Management Analysis of an Internationally Shared Waterbody: The Yellow Sea Large Marine Ecosystem

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Abstract
Internationally shared waterbodies face a difficult set of management challenges, and many are being exploited at unsustainable rates. This report looks at the United Nations Environment Program’s Regional Seas program and the Large Marine Ecosystem (LME) concept, which have been developed as management tools for improving the sustainability of transboundary marine ecosystems. The Yellow Sea LME is possibly the most intensively exploited and degraded LME worldwide. Six management options were reviewed using criteria developed to discover the best path towards sustainable marine resource use. The most promising option is to combine an expanded version of the current programs with a community-based management component to ensure quicker implementation of programs and to increase community involvement. International management plans of shared areas are extremely difficult to put in place in a way that satisfies all constituents as well as meets all goals, combining the use of tools such as ecosystem and community based management may be most effective at achieving project goals.

1. Introduction
Internationally shared waterbodies face a difficult set of management challenges. The complexity of regional issues, often characterized by administrative, cultural, and linguistic differences, technical and physical obstacles, and the psychological idea of “cross-border ignorance” explain these challenges. One way this has been dealt with is through the development of ecosystem based management programs. The goal of ecosystem based management includes protecting ecological interactions and processes necessary to sustain ecosystem structure and function. The United Nations Environment Programme (UNEP) Regional Seas program (RSP) has been developed as an ecosystem based management tool for improving the sustainability of transboundary marine ecosystems. The Large Marine Ecosystem (LME) concept has been developed more recently as a functional management tool within regional seas. Specific LMEs are degrading faster than others; one example is the Yellow Sea (YS). This report analyzes the management of the Yellow Sea through the Regional Seas (RS) and Large Marine Ecosystem projects, focusing on fisheries management. Many people rely on the marine resources of the Yellow Sea; therefore sustainable management and improving the

1 Cohn (1999)
2 Christensen (1996)
3 NOAA (2004)
current health of the system are urgently important. A range of policy alternatives was analyzed according to a relevant set of criteria.

2. Methods

In producing this report, I reviewed published literature on the RSP and LME programs, as well as literature specific to the Yellow Sea. I developed the criteria and options used in the management analysis through these literature reviews, and expert interviews, including best practices and critiques of LME projects and similar programs, as well as relevant articles in related international legal mandates (see section 7). I worked with two researchers from the Woods Hole Oceanographic Institution (WHOI) Marine Policy Center closely on some of this work. I received data from the Korean Ocean Research and Development Institute (KORDI) on the economic marine activities of the region, as well as biological data from the Sea Around Us Project (see section 4). The purpose of this project is to analyze the current situation in the Yellow Sea LME, and to develop criteria and options to analyze and recommend the best management plan for the region.

The options presented are based on typical marine ecosystem management plans for areas facing transboundary problems such as the RSP/LME programs, as well as some ideas developed according to current critiques (see section 9). Critiques include the lack of involvement from Japan, and lack of on the ground implementation of management changes in the region.\(^4\) Many of the options are management plans that have succeeded in similar situations such as the Baltic Sea LME, as discovered through my literature review. I reviewed the 2002 Sherman document on improving management of LMEs and used some of the ideas listed here in developing management options.\(^5\) In comparing the options and criteria, to create the decision matrix, I considered the main goals of the original YSLME project, as well as the major issues pertinent to the region.

This research highlights problems with the large-scale ecosystem management currently occurring in the region, and criteria development was based in part on these problems (see section 10). I reviewed the criteria UNEP uses to review management projects, as well as the

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\(^5\) Sherman (2002)
criteria used to analyze the Caribbean Environment Programme Action Plan,6 and used these as a guide for developing some of the criteria used here. After reviewing the five-module7 approach to assessment that is currently used to assess an LME, I incorporated these ideas but broke them down into more manageable units for analysis, as well as some that dealt more directly with management plans than with the functioning of the system.

My recommendations involved analysis of these developed criteria and the management options I presented (see section 11). In the recommendations, I considered certain criteria such as “improving the ecosystem” more important than others, as this is one of the clearly stated objectives of the Yellow Sea LME project. Criteria that seemed critical to the implementation of any management project in the region, such as “likelihood of political agreement” were also considered more closely. Failure to meet either of the two criteria listed here, led to elimination of the option being reviewed.

I then created a decision matrix, or subjective evaluation of each option as compared against each criterion based on the Weimer/Vining method (see matrix in appendix).8 The rankings used are on an increasing scale from negative-negative thru zero to positive-positive and are relative to the other options considered. Finally, I discuss these Yellow Sea specific recommendations in relation to other LME/RSP projects in general. Although LMEs are all somewhat different, there are important results from this study that should at least be considered when planning for the management of any similar system. While there were a fairly large number of documents available on biological factors of LMEs there was much less available on governance and management structure.

3. Structure of the Report

This report next discusses relevant background information on the Yellow Sea region, including location, conditions, and marine industries. It then covers the structure of the Regional Seas program with a specific look at the Northwest Pacific Regional Sea, and the structure of the Large Marine Ecosystem concept with a detailed look at the YSLME project. The report then proceeds to cover international legal mandates related to management of the Yellow Sea,

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6 UNEP CEP (2005)
7 Sherman (2002)
8 Weimer (1999)
4. Background

Marine ecosystems worldwide are being exploited at unsustainable rates. We know enough about marine systems to be certain that the ocean’s productive capacity cannot keep up with our ever-increasing demands.9 Fisheries are being overfished; pollution both from land-based and sea-based sources, marine traffic, oil drilling and mining, and other anthropogenic influences are having negative impacts on marine resources.10 Management changes are needed to improve the state of the world’s oceans. The Yellow Sea is one such damaged marine ecosystem; the valuable and deteriorating marine resources of the sea are shared by the multiple nations that border it.11

Regionally shared seas face a particular set of management challenges. They often have a complex set of constituents, governance structures, and management organizations, and some of these are addressed below.12 Different governments and constituents often have a variety of competing goals and priorities.13 The authority of the management through international agreements always lies within the involved nations; each nation may choose to back out of an international agreement at any point, they are non-regulatory, and can only urge nations to create legally binding laws.14 Management of these shared resources depends on the cooperation of international, national, regional, and local institutions.15 Challenges can also arise in scientific studies of these shared waterbodies; such as evaluating available science to ensure that the best available data is relied upon.16 The biophysical environment of such a large area varies greatly,
and the scientific community comes from a wide variety of backgrounds adding to the complicated management issues.

In continental shelf LMEs, such as the Yellow Sea and the Northeast United States Shelf, excessive fisheries effort has caused large-scale declines in catch and changes in diversity and dominance of the fish community.\(^\text{17}\) The YS is one of the most intensively exploited LMEs in the world, and overfishing is arguably the most detrimental anthropogenic impact in the region.\(^\text{18}\) In both of these ecosystems, pollution and environmental disturbance are of secondary and tertiary influence.\(^\text{19}\) The health of the YSLME has changed greatly over the past five decades, due to the ever-increasing pressures on the marine resources of the region.\(^\text{20}\) There is also an increased frequency of harmful algal blooms occurring in the waterbody.\(^\text{21}\) These conditions have not improved and in fact have worsened since the current management program was put in place.\(^\text{22}\)

### 4.1 Location of the Yellow Sea

The YSLME is a semi-enclosed sea bordered by the developing nations of the People’s Republic of China (China), the Democratic People’s Republic of Korea (North Korea), and the Republic of Korea (South Korea) (see Figures 1 and 2).\(^\text{23}\) The governing structures of these quickly developing nations vary greatly at the national level. LMEs bordered by developing nations face distinct management challenges as well, including changing economies, industries, and in this case growing populations.\(^\text{24}\) Additionally, ten percent of the world’s population inhabits the area that drains into the Yellow Sea.\(^\text{25}\) Large metropolitan areas on the Yellow Sea include Qiangdao, Tianjin, Dalian, and Shanghai in China, as well as Seoul/Inchon in South Korea.
Korea and Pyongyang- Nampo in North Korea. Japan is located immediately outside of the LME boundary, but also relies heavily on resource use in the region.

Figure 1. Large Marine Ecosystems worldwide.

Figure 2. The Yellow Sea is bordered by China, South Korea, and North Korea, with Japan located to the southeast.

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26 YSLME (2005)
4.2 Oceanographic Conditions

The Yellow Sea Large Marine Ecosystem (YSLME) is considered representative of continental shelf systems and semi-enclosed seas. It is dominated by the interactions of the high temperature high salinity Kurishio Current, and the coastal cold-water masses from some of the regional spawning and feeding grounds. Due to marked seasonal variations, it can support both cold-temperate and warm water species. This allows for a highly diverse biological system, making it internationally significant. The weather in the Yellow Sea is dominated by strong northerly monsoon winds from late November through March. The northern portion of the Yellow Sea, the semi-enclosed Bohai Sea, is a spawning and nursing ground for many commercially important fish and shrimp. There are a few major rivers that flow into the YS and empty large quantities of sediment, affecting its salinity and hydrography, notably the Yellow River, and the Yangtze River.

The Bohai bay and the mouth of the Yangtze River are the most heavily polluted Chinese waters, both of which are within the Yellow Sea LME. Approximately 100 million tons of

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27 NOAA (2004)  
28 LME (2005)  
29 YSLME (2004)  
30 NOAA (2004)  
31 YSLME (2005)  
32 NEWS Pollution Worsens in China (2005)
domestic sewage and 530 million tons of industrial wastewater are discharged into the Yellow Sea annually.\textsuperscript{33} The Chinhae Bay off the South Eastern coast of South Korea is also one of the most heavily impacted estuarine systems in the region.\textsuperscript{34} Most management policies do not connect water quality problems with land-use management and economic development, nor do they correlate fishery depletion with pollution or habitat loss.\textsuperscript{35}

\textit{4.3 Marine Industry Activities of the YSLME}

A wide variety of marine industries are prevalent in the Yellow Sea. They include: shipping, aquaculture, oil and gas removal, tourism and fisheries. Only a few of these industries rely on a healthy marine system, however, they all need to be considered when deciding on management practices.

South Korea and China depend on ocean shipping for their growing trade sectors.\textsuperscript{36} They are internationally competitive with their shipbuilding and port industries. Korea is ranked tenth in the world for overall maritime industry, and sixth in seaborne cargo.\textsuperscript{37} The Yellow Sea ports of Tianjin, Qingdao, Incheon, Dalian, and Qinhuangdao are among the top 25 in the world in the amount of cargo that moves through them.\textsuperscript{38} Shipping impacts the region, does not rely on a healthy sea and is certainly a large sector of the marine economic activities of the YSLME. The increasing amount of international shipping traffic has led to oil spills and collisions, and the region is severely impacted by eutrophication.\textsuperscript{39}

China reported 63\% of world aquaculture in 1998.\textsuperscript{40} This is continuing to grow, but modern aquaculture practices are often unsustainable, due to water pollution and other environmental effects.\textsuperscript{41} China’s oil and gas revenue from the Yellow Sea was 10.9 billion Yuan (US$ 1.3 billion) in the year 2000. This is not a major revenue inlet for the region, yet there are

\textsuperscript{33} Sherman (2002) 
\textsuperscript{34} Lee (1998) 
\textsuperscript{35} Lee (1998) 
\textsuperscript{36} Kwak (2005) 
\textsuperscript{37} Kwak (2005) 
\textsuperscript{38} ISL (2004) 
\textsuperscript{39} NOAA (2004) 
\textsuperscript{40} Pauly (2002) 
\textsuperscript{41} Midlen and Redding (1998)
~14 exploratory wells in the region. Neither aquaculture or oil and gas removal necessarily depend on a healthy marine ecosystem, however both industries can affect the health of the sea.

Coastal tourism is a marine activity that relies to some degree on a healthy marine ecosystem, and can have major impacts on the waterbody. South Koreans as well as Chinese citizens are now seeing greater incomes and more leisure time than ever before; this has led to the importance of recognizing the Yellow Sea coastline as a recreational area. The Republic of Korea has been working to increase tourism, especially coastal and marine tourism in the nation. Declining availability of fish resources is leading small Korean fishing villages to put more concentrated effort into the tourism industry. Tourism is a young industry in the coastal Yellow Sea, but it appears to be a growing economic sector in the region.

This paper focuses on fisheries, as this is the largest economic marine industry that does rely on a healthy ecosystem in the Yellow Sea. China is the world’s top fish producer, and the fishing industry in Korea averages about tenth largest in the world. Seafood is an essential source of protein and an important part of the culture in the region. In 2003, fish landings in five major Yellow Sea coastal cities in Korea amounted to 66 thousand metric tons valued at 250 billion Won (US$ 210 million). Fish landings in Yellow Sea coastal regions in China were 5.6 million metric tons in 2000. These are significant numbers highlighting the fact that fisheries are one of, if not, the major marine industry in the Yellow Sea. However, due to changes in species composition, sizes, and trophic levels, the fishing industry is having trouble. Government subsidies for fisheries are being used in both China and South Korea. A recent FAO study found that many Korean fishing fleets are heavily dependant on government subsidies in order to operate profitably, to the extent that many of these fisheries are not economically feasible.
without subsidies. Starting in 1995, China has practiced a midsummer moratorium in July and August for their fishing industry, as it has become clear that the fisheries are failing. Management plans for the YSLME must focus to a large degree on improving the sustainability of the marine resources, as well as the fishing industry. So far, the policies and regulations in use have not achieved this goal.

The major fisheries are at extremely low levels today compared with 3 decades ago, and are now no longer ecologically sustainable. Since the 1960s the number of fishing boats, and the improvement of fishing gear, have spurned this overfishing phenomenon. There have been significant changes in catch composition due to overfishing. Some of these changes include a change in commonly caught species, and a smaller average size of fish landed (see chart 2). The average trophic level of species in the Yellow Sea has been reduced (see chart 3).

5. Structure of the UNEP Regional Seas Program

The United Nations Environment Programme (UNEP) Regional Seas Programme was created in 1974 as a regional approach to protecting the environment and managing natural resources (see timeline in appendix). UNEP began the Regional Seas program as a catalyst for the United Nations Conference on the Law of the Sea (UNCLOS) agreements. This was shortly after the UN Conference on Human Development and Environment (UNCED) in 1972. The Regional Seas program is a globally comprehensive initiative that aims to protect marine and coastal environments. It addresses the continuing degradation of the world’s oceans and coastal areas through sustainable management and through cooperation between neighboring countries. The Regional Seas Program incorporates the principles of integrated coastal management (ICM), and ecosystem-based approaches to management. Eighteen regional seas are designated throughout the world. There are currently 140 countries that participate in 13

53 FAO (2003)  
55 FAO (2000)  
56 Biodiversity Clearing House (2005)  
57 Sea Around Us Project data (2005)  
58 Sherman (2002)  
59 Sea Around Us Project data (2005)  
60 UNEP (2005)  
61 UNEP (2005)  
62 UNEP (2005)
regional seas programs. UNEP and the United Nations Development Programme (UNDP) directly administer six of these programs, while national representatives administer the others.\textsuperscript{63} The Regional Seas programs function through individual action plans and correlated conventions that all reflect a similar approach, but are tailored towards the individual needs of the nations involved and the environmental problems specific to their region. The governance structures of these programs are quite complicated due to the intricacies of regional management.

Each Regional Seas program is required to create an action plan (AP) that is agreed upon by all member nations of that program. Action Plans consist of five sections: environmental assessment, environmental management, environmental legislation, institutional arrangements, and financial arrangements.\textsuperscript{64} These sections analyze the current situation of the sea, and outline a strategy to address the causes of these problems and their impacts on the region.\textsuperscript{65} The AP also provides the legal framework to the action plan. This step usually leads to specific legislation on environmental regulations in each signatory nation. Many of the Regional Seas programs are provided seed money from the Global Environment Facility (GEF) and the UNDP. The governments of these beneficiary regions are expected to assume financial responsibility within a set time frame.\textsuperscript{66}

Each regional seas project has a regional coordinating unit (RCU) that is the command post for the implementation of the AP.\textsuperscript{67} The responsibility to ensure the AP’s activities are implemented and monitored relies with the RCU. The legally binding convention each region develops and ratifies, expresses in clear terms the commitment and political will of governments to tackle their common environmental issues through coordinated activities. Twelve of the current Regional Seas programs have developed and instituted a convention.\textsuperscript{68} They set out what each government is responsible for accomplishing in implementing the AP. They are often supplemented by protocols, which are separate linked agreements describing what each government must do in the case of certain situations. Some of these conventions have been

\begin{itemize}
\item[\textsuperscript{63}] UNEP (2005)
\item[\textsuperscript{64}] UNEP (2005)
\item[\textsuperscript{65}] UNEP (2005)
\item[\textsuperscript{66}] UNEP (2005)
\item[\textsuperscript{67}] UNEP (2005)
\item[\textsuperscript{68}] UNEP (2005)
\end{itemize}
highly effective, while others are struggling. Each region establishes regional activity centers (RAC). Each RAC reports directly to the RCU and carries out activities related to the AP (see Figure 3). RACs for the region are financially supported by contracting parties and by the host country. Often there is a RAC located in each involved nation.

5.1 The Northwest Pacific Regional Sea (NWPRS)

The Northwest Pacific Regional Sea project is one of the six UNEP administered RS programs. It is encompasses a large area in the Northwest Pacific, which includes the Yellow Sea. Therefore the Yellow Sea falls under this RS management program. UNEP has responsibility for the secretariat functions of the NWPRS through the use of a regionally located RCU. UNEP provides financial and technical support, and is closely involved in all activities and projects, while promoting sustainable use of marine resources in the region.

The Northwest Pacific Action Plan (NOWPAP) was adopted in 1994 and established at the Korea Ocean Research and Development Institute (KORDI) by government representatives and academics from the involved nations. The four nations that have legally adopted NOWPAP are Japan, China, the Russian Federation, and South Korea; North Korea currently remains an observer. There is an RAC located in each party nation, and six projects have been identified. They include: planning monitoring and assessment systems, developing outreach and environmental education, creating a contingency plan for oil spills, preparing a plan to abate land based pollution, setup of programs to protect marine/coastal biodiversity, and initiating programs to promote sustainable use of marine resources based on ecosystem management. There are currently no legally binding conventions or protocols in the region.

Figure 3. Structure of the Northwest Pacific Regional Sea program.

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69 UNEP (2005)
70 UNEP (2005)
71 UNEP (2005)
72 UNEP (2005)
6. Structure of the Large Marine Ecosystem Concept

Due to the continued problems of regional management of international water bodies, the Large Marine Ecosystem (LME) concept was implemented as the functional management unit within regional seas. The Regional Seas program was a good idea in concept and on paper, but the necessary improvements in resource management did not often occur.\(^73\) Large marine ecosystems are a separate and smaller delineation of global coastlines and seas. They are characterized by distinct bathymetry, hydrography, productivity, and trophic interactions.\(^74\) The concept began in the US National Oceanic and Atmospheric Administration (NOAA), in 1984 by Ken Sherman, the Director of the NOAA Narragansett Fisheries lab. There are 64 LMEs designated within Regional Seas worldwide. Each LME project has its own regionally located and staffed functioning LME office.\(^75\) This is an especially interesting structure since it works within the UNEP regional seas program, but the contacting institution is the NOAA Narragansett office.

6.1 Yellow Sea LME

The YSLME is a subsection of the Northwest Pacific Regional Sea. The Yellow Sea is unique in that it has a high level of marine industry activity, and a medium level of

\(^{73}\) Sherman (2005)  
\(^{74}\) Sherman (2002)  
\(^{75}\) NOAA/UNEP (2004)
socioeconomic development.\textsuperscript{76} This suggests a major management challenge to achieve sustainability (i.e. balancing economic growth with resource protection). All other LMEs with high levels of marine industry activity also have high levels of socioeconomic development, and the majority of LMEs with medium level socioeconomic development have low levels of marine activity on the scales used in the Hoagland (2005) study.\textsuperscript{77} The Yellow Sea has the most intense levels of marine industry activity as compared to all other LMEs studied.\textsuperscript{78}

Currently a UNDP/GEF (International Waters program) project is underway for the region, entitled “Reducing Environmental Stress in the Yellow Sea Large Marine Ecosystem.”\textsuperscript{79} It focuses on improving ecosystem health, and sustainably managing fisheries. This project was accepted in the fall of 1997, and actively involves China and South Korea, while North Korea has observer status. Japan is not involved in management at the LME level, because of political disagreements that led to unwillingness to participate.\textsuperscript{80} The YSLME project aimed to create a transboundary diagnostic analysis (TDA), national action plans, and a regional action plan similar to the NOWPAP, as well as initiate and facilitate the implementation of this regional plan.\textsuperscript{81} This regional strategic action plan (SAP) deals with legal, policy and institutional reforms, as well as investments, in order to address the regional environmental issues. The SAP identifies actions to be taken by the involved nations to restore and preserve the YSLME, with a focus on addressing land and sea based pollution, overfishing, and habitat degradation.\textsuperscript{82} The TDA acts as the technical basis for the SAP, identifying issues, exploring threats and causes, and ranking them according to national, regional, and global priorities.

The project management office, similar to the RCU, is located in KORDI in South Korea, while the project manager, Yihang Jiang, is from China and has worked for the Intergovernmental Oceanographic Commission (IOC), as well as the State Oceanic Administration (SOA) in China.\textsuperscript{83} Under the YSLME project management office there are two committees and five regional working groups. All groups are comprised of: government officials

\textsuperscript{76} Hoagland (2005)  
\textsuperscript{77} Hoagland (2005)  
\textsuperscript{78} Hoagland (2005)  
\textsuperscript{79} NOAA (2004)  
\textsuperscript{80} Sherman (2005)  
\textsuperscript{81} NOAA (2004)  
\textsuperscript{82} NOAA (2004)  
\textsuperscript{83} YSLME (2005)
in environment agencies, science academics, and independent research scientists all from China or South Korea. A government science agency representative from Japan, and a representative from the World Wide Fund for Nature attend as observers. Some meetings also include a NOAA representative and UNDP or UNEP representatives, but no industry representatives are mentioned.

The two committees consist of the Project Steering Committee (PSC), and the Regional Science and Technical Panel (RSTP). The five working groups are focused on pollution, fisheries, biodiversity, ecosystem, and investment. The working groups each report to the RSTP, which in turn reports to the PSC (see Figure 4). The regional working groups are made up of four scientists (two from each nation) both social and natural, and two experts (one from each nation) from the legal, regulatory, investment, and/or environmental management fields, as well as one additional expert who acts as the Chairperson. The RSTP consists of chairs from each of the working groups, representatives from each partner organization, the Yellow Sea project manager, national project coordinators, and other regional experts. All groups work on a consensus basis.

The official launching ceremony for the YSLME project took place in March 2005, the same day the first meeting of the PSC was called. The RSTP has met twice (December 2004, July 2005), while working groups met for the first time in spring of 2005. During these past meeting sessions the working groups decided what information to collect, and who to contract to collect it. Although the project has been ongoing since 1997, it is clearly still in the initial stages (see timeline in appendix).

Figure 4. Structure of the Yellow Sea LME project.

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84 UNDP/GEF (2005)  
85 UNDP/GEF (2005)  
86 UNDP/GEF (2005)  
87 UNDP/GEF (2005)  
88 UNDP/GEF (2005)
6.2 Global Environment Facility

The Global Environment Facility (GEF) financially supports the LME approach in many projects.\(^8^9\) There is currently a GEF/UNDP Yellow Sea project ongoing, entitled “Reducing Environmental Stress in the Yellow Sea Large Marine Ecosystem.”\(^9^0\) The GEF was created in June of 1991, to bring financial support to projects focused on achieving global environmental benefits specifically in the areas of climate change, biodiversity, international waters, and ozone depletion. The concept is that GEF funds global environmental benefits of these projects, while leveraging money on a national level, so that the involved nations fund the national benefits of these projects.\(^9^1\) The focus is placed on technology and capacity building, rather than funding one particular activity. These GEF tools and resources are currently being used in the running of the YSLME project.\(^9^2\)

7. Related International Legal Mandates

One of the aims of the YSLME project is to further national and regional commitments to international agreements.\(^9^3\) The specific related conferences are discussed below.

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\(^{8^9}\) Sherman (2002)
\(^{9^0}\) GEF (2005)
\(^{9^1}\) Pernetta (1998)
\(^{9^2}\) YSLME (2005)
\(^{9^3}\) YSLME (2005)

Three Law of the Sea conferences have been held by the United Nations with a goal of outlining the rights and duties of all countries regarding the oceans. The United Nations Convention on the Law of the Sea III (UNCLOS) was held in 1973, and after nine years of negotiation that conference agreed on a new “constitution” for the seas.\(^{94}\) The marine environmental protection sections of the UNCLOS framework were fleshed out through a series of Regional Sea agreements in the 1970s.\(^{95}\) Including the Northwest Pacific Regional Sea agreement. UNCLOS was ratified by China, South Korea and Japan in 1996. The treaty sanctioned major maritime zones, and delimited a 200-mile exclusive economic zone (EEZ) for every nation. UNCLOS, however, did not provide much guidance to nations regarding management approaches for national ocean zones.

China, South Korea, North Korea, and Japan thus proclaimed their EEZs. These EEZ proclamations overlapped, leading to provisional fishery agreements.\(^{96}\) The fishery agreements are among a host of bilateral agreements in the region that do not include all involved nations and cause contention between nations.

7.2 United Nations Conference on Environment and Development

The United Nations Conference on Environment and Development (UNCED) in 1972 recognized the unsustainable production and consumption of many developed nations as directly contributing to continued environmental degradation. Thus growing environmental concerns reached the top of the international agenda.\(^{97}\) UNCED gives additional political impetus for UNCLOS by highlighting the legal framework it created and building from it. One particular central output of UNCED, Agenda 21, was intended to be a road map of sorts toward sustainable development. Chapter 17 of Agenda 21 deals with coastal and ocean issues, and this section stresses integrated management, sustainable use and conservation, and addressing international

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\(^{94}\) Cicin-Sain (1998)  
\(^{95}\) Kimball (2002)  
\(^{96}\) Kim (2003)  
\(^{97}\) Cicin-Sain (1998)
and regional cooperation and coordination among other areas. The RSP/LME program works toward implementation of this section. The UNCED treaty is a non-binding document, but indicates willingness to be a part of the international plan towards sustainable environmental management.

7.3 FAO Code of Conduct for Responsible Fisheries

The United Nations Food and Agriculture Organization (FAO) Code of Conduct for Responsible Fisheries was adopted in 1995, and lays down a set of guidelines and principles to promote responsible fishing and fisheries activities. It discusses the need for cooperation in dealing with transboundary species and issues, such as those in the Yellow Sea. Article 10 discusses coastal area management for fisheries, with provisions on institutional framework, policy measures, and regional cooperation and implementation. This has been and should continue to be considered when reviewing management plans for the YSLME.

7.4 Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA)

The GPA was adopted in 1995, and aims to be a source of guidance for national or regional authorities implementing actions to control marine degradation from land-based pollution. The Regional Seas program is considered a platform for regional implementation of the GPA. The GPA benefits from networks setup by the Regional Seas programs, and many RSPs rely on support from the GPA in developing and implementing land-based pollution protocols.

8. Accomplishments and Failures of Current YSLME Management

The YSLME project has accomplished the setup of a multilevel governance structure. The project certainly has made some great steps in bringing together nations that are not entirely

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98 Cicin-Sain (1998)
99 FAO (1995)
100 FAO (1995)
101 GPA (1995)
102 GPA (1995)
103 GPA (1995)
used to working together, yet there is still a lot to be done before reaching the original project goals.\textsuperscript{104}

The objective of the YSLME project is to achieve environmentally sustainable management and use of the region through ecosystem-based management and by reducing the current stresses on the heavily developed system.\textsuperscript{105} The YSLME project brief document was created in May of 1994.\textsuperscript{106} Only very recently have meetings convened and diagnostic projects begun. In all these years there still is no official TDA document, which is considered the starting point for management. It provides the technical basis for developing the SAP, and identifies sources and causes of problems as well as potential preventative and remedial actions.\textsuperscript{107} The SAP outlines the targeted activities that should, once implemented, solve the water-related environmental problems of the region.\textsuperscript{108} It is used to guide the GEF funded project implementation.

The Preliminary Transboundary Diagnostic Analysis was completed in November of 2001.\textsuperscript{109} This is the initial step toward creating a TDA. It lists the perceived problems and possible root causes, as well as specific issues for the TDA to look into further and analyze.\textsuperscript{110} The TDA is currently in process, with the most recent working groups meetings focusing on contracting people to do the basic diagnostic analysis research.\textsuperscript{111} This slow process may be due to the extensive work involved in such a large scale international management plan, as well as funding issues and infrastructure development. However, while progress has been moving slowly along, the ecosystem has continued to decline in productivity (see Charts 2 and 3).

During the 2003 World Conservation Union (IUCN)/IOC/NOAA Consultative Meeting on LMEs, a representative for the YSLME described negative changes observed in the region partly associated with fishing pressures.\textsuperscript{112} He noted “that management of fisheries and mariculture is critical and that water quality is key to maintaining both biodiversity as well as

The YSLME representative described the reduction of zooplankton biomass, and the rise of anchovy to the dominant species of fish in the YS, which is consistent with the Pauly-Christensen theory of ‘fishing down the food chain’. Therefore even nine years after the project began implementation of management actions have stalled, and conditions are continuing to worsen.

There are 126 nations around the globe that have made governmental commitments to ecosystem-based management of their marine resources with the initiation of LME projects. There are currently 16 LME projects occurring, and very few are in the full implementation stage, they have been occurring for different amounts of time, but it is not out of the ordinary that it should take so long for a LME project to get to actual implementation. The Yellow Sea is not unique in this, but the problem with the Yellow Sea in particular is that the ecosystem is so degraded, and the nations relying on this resource are continuing to develop so quickly, that immediate action needs to be taken to protect these resources, thereby protecting the people that depend on them. Even after a management project is implemented it will take time to see results, therefore the sooner changes are made the better.

9. Management Options for the Improvement of the Yellow Sea LME

Below is a list of the management options reviewed. They were chosen based on the current management plans for other internationally shared waterbodies, problems with the current management of this system, and critiques of the current system by other authors. These particular options are ones that show at least some potential for meeting the desired criteria (see section 10), and the original goals of the YSLME project.

1. Maintain current regional programs. The current plans for regional and national level management are in the early stages of development and have not reached their full

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113 IOC (2003)
114 IOC (2003)
115 LME (2006)
potential to manage the YSLME sustainably.\textsuperscript{118} It is possible that this management scheme will improve the marine resources and influence users to switch to sustainable practices. The combined regional sea and LME programs have worked to improve other shared waterbodies to some degree, such as the Baltic Sea LME.\textsuperscript{119}

2. \textbf{Expand the current program to fully include Japan and North Korea.} As mentioned the current program is in its early stages and may still have the potential to improve the sustainable use of marine resources. However, North Korea only has observer status at the YSLME project level, and Japan is not involved at this level.\textsuperscript{120} Yet Japan has a large impact on the YS fishery, and North Korea also has a fairly significant impact (see Chart 1). Japan removes the second largest amount of fish from the Yellow Sea, closely following China.\textsuperscript{121}

3. \textbf{Manage through Regional Seas program only.} This option was reviewed because the regional seas program has succeeded to some degree in other areas, before the genesis of the LME program. One such region is the Wider Caribbean with the Cartegena Convention.\textsuperscript{122} Another example of this is the Barcelona Convention of 1976, which helped to improve the marine ecosystem of the Mediterranean Sea, well before the genesis of the LME concept in 1984.\textsuperscript{123} Also the Northwest Pacific Regional Sea includes Japan and other nations that impact the Yellow Sea, and are not included in the LME delineation.

4. \textbf{Manage through LME program only.} The Large Marine Ecosystem projects encompass ecologically distinct units of the sea. They are much smaller, involve fewer nations directly, and thus are more manageable than the designated Regional Seas.\textsuperscript{124} This is not

\textsuperscript{118} UNDP/GEF (2005)
\textsuperscript{119} ICES (2005)
\textsuperscript{120} NOAA (2004)
\textsuperscript{121} Sea Around Us Project (2005)
\textsuperscript{122} UNEP CEP (2005)
\textsuperscript{123} Europa (2004)
\textsuperscript{124} Sherman (2002)
currently being done anywhere and never has been, however, it would focus all resources
on the ecological unit of concern.

5. **Designate nation with most financial and technical resources to take the lead in current
management projects.** This option is based on the happenings of the Baltic Sea LME.
The Baltic Sea is a good example of a LME that is well managed and has shown
improvements in the health of the marine ecosystem.\(^{125}\) It is considered a successful
program, and this is due in part to Sweden taking the management lead in the region.
Relying on the nation with the most financial and technical resources to take the lead in
current management projects could conceivably lend more financial and governance
support to the management of the YSLME.

6. **Community based management of natural resources.** This option was considered for a
number of reasons, one of which is that the UN-Habitat Best Practices database states
“being able to count on public participation is a key factor in sustainable coastal
development.”\(^{126}\) The Yellow Sea region historically has had community-based fisheries
management institutions in place, and more recently these have been declining due in part
to national level management.\(^{127}\) Literature supports the idea that fisheries resources can
be better managed when fishers and other community-level stakeholders are involved in
management.\(^{128}\) Case studies, in the literature, revealed a variety of local or traditional
practices for marine management and conservation.\(^{129}\) This traditional ecological
knowledge is often highly effective at protecting the environment.\(^{130}\)

**10. Criteria for Assessment of Management Options**

\(^{125}\) Karkkainen (2004)  
\(^{126}\) UN-Habitat (2006)  
\(^{127}\) Pomeroy (1995)  
\(^{129}\) Berkes (2000)  
\(^{130}\) Berkes (2000)
I developed this particular set of criteria through literature reviews (see section 15), and expert interviews (for example with Ken Sherman, and Di Jin\textsuperscript{131}), including best practices (such as practices in successful LMEs like the Baltic Sea) and critiques of LME projects and similar programs\textsuperscript{132}. Some of these criteria will interact with each other; however, I tried to choose a set of criteria that would look at a wide range of factors involved with possible or previous management problems for LMEs. The first criterion of improving the marine ecosystem and conserving marine resources for future use is seen as the most important criterion, since this is the major goal of the original YSLME project. Secondly the political feasibility criterion is considered, as an option will not be effective if it is never implemented.

- \textit{Improving the sustainability of marine resources.} This criterion is the main goal of the original YSLME project; therefore it should be the overall goal of the selected policy option.\textsuperscript{133} There are many people who rely on this system and its resources. Long-term improvements of the marine ecosystem status should help to strengthen and sustain fisheries, as well as other resources. This would benefit all those in the region who rely on these resources for income and food. If an option fails this criterion it should not be selected, as it will not solve the problem the region hopes to address.

- \textit{Minimize time to implement program actions.} The Yellow Sea has been seeing continual declines in productivity, loss of resources, and reductions in biophysical health.\textsuperscript{134} Literature supports the urgent need for improvement of the system, especially with the growing number of people relying on these marine resources.\textsuperscript{135}

- \textit{Maximize financial feasibility of the program.} This criterion was considered in order to understand the ease of which a management project could be funded. However it should be noted that financial availability does not necessarily translate into resource protection. The GEF funded projects include the caveat that the nations of the region will eventually

\textsuperscript{131} Ken Sherman (2006), Di Jin (2006)
\textsuperscript{133} YSLME (2005)
\textsuperscript{134} NOAA (2004)
\textsuperscript{135} LME (2005)
take over financial responsibility.\textsuperscript{136} It is important to consider if funds may be available for the project in the future.

- \textit{Maximize likelihood of political agreement.} The historical relationships among the nations involved in the Yellow Sea are complex, and the three nations have significant differences in terms of their political institutions.\textsuperscript{137} According to a World Bank Institute study on governance, South Korea, China, and North Korea are ranked from relatively high to low, respectively, on various indicators for voice and accountability, government effectiveness, regulatory quality, rule of law, and control of corruption.\textsuperscript{138} These differences have led to complications in working together to manage a shared ecosystem.

- \textit{Minimize long-term negative economic impacts to resource users.} Fisheries, is a major economic sector in all involved nations, as well as an important food source for citizens.\textsuperscript{139} If fishery overexploitation continues, the entire system may collapse, reducing overall catch and economic gain by a great amount in the future.\textsuperscript{140} While there may be some short-term changes in economies, it is especially important that long-term economic impacts are minimized in this developing region. The short-term impacts are not listed as a separate criterion as they will rank similarly throughout the options if marine sustainability is to be improved.

\textbf{11. Analysis of Options}

Each option was evaluated against each criterion. The rankings used are on an increasing scale from negative-negative thru zero to positive-positive and are relative to the other options considered. There is some interaction between criteria per option; this is seen most clearly in the connection of the “improve sustainability of marine resources” criterion to other criteria. This criterion was considered most important in the option evaluations, not only is there this interaction factor, but this also is the main goal of the original YSLME project.\textsuperscript{141} These

\textsuperscript{136} \textit{UNDP/GEF (2005)}  
\textsuperscript{137} \textit{NOAA (2004)}  
\textsuperscript{138} \textit{Kaufmann (2005)}  
\textsuperscript{139} \textit{FAO (2005)}  
\textsuperscript{140} \textit{FAO (2000)}  
\textsuperscript{141} \textit{YSLME (2006)}
evaluations were based on literature reviews, expert interviews, best practices, and past occurrences in similar situations (see section 2). I used examples found in the literature to understand what would most likely occur if these options were used in the YSLME. For some of the options, I could look at what has already happened in the YS to understand what outcomes are likely. This analysis is elucidated below (see Figure 5).
Figure 5. Decision Matrix.

<table>
<thead>
<tr>
<th>Options</th>
<th>Improve Sustainability of Marine Resources</th>
<th>Minimize Time to Implement Program</th>
<th>Maximize Financial Feasibility of the Program</th>
<th>Maximize Likelihood of Political Agreement</th>
<th>Minimize Long Term Negative Economic Impact to Resource Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain current programs</td>
<td>-</td>
<td>0</td>
<td>+</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Expand current program to include Japan and North Korea</td>
<td>+</td>
<td>0</td>
<td>++</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>Rely only on Regional Seas program</td>
<td>- -</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>- -</td>
</tr>
<tr>
<td>Rely only on LME program</td>
<td>0</td>
<td>0</td>
<td>- -</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Designate nation with most financial/technical resources to lead current mgmnt.</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>- -</td>
<td>++</td>
</tr>
<tr>
<td>Community based management of natural resources (combined with expanded program + +)</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>++</td>
<td></td>
</tr>
</tbody>
</table>

28
11.1 Maintain current regional programs.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Improve Sustainability of Marine Resources</th>
<th>Minimize time to implement program actions</th>
<th>Maximize Financial Feasibility of the program</th>
<th>Maximize Likelihood of Political Agreement</th>
<th>Minimize Long-Term Negative Economic Impact to Resource Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain Current Programs</td>
<td>-</td>
<td>0</td>
<td>+</td>
<td>++</td>
<td>-</td>
</tr>
</tbody>
</table>

**Improve sustainability of marine resources:** The YSLME has not seen much improvement in the sustainability of its marine resources since the current program began. Yet there is still a possibility that as the plan proceeds, actions will be taken that improve the system. However, this ecosystem is degrading quickly and the current management process is quite slow, and in order to achieve some level of sustainability, immediate action is recommended.\(^{142}\)

This RSP/LME plan has been effective in other regions in the past. The Baltic Sea LME is considered a success, because the ecosystem has seen great improvements.\(^{143}\) However the Baltic Sea region faces a somewhat different set of challenges, and currently fish stocks are continuing to decline in the YSLME.\(^{144}\) The Yellow Sea really needs immediate improvement, and this has not been seen through the current management programs. (Ranking = -)

**Minimize time to implement program actions:** The current layered management scheme of RSP and LME projects has been in place since 1997 (see timeline in appendix).\(^{145}\) However, even in the past nine years, average trophic levels of fish landed as well as average size of fish landed have continued to decline (see Charts 2 and 3). Progress has been made in building connections and setting up plans for management between China and South Korea, however the program is still in the early diagnostic analysis phase.\(^{146}\)

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\(^{142}\) Pauly (2002)  
\(^{143}\) Karkkainen (2004)  
\(^{144}\) Sea Around Us Project data (2005)  
\(^{145}\) YSLME (2005)  
\(^{146}\) YSLME (2005)
of the working groups focused on creating the transboundary diagnostic analysis. There has not been much on the ground management implementation yet. (Ranking = 0)

**Maximize financial feasibility of the program**: This program is currently in place, so it is therefore financially possible. However, it is receiving GEF/UNDP funding, and when this funding ends the region must support all programs on their own. China and South Korea have funded some environmental programs in the region, signifying their commitment to this cause.\textsuperscript{147} China has practiced a midsummer moratorium on fishing vessels, for July and August since 1995.\textsuperscript{148} South Korea implemented a program to reduce fleet capacity in which the government pays fishing vessel owners to decommission their vessels.\textsuperscript{149} Therefore future funding by these nations may be possible. (Ranking = +)

**Maximize likelihood of political agreement**: This particular option is politically feasible since it is currently in practice. However the involvement of North Korea and Japan in the LME project has not occurred due to political differences,\textsuperscript{150} and solving these issues would improve the program’s effectiveness.\textsuperscript{151} While there currently is political agreement between South Korea and China to continue with the current programs, North Korea is still not fully involved, and Japan has not come into the discussion either. (Ranking = ++)  

**Minimize long-term negative economic impacts to resource users**: Maintaining current programs will probably continue to have low negative effects on the maritime economies of involved nations, mainly because as of yet there have not been many regional restrictions on marine industries to detract from economic gain. Yet in the long term, if they do not improve the ecosystem, the economic impacts will be disastrous to those who depend on healthy marine ecosystems, such as fishers or the tourist industry.\textsuperscript{152} There has yet to be any significant positive changes to ensure the longevity of industries that depend on a healthy ecosystem in the YSLME. (Ranking = -)

\begin{itemize}
  \item \textsuperscript{147} YSLME (2005)
  \item \textsuperscript{148} Information Office (1998)
  \item \textsuperscript{149} FAO (2003)
  \item \textsuperscript{150} Ken Sherman (2005)
  \item \textsuperscript{151} YSLME (2005)
  \item \textsuperscript{152} NOAA (2004)
\end{itemize}
11.2 Expand current program to fully include Japan and North Korea.

<table>
<thead>
<tr>
<th>Option</th>
<th>Criteria</th>
<th>Improve Sustainability of Marine Resources</th>
<th>Minimize time to implement program</th>
<th>Maximize Financial Feasibility of the Program</th>
<th>Maximize Likelihood of Political Agreement</th>
<th>Minimize Long-Term Negative Economic Impact to Resource Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expand current program to include Japan and North Korea</td>
<td>+</td>
<td>0</td>
<td>++</td>
<td>0</td>
<td>0</td>
<td>+</td>
</tr>
</tbody>
</table>

**Improve sustainability of marine resources:** Involving these two nations in the management plans will greatly improve the strength of the current management program. The GEF supports broad stakeholder involvement, and studies have shown that management programs work most effectively when all stakeholders are involved.\(^{153}\) (Ranking = +)

**Minimize time to implement program actions:** Involving more nations in the LME project will mean more discussion and infrastructure to setup\(^{154}\), and could slow the process a bit. However, these nations may bring tools or resources that help implementation move along. (Ranking = 0)

**Maximize financial feasibility of the program:** Involving Japan in the LME process may increase the ease of funding for projects, as they have more financial resources, which could potentially be used.\(^{155}\) (Ranking = ++)

**Maximize likelihood of political agreement:** The current program does not involve all the necessary constituents; while it has made great strides in bringing together interested parties from both China and South Korea, securing participation from Japan and North Korea should improve the progress of the program. The likelihood of political agreement is not high, as these nations probably would be involved currently if it were politically agreeable to all parties. However, both nations have shown some interest recently. North Korea allowed for a 2003 UNEP state of the environment report to be conducted and written, showing some interest in participating in environmental projects.\(^{156}\) Japan has such a high impact on the fisheries in the

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\(^{153}\) GEF (2005)  
\(^{154}\) UN Habitat (2006)  
\(^{155}\) LME (2006)  
\(^{156}\) UNEP (2003)
region, which means they also have a high stake in protecting these resources.\textsuperscript{157} Japan is a prosperous nation with much to gain from sustaining the marine ecosystem it so relies upon.\textsuperscript{158} (Ranking = 0)

\textbf{Minimize long-term negative economic impacts to resource users:} Having all stakeholders involved often increases efficiency of a program.\textsuperscript{159} Involving all nations that strongly impact the system is likely to help improve it, as noted in the above criterion, therefore the fisheries will be more likely to continue so long-term economic impacts should not be very negative. This criterion is often related to some degree to the “improve sustainability of marine resources” criterion. Improved financial feasibility should also help to minimize long-term negative economic impacts. (Ranking +)

11.3 \textit{Manage through regional seas program only.}

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Improve Sustainability of Marine Resources</th>
<th>Minimize Time to Implement Program</th>
<th>Maximize Financial Feasibility of the Program</th>
<th>Maximize Likelihood of Political Agreement</th>
<th>Minimize Long-Term Negative Economic Impact to Resource Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option</td>
<td>- -</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>- -</td>
</tr>
</tbody>
</table>

\textbf{Improve sustainability of marine resources:} Certain Regional Seas programs such as those in the Wider Caribbean have been improving the marine ecosystem, long before the LME concept was developed.\textsuperscript{160} Based on this information, the possibility remains that improvements may occur with just the RS program in effect. However, differences in political institutions and governance between the two regions may result in different conclusions. The Cartagena convention was very useful in the Wider Caribbean RSP, but the Northwest Pacific Regional Sea has yet to agree upon a convention.\textsuperscript{161} There are also separate seas within the Northwest Pacific Regional Sea, making general management plans less specific.\textsuperscript{162} Therefore it seems much less

\textsuperscript{157} Sea Around Us Project data (2005)
\textsuperscript{158} FAO (2005)
\textsuperscript{159} UN Habitat (2006)
\textsuperscript{160} UNEP CEP (2005)
\textsuperscript{161} UNEP RSP (2005)
\textsuperscript{162} UNEP RSP (2005)
promising that the Regional Sea program alone will be enough to meet this criterion in the region. (Ranking = - -)

**Minimize time to implement program actions:** Removing the LME project and relying only on the Regional Seas program will probably mean less specified actions are decided upon as this larger region has a larger variety of issues to deal with. This will probably mean that implementing management actions in the Yellow Sea will be a slow process, as RSP recommendations will have to be discussed and made applicable to the Yellow Sea by the bordering nations. The RSP management level includes nations that do not much impact the Yellow Sea, therefore involving possibly more constituents than necessary and possibly slowing the process.163 (Ranking = -)

**Maximize financial feasibility of the program:** Managing through the regional seas program only is probably financially feasible, as this program is already in place. However it would mean doing away with the long-term financial burden associated with the LME project, as well as the short-term benefits of GEF/UNDP LME funding. (Ranking = +)

**Maximize likelihood of political agreement:** Leaving only the Regional Seas program in place and removing the LME approach will involve all the constituent nations, and is probably politically feasible, as it had occurred for several years before the LME approach was added.164 Yet changes were made because this was not working, therefore people may not be willing to rely strictly on a program that had not worked for them previously. (Ranking = +)

**Minimize long-term negative economic impacts to resource users:** If this management structure does not succeed at improving the sustainability of the marine environment, it could have devastating long-term economic impacts. Focusing all resources on a higher level of management than necessary may also be financially wasteful in the long-term.165 (Ranking = - -)

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163 UN Habitat (2006)
164 NOAA/UNEP (2004)
165 UN Habitat (2006)
11.4 Manage through large marine ecosystem concept only.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Improve Sustainability of Marine Resources</th>
<th>Minimize Time to Implement Program</th>
<th>Maximize Financial Feasibility of the Program</th>
<th>Maximize Likelihood of Political Agreement</th>
<th>Minimize Long-Term Negative Economic Impacts to Resource Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rely only on LME Program</td>
<td>0</td>
<td>0</td>
<td>- -</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Improve sustainability of marine resources:** This LME designation includes the biologic and oceanographic area that is affected,\(^{166}\) and it is a smaller more manageable size than the RS. However, without involving Japan at all, the management plans may not be very successful.\(^{167}\) Managing resources actually means managing resource users, and by leaving out a nation such as Japan which has a large impact on the system the program will not be as effective as it could be. (Ranking = 0)

**Minimize time to implement program actions:** The LME management unit is on a smaller scale than the RS, so it may be somewhat easier to implement actions. However, it is not likely that this will move any faster than the current management plans are moving, as there are no hold ups in the LME project due to the Regional Seas program in the Yellow Sea.\(^{168}\) (Ranking = 0)

**Maximize financial feasibility of the program:** In the short term, the UNDP/GEF funding will probably still be available for this management plan. However, in the long term limiting the number of nations involved with the program will limit the possible sources of funding. China and South Korea are currently developing nations, making the ease of which they can fund these projects lower than a more developed nation such as Japan. This does not mean it cannot happen, it just means that there is less potential funding in the first place.\(^{169}\) (Ranking = - -)

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\(^{166}\) LME (2005)  
\(^{167}\) UN Habitat (2006)  
\(^{168}\) UNEP RSP (2005)  
\(^{169}\) LME (2006)
Maximize likelihood of political agreement: Reducing involvement in regional treaties is often looked down on by the other nations involved in the program. Therefore having the nations involved in the YSLME project back out of the NWPRS program could lead to less regional support in the future. It is also important to note that ecosystem boundaries are not political, and are not always efficient management units. (Ranking = -)

Minimize long-term negative economic impacts to resource users: This criterion interacts with the “improve sustainability of marine resources” criterion. Therefore, it probably will not minimize long-term negative economic impacts well. Having less regional support will probably add to this, and leave the YS nations facing even more economic stress. (Ranking = -)

11.5 Designate nation with the most financial or technical resources to lead current management.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Improve Sustainability of Marine Resources</th>
<th>Minimize Time to Implement Program</th>
<th>Maximize Feasibility of the Program</th>
<th>Maximize Likelihood of Political Agreement</th>
<th>Minimize Long-Term Negative Economic Impact to Resource Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designate Lead Nation</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>- -</td>
<td>++</td>
</tr>
</tbody>
</table>

Improve sustainability of marine resources: The “designate a nation to lead current management” option has been shown to succeed in other cases, namely in the Baltic Sea LME. Sweden being the most prosperous nation in the Baltic Sea region took the lead in management. Through the use of the LME/RSP programs and Sweden’s initiative, resource management changes began to move forward. This LME is often touted as a success story.

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170 UNEP (2005)
171 NOAA/UNEP (2004)
172 Pernetta (1998)
174 LME (2005)
However, it is unclear if the same effect would occur through a similar program in the Yellow Sea. (Ranking = +)

**Minimize time to implement program actions:** Having a lead nation in management should help things run smoothly, thereby reducing the time to implementation. However, it is again unclear as to whether or not this process will be effective with the Yellow Sea LME. (Ranking = +)

**Maximize financial feasibility of the program:** By allowing management to be led by the nation with the most resources for management, it will probably be even easier to fund this program.\(^{176}\) Financial resources would come from the nation that has the most, thereby allowing for the most equitable funding. (Ranking = + +)

**Maximize likelihood of political agreement:** The historical regional governance issues and political relationships are complicated in this area.\(^{177}\) The interactions between these nations have often been extremely negative, making it highly unlikely that all nations would agree to this option.\(^{178}\) This criterion alone is enough to make this option unviable. (Ranking = - -)

**Minimize long-term negative economic impacts to resource users:** Having a prosperous nation lead management should have less negative economic impacts in both the short and long term, as it relies on their wealth more heavily, thus management funds are not drawn as much from the less developed nations with less funding to share.\(^{179}\) This combined with the improved conditions of the ecosystem, should lead to enhance long-term economic stability. The balance of power change inherent with this option may also have economic effects on the other nations that should be carefully scrutinized prior to implementation. (Ranking = + +)

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\(^{175}\) LME (2005)
\(^{176}\) Lee (1998)
\(^{177}\) CIA (2005)
\(^{178}\) NOAA (2004)
\(^{179}\) Lee (1998)
11.6 Community based management of natural resources.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Improve Sustainability of Marine Resources</th>
<th>Minimize Time to Implement Program</th>
<th>Maximize Financial Feasibility of Program</th>
<th>Maximize Likelihood of Political Agreement</th>
<th>Minimize Long-Term Negative Economic Impact to Resource Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community based management of natural resources</td>
<td>+ (combined with expanded program + +)</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>++</td>
</tr>
</tbody>
</table>

**Improve sustainability of marine resources:** According to the literature fisheries management, experts agree that in order to improve the underlying causes of fishery overexploitation, you must focus on management of the people not the fish per se.\(^{180}\) While national governments have been attempting to control coastal fisheries management, they have often under-estimated local communities’ abilities and knowledge to manage the systems.\(^{181}\) The Yellow Sea region historically has had community-based fisheries management institutions in place, suggesting that there is potential for this to be successful in the area.\(^{182}\) Many investigations of coastal fishery management around the world have shown that when left to their own devices, fishing communities can often regulate and manage an ecosystem well.\(^{183}\) However, when the cause of problems is a good distance away (as is often the case with transboundary systems), improvement may be difficult to accomplish on strictly a community level.\(^{184}\) Therefore combining this tool with the continuation of an expanded version of the current management scheme would greatly improve marine resources. (Ranking = +, combined with expanded program = + +)

**Minimize time to implement program actions:** Time to implementation of community based management projects are often less than that of large scale multi-national governance.

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\(^{180}\) Pomeroy (1995)
\(^{182}\) Pomeroy (1995)
\(^{183}\) Pomeroy (1995)
\(^{184}\) Bastrup-Birk (2003)
management structures. Within two years of initial project beginnings, a fishery management and conservation plan was created and implemented in 65 coastal villages in Samoa. Although they may still have a variety of stakeholders to deal with, they will not have quite the amount of setup and discussion that an intergovernmental management program has. (Ranking = +)

Maximize financial feasibility of the program: While there will be fewer financial sources to draw from, projects will be smaller scale, which should make them more affordable. (Ranking = 0)

Maximize likelihood of political agreement: Locally a community-based management project will have a high likelihood of political agreement. However, there is an international stake in the management of the YS as well, that will not be fully taken into account, and some involved groups will be less amenable to their removal from the management structure. (Ranking = 0)

Minimize long-term negative economic impacts to resource users: Community based management should improve the sustainability of the resources as mentioned above, thereby producing minimal negative long-term economic impacts. This option may also bypass some of the administrative levels that would be absorbing funds if all management went on at the regional level only. This plan will be management at the level of those who are actually being managed, which is often more efficient and effective. (Ranking = + +)

12. Recommendations and Discussion

Ecosystem management has recently been touted as the solution to many management problems. The goal of ecosystem management is to manage in order to ensure ecological interactions and processes are disturbed as little as possible, and that ecosystem structure and function are sustained. Once put into practice there may be many complications in this large-scale management, which is why it is essential to continually monitor and assess the

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185 UN Habitat (2006)
186 King (1999)
187 Cicin-Sain (1998)
188 UN Habitat (2006)
189 Pomeroy (1995)
190 Christensen (1996)
effectiveness of such projects.\textsuperscript{191} The UNEP Regional Seas program and the Large Marine Ecosystem projects are examples of large-scale marine ecosystem management in practice.

In comparing the options and criteria to create the decision matrix, I considered the main goals of the original YSLME project, as well as the major issues pertinent to the region. As mentioned the first criteria of improving the marine ecosystem and conserving marine resources for future use, is seen as the most important criterion. It is the main goal of the original YSLME project, and therefore it is the main goal that a policy/management program is being developed to fulfill. Therefore any option that does not meet this criterion was automatically eliminated. Political feasibility was the next criterion given extra consideration, because it is essential that an option be implemented in order to see any advances from it.

In completing the decision matrix, I recommend a combination of expanding the current program to more fully include Japan and North Korea, as well as supporting community-based fisheries management for the YSLME. Before elaborating on these recommendations, I will briefly mention the major reasons the other options were not chosen. The current management program has not yet proven successful, and while it still may lead to ecosystem improvements as time moves on, the time to implementation of management actions does not seem quick enough to meet the urgent demands in the Yellow Sea.\textsuperscript{192} Since the sustainability of the YS marine ecosystem is truly the major goal of these policies, this approach may not be optimum. The regional programs involve time-consuming discussions between nations before implementing any plans, as well as complicated multi-level governance structures.\textsuperscript{193} Fish stocks are failing, size and amount are being drastically reduced, and the appearance of harmful algal blooms is increasing yearly.\textsuperscript{194} In order to sustain the marine resources as well as the people who rely on them, management changes need to be made quickly.

A major issue with relying only on the Regional Seas program is that it is not focused in enough on specific Yellow Sea problems. Therefore recommendations are more likely to be broad and general and consequently less effective.\textsuperscript{195} Managing through the LME program only will most likely have limited support and limited stakeholder involvement, and is therefore not as

\textsuperscript{191} Christensen (1996)  
\textsuperscript{192} Sea Around Us Project data (2005)  
\textsuperscript{193} YSLME (2005)  
\textsuperscript{194} NOAA (2004)  
\textsuperscript{195} Sherman (2002)
good an option as some of the others. While the option of having one nation lead current management, fares well in the decision matrix, it will probably not work for this region. This has worked well in the Baltic Sea LME, and is considered a successful program. However, the lack of political feasibility in the Yellow Sea region for this option probably will not be overcome. The governance differences and history between the involved nations is complicated and has often been challenging to overcome.

Expanding the current program to ensure involvement of all necessary constituents, in this case especially including Japan and North Korea would improve the management of the YS. Japan has a large stake in the sustainability of the YS, and is a major resource user in the region (see Chart 1). Japan is also a more developed nation than those currently involved in the YSLME project, and therefore could improve ease of funding. It is often important to involve small community fishers in management decisions as well, as they can help to balance the scientific, social, and economic goals of a plan. Community-based management can lead to a shorter time to implementation period. The GEF also supports broad stakeholder involvement, and studies have shown that management programs work most effectively when all stakeholders are involved.

The expanded LME/RSP management program will deal with many issues of the current project. Time to implementation is one of the issues that could be dealt with by the combination of policies suggested here. The Yellow Sea LME project was proposed in 1997, and the initial meetings of the working groups were not held until the spring of 2005. As of yet they have mainly suggested information to collect and who to hire to collect it. This seems to be an inefficient process to manage such an important natural resource. The Yellow Sea is in immediate need of improvement in order to sustain the ecosystem, and the humans who rely on

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196 YSLME (2005)  
197 LME (2006)  
198 NOAA (2004)  
199 LME (2006)  
200 Wiber (2004)  
201 King (1999)  
202 GEF (2005)  
203 UNDP/GEF (2005)  
204 UNDP/GEF (2005)
it.\textsuperscript{205} Large-scale international projects such as the Regional Seas programs and the Large Marine Ecosystems projects, have multi-layered complex governance structures that take time and money to develop. After approximately 9 years of this development, the YSLME project is still in the early phases of actual management.

Involving community-based management in this region is important to achieving the desired human development goals and environmental sustainability. Small-scale community fishing is relied on for regional food security and the majority of non-imported seafood.\textsuperscript{206} The importance of small-scale fisheries is somewhat difficult to quantify in the region, because of lack of information and statistics.\textsuperscript{207} However, they are generally thought to be under considerable pressure and many inshore coastal areas are considered severely depleted.\textsuperscript{208} There is an urgent need to treat fisheries more comprehensively, in order to meet national and international goals for both development and environmental sustainability.\textsuperscript{209}

In an optimum situation, Japan would be fully included in management from an LME perspective under a signed Regional Seas convention. Collaboration with this nation, whose impacts on the YS are so great, seems necessary for sustainable resource management. North Korea should also become more involved in developing management plans, thus building on regional cooperation. Engaging local citizens in the decision-making processes that will most affect them through community based fisheries management would be an ideal improvement as well. The complicated multi-tiered management structure may not be avoidable and can have benefits when dealing with so many nations. However, expediting the time to implementation is essential at this point. To this end, I recommend combining an expanded version of the current ecosystem based management plan with support of community-based management initiatives.

Community-based management can seem contradictory to ecosystem-based management, but I argue that the two can actually complement each other quite well. However, community based management organizations can benefit greatly from upper level governance support, especially in the critical capacity building stages.\textsuperscript{210} Especially with the complexity of

\begin{flushright}
\textsuperscript{205}YSLME (2005) \\
\textsuperscript{206}Asia-Pacific Fishery Commission (2006) \\
\textsuperscript{207}Asia-Pacific Fishery Commission (2006) \\
\textsuperscript{208}FAO (2000) \\
\textsuperscript{209}Asia-Pacific Fishery Commission (2006) \\
\textsuperscript{210}Wiber (2004)
\end{flushright}
transboundary ecosystem management, it often seems to call for initial intervention from outside agencies to activate communities that may be in a state of inaction.\textsuperscript{211} When dealing with transboundary issues communities, or even countries can fall into a state of latency waiting for the other side to fix the problems first.\textsuperscript{212} However, an intergovernmental management scheme can be inefficient, and does not always make good use of local knowledge, nor is it always fully supported by local communities when they are not involved in decision-making.\textsuperscript{213}

The expanded program could provide support and initiative to community-based projects, as well as continue with current ecosystem management plans. This combination has succeeded to some degree in the Gulf of Guinea LME, with quite a few effective mangrove restoration projects.\textsuperscript{214} If the regional management structure is encouraging and supporting these community-based initiatives while it is setting up the multi-level governance structure used, the time to implementation should be reduced. There are currently very few conspicuous examples of community-based ecosystem level restoration and management. However, a plan has been developed to assess the feasibility of this for the Georgia Basin/Puget Sound area in Canada\textsuperscript{215} as well as a similar plan for the Lower Amazon Floodplain.\textsuperscript{216}

13. Conclusions

In general this research has shown the complications involved with management of transboundary water systems, and some possible solutions to these problems. It may not be possible to avoid complicated multi-tiered management regimes for regionally shared waterbodies, yet there can be ways to make this management more efficient. It is important to note that there are national level policies and management issues that should be considered in a full evaluation of the YS region, which are not addressed here. These national governments are beginning to develop improved management plans for the YSLME, such as the Chinese midsummer moratorium for their fishing industry.\textsuperscript{217}

\textsuperscript{211} Bastrup-Birk (2003) 
\textsuperscript{212} Bastrup-Birk (2003) 
\textsuperscript{213} UN Habitat (2006) 
\textsuperscript{214} Sherman (2002) 
\textsuperscript{215} Bastrup-Birk (2003) 
\textsuperscript{216} McGrath (2005) 
\textsuperscript{217} Chinese Government (1998)
The recommendations herein should be considered for other LME/RSP projects as well; while all are distinctly different many do share common features, and all deal with general shared waterbody management issues. Oftentimes one management option cannot incorporate every aspect of an issue, in these cases a combination of programs may work best. There are strong benefits to both the ecosystem management and the community based management approaches. A combination of these approaches appears to be an excellent option for management of an internationally shared waterbody such as the Yellow Sea Large Marine Ecosystem.

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Appendix.

Timeline of Important Dates

1974 – UNEP Regional Seas program
1976 – Barcelona Convention for the Mediterranean Regional Sea
1984 – Large Marine Ecosystem concept adopted
1991 – Global Environment Facility created
1994 – Northwest Pacific Action Plan adopted
1994 – YSLME Project Brief created
1995 – Chinese Moratorium on Fishing in the Yellow Sea in July and August
1995 – FAO Code of Conduct for Responsible Fisheries
1995 – Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
1996 – UNCLOS ratified by China, South Korea, Japan
1997 – Yellow Sea Large Marine Ecosystem project initiated
2001 – YSLME Preliminary Transboundary Diagnostic Analysis created
2004 – First meeting of the YSLME Regional Scientific and Technical Panel
2003 – North Korea allows UNEP to create State of the Environment plan
2005 – YSLME Regional Working groups first meeting
List of Acronyms

EEZ – Exclusive Economic Zone
YS – Yellow Sea
YSLME – Yellow Sea Large Marine Ecosystem
LME – Large Marine Ecosystem
RS – Regional Sea
RSP – Regional Seas Program
IOC – Intergovernmental Oceanographic Commission
AP – Action Plan
RSTP – Regional Scientific and Technical Panel
SOA – State Oceanic Administration (China)
SAP- Strategic Action Plan
RCU – Regional Coordination Units
TDA – Transboundary Diagnostic Analysis
KORDI – Korean Ocean Research and Development Institute
PSC – Project Steering Committee
UNDP – United Nations Development Program
UNEP – United Nations Environment Program
GEF – Global Environment Facility
NOWPAP – Northwest Pacific Action Plan
NOAA – National Oceanic and Atmospheric Administration
UNCED – United Nations Conference on Environment and Development
RAC – Regional Activity Centers
IUCN – The World Conservation Union
FAO – United Nations Food and Agriculture Organization
GPA – Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
ICM – Integrated coastal management
WHOI - Woods Hole Oceanographic Institution
NWPRS – Northwest Pacific Regional Sea
## Decision Matrix

<table>
<thead>
<tr>
<th>Options</th>
<th>Improve Sustainability of Marine Resources</th>
<th>Minimize Time to Implement Program</th>
<th>Maximize Financial Feasibility of the Program</th>
<th>Maximize Likelihood of Political Agreement</th>
<th>Minimize Long Term Negative Economic Impact to Resource Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain current programs</td>
<td>-</td>
<td>0</td>
<td>+</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Expand current program to include Japan and North Korea</td>
<td>+</td>
<td>0</td>
<td>++</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>Rely only on Regional Seas program</td>
<td>- -</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Rely only on LME program</td>
<td>0</td>
<td>0</td>
<td>- -</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Designate nation with most financial/technical resources to lead current mgmnt.</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>- -</td>
<td>++</td>
</tr>
<tr>
<td>Community based management of natural resources (combined with expanded program ++)</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+ +</td>
</tr>
</tbody>
</table>
Chart 1. Fish take by nation. Note the significance of the Japanese fishery. This chart does not take into account effort, or changes in target species; catch per unit effort (CPUE) actually decreased over this same time period.

Data Source: UBC Sea Around Us Project (2005)
Chart 2. Change in average maximum length of fish caught. This type of decline is a commonly cited sign of overfishing. Notice the decline even in more recent years, since the current management program began.

Data Source: UBC Sea Around Us Project (2005)
Chart 3. Change in average trophic level of fish caught. This type of decline is often considered a sign of overfishing.

Data Source: UBC Sea Around Us Project (2005)