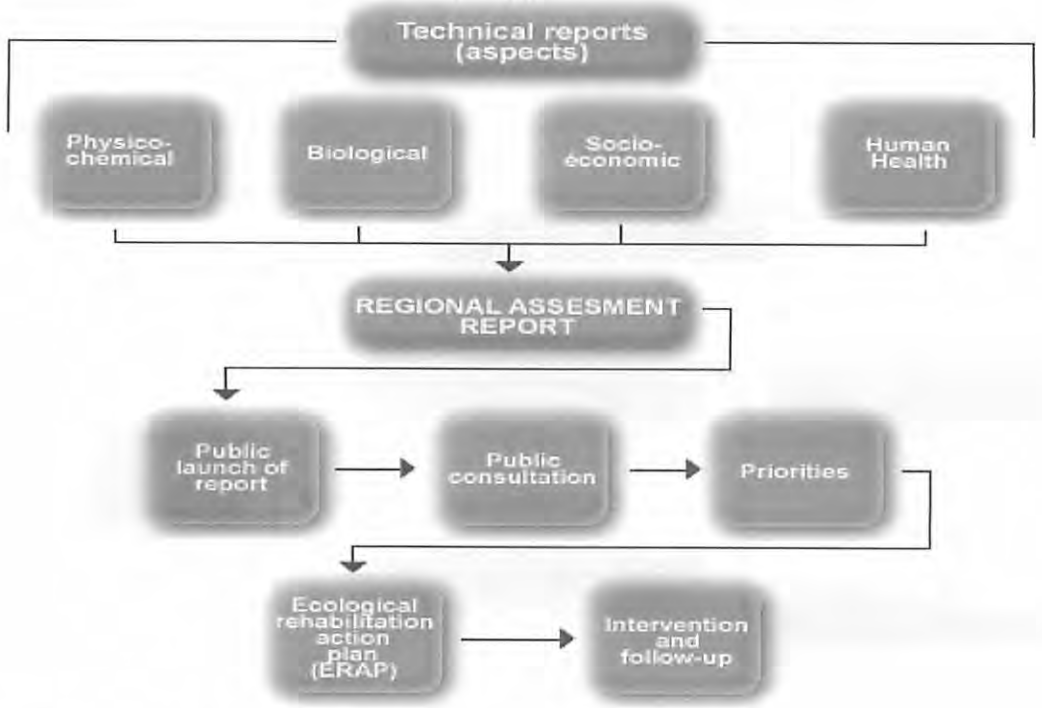


Figure 1. The stage of the ZIP program

Phase III (1998-2003) of the SLAP has two distinguishing features. One is the growing public involvement in protection and conservation of the St. Lawrence River. The other is the increasing efforts to build consensus among all partners with a view to achieving concrete and measurable results. This consensus building is present at all levels. The community involvement priority area puts the focus on action at the local level. A federal-provincial team has accomplished the task of preparing *environmental assessment* of 14 study areas (figure 1). The findings are available in a series of reports on the biological, physico-chemical, socio-economic and health aspects in each of the 14 areas covering the St. Lawrence River. This marks the first time that this type of information has been published in the form of technical reports and a regional assessment report for each area. The *consultation* process takes the form of a symposium organized by the ZIP Committee. Participants are invited to discuss the environmental assessment and identity priorities for action in their territory. An *Ecological Rehabilitation Action Plan* (ERAP) is then developed by the ZIP Committee, in co-operation with local stakeholders (figure 2). The ERAP will serve to determine, the appropriate course of environmental action, in keeping with the priorities identified during the public consultation process.

Implementation of the ERAP fosters the community's involvement in the projects conducted by the ZIP Committees, among others. ZIP Committees also receive technical and scientific assistance from government in conducting their projects. In implementing the ERAP, the different government stakeholders work together to co-ordinate their actions. This unique

alliance has allowed riverside communities all along the St. Lawrence River to identify their local priorities for action and to develop their own ecological rehabilitation action plans. The process is a dynamic one that relies upon local participation to make it work.

Source: http://www.slv2000.qc.ca/index_a.htm

Figure 2 The Ecological Rehabilitation Action Plan (ERAP)

The marine protected areas program

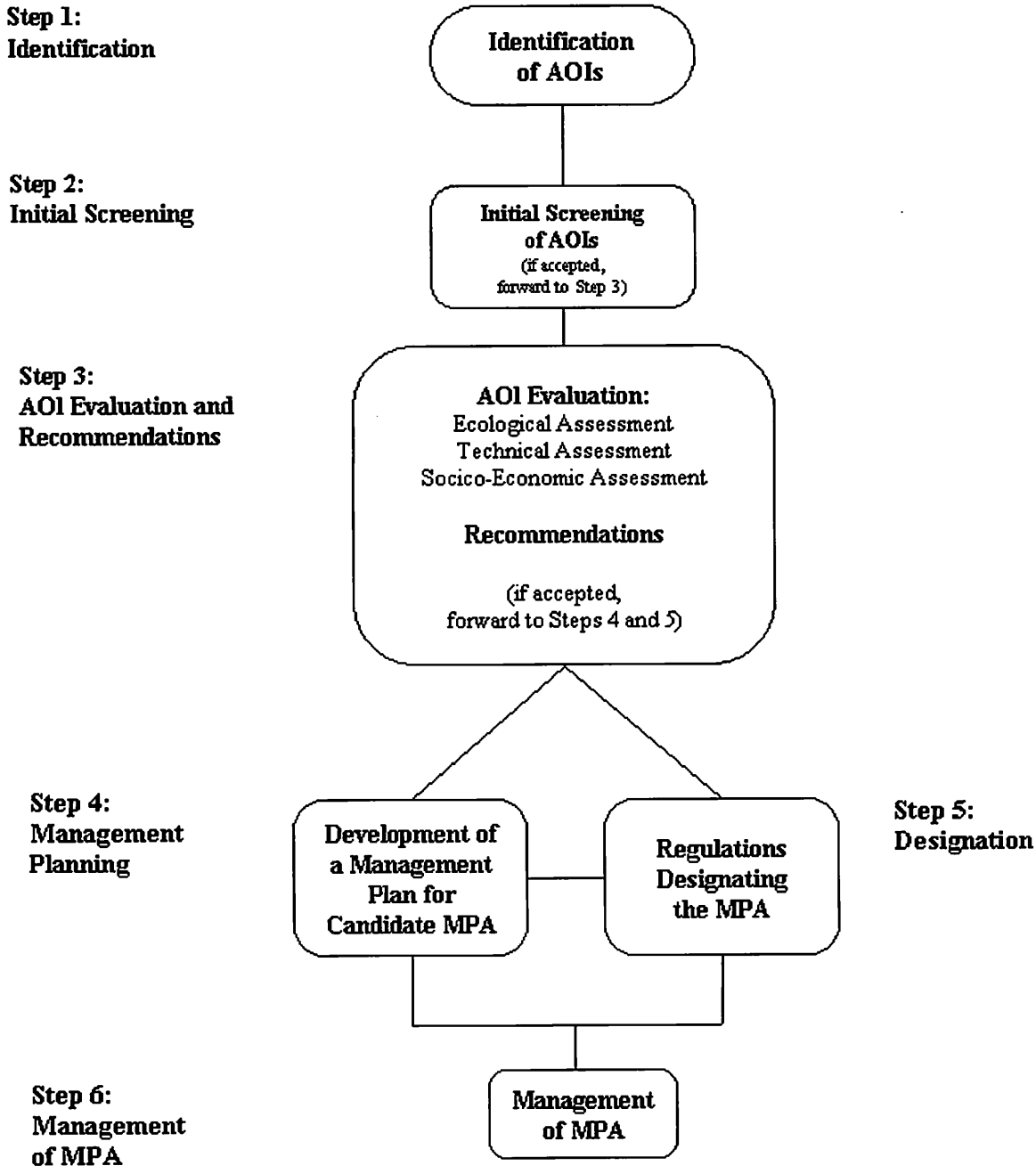
In Canada, and across the world, there is a growing recognition that marine protected areas have a critical role to play in the conservation and protection of marine life and their habitats. Canada's oceans are rich and have enormous potential to benefit both present and future generations. Our coastal and offshore marine ecosystems are host to a remarkable diversity of species including marine mammals, fish, and a wide variety of invertebrate species and plants. However, threats to the biodiversity, productivity and ecological integrity of marine ecosystems must be addressed, not only because we value our oceans but also because coastal communities and regional economies depend on healthy productive oceans.

Canada's *Oceans Act* came into effect in 1997 and provides tools to develop a new approach to the integrated management of oceans based on partnerships, prevention and sustainable

development while respecting existing jurisdictions. One of these tools is the creation of marine protected areas (MPAs) to conserve and protect unique habitats, endangered or threatened marine species and their habitats, commercial and non-commercial fishery resources (including marine mammals) and their habitats, marine areas of high biodiversity or biological productivity, and any other marine resource or habitat requiring special protection. It is important to note that MPAs are not marine parks. MPAs are first and foremost a tool to better manage human activity, some aspects of which may threaten marine living resources, species or habitat.

Once an MPA is established, concrete measures can be implemented in order to meet protection objectives specific to the targeted area. MPAs are therefore a useful tool for coastal communities, which are dependent on the health and productivity of oceans. MPAs are implemented via management plans and regulations. MPAs are characterized by the following aspects: a flexible management tailored to specific needs, an approach based on partnership and prevention, the respect for existing jurisdictions and Aboriginal rights. The current activities may be maintained within a sustainable development context. Interestingly, the MPA zoning may be permanent, temporary or seasonal in order to reach various levels of protection.

Figure 1: Framework for Establishing and Managing MPAs under the Oceans Act



A case study: the Manicouagan MPA

The Manicouagan Peninsula is located in Quebec on the North Shore of the St. Lawrence Estuary, immediately west of the city of Baie-Comeau (figure 3). The area extends

southward from the shoreline into the Laurentian Channel (to the 300 m isobath) and covers about 700 km².The purpose of the proposed MPA is to conserve, protect and better understand the peninsula's estuarine and marine ecosystems, including their rich biodiversity and biological productivity, while sustaining those activities taking place in the area that are consistent with this purpose. The marine environment around the Manicouagan Peninsula area is one of the richest and most productive in the St. Lawrence system. The convergence of freshwater from three rivers (Betsiamites, Outardes and Manicouagan) with salt water from the lower estuary, create ideal conditions for the growth of phytoplankton, microscopic algae that forms the basis of the food chain for the lower estuary and part of the Gulf of St. Lawrence. It attracts a variety of invertebrate, fish and marine mammal species from vastly diverse habitats extending out into deep waters. The presence of large concentrations of seabirds is also a good indicator of the high biological productivity in the area.

The proposed MPA also includes salt marshes which are known to be amongst the most productive habitats on the planet. The area is also rich in eelgrass beds, aquatic plants that colonize sandy tidal flats and which serve as shelter, food source and breeding ground for many marine species. Sand flats in the area harbour the largest clam beds in Quebec and also provide rest and whelping areas for a colony of harbour seals, the only species of seals to reside in the St. Lawrence Estuary year-round. This area of interest (AOI) was initially proposed for designation as an MPA by Pointe-aux-Outardes Nature Park, an environmental non-government organization (Step 1). Following the selection of this Area of Interest by the Department Fisheries and Oceans (DFO) of Canada in 1998 (Steps 2 and 3), a technical committee including representatives from the Manicouagan Regional Municipal County, Betsiamites Band Council, Pointe-aux-Outardes Nature Park and DFO, drafted a preliminary management plan for use in public consultations which were carried out in the six involved communities (Step 4). The designation of the Manicouagan MPA through regulation under the *Oceans Act* is expected to occurs in the winter of 2006 (Step 5) and the development of a management plan is on-going (Steps 4-6).

Source: http://www.dfo-mpo.gc.ca/home-accueil_e.htm

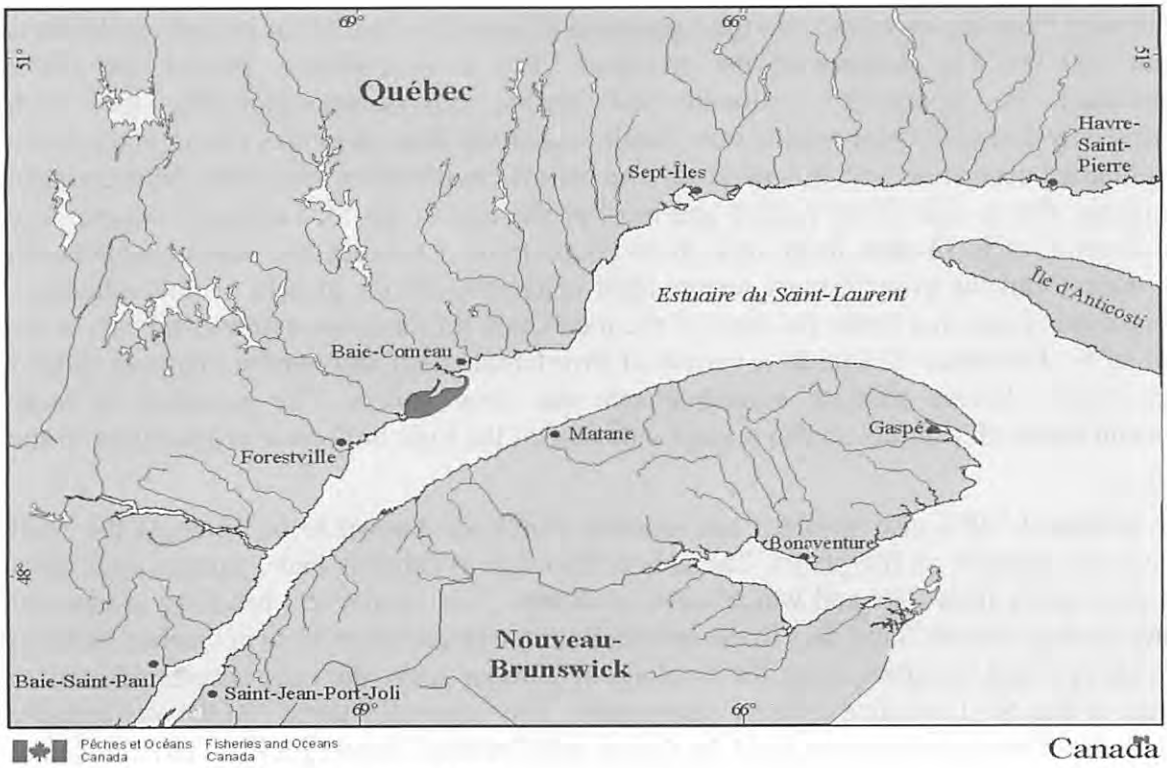


Figure 3 The Manicouagan MPA

THE BAPE: a tool for participative democracy

« Our vision is that of a Québec where the citizens of all regions are better informed about environmental questions and major projects submitted for public consultation. Citizens know that they have the possibility of being consulted by an independent and impartial organization to ensure that their concerns and opinions are taken into consideration when the government makes its decision »

The Bureau d'audiences publiques sur l'environnement (BAPE) is a quasi-judicial government organization dedicated to informing and consulting the public on questions related to the quality of the environment. The BAPE reports to the Minister of Sustainable Development, Environment and Parks who entrusts the organization with its mandates. BAPE members are appointed by the government. With the help of the BAPE, which serves as a participative democracy, social convergence and decision-making assistance tool, citizens can influence the decision-making process when it comes to projects that may have major repercussions on the environment.

In 1978, the Québec National Assembly passed the Act to amend the Environment Quality Act. The effect of this legislation was to establish the Bureau d'audiences publiques sur l'environnement, to provide for its composition as well as its role, and to establish for certain projects an environmental impact assessment and review procedure calling on public participation. The types of project subject to this procedure include roads, waste elimination sites, electricity production, transmission and distribution facilities, industrial projects, etc.

At the request of the Minister of Sustainable Development, Environment and Parks, the BAPE makes available the documents related to a project during a public information and consultation period. During this period, citizens, groups, organizations and municipalities can request a public hearing. Unless the Minister deems the request frivolous, he mandates the BAPE to hold an inquiry and a public hearing or mediation. The results of the public consultation and the analysis made by the commission are then sent to the Minister.

Stages that a project goes through prior to the BAPE

Proponents must first inform the Minister of Sustainable Development, Environment and Parks of their intention to carry out a project. By way of a directive, the Minister informs the proponent of the elements that must be found in his impact study: the justification for the project, the project's variants, the description of the natural and human environment, the project's impacts, mitigation measures, etc. When the impact study is deemed admissible, the Minister of Sustainable Development, Environment and Parks mandates the BAPE to make it available to the public along with the other documents related to the project, and to hold the public information and consultation period.

Information and consultation of the file

The information period is a 45-day period during which the BAPE makes available to the public the documentation related to the project. For this purpose, the BAPE opens consultation centres in the region in question and deposits all the information at the BAPE documentation centres. At these locations, interested persons can consult the impact study and its summary prepared by the proponent, as well as other documents related to the project. All the documentation is also made available on the BAPE web site. To inform the public about the environmental assessment procedure, the BAPE's role and the project under study, the BAPE hold an information session in the region where a project is to take place. Interested persons can register their comments concerning a project in a register that is available at all the consultation centres. At the end of the information period, the BAPE sends the Minister of Sustainable Development, Environment and Parks a factual report recalling the questions and comments received during this period. The information found in the register also enables the BAPE to get in touch with those persons interested in following the progress of a project, should the Minister mandate the BAPE to hold environmental mediation or a public hearing.

Request for a public hearing

During the public information and consultation period, any person, group, organization or municipality may submit to the Minister of Sustainable Development, Environment and Parks a request for a public hearing, which is a written explanation of the reasons for their request and their interest in the environment affected by the project.

Public hearing

Unless the Minister of Sustainable Development, Environment and Parks deems the request frivolous, he entrusts the BAPE with a mandate to make inquiry and to hold a public hearing. The President of the BAPE sets up a commission and designates the BAPE member who will serve as commission chairman. Commissioners have the status of an investigator and, as a result, benefit from quasi-judicial powers allowing them, among other things, to require the

tabling of documents in order to make them available to the public. Commissioners are empowered to take such action under An Act respecting public inquiry commissions. They must take an oath and must also abide by a code of ethics and professional conduct. In addition to making inquiry, the commissioners help citizens understand the technical aspects associated with a project. The hearing takes place in two parts: the aim of the first part is to inform the public and the commission about the project, whereas the second part centers on obtaining the public's opinions.

First Part of the public hearing: obtaining information

Public hearings are held in two parts. At the start of the first part, the commission listens to the applicants, namely those persons who have asked the Minister to hold a hearing, who want to explain the reasons for their request. The proponent then presents his project and the anticipated repercussions on the environment. Following his presentation, the proponent and the resource persons of the various departments and organizations invited by the commission answer the questions raised by the public and the commissioners in order to provide them with the most comprehensive and most understandable information possible.

Preparation of briefs

Once the first part of the hearing has been completed, the persons, groups, organizations or municipalities prepare their intervention for the second part, which is reserved exclusively for expressing their opinions. Citizens have at least 21 days to draft their brief or to prepare their oral presentation. For this purpose, they have access to the impact study, the documents submitted, and the transcriptions of the sessions of the first part, which are available on the BAPE web site and at the consultation centres.

Second Part of the hearing: voicing opinions

The commission wants to hear the public's opinions during the second part of the public hearing. Any person may submit a brief or make known verbally their opinion and their suggestions concerning the project, the impact study or any other document related to the file. The only formality consists of informing the coordinator at the commission's secretariat. During the second part, a brief may also be submitted without having to make an oral presentation before the commission. When a brief is presented or an oral presentation is made, the commission may ask the authors questions concerning any aspect of their presentation. Finally, during each public session, the commission can hear all those persons who wish to rectify facts related to the project brought up during the second part of the hearing.

BAPE report

Following the second part of the hearing, the briefs submitted and the transcriptions of the second part are added to the documents already available at the consultation centres. In the regions, these documents will remain available until the end of the commission's mandate. In Québec and in Montréal, the documents are available on a permanent basis at the BAPE documentation centres and, as the case may be, on the BAPE web site. The commission drafts the report, which contains an analysis of the viewpoints expressed during the hearing and reports on the commission's findings and opinions. At the end of the commission's mandate, the BAPE report is submitted to the Minister of Sustainable Development,

Environment and Parks, who then has 60 days to make public the BAPE report. In light of the BAPE report and the environmental analysis prepared by his department, the Minister makes his recommendation to the Cabinet, which is responsible for the final decision concerning the project. This decision may be to authorize the project, with or without changes and under the conditions that the Cabinet determines, or to turn down the project.

Source : http://www.bape.gouv.qc.ca/

CONCLUSION

"Virtual water" is the water that is needed to grow and process foods and other products. Japan imports 168 billion m^3/year of virtual water (including that in food) compared with withdrawals in Japan of 92 billion m^3/year (including that for irrigation)[2]. Thus Japan is dependent for its survival on sustainable water management practices at home and in the countries from which it imports food and other products, just as it depends on oil imports for much of its energy.

A large proportion of the Japanese population lives in flood plains on the coast. Steep rivers run from the mountains to the sea. The consequence is that Japanese water managers gained a lot of experience in storing water to prevent flood damage and to supply water during periods of low rainfall. The real time weather observation network and warning system in Japan is one of the most advanced in the world. Other technology such as that for water and wastewater treatment is also among the most advanced in the world.

Japan was one of the first countries in the world (if not the first) to adopt a water law that made provision for sustaining the environment. The cultural links between the people and water are recognised and previous infrastructure that broke these links is being rethought.

Québec is committed to water management with the full involvement of its citizens. We believe that this approach will ensure the sustainability of this essential resource. Perhaps some of our experience may be adapted to the circumstances and culture of the people in the Ariake Plain

[2] Oki, Prof. Taikan et al; Virtual Water Trade to Japan and in the World; 2002

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Québec

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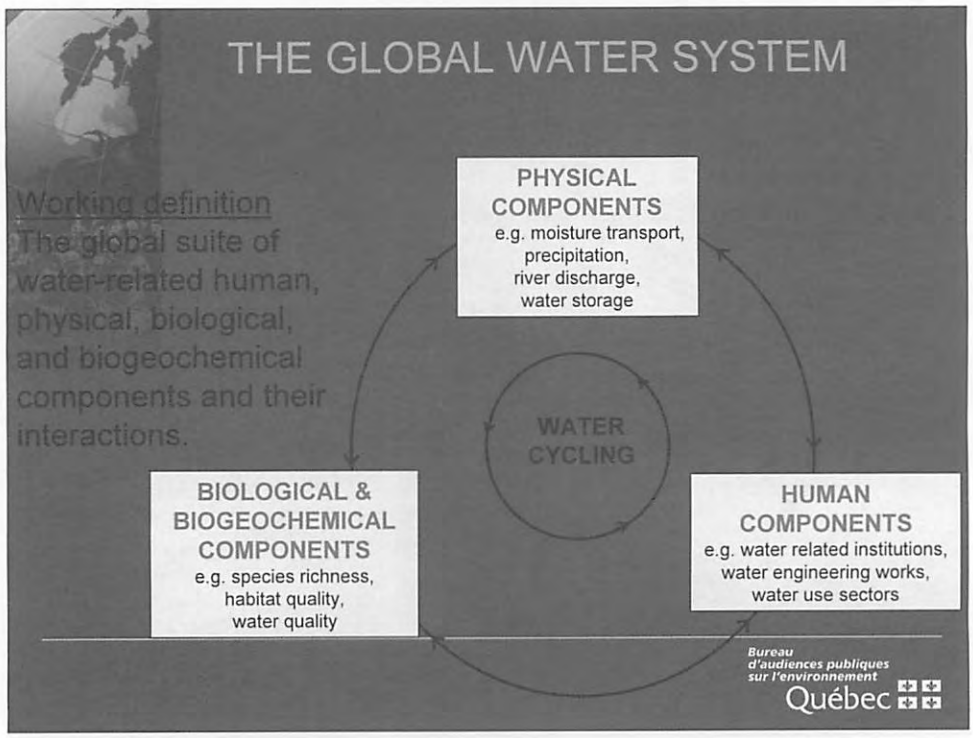
THE GLOBAL WATER SYSTEM
Working definition
The global suite of water-related human, physical, biological, and biogeochemical components and their interactions.
PHYSICAL COMPONENTS
e.g. moisture transport, precipitation, river discharge, water storage
WATER CYCLING
BIOLOGICAL & BIOGEOCHEMICAL COMPONENTS
e.g. species richness, habitat quality, water quality
HUMAN COMPONENTS
e.g. water related institutions, water engineering works, water use sectors
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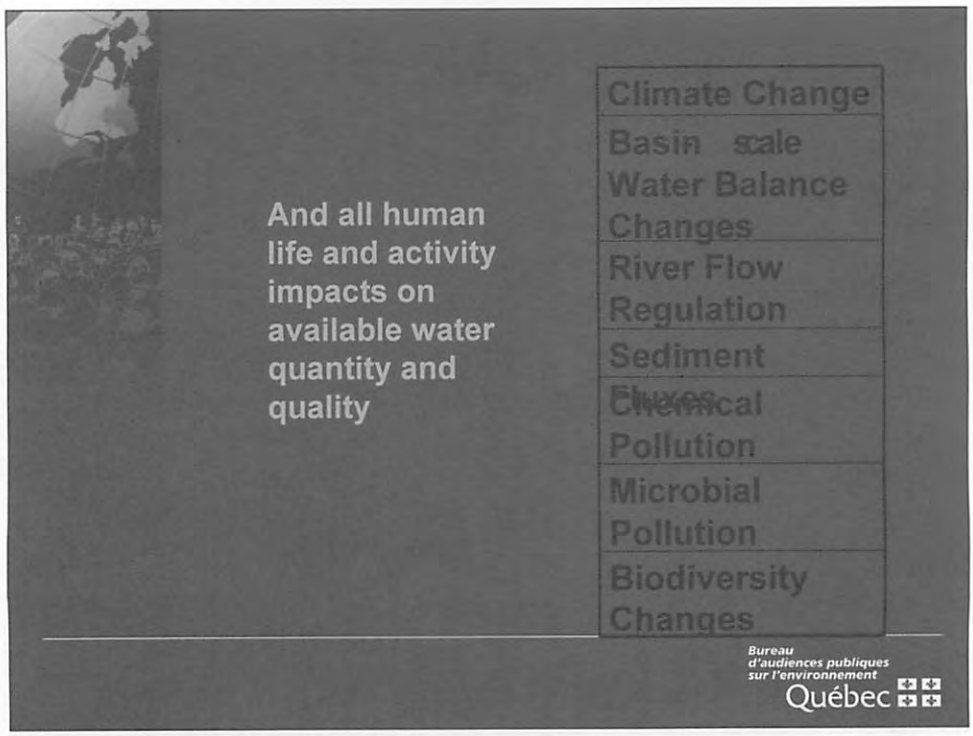
And all human life and activity impacts on available water quantity and quality
Climate Change
Basin scale Water Balance Changes
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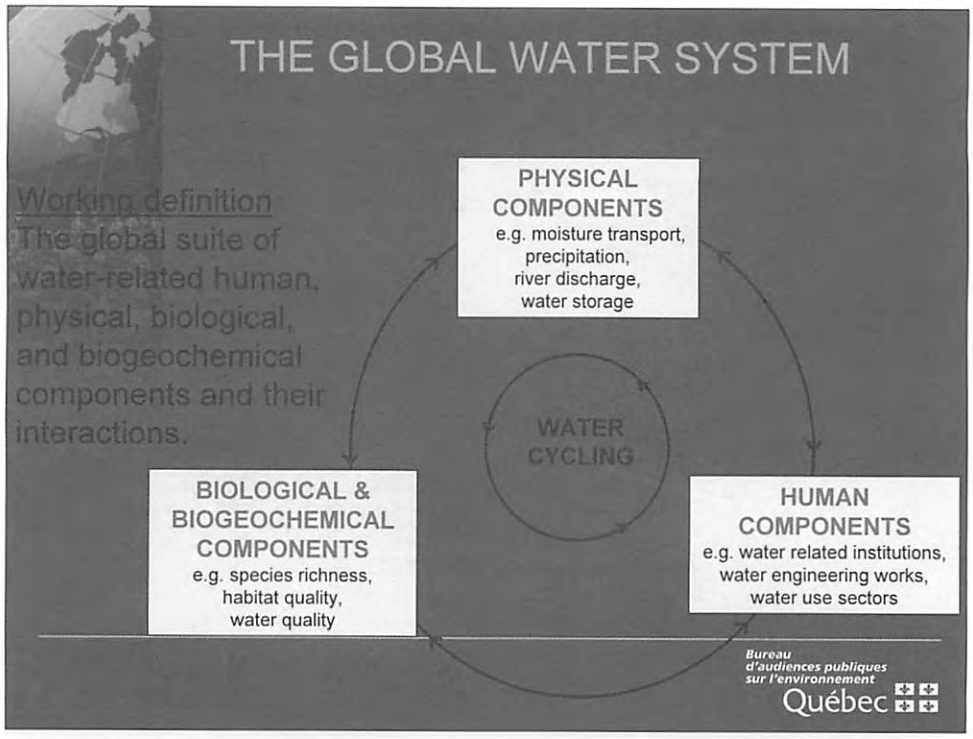
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e.g. water related institutions, water engineering works, water use sectors
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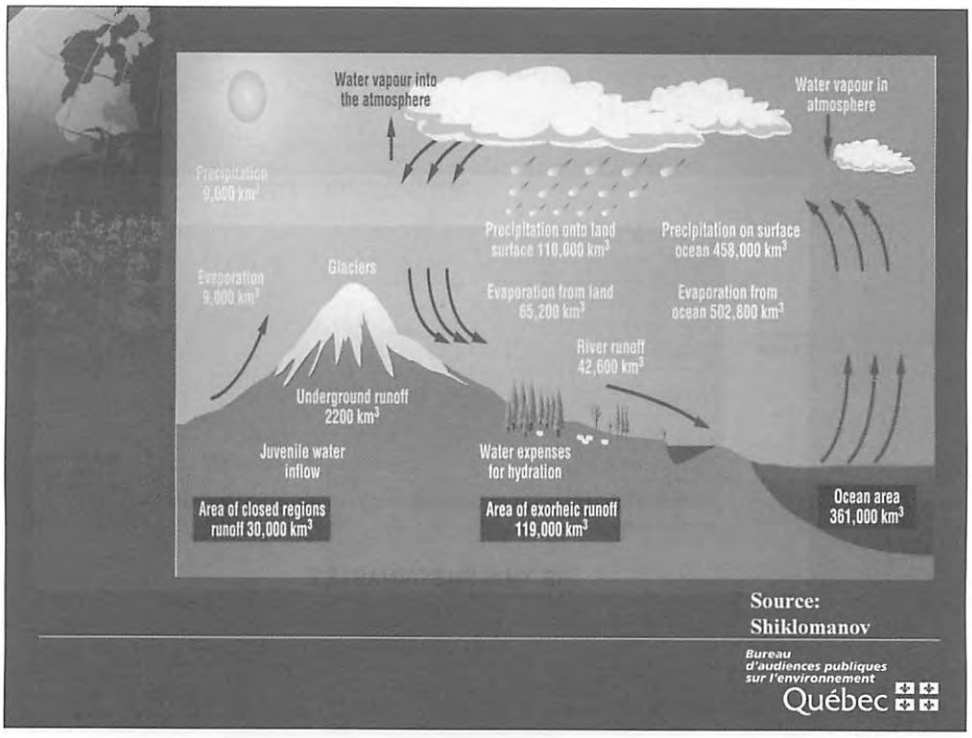
Water vapour into the atmosphere
Water vapour in atmosphere
Precipitation 9,000 km³
Precipitation onto land surface 110,000 km³
Precipitation on surface ocean 458,000 km³
Evaporation 9,000 km³
Glaciers
Evaporation from land 65,200 km³
Evaporation from ocean 502,800 km³
River runoff 42,600 km³
Underground runoff 2200 km³
Juvenile water inflow
Water expenses for hydration
Area of closed regions runoff 30,000 km³
Area of exorheic runoff 119,000 km³
Ocean area 361,000 km³
Source: Shiklomanov
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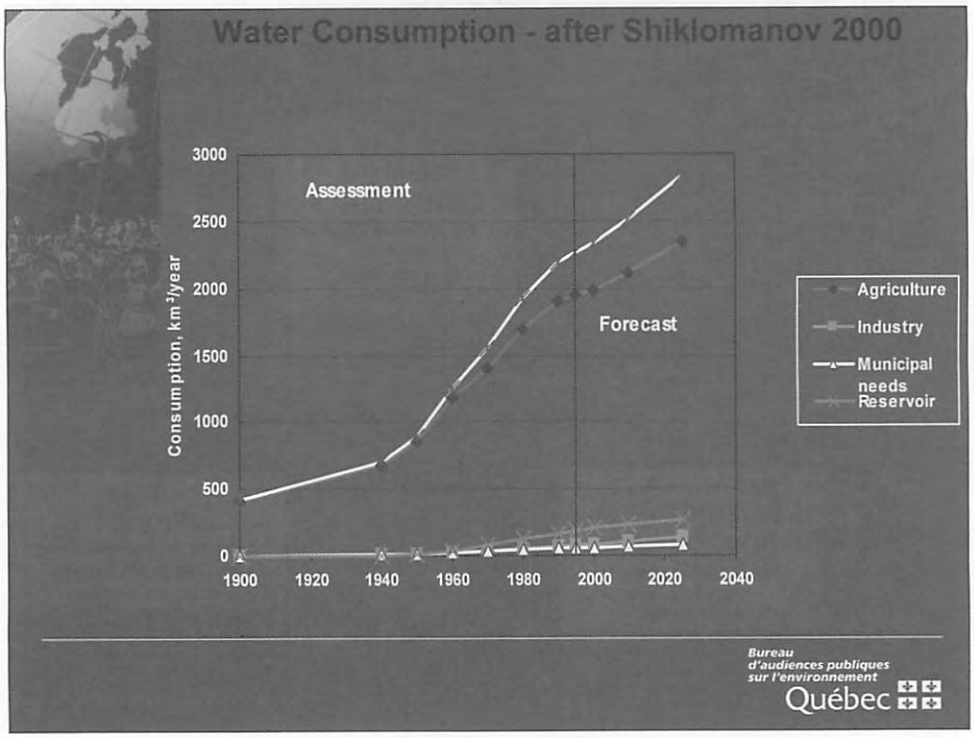
Water Consumption - after Shiklomanov 2000
Assessment
Forecast
Consumption, km³/year
3000
2500
2000
1500
1000
500
0
1900
1920
1940
1960
1980
2000
2020
2040
Agriculture
Industry
Municipal needs
Reservoir
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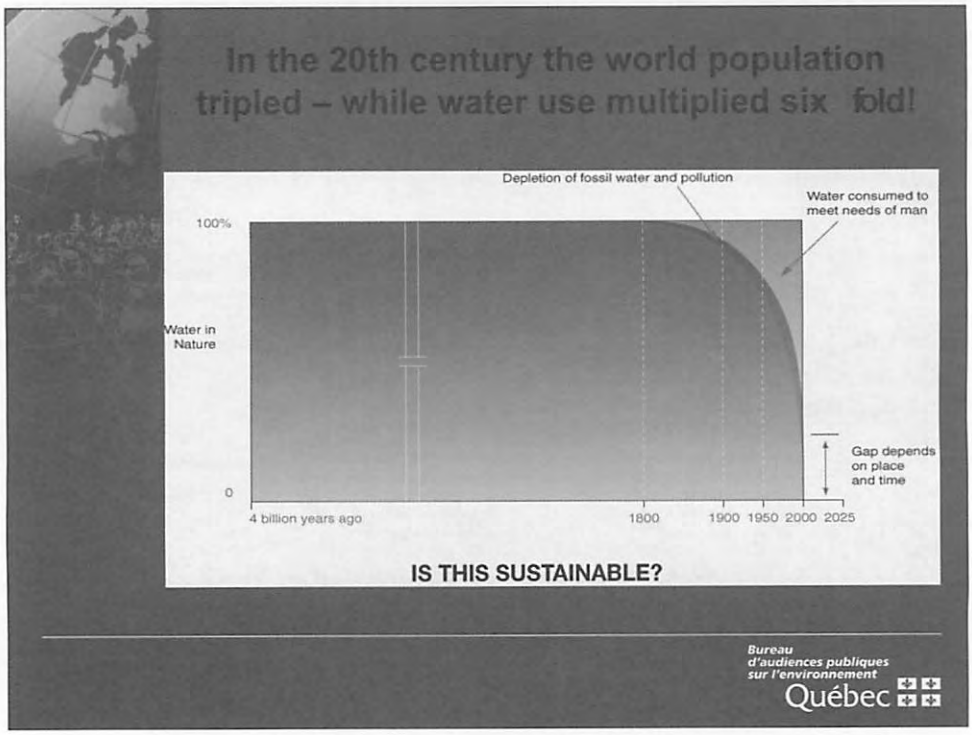
In the 20th century the world population tripled – while water use multiplied six fold!
Depletion of fossil water and pollution
Water consumed to meet needs of man
100%
Water in Nature
0
Gap depends on place and time
4 billion years ago
1800
1900
1950
2000
2025
IS THIS SUSTAINABLE?
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LOCAL SYSTEMS
The Saga Plain

« When it rains, there is a flood. When it shines, there is a drought»

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Saga Plain

« One of the greatest breadbaskets in Japan»

- A 60 000 ha low-land widely below sea-level with a long history of impoldering works for rice cultivation
- Exposed to river floods and high tides
- ~ 570 000 people
- ~ 1900 business establishments
- Agriculture is the primary industry

Source: Saga Prefecture

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Ariake Sea

- Enclosed coastal sea easily eutrophicated due to its topography (80 km x 45 km x 15 m)
- Very high tide (>6 m) and very large tidal wetland → bivalves and Nori
- Red tides increasing for recent years
- Fishery and bivalve productions decline severely since mid 1970
- Unprecedented poor harvest of Nori in 2000/2001 became a national dispute.

Source : Ministry of Environment of Japan; Kurokura, H., 2004)

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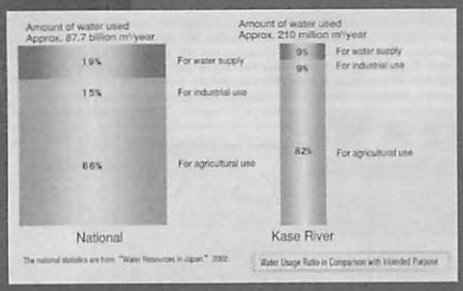
The 21st century challenge: Saga, City of Water



« River water is retained for agriculture, resulting in a shortage downstream »

Source : Saga prefecture

- The today challenge is to integrate flood control strategies, agricultural and domestic uses and in addition, to secure good quality water for the Saga people
- Community involvement in the decision making process for the benefit of Saga Plain and Ariake Sea environment

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PARTICIPATIVE APPROACH IN CANADA

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The Great Lakes and St. Lawrence River system

Source : Saint-Laurent Vision 2000

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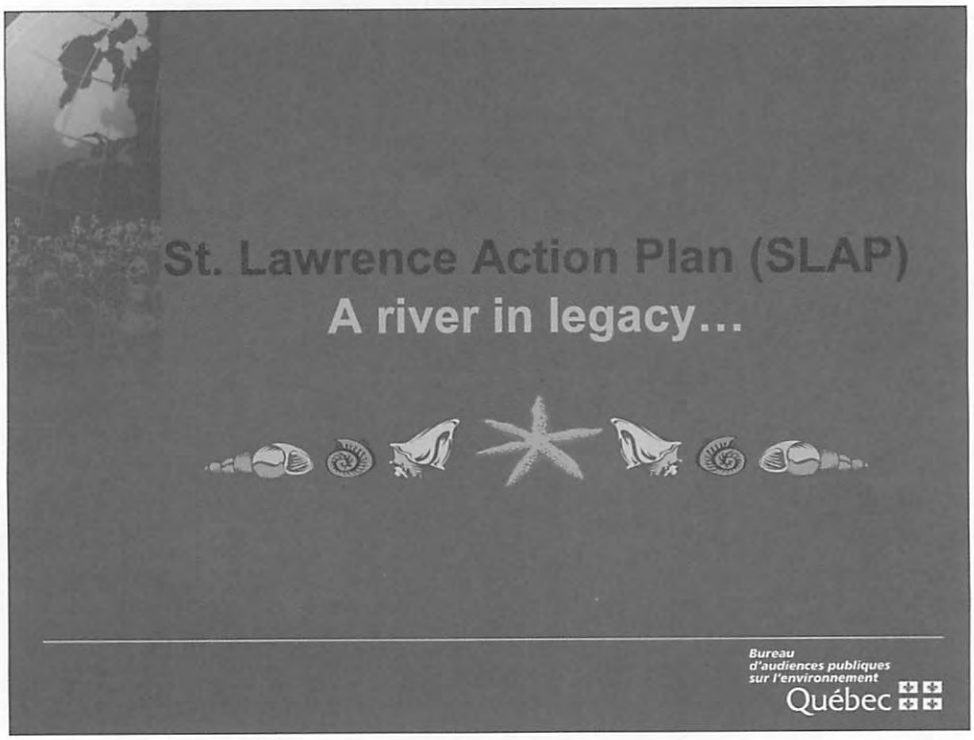
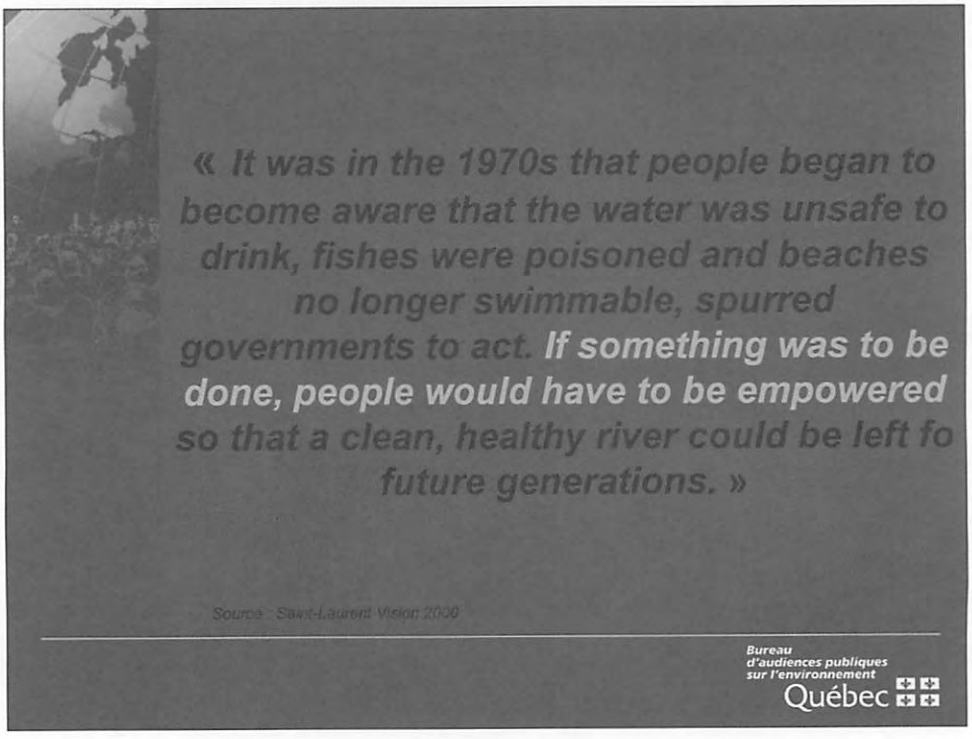
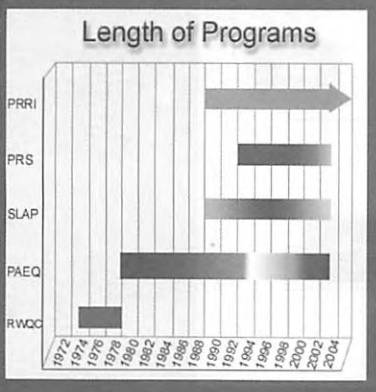

St. Lawrence Action Plan (SLAP)
A river in legacy…
Bureau
d'audiences publiques
sur l'environnement
Québec


« It was in the 1970s that people began to become aware that the water was unsafe to drink, fishes were poisoned and beaches no longer swimmable, spurred governments to act. If something was to be done, people would have to be empowered so that a clean, healthy river could be left fo future generations. »
Source : Saint-Laurent Vision 2000
Bureau
d'audiences publiques
sur l'environnement
Québec

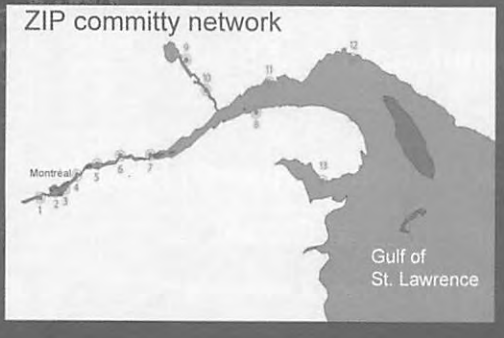
St. Lawrence River Restoration
Canada–Québec 20 years of action



Source : Saint-Laurent Vision 2000

- RWQC: River Water Quality Committee
- PAEQ: Quebec wastewater treatment program
- SLAP: St Lawrence Action Plan
- PRRI: Industrial waste reduction Program
- PRS: Pesticide Reduction Strategy

Community Involment (SLAP)
Area of Prime Concern (ZIP) Program

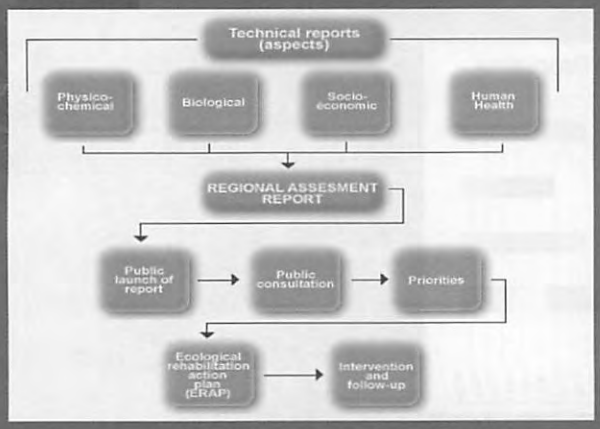


Source : Saint-Laurent Vision 2000

- Support 14 ZIP committees on local environmental issues
- Support 150 projects proposed by the communities
- Provide ZIP with scientific and technical support
- Disseminate scientific and technical knowledge on the St. Lawrence

ZIP Program Phases

Groups working together



Source : Saint-Laurent Vision 2000

- The partners have roles and responsibilities at each stage of the ZIP Program

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After 20 years of clean-up (SLAP)

The St. Lawrence beluga, a threatened marine mammal

Source : Saint-Laurent Vision 2000

- Reduction of Toxic Substances
- Maintenance of Biodiversity
- Community Involvement (ZIP)
- Protection of Human Health
- Agricultural Clean up
- Restoration Activities
- Managing in Partnership
- Significant Economic Spin offs

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Marine Protected Areas Program

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Marine Protected Areas Program

Canada's Oceans Act adopted in January 1997 gives the Department of Fisheries and Oceans (DFO) the ability to establish Marine Protected Areas in order to conserve and protect :

- commercial and non-commercial fisheries resources including marine mammals
- endangered or threatened species and their habitats
- unique habitats
- areas of high biodiversity and biological productivity
- any habitat or resource to fulfill DFO's mandate

Source : Department of Fisheries and Oceans (DFO)

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Location of Manicouagan MPA

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RATIONALE

- High ecological value : biological productivity and diversified habitats
- Important feeding area for bird colonies
- Credibility and vast experience of instigator (NGO, PNPAO)
- Anticipated interest of community to participate actively in the establishment of the MPA
- Learning by doing: a co-management model with local partners
- High potential for public awareness and education to conserve and protect the marine environment

Fisheries and Oceans (DFO)

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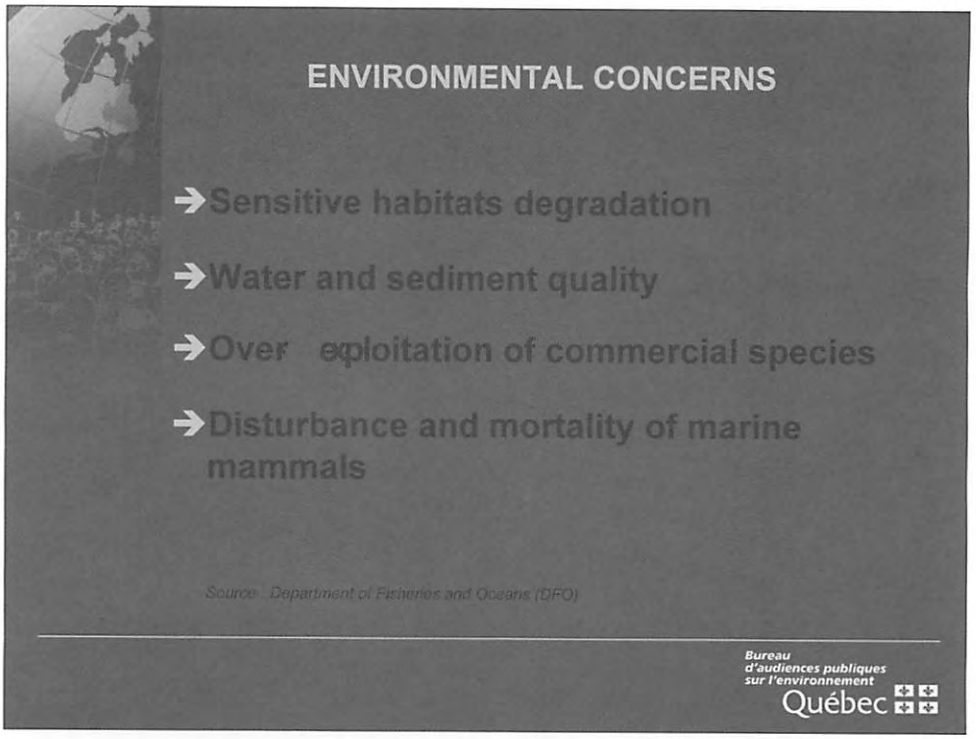
ENVIRONMENTAL CONCERNS
➔Sensitive habitats degradation
➔Water and sediment quality
➔Over exploitation of commercial species
➔Disturbance and mortality of marine mammals
Source : Department of Fisheries and Oceans (DFO)
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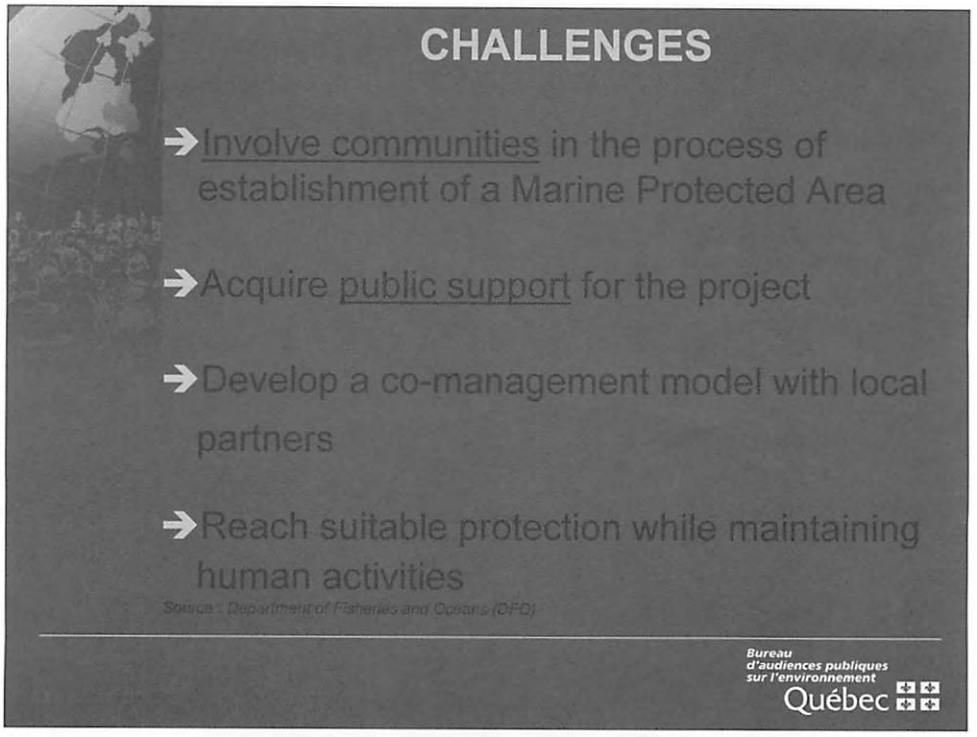
CHALLENGES
➔Involve communities in the process of establishment of a Marine Protected Area
➔Acquire public support for the project
➔Develop a co-management model with local partners
➔Reach suitable protection while maintaining human activities
Source : Department of Fisheries and Oceans (DFO)
Bureau d'audiences publiques sur l'environnement
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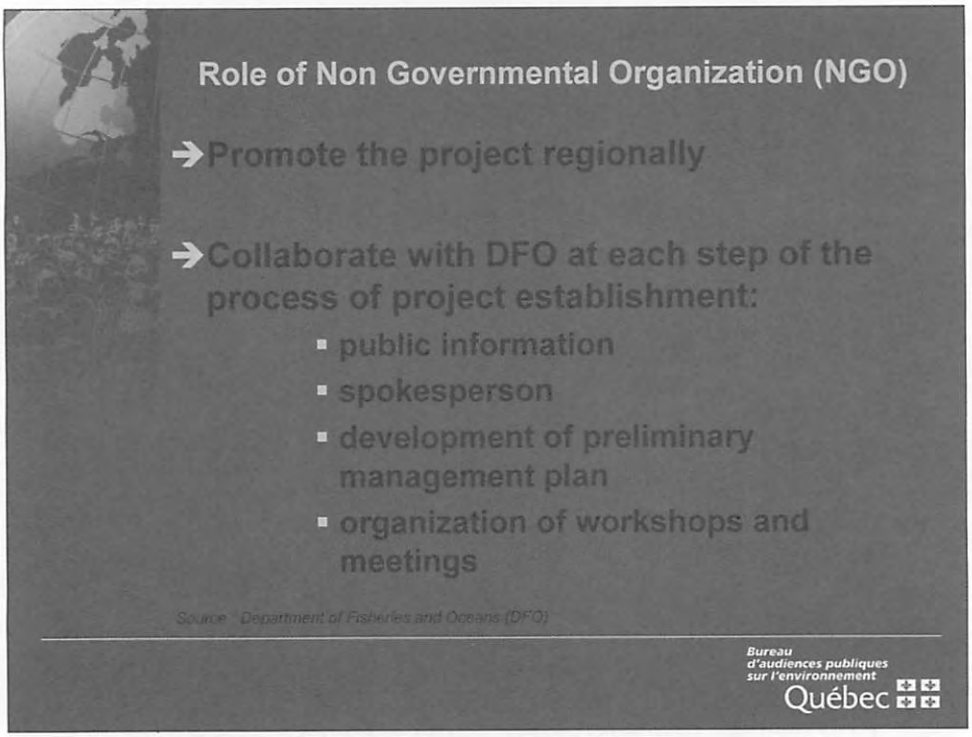
Role of Non Governmental Organization (NGO)
➔Promote the project regionally
➔Collaborate with DFO at each step of the process of project establishment:
▪ public information
▪ spokesperson
▪ development of preliminary management plan
▪ organization of workshops and meetings
Source : Department of Fisheries and Oceans (DFO)
Bureau d'audiences publiques sur l'environnement
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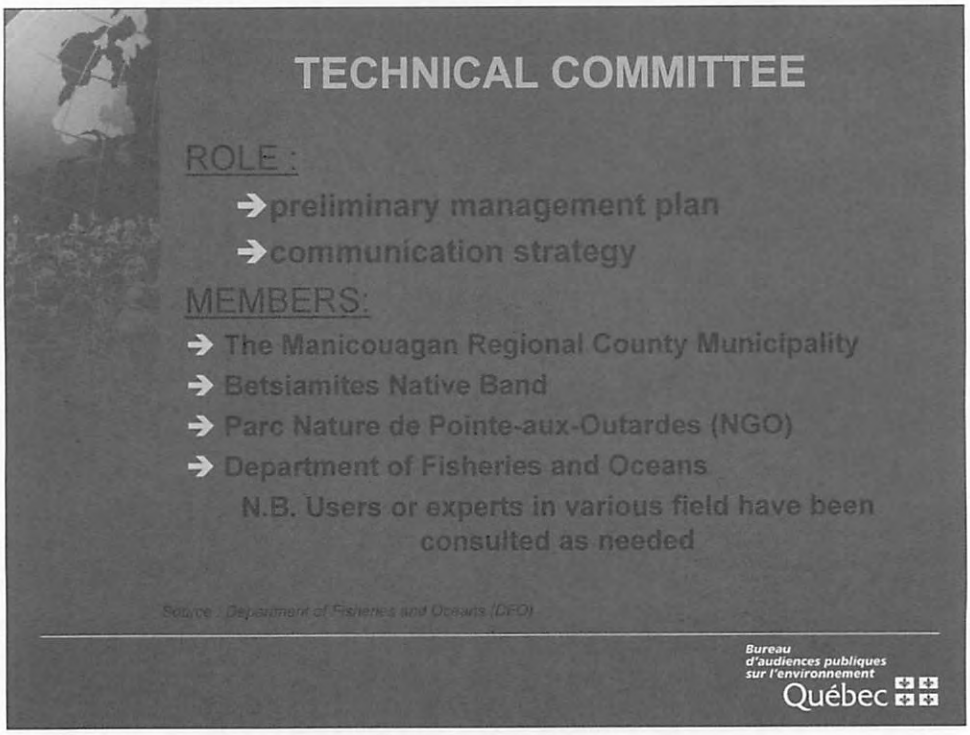
TECHNICAL COMMITTEE
ROLE :
➔preliminary management plan
➔communication strategy
MEMBERS:
➔ The Manicouagan Regional County Municipality
➔ Betsiamites Native Band
➔ Parc Nature de Pointe-aux-Outardes (NGO)
➔ Department of Fisheries and Oceans
N.B. Users or experts in various field have been consulted as needed
Source : Department of Fisheries and Oceans (DFO)
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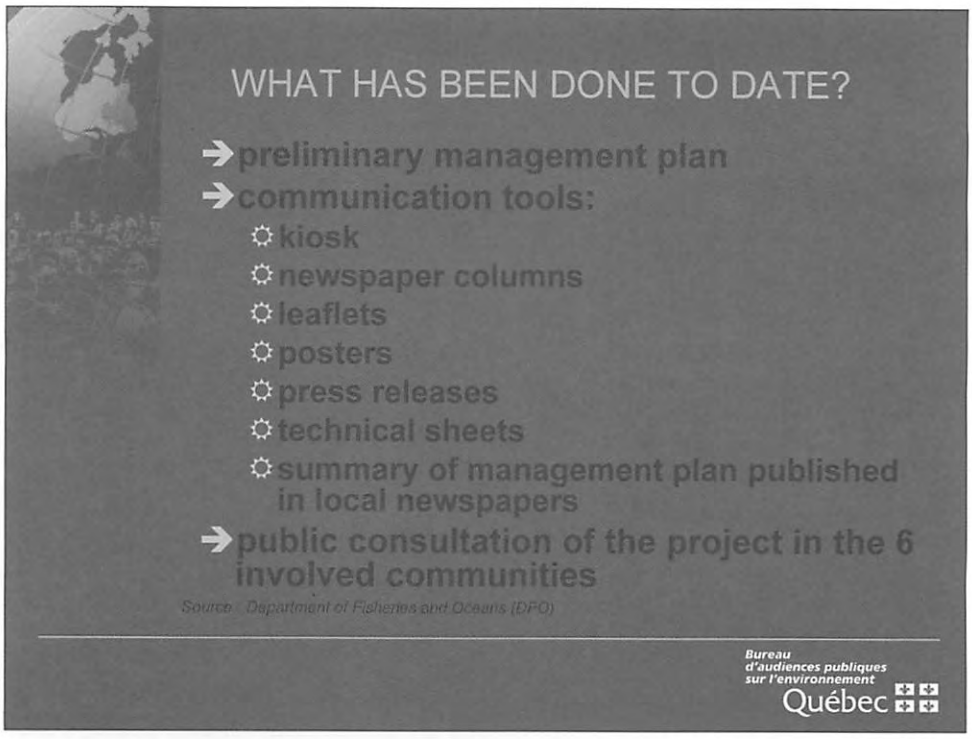
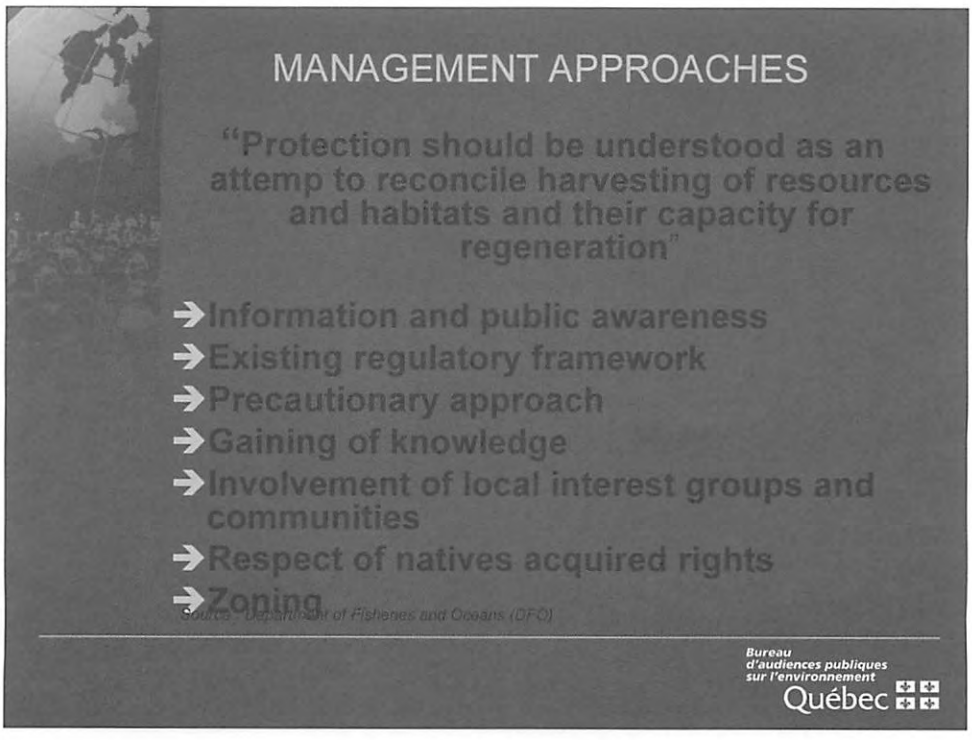

WHAT HAS BEEN DONE TO DATE?
preliminary management plan
communication tools:
kiosk
newspaper columns
leaflets
posters
press releases
technical sheets
summary of management plan published in local newspapers
public consultation of the project in the 6 involved communities
Source : Department of Fisheries and Oceans (DFO)
Bureau d'audiences publiques sur l'environnement
Québec


MANAGEMENT APPROACHES
"Protection should be understood as an attemp to reconcile harvesting of resources and habitats and their capacity for regeneration"
Information and public awareness
Existing regulatory framework
Precautionary approach
Gaining of knowledge
Involvement of local interest groups and communities
Respect of natives acquired rights
Zoning
Source : Department of Fisheries and Oceans (DFO)
Bureau d'audiences publiques sur l'environnement
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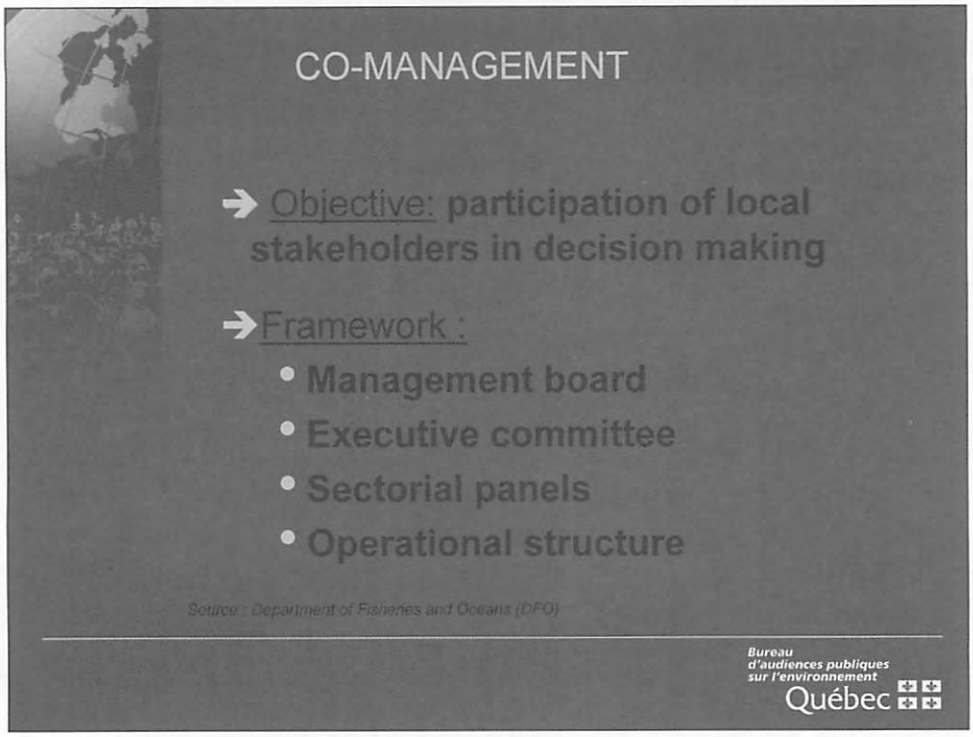
CO-MANAGEMENT
➔ Objective: participation of local stakeholders in decision making
➔Framework :
• Management board
• Executive committee
• Sectorial panels
• Operational structure
Source : Department of Fisheries and Oceans (DFO)
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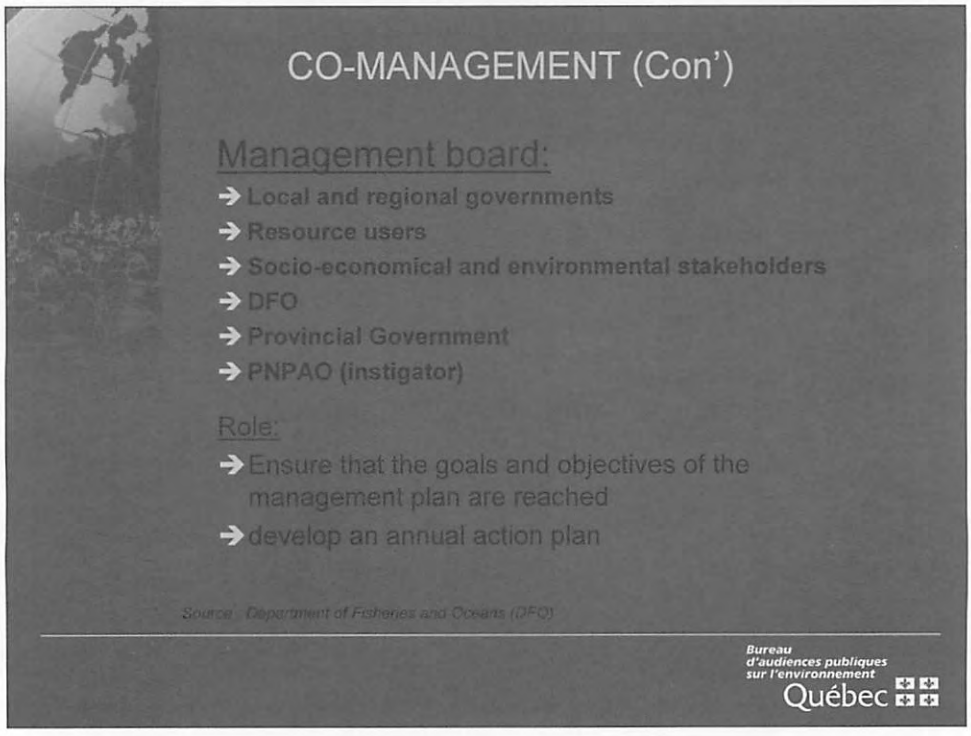
CO-MANAGEMENT (Con')
Management board:
➔ Local and regional governments
➔ Resource users
➔ Socio-economical and environmental stakeholders
➔ DFO
➔ Provincial Government
➔ PNPAO (instigator)
Role:
➔ Ensure that the goals and objectives of the management plan are reached
➔ develop an annual action plan
Source : Department of Fisheries and Oceans (DFO)
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LESSONS LEARNED

- **Community consciousness** to the importance and fragility of the marine environment must be increase in order to obtain project support
- The **information given about the project must clear and understandable**
- **Resource users** must be involved in the development of the preliminary management plan

Source : Department of Fisheries and Oceans (DFO)

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LESSONS LEARNED (Con')

- **Potential opponents** must be known and their viewpoint incorporated into the process
- The approach confirms the importance of keeping **communities informed regularly** (communication strategy)
- **Working with people from the beginning** lengthens the process and makes it more difficult but **increases chances of success**

Source : Department of Fisheries and Oceans (DFO)

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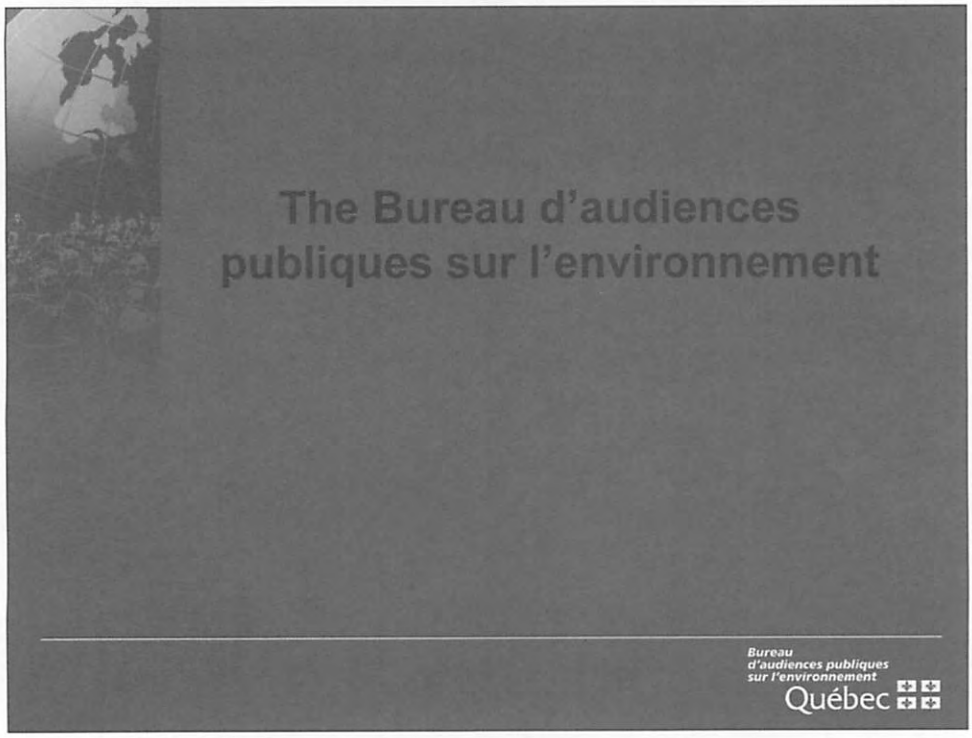
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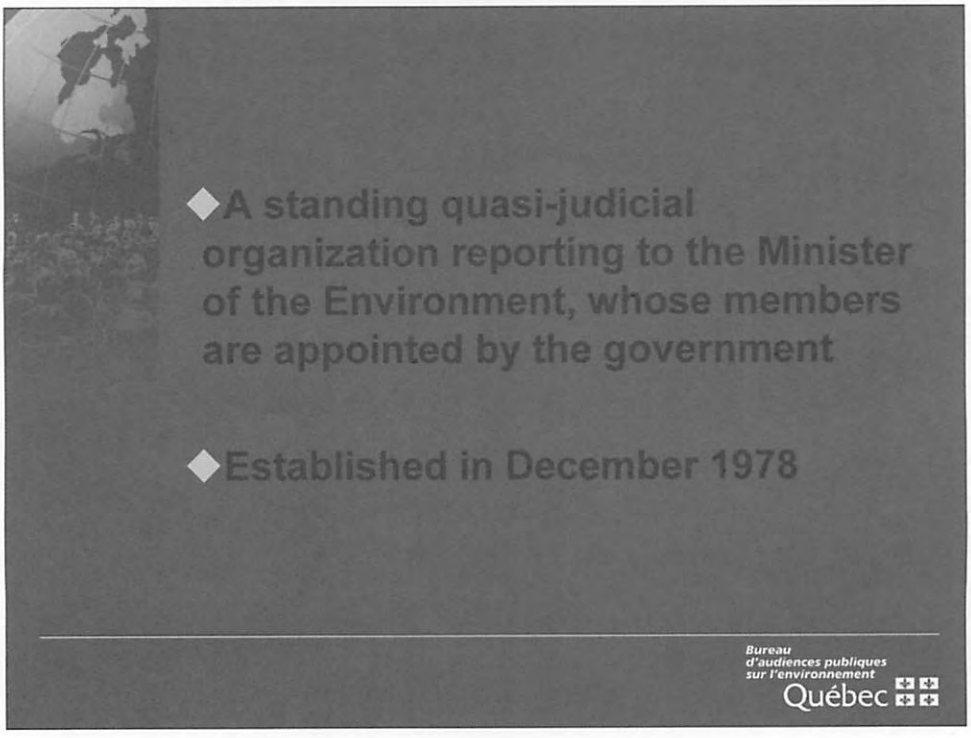
A standing quasi-judicial organization reporting to the Minister of the Environment, whose members are appointed by the government
Established in December 1978
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Mission

Inform and consult the public on environment quality-related issues raised by the Minister of the Environment in order to enlighten government decision-making from a sustainable development viewpoint.

To do so, the BAPE:

- holds information and public consultation periods;
- holds public inquiries and hearings;
- carries out environment-related mediation.

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Values

- Neutrality
- Autonomy
- Transparency
- Equity

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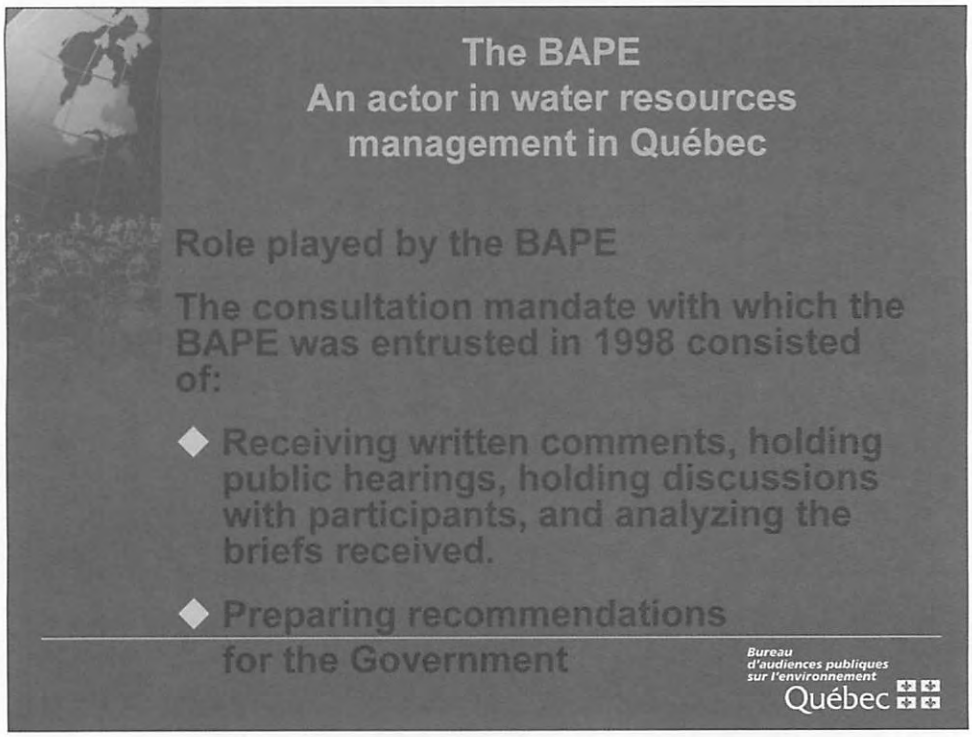
The BAPE
An actor in water resources management in Québec
Role played by the BAPE
The consultation mandate with which the BAPE was entrusted in 1998 consisted of:
Receiving written comments, holding public hearings, holding discussions with participants, and analyzing the briefs received.
Preparing recommendations for the Government
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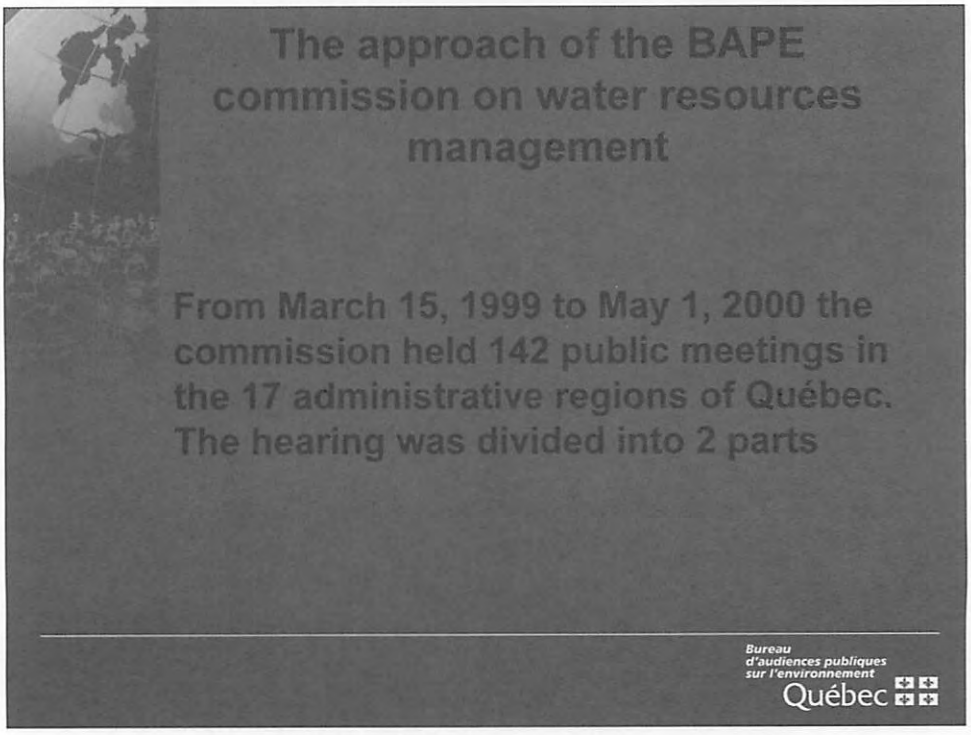
The approach of the BAPE commission on water resources management
From March 15, 1999 to May 1, 2000 the commission held 142 public meetings in the 17 administrative regions of Québec. The hearing was divided into 2 parts
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Part One: Building Knowledge

Public meetings dealing with the proposed management orientations were first held in Montréal.

The commission then toured the regions and went on to organize theme-oriented meetings.

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Part Two: Giving Public Opinion Centre Stage

During its tour of the 17 regions of Québec, the commission heard 379 briefs.

The BAPE report entitled *Water: a resource to be protected, shared and enhanced* was submitted to the Minister of the Environment on May 1, 2000.

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Québec Water Policy *Water. Our Life. Our Future*

(Released in 2002)

This policy seeks to:

- ensure the protection of this unique resource of our collective heritage;
- manage water in an integrated manner, in a sustainable development perspective;
- better protect public health and the health of ecosystems.

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After reaffirming that water is an essential element of the collective heritage of Quebecers, the policy presents measures and government commitments intended to:

- implement integrated watershed-based management to reform water governance;
- implement this form of management in the St. Lawrence River, by granting a special status to this major waterway;
- protect water quality and aquatic ecosystems;
- continue water clean-up efforts and improve the management of water services;
- promote water-related recreotourism activities

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CONCLUSION

- Japan imports 168 billions m³/year of virtual water (including that in food) compared with withdrawals in Japan of 92 billions m³/year (including that for irrigation).
- Japan is dependent for its survival on sustainable water management practices at home and in the countries from which it imports food and other products.

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CONCLUSION (Con')

- Japanese water managers have gained a lot of experience in storing water to prevent flood damage and to supply water during periods of low rainfall.
- Japan was one of the first countries in the world (if not the first) to adopt a water law that made provision for sustaining the environment.

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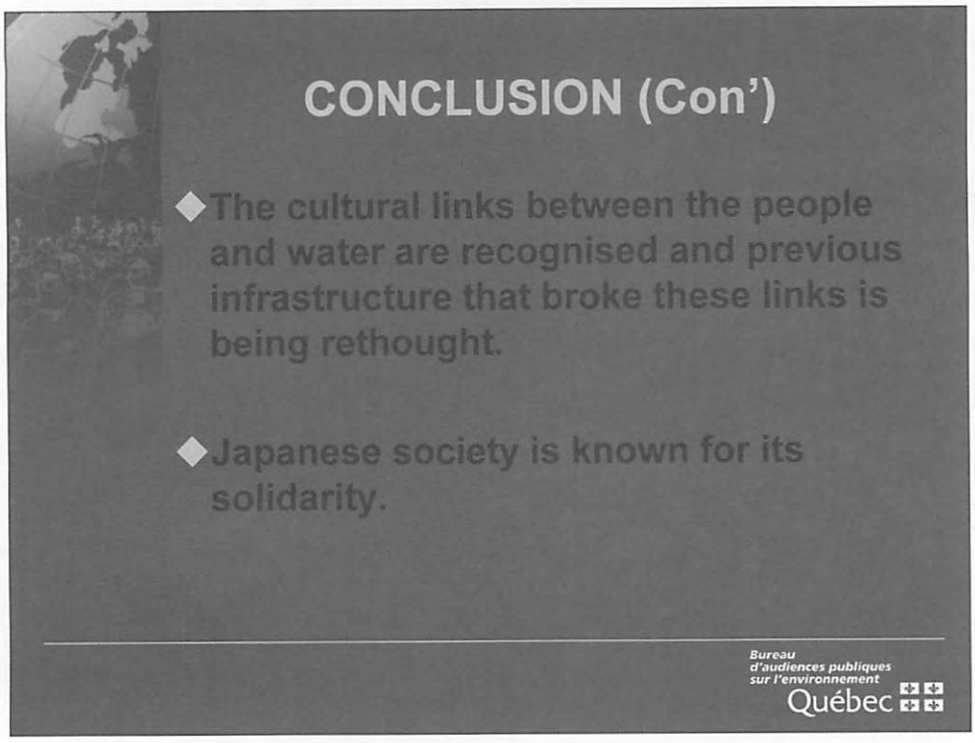
CONCLUSION (Con')
The cultural links between the people and water are recognised and previous infrastructure that broke these links is being rethought.
Japanese society is known for its solidarity.
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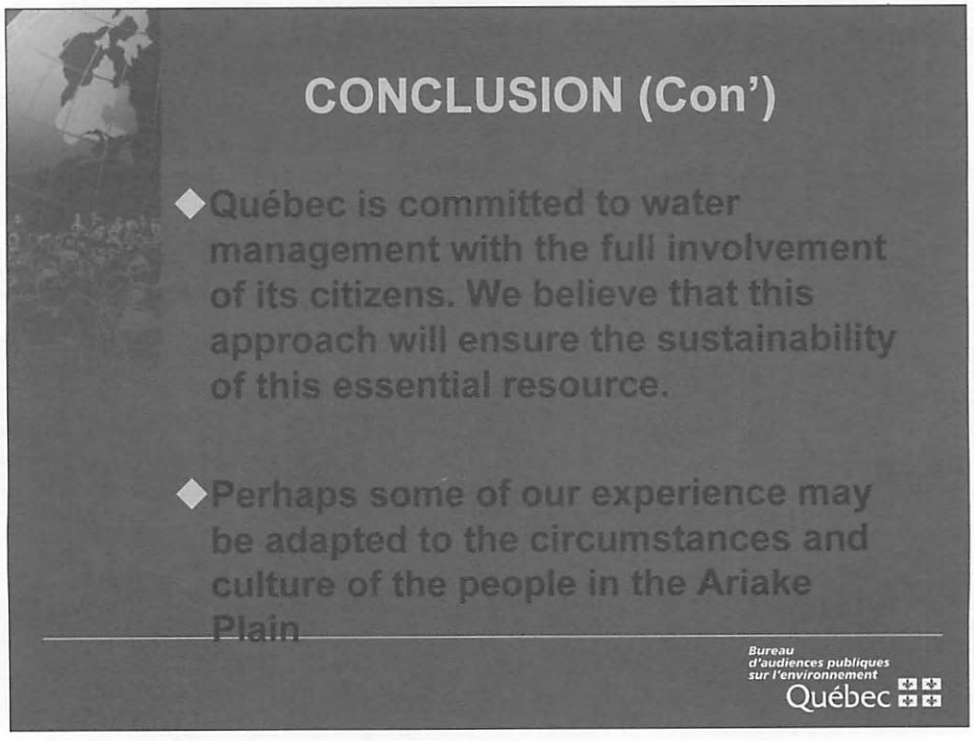
CONCLUSION (Con')
Québec is committed to water management with the full involvement of its citizens. We believe that this approach will ensure the sustainability of this essential resource.
Perhaps some of our experience may be adapted to the circumstances and culture of the people in the Ariake Plain
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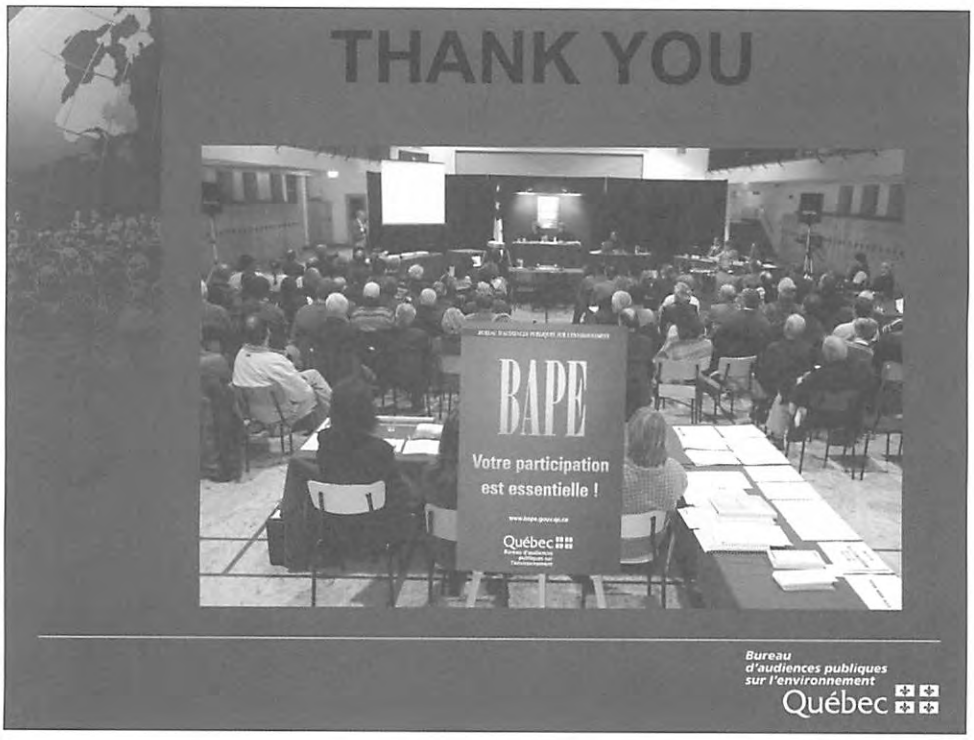
THANK YOU
BAPE
Votre participation
est essentielle !
Québec
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d'audiences publiques
sur l'environnement
Québec

Habitat Restoration to Recover Ecosystem Function

Dr. Jonathan Grabowski
Gulf of Maine Research Institute, USA

Talk Summary: In order to illustrate how habitat restoration can be utilized as a tool recover ecosystem functioning, I am going to focus my talk on oyster reef restoration efforts in the southeastern U.S. over the past couple of decades. Although efforts initially were aimed solely at rebuilding the commercial oyster fishery, our recent work has focused on quantifying and recovering ecosystem goods and services in addition to producing oysters for harvest such as habitat stabilization, water filtration, and mobile fish nursery and adult habitat. In particular, we recently conducted a synthesis of the amount of augmented fish production that is obtained by restoring oyster reef habitat. Evaluation of methods to culture bivalve species has facilitated regulator shift from destructive wild harvest practices to culture methods that also produce ancillary benefits such as improving water quality and creating artificial habitat that provides food resources and refuge for nursery fishery species. We also have been investigating the landscape consequences of multiple habitat arrays on the communities that utilize restored oyster reefs. I will then discuss how we are building this into a bioeconomic assessment of habitat values to better facilitate incorporation of these values into management assessments of the costs of future impairments and the economic value of ecological restoration efforts.

Habitat restoration to recover ecosystem function

Jonathan H. Grabowski, Ph.D.
Research Scientist, Marine Ecologist
Gulf of Maine Research Institute
350 Commercial Street
Portland, Maine 04101 USA

1. I would like to start by expressing my deepest gratitude to Dr. Kusuda, the NPO Association of Ariake Bay Rehabilitation, and the Saga Prefectural Government for inviting me to participate in what promises to be a very meaningful symposium. Protecting and rehabilitating our world's aquatic ecosystems, which we depend upon for the provision of ecosystem goods and services, will be even more critical as we move further into the 21st century in response to both natural disasters and human-population growth pressures.

2. Problems such as overfishing, invasive species, habitat fragmentation and degradation, global climate change, and increased coastal pollution from organic enrichment and chemical contaminants are common to estuarine systems worldwide, and will continue to grow in magnitude and impair ecosystem health if not minimized or prevented. Therefore, I commend the organizers of today's symposium for being proactive in the rehabilitation of Ariake Bay.

3. Habitats are valued for the important ecosystem goods and services they provide. When habitats are disturbed, they lose the ability to perform the ecosystem goods and services associated with them. Removal of the habitat disturbance *may* at times result in a return to healthy ecosystem without any particular restoration intervention. However, some severe disturbances from practices such as overharvesting, pollution and habitat degradation and loss can alter ecosystems dramatically and ultimately limit their ability to recover naturally. In these severe cases, restoration of resources and habitats may be necessary to return to predisturbance conditions and recover ecosystem goods and services that mankind is so dependent upon.

4. Unfortunately, restoration efforts are often conducted to mitigate for ecosystem damages without proper assessment of whether the rehabilitated system will recover ecosystem functions that were impaired. For instance, managers often assume that simply restoring habitat structures will return ecosystem services such as production of fish. But, this is not always the case. Several mitigation efforts for perturbations in coastal embayments have included building artificial reefs for fish offshore around North America in spite of the lack of conclusive evidence of whether these structures actually augment fish production. Therefore, experimental approaches are needed to assure that habitat restoration results in the actual recovery of the ecosystem goods and services upon which society has placed value.

5. I intend to focus today on restoring marine habitat to recover ecosystem goods and services such as the provision of nursery grounds for economically important finfish species. Over the past decade I have been involved in several oyster reef restoration projects aimed at restoring habitat to recover ecosystem function in the United States. Thus, I will utilize past research

experience to illustrate the importance of considering habitat restoration within an ecological context.

In particular, I will first focus on a synthesis we conducted using existing data from oyster reef restoration efforts in the southeastern United States in Texas, Louisiana, South Carolina, North Carolina, Virginia, and Maryland to determine the amount of augmented fish production that is obtained by restoring oyster reef habitat. I will then discuss how we demonstrated empirically the importance of considering the landscape in which restoration is conducted when quantifying the ecosystem goods and services that will be provided. And finally, I will briefly discuss how these studies are being integrated into a bioeconomic assessment of the value of ecosystem goods and services provided by oyster reefs. This information is intended to facilitate coastal regulators develop an ecosystem management plan that maximizes their benefits such as the production of oysters and finfish for commercial and recreational harvest by these critical estuarine habitats.

6. Oyster reefs historically have been managed a resource to exploit rather than a habitat to protect for the ecosystem goods and services that they provide.

7. This management view along with the introduction of the mechanical dredge at the turn of the 20th century in the United States established the conditions for wide scale overharvesting, with current US landings less than 5% of the historic maxima. The long history of habitat degradation and removal of reproducing adults coupled with more recent problems associated with disease and poor water quality have combated efforts to restore oyster populations in areas such as coastal North Carolina.

8. The collapse of oyster populations has resulted in the loss of ecosystem goods and services. For example, oysters filter water, thereby increasing light penetration through the water column and benefiting other habitats such as the sea grass bed depicted here. Oyster reefs also have been recognized as important nursery and adult habitat for commercial and recreational finfish. Oyster reefs stabilize erosion of other important structured habitats including the salt marshes and sea grass beds.

9. To quantify how many kilograms of augmented or increased fish production is created per year by restoring a unit of oyster reef, we conducted a synthesis of existing data from restoration projects throughout the southeastern U.S. Fish densities on restored reefs were compared to those of control sites without restored oyster reef habitat to quantify the amount of additional fish that are available as a function of the reef habitat.

Before we could determine whether restoring oyster reef habitat augments fish productivity, we had to ask the following two questions: First, does reef habitat limit recruitment of fish? And second, does reef habitat enhance fish growth?

10. To determine if recruitment of a particular species is limited by reef habitat, we assessed the following two criteria: First, a particular fish species that is limited by oyster reef habitat should exhibit reef exclusive or highly augmented settlement on oyster reefs. Second, the life history of a particular species should be tightly coupled with reef structure and associated prey resources.

If a species met both of these criteria, the augmented density was converted to augmented production and 100% of the augmented production of the fish was attributed to the reef.

11. For species with greater densities on oyster reef than on unstructured bottom but did not meet both of the two criteria, we deemed that growth is augmented by reef habitat and calculated augmented growth in the following manner: We first compared the density of fish on reef vs. off to quantify augmented fish densities. We then used an algorithm to convert augmented density to augmented production. And we corrected augmented production by an index of reef exclusivity that accounts for how important the reef is to the fish. This index was based on life history information and a comparison of stomach content analyses to benthic fauna associated with reef vs. mud habitats.

12. From our analyses, we concluded that restored oyster reef habitat augments the following 15 species or species groups. Collectively we estimated that restoring reef habitat will augment fish production by 2.57 Kg per $10m^2$ annually.

13. We then projected augmented fish production over the potential lifespan of the reef to assess: We discounted future production to account for the loss in production that accumulates after the initial disturbance. It is important to consider that how this habitat is managed ultimately will influence the return on our investment. For instance, allowing harvesting of oysters that destroys the reef will consequently greatly reduce the overall value of this reef in terms of fish production.

14. After developing tools to quantify ecosystem goods and services associated with restored habitat, we can now begin to build in the type of complexity that exists in the real world so that we can more broadly apply these analytical tools. The following study illustrates how where a restored reef is located will largely influence the quantity and quality of ecosystem goods and services provided by the habitat.

15. While oyster reefs are beginning to receive recognition for the ecosystem services that they provide, understanding of how community structure on oyster reefs is influenced by neighboring habitats and larger scale processes remains limited.

16. The mobility and range extent of macroinvertebrate and fish species is largely influenced by characteristics of habitats such as patch size, shape, and habitat complexity. Therefore, the spatial mosaic of habitat patches will influence the degree of connectivity among them. Within enclosed embayments in the eastern U.S., the adjacency of oyster reef habitat to other types of habitats could be important for community structure within oyster reefs. For instance, predation might be higher on oyster reefs adjacent to seagrass beds if mobile organisms that utilize seagrass habitat as subtidal refuge migrate into neighboring oyster reefs to forage as the tide comes in. As water approaches an intertidal oyster reef on an incoming tide, the type of habitat in front of the oyster reef could also influence important processes such as settlement rates and food particle flux, thereby affecting delivery of new recruits and food particles to the oyster reef.

17. We restored reefs in estuarine embayments in coastal North Carolina, which is located along the mid-Atlantic Bight in the Southeastern United States.

18. Reef habitat was restored in 1997 using Shallow draft barges to transfer 25 tons of shell in the shallow embayments where we intended to conduct restoration efforts. We then loaded the shell into baskets and carried to the individual restoration sites. After planting dead shell, Oyster reefs were colonized by adult oysters within the next couple of months, and reef reestablishment was quite rapid.

19. We constructed reefs where they historically existed in the intertidal zone prior to extensive harvesting resulted in the destruction of much of the reef habitat in coastal North Carolina. In particular, we constructed reefs on the edges of salt marsh away from seagrass habitat, in between seagrass and salt marsh habitat, and on mud flats that are isolated from structured habitats. We also sampled control environments in each landscape so that we can tease apart how the landscape in which a reef is restored influences the transient and resident communities of animals that recruit to and utilize the reef.

20. We sampled the transient and resident communities that recruit to and utilize these habitats in each landscape from 1997 to 2001 using a wide variety of gear types. For instance, we used gill nets, pop-up nets, and traps to capture predatory and juvenile fish. We used core and quadrat sampling techniques to quantify resident invertebrate taxa. We coupled these data with stomach content information from juvenile and adult fish to understand how the landscape in which a reef is restored influences food web dynamics.

21. Examining the effects of where a reef is restored on the community of organisms that utilize it illustrates just how important it will be for managers to consider restoration ecology within a landscape context when attempting to restore habitat to recover ecosystem goods and services. First we noted that reef structure was greatest on mud flats reefs. This is probably a function of increased water flow across mud flats, which acts to increase food delivery and decrease oyster mortality by decreasing predator detection of oyster prey.

Restoring reef habitat augmented most prey categories across all three landscapes though responses of two, bivalves and resident decapods, were landscape specific. Reef habitat augmented juvenile fish abundance in only one of the three landscapes, the mud flat landscape, in spite of greater prey densities in all three landscapes. This could be a consequence of greater resource availability, namely higher habitat structure as well as greater bivalve and resident decapod densities, but it could also be a function of reduced predator densities. It might also be that oyster reefs and seagrass beds are functionally redundant, such that restoring reef habitat would only augment fish production when other habitats are not present.

22. Having examined how to quantify ecosystem goods and services and how natural complexity will influence the provision of these benefits more broadly, we can now assess the bioeconomic value of these functions.

23. I will only briefly discuss our assessment of the value of restored oyster reefs because we are currently working with economists to develop a quantitative bioeconomic model. We are utilizing our estimates of augmented fish production to assess the economic value of restored oyster reef habitat to the commercial and recreational fisheries that benefit from this function. Quantifying the value of ecosystem goods and services also requires some ingenuity. For instance, oyster reefs act as a natural filter and perform a function that is comparable to waste sewage treatment plants. Therefore, by comparing the cost of operating sewage treatment facilities to process an equivalent amount of water to a unit of oyster reef habitat, we can assess the value of this function.

Increasing water clarity and stabilizing shoreline habitats supports the maintenance of other critical habitats such as seagrass beds and salt marshes, resulting in a positive feedback of additional benefits associated with these habitats. Once again the importance of thinking more broadly about how the array of habitats interact to influence ecosystem functioning in shallow embayments will be critical.

23. In conclusion, quantitative synthesis of the ecosystem functions associated with restored habitats is necessary to better understand the linkages between attributes of habitats and the provision of ecosystem goods and services such as habitat for economically valuable fish species. Restored oyster reef habitat could augment fish production by increasing the amount of nursery habitat available for juvenile fish. However, managers should carefully consider that activities such as oyster harvesting will largely influence the provision of future goods and services. Managers must also consider where restored reefs will be located because the landscape setting of a reef will largely dictate whether it provides these ecosystem functions. Building this ecological information into a quantitative bioeconomic model of ecosystem functions will also assist managers assess the cost of activities such as pollution that impair ecological systems and mitigate future ecosystem disturbances.

24. Finally, the goal of restoration ecology is to recover ecosystem goods and services that have been lost. Therefore, developing methods to quantify these ecosystem goods and services will help managers attain this goal. Hopefully these research insights will be of value in considering how to move forward with rehabilitating Ariake Bay here in Japan.

25. Thank you very much for your attention and I would be happy to entertain any questions.

Habitat Restoration to Recover Ecosystem Function

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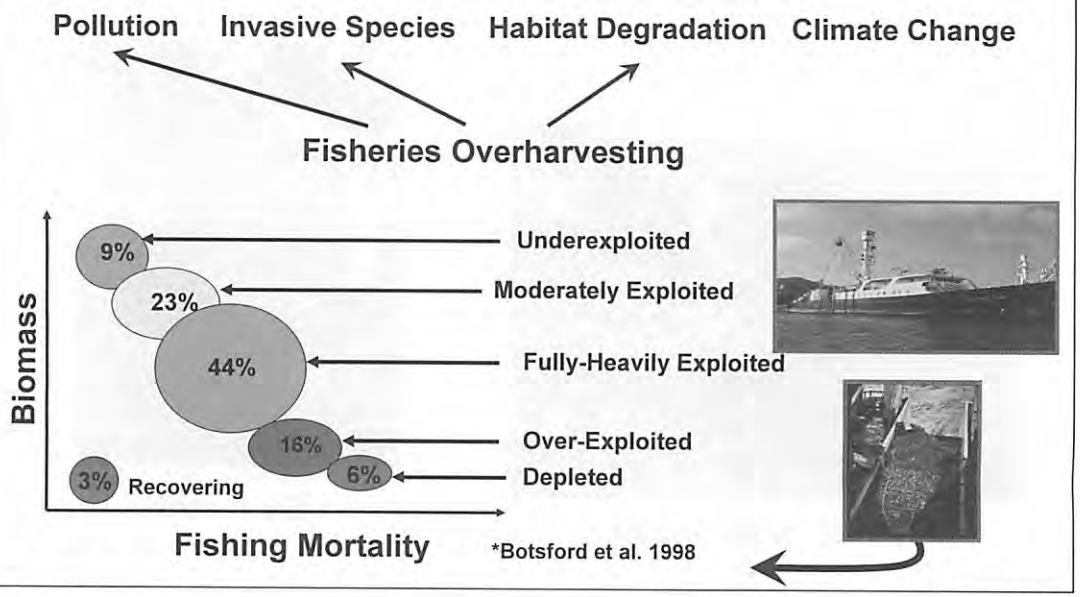
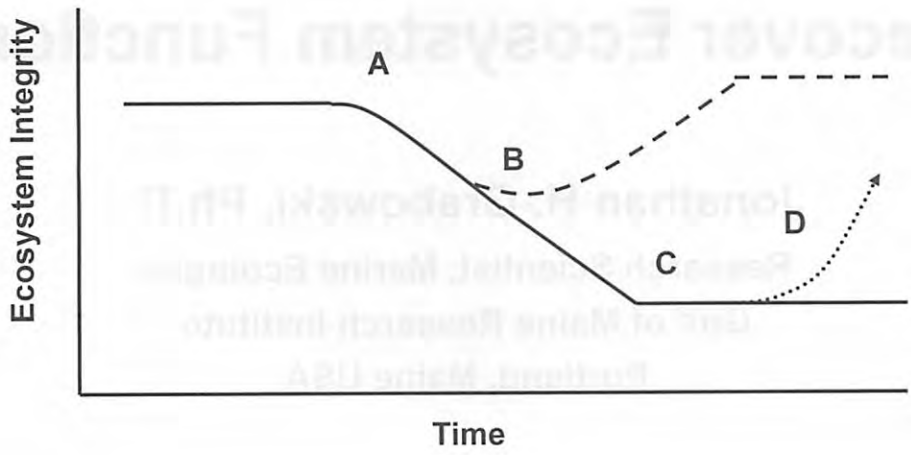
Global Threats to Protected Embayments



When is Restoration Necessary?



Applications for Restoration Ecology and Fisheries Management

Oyster restoration

By Catch

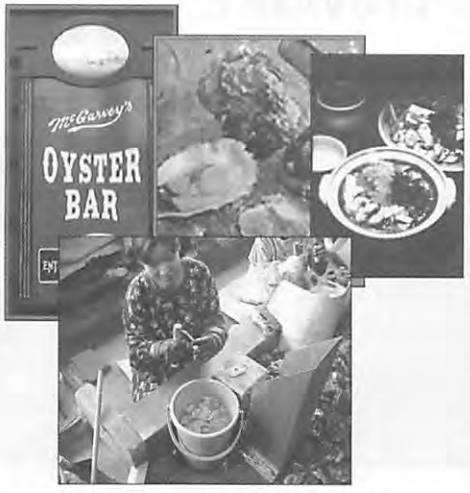
Outline

I. Restoring habitat to recover ecosystem goods and services: Augmenting fish production by restoring oyster reef habitat.

II. Landscape effects on restored habitats: Spatial setting of restored reefs influences nursery function.

III. Quantifying the value of ecosystem functions: Bioeconomic model of ecosystem goods and services provided by oyster reefs.

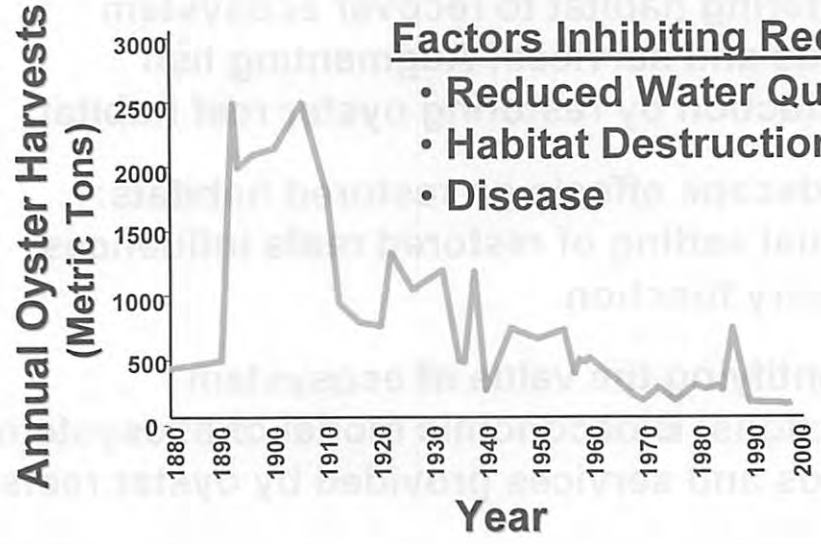
Oyster Reef Management: Historical View



Resource to Exploit

~~Habitat to Protect~~

Overharvesting & U.S. Fishery Collapse



Factors Inhibiting Recovery

- Reduced Water Quality
- Habitat Destruction
- Disease

What ecological goods & services do oysters provide?

Filter Water

Stabilize Adjacent Habitats

Produce Valuable Fish

Collapse = Loss of Goods and Services

How many Kg of fish/yr are created by restoring an oyster reef?

Pre-Restoration

Post- Restoration

△ 2° Production = ___ Kg m^{-2} Yr^{-1}

Meta-Analysis of Research in Southeastern U.S.

Does Reef Habitat Limit Recruitment?

A: FISH SPECIES → Limited by Reef Area → ↑ SETTLEMENT

B: LIFE HISTORY → Coupled with → REEF STRUCTURE, PREY RESOURCES

Does Reef Habitat Promote Higher Growth?

AUGMENTED DENSITY → Fail → ONE OR BOTH CRITERIA

We Calculated Augmented Production By:

1. Reef vs. Control Density → Augmented Density
2. Augmented Density → Augmented Production
3. Augmented Production → Weighted Production

Fish Species Enhanced by Reefs


Gag Grouper


Gray Snapper


Stone Crab


Black Sea Bass


Southern Flounder


Sheepshead Minnow


Pigfish


Sheepshead


Bay Anchovy


Silversides

Others: Toadfish Tautog Gobies Blennies Spottail Pinfish

Long-term Projection of Augmented Secondary Production from Restored Oyster Reefs in Tampa Bay, Florida USA

1 yr	2 yrs	10 yrs	20 yrs	30 yrs
2.5	4.9	21.9	38.2	50.4

Units: kg/ 10 m^2

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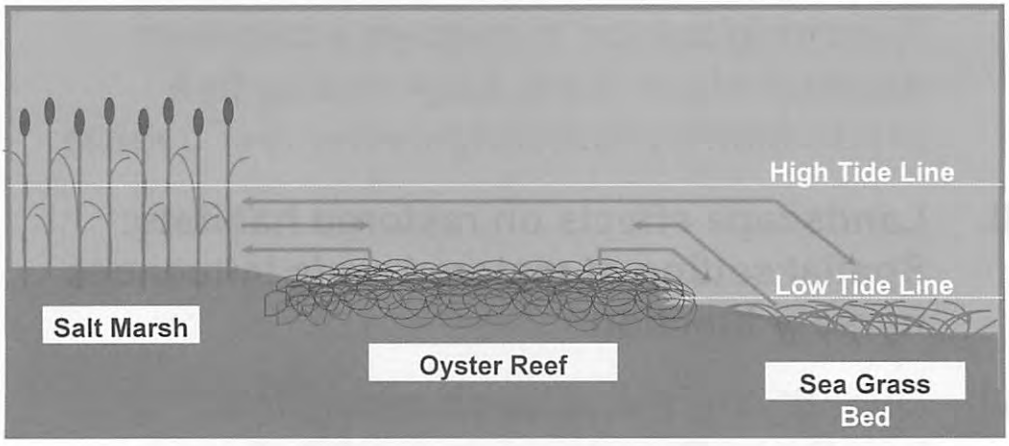
Regional Importance of Reefs in Estuary

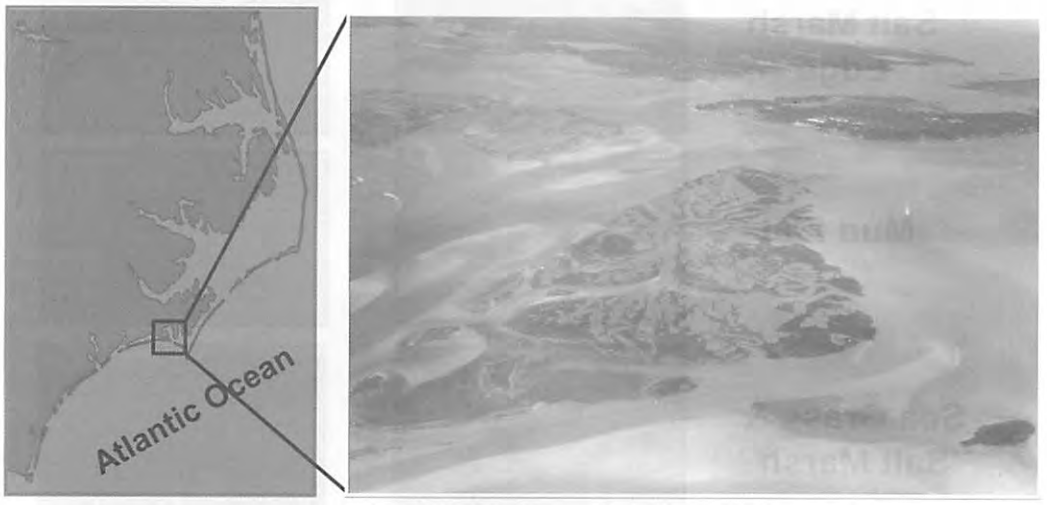
Landscape Scale Effects



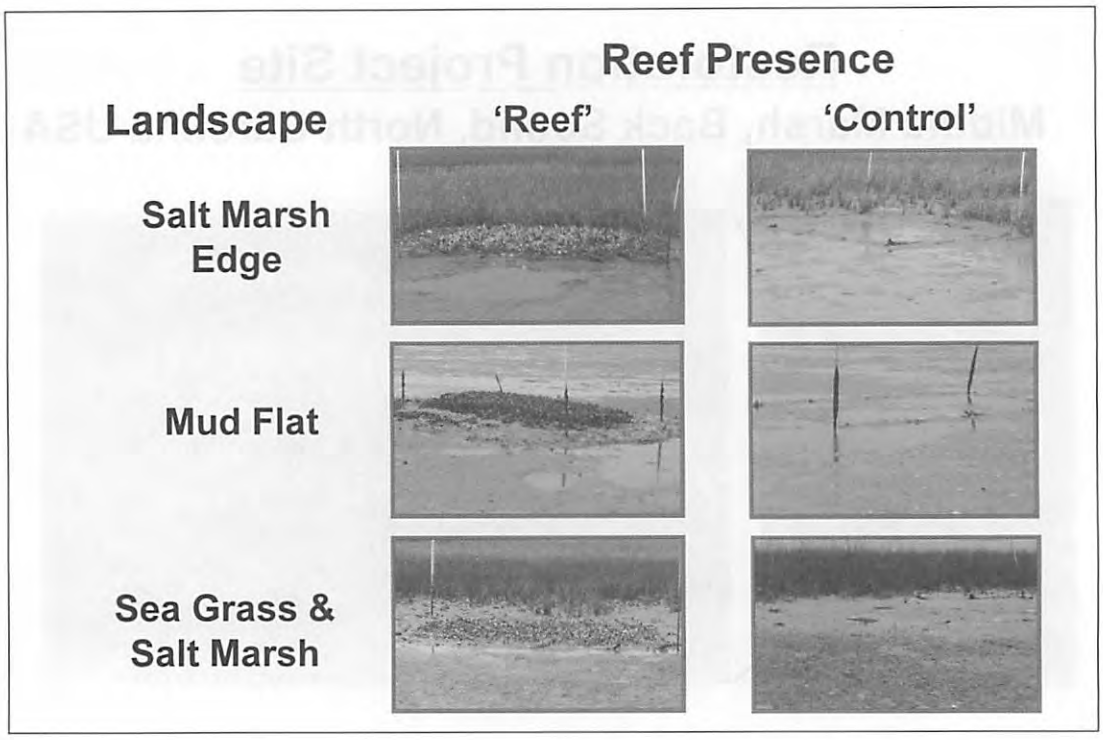
Reef Functioning and Ecology Could Depend on Adjacent Habitats

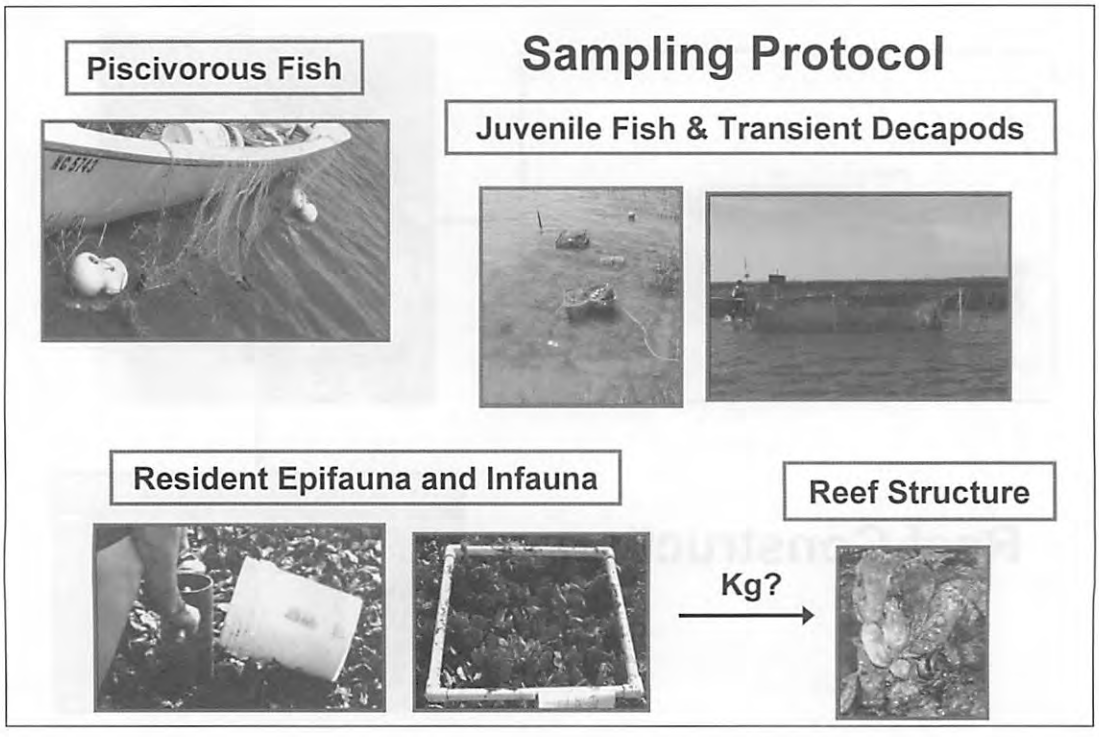
Restoration Project Site

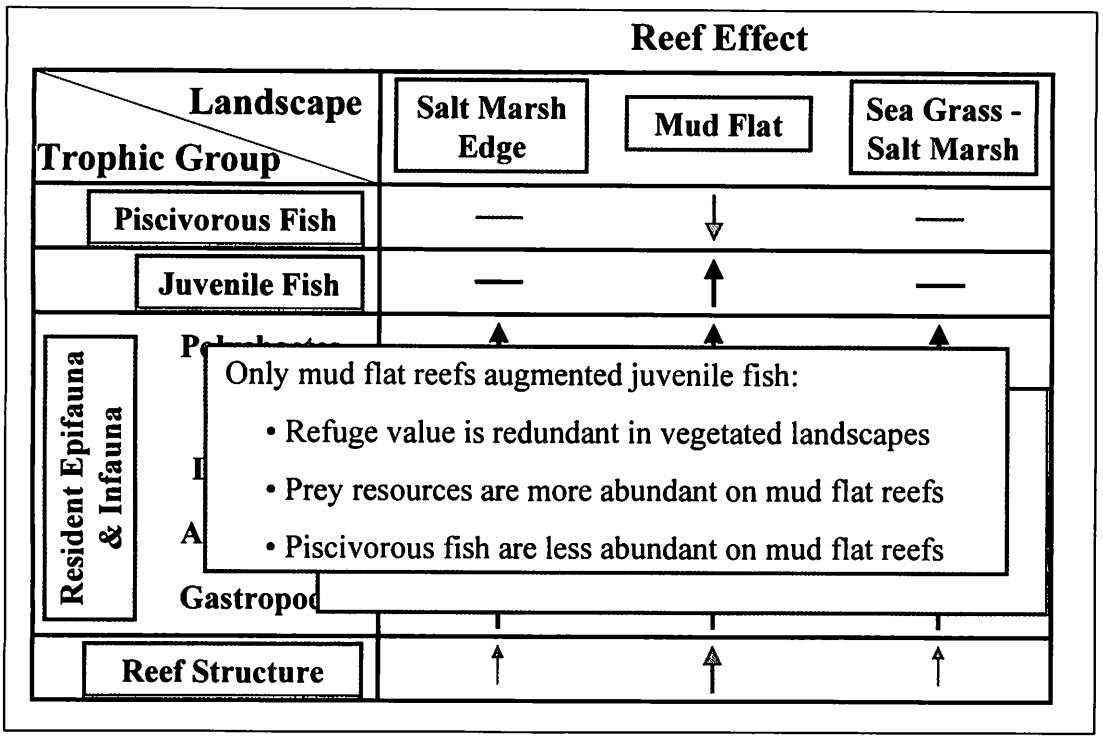
Middle Marsh, Back Sound, North Carolina USA



Reef Construction


Reef Presence
Landscape
'Reef'
'Control'
Salt Marsh Edge
Mud Flat
Sea Grass & Salt Marsh


Sampling Protocol
Piscivorous Fish
Juvenile Fish & Transient Decapods
Resident Epifauna and Infauna
Reef Structure
Kg?



Outline

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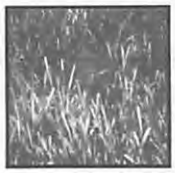
Quantifying the Bioeconomic Value of Ecosystem Goods and Services Provided by Oyster Reefs

Filter Water



Stabilize Adjacent Habitats

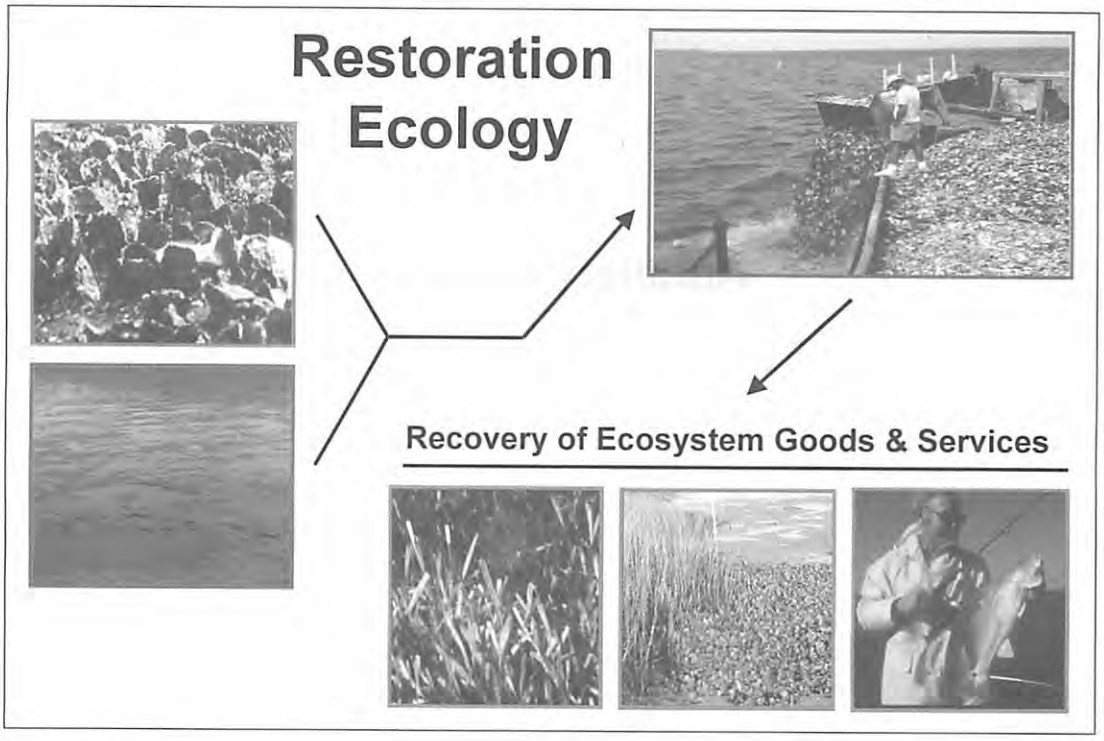
Produce Valuable Fish

Consider: Oyster reefs function like sewage treatment plants

Economic Value: Compare cost to process water by a sewage treatment plant to water processed by oyster reef

General Conclusions

- Quantifying whether restoration efforts recover ecosystem functioning is critical
- Management decisions (i.e., harvesting practices, location) will determine the extent to which restoration is successful
- Bioeconomic models will guard against future ecological disturbances



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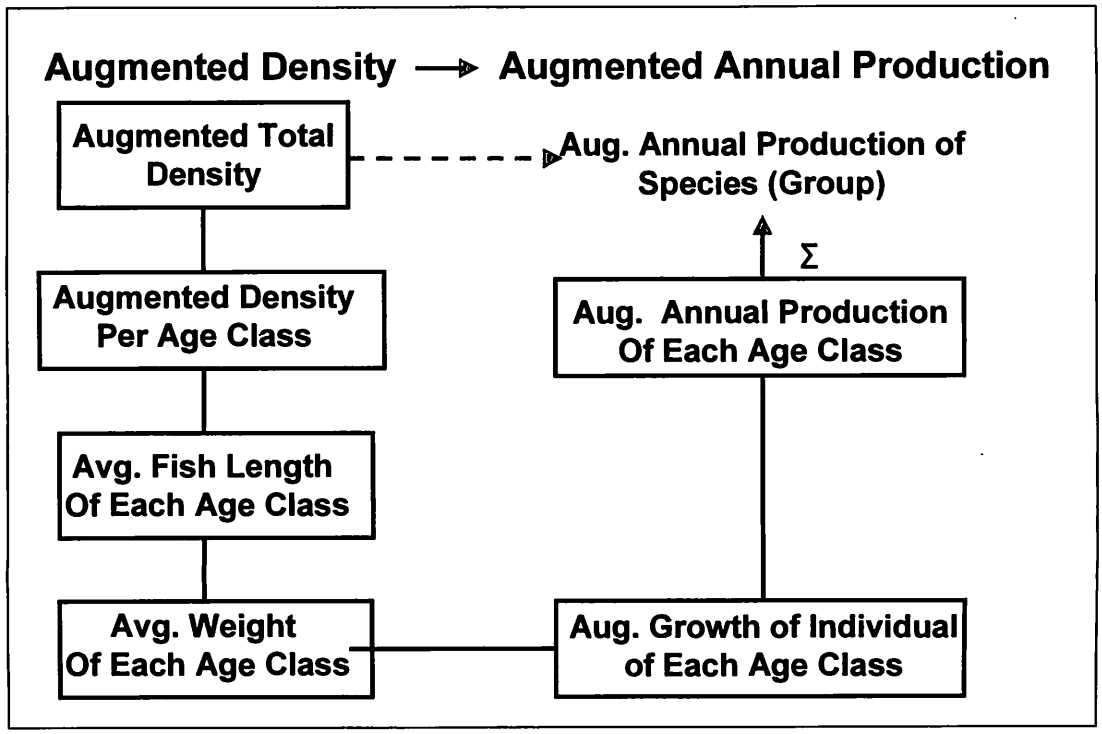
Ancillary Slides

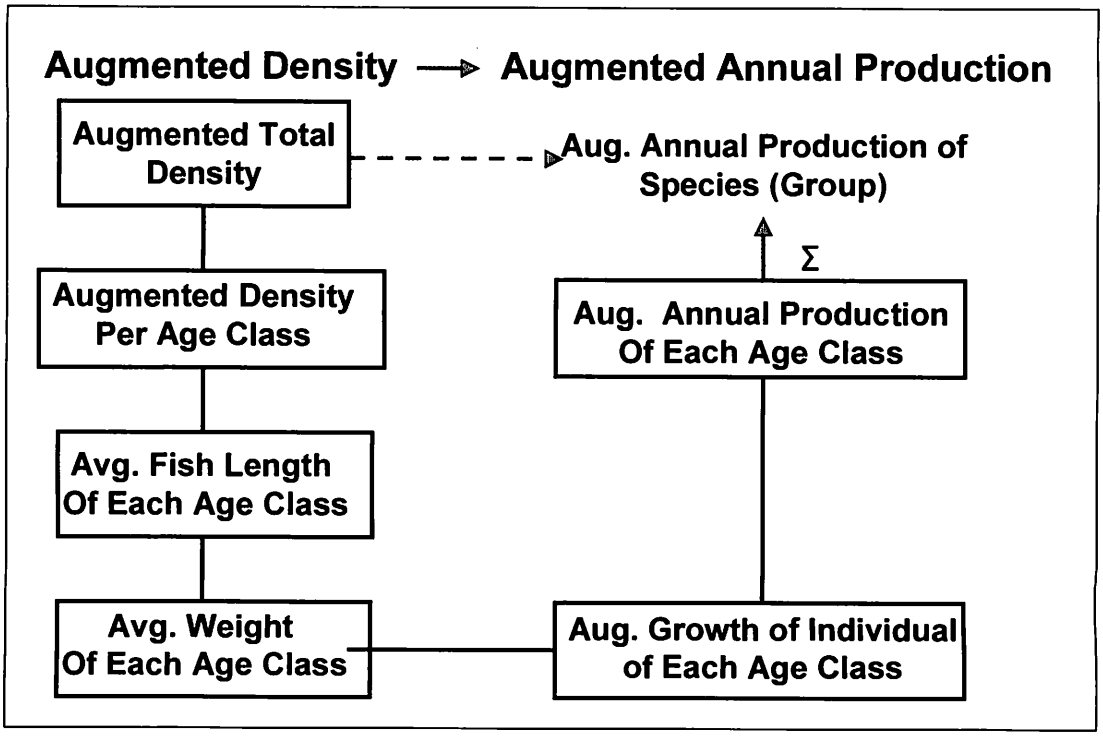


Annual Augmented Production

Species Group[a]	IRE[c]	Class	Ann. Aug. 2° Prod.*
Sheepshead Minnow	0.100	G	0.000
Bay Anchovy	0.100	G	0.019
Silversides (3 spp.)	0.100	G	0.002
Gobies	-	RE	0.644
Blennies	-	RE	0.050
Sheepshead	-	RE	0.586
Stone Crab	-	RE	0.653
Gray Snapper	-	RE	0.114
Toadfish	-	RE	0.022
Gag Grouper	-	RE	0.293
Black Sea Bass	0.750	G	0.046
Spottail Pinfish	0.750	G	0.005
Pigfish	0.750	G	0.135

* Kg/10m^2/Yr

Total: 2.570



Wetlands Development and Its Lesson

Dongsung Kim and Sukjae Kwon
(Korea Ocean Research and Development Institute)

1. Coastal wetlands (tidal flats) and filled areas in Korea

The tidal flats, which have an area of about 255,000 ha (based on 1999), are concentrated in the western coastal area of Korea (over 90%) and were reduced by 37 % (150,700 ha) over a period of 40 years (1960~2000). They will decrease another 3,800 ha because of development plans between 2001~2011 (see Table 1). There are two main reasons for their reduction: a shortage of land for economic development and an underestimation of the value of tidal flats. The drive for conservation of tidal flats comes from the realization that they are valuable parts of our environment, and moreover, there has been an international trend emphasizing the important functions and the role tidal flats play in balancing our eco-system. The creation of replacement tidal flats, which is a kind of conservation measure, can be thought of in two ways: 1) restoring or enhancing already damaged environments, to be carried out by national or local governments; and 2) creating additional tidal flats to mitigate of unavoidable destruction of existing wetlands. The two methods can be achieved by combining coastal maintenance projects, environmental impact studies, and permit systems. Since the tidal flats are typical quasi-public goods (or non-market goods), their loss by reclamation brings negative externalities to people. The externality problem can be solved if the developer internalizes the environmental costs to avoid market failure.

Table 1. Size of tidal flats and reclamation areas in Korea

	Year	Size (ha)
Tidal flats	1999	255,000
Tidal flat reduction due to reclamation	1960 ~2000	150,700
Planned reclamation	2001 ~2011	3,800

2. Representative cases of reclamation in Korea

- Shiwha Project

The Shiwha Project was planned in the late 1980's before the establishment of wetlands conservation policy such as the Integrated Coastal Zone Management Program (ICZM), and was completed in 1994. The plan was to construct a seawall of 12.7 kilometers in the mouth of the estuary. As a result of the project, 110 square kilometers of land was created. This land has been utilized for agriculture, industrial complexes, and residential use (see Fig. 1 and 2). Additionally, Shiwha Lake was converted to freshwater.

The project was a typical failed case among the Korean government's development plans because huge environmental costs were produced compared to the benefits obtained from the project. The government expected to fill Shiwha Lake with fresh water in accordance with the plan, whereas the lake had previously been filled with salt water, and water quality suffered. To solve the problem, the government lowered the inshore sea level by 1 meter and created a mudflat. The newly created mudflat has functioned as wetland because of its natural cycles, such as the new clusters of salt plants and land plants. Furthermore, natural heritage species such as plover-snipes and oystercatchers, and endangered species such as spoon-billed sandpipers are beginning to live in the lake. The development project gives us a good lesson about Mother Nature's amazing capacity to restore original landscapes. There is some bad news, however, it seems that clams, which came into the lake with sea water via a lowered sea level of -1.5 meters during the summer season, are killed by the tons every year. Accordingly, white clam hills are stretched along the coastline.

Now the surrounding area of Shiwha Lake is exposed to several experimental development plans including the build up of the industrial complex, new development to combat urban sprawl, and land usage to improve agricultural productivity. Meanwhile, a new proposal recently came out in favor of the Kyunggi government and people's interest in consulting with the federal government and calling for the "Civil Act for the Creation of the Ecopark." The main idea is to preserve the natural ecosystem by laying aside the area as a tourist site. Another effort calls for getting the wetlands back to their natural state by letting seawater flow into the lake. Those who support this plan pointedly say that modifying the coastline without restoring the marine ecosystem can make the area vulnerable to global environmental changes like sea level upheaval.

Since the government announced that the Saemanguem project will go ahead, environmentalists have been concerned about how the land-to-be will affect the ecosystem of the neighboring area if and when the project is completed.

The Ministry of Agriculture, which supervises the project, has been pushing the project as "environmentally friendly" land use. On the other hand, religious groups and environmentalists oppose the project; they argue that the plan will eventually result in environmental degradation and destruction by affecting hundreds of species in the area.

The memories of the disastrous impacts of the Shiwha project on the neighboring areas haunt the minds of those who oppose the Saemanguem plan. International societies, including Wetland International and Friends of the Earth, also see preserving the wetland as it is to be a better option for the natural ecosystems and for humanity as well.

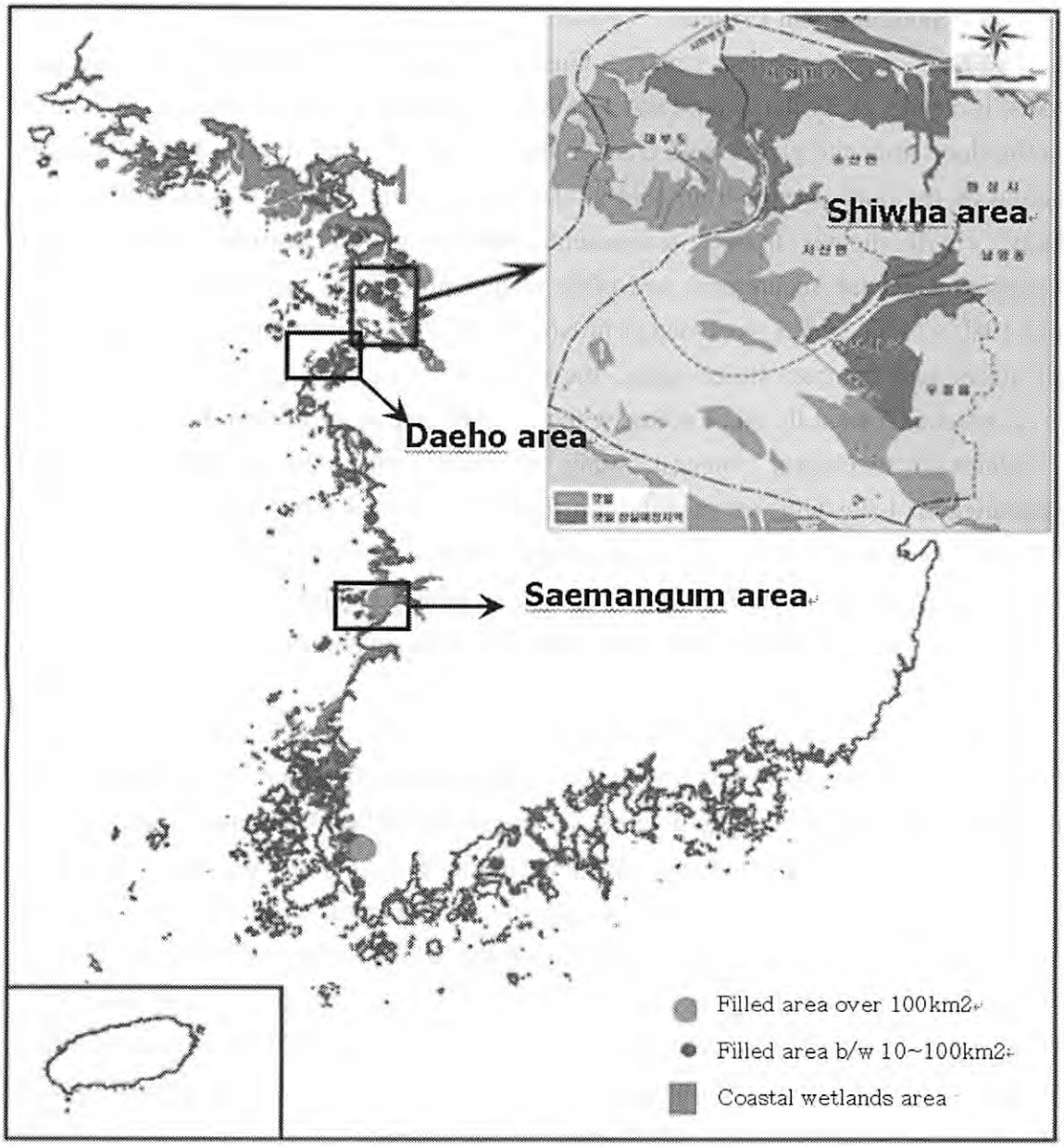


Fig. 1. Coastal wetland area and filled areas in Korea

Fig.2 Shiwha area development policy and the ecological park planned by residents adjacent to the Shiwha area

- **Saemanguem Project**

The Saemangeum project connects Gusan to Buan by constructing 33km-long sea dikes. It creates 28,300ha of land and 11,800ha of freshwater lake. The project has been on the floor since the global food crisis in the early 1970's and the rise in food imports caused by the poor harvest from cold weather in the early 1980's. A project feasibility study, environmental impact assessment, public opinion hearings, public water reclamation license securement and other related procedures were carried out in the mid-1980's, after which work began in November. After constructing the 33 km-long sea dikes and the two sluice gates, the reclaimed land will be developed into an environmentally friendly place in line with the needs and wants of the public.

Whereas specialists forecast water shortages after 2006, the creation of Saemangeum Lake will secure 1 billion tons of fresh water that corresponds to 200 medium-size agricultural reservoirs, enabling sufficient supply for the region. This will put an end to the recurring flooding of 12,000 ha of agricultural land in the Dogjin and Mangyung river basin resulting from reverse flow, thus saving about 400 billion Won in land drainage costs.

Construction of the dikes will shorten a traffic route between Gunsan and Buan from 99km to 33km. This will improve overland transportation in general by connecting the mainland to the island. A modern tourist site consisting of farmland, lakes, seashore, and Byunsan National Park will greatly contribute to the regional economy.

The environmentally friendly sequential development plan provides for the construction of the sea dikes by 2006 and then the development of the Dongjin region, which has better water resources. After that, the Mangyeong region will be developed with the aim of bringing water quality in the area up to a standard. The reclaimed land will be developed in line with anticipated social changes and economy trends through the coordination of opinions from the public and specialists.

From 1991 to 2003, 1.6 trillion Won has already been invested for the project, leaving an opening of only 2.7 km in the sea dikes still to be closed. For the remaining 2.7 km of the dike, pitching stones and gabions are already in place which makes it difficult for the fishing boats to pass through as the gates are not ready. With 160 billion Won of investment in 2004, the sea dikes will be reinforced, which, along with the construction of the Sinsi sluice gate, will result in 85% completion of the construction works.

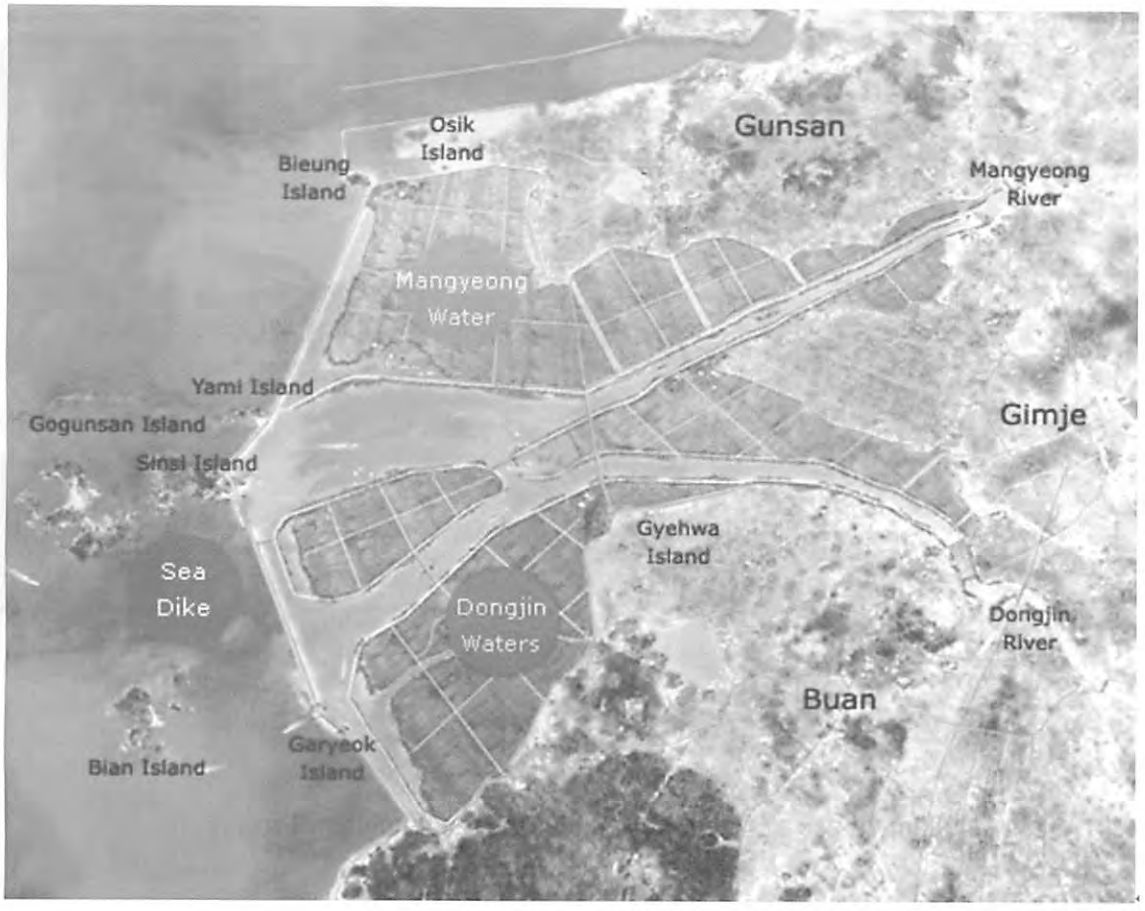


Fig. 3. Development plan in the Saemangum area

If construction is halted, the erected portion of the dikes will be washed away by storm surges and extreme waves, thus bringing debris and quarries out to the tidal flats and coasts nearby, resulting in further environmental degradation. To prevent this degradation, extra maintenance costs will be required each year in addition to the significant construction costs still required.

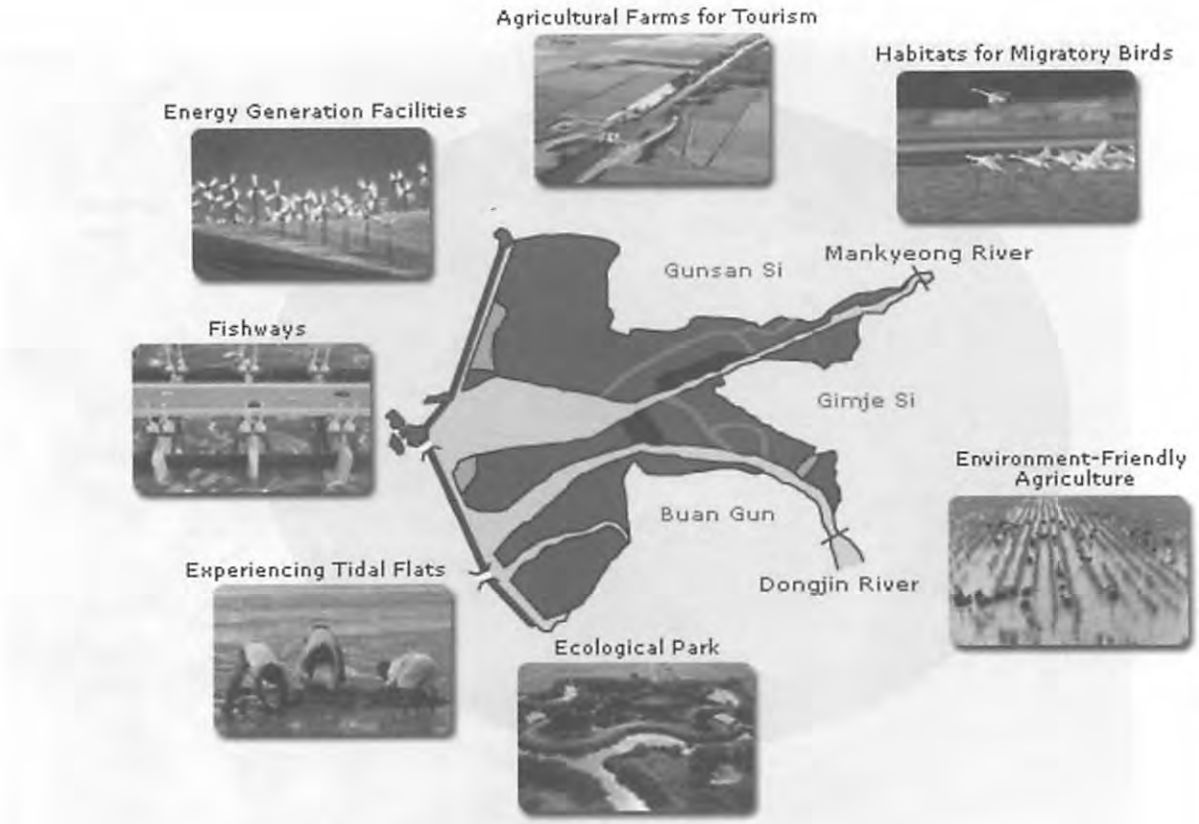


Fig. 4. Planned use of filled areas under the Saemanguem Project

- **Daeho Project**

The Daeho project was started in 1981 before establishing wetlands conservation policy such as the Integrated Coastal Zone Management Program (ICZM), and was completed in 1995. There are two dikes; Seokmoon (10.6km) and Daeho (7.8km). For the project, 37.5 square kilometers of land planned for agriculture, industrial complexes, and residential areas was created. However, the plan was changed to transform a section of the reclaimed area into an ecological area to improve the environment and tourism in the project zone. So far, the Daeho project can be evaluated as more successful than the Shiwha project from a green view.

Fig. 5. Seokmun dike and Daeho dike

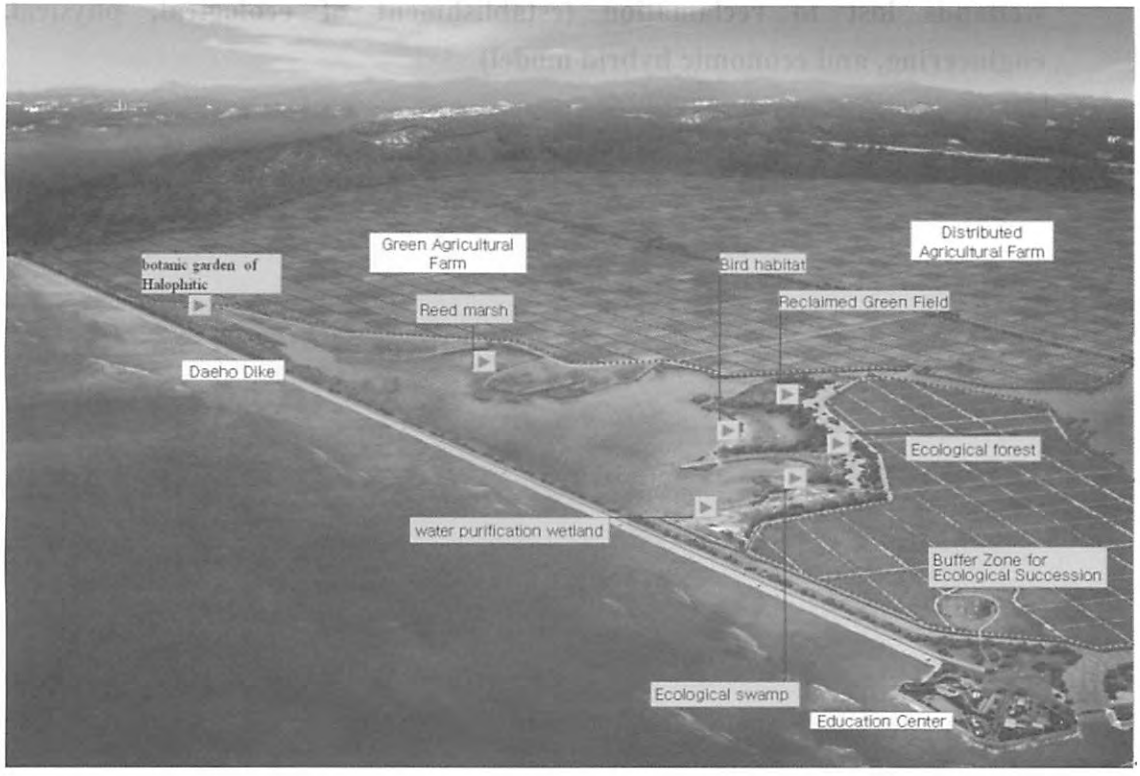


Fig. 6. Transformation of reclaimed area to ecological area in the Daeho project zone

3. Discussion

- **Benefit/Cost Analysis of development including environmental costs**
  - **Evaluation of wetland functions (understanding the ecosystem)**
  - **Non-use value of wetlands (application of evaluation techniques, i.e., TCM, HPM, CVM, Emergy method)**
- **Policymaker's decision and NGO for development/reclamation**
- **Wetlands Conservation Regulation**
- **Review of current regulations and amendment/creation of regulations, if needed**
- **Research on creation/restoration/enhancement of replacement wetlands for wetlands lost to reclamation (establishment of ecological, physical, engineering, and economic hybrid model)**

Estimation of Cohesive Sediment Shoaling and Means of Sedimentation Control

Dr. Ashish J. Mehta
Department of Civil and Coastal Engineering University of Florida USA

This presentation will consist of two parts. In the first part we will look at how a simple modeling methodology was used to estimate cohesive sediment shoaling under the proposed San Francisco Airport runway extension on a piled structure in San Francisco Bay.

In the second part we will examine how the efficiency of an in-line trap may be optimized. The example presented will be the C-18 tidal canal in the Loxahatchee Estuary in Florida, where accumulation of organic-rich muck has degraded water quality.

In concluding comments we will consider some examples of techniques for fine sediment control.

Estimation of Cohesive Sediment Shoaling and Means of Sedimentation Control

Ashish J. Mehta
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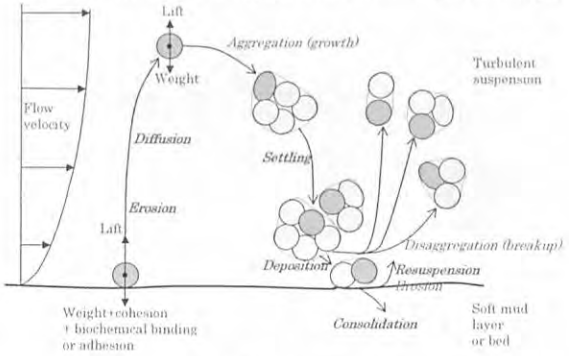
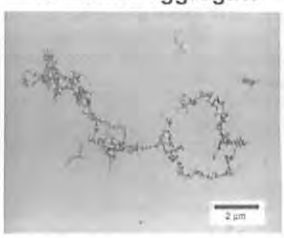
Gainesville, FL 32611, USA

Aggregation dynamics: Pickup-growth-settling-breakup of flocs

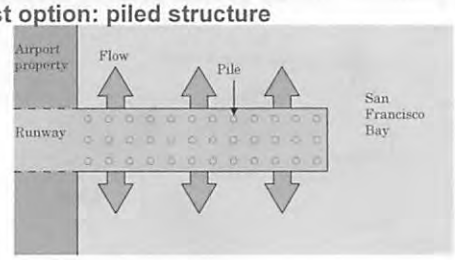


A marine aggregate

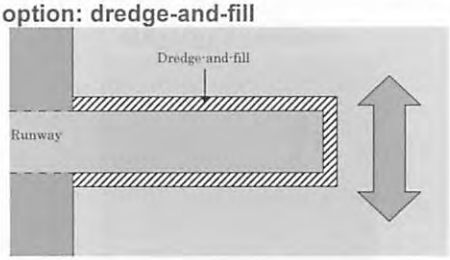


Question: How to extend SFO airport runway into San Francisco Bay?

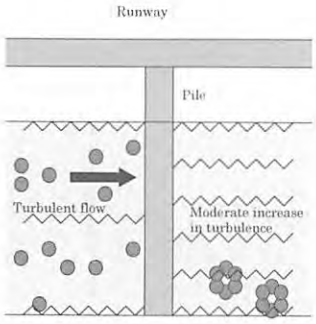
Higher cost option: piled structure



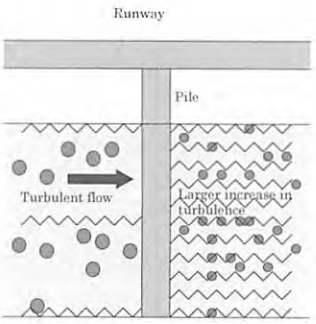
Lower cost option: dredge-and-fill



Effect of piled structure on flocs depends on pile-induced turbulence



Moderate increase in turbulence: floc growth

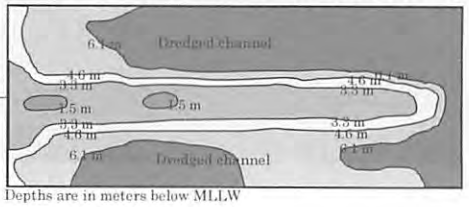


Larger increase in turbulence: flow breakup

Calibrate flocculation model using data from Pier 42 of the Port of San Francisco

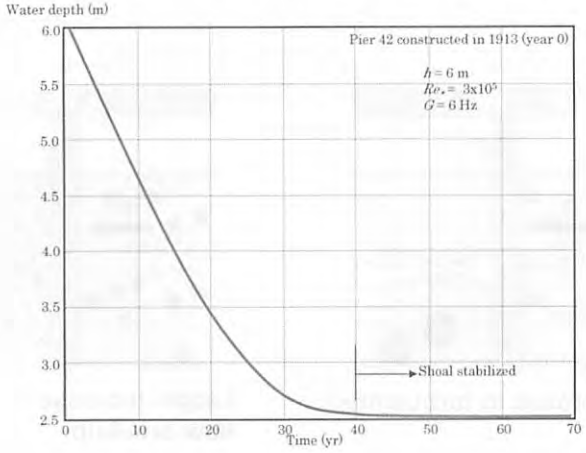
Pier 42 – piled structure

69 years of Accumulation under Pier 42



Depths are in meters below MLLW

Flocculation model simulation of shoaling under Pier 42



Optimization of sediment traps for capturing organic-rich sediment in C-18 tidal canal of the Loxahatchee Estuary, Florida

Dredging to improve navigation in a PCB laden estuary