Science
Council of
British
Columbia

Ocean Opportunities
for
The West Coast of Canada

Strategic Framework Overview Report

Strategic Planning For Applied Research And Knowledge

April 30, 1993

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for
The West Coast of Canada

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Prepared under the direction of the SPARK OCEANS Committee of the Science Council of British Columbia.

April 1993

This report has been prepared under the direction of the SPARK Oceans Committee and associated working groups, and represents the views of that committee and the working groups. While SPARK is an initiative of the Science Council of British Columbia, the views and recommendations expressed in this report are not necessarily those of SPARK, the members of the SPARK Steering Committee, or the Science Council.

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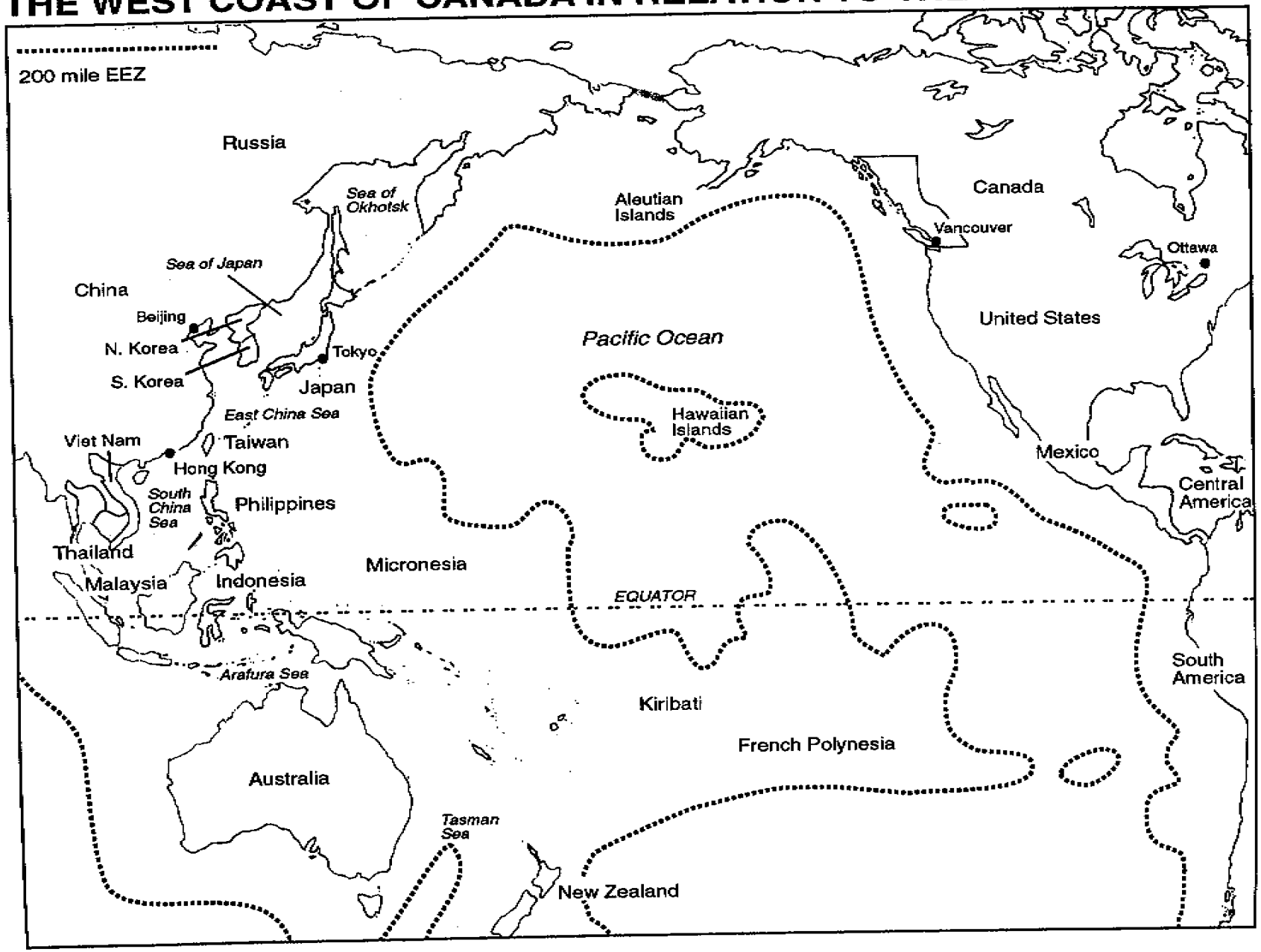
The SPARK OCEANS Committee wishes to acknowledge the contributions of the many volunteers from ocean industries, the universities, colleges, governments, and coastal communities who contributed to working groups, other sectoral activities, and the Oceans Forum. Without the input of these volunteers, this report would not have been possible. Their names and affiliations are given in Appendix I, together with the members of the SPARK Oceans Committee and the participants in the SPARK Oceans Forum held in Vancouver in December, 1992.

The SPARK OCEANS Committee also wishes to thank the SPARK Initiative of the Science Council of British Columbia for their fiscal support, with additional assistance from the Ministry of Agriculture, Fisheries and Food; Ministry of Economic Development, Small Business and Trade; and the Department of Fisheries and Oceans Industry, Science, and Technology Canada; and the National Research Council.

"There is a tide in the affairs of men,
which, taken at the flood, leads on to fortune.
Omitted, all the voyage of their life
is bound in shallows and in miseries.
On such a full sea are we now afloat,
and we must take the current when it serves,
or lose our ventures."

-- Julius Caesar
by William Shakespeare

THE WEST COAST OF CANADA IN RELATION TO THE PACIFIC BASIN



I. EXECUTIVE SUMMARY

This report reviews the future opportunities related to oceans and coastal activities on the West Coast of Canada. The present direct contribution of ocean and coastal activities to the economy is almost $4 billion per year, but future opportunities are much greater if the present administrative uncertainties are replaced by a coordinated approach that demonstrates responsible stewardship towards our oceanic and coastal heritage.

This review was initiated in 1992 by the Strategic Planning for Applied Research and Knowledge (SPARK) initiative of Science Council of British Columbia. A 21 person SPARK steering committee and volunteer working groups from the various sectors of marine activities identified strengths, weaknesses, and opportunities, and developed recommendations for action. A process of workshops and meetings, involving more than 400 people with diverse ocean interests, synthesized these findings into a strategic framework for ocean industry, science and technology on the West Coast of Canada.

The central, unifying issue underlying all activities and opportunities is the need for an integrated framework to allow stewardship of the marine environment and sustainable management of oceanic and coastal resources while diverse activities are taking place.

The future of many of the coastal communities of British Columbia will be dependant on diverse marine activities, including fishing, aquaculture, transportation, tourism, marine technology and services, and resource utilization. These communities, of both First Peoples and other residents, have a vital role to play in decisions on the allocation and management of resources.

Taken together, ocean-related activities accounted for more than $3.8 billion of revenue to British Columbia in 1990. Of this total, over $1.45 billion was related to local port activities in ocean transportation and ferry systems, with commercial fisheries and aquaculture accounting for $1.056 billion. Other important contributors to the total include marine related tourism and recreational activities ($782 million), sub-sea robotics, electronics, information technology, marine engineering, services and other technologies, $476 million.

All West Coast these activities have substantial opportunities for growth in the Pacific Rim marketplace. There are strong interconnections among all these activities. They also demand a healthy ocean, managed with sustainable objectives.

Many opportunities are identified for better deployment of scarce research resources, for more rational economic development of sustainable ocean-related activities, and for development of Pacific Rim markets for Canadian marine technologies.

The importance of the Pacific basin as a focus for our ocean science, technology and commercial activities was recognized. Because of the international nature of the Pacific ocean, an international or global perspective on all West Coast activities is needed. We need to develop new, dynamic, interactions between our science, technology, industrial and government capabilities to access Pacific Basin opportunities.

An important conclusion from the SPARK process is the detrimental impact of jurisdictional and regulatory confusion and uncertainty on the realization of future opportunities. These uncertainties arise from federal/provincial jurisdictional disputes, the unclear mandates of numerous agencies, and a lack of policy and vision. They impact on all ocean-based activities, and on **the responsible conservation of the ocean environment.**

The SPARK process found that potential revenues well in excess of $7 billion by early in the next century are at serious risk, because of the lack of effective coordination of ocean activities.

Within British Columbia (and especially in the Strait of Georgia), the current growth of urban populations, tourism and other uses of our coastal waters will create increasing conflicts, unless immediate actions are taken. All levels of governments, and other ocean interests, must move toward a coordinated, long-term perspective of our oceanic and coastal heritage.

While many detailed recommendations are contained in this report and its supporting documents, the focus of the steering committee (strongly backed by the SPARK Oceans Forum) was to obtain agreement on an **effective organizational structure** to advise on policies and initiatives towards sustainable objectives.

To bring all interests and initiatives together to allow an authoritative consensus to emerge on sustainable management opportunities, the SPARK Oceans Committee recommends that an independent **Oceans and Coastal Forum** be established. This forum would advise on the coordination of diverse ocean activities and develop **Ocean Activities Management Plans.**

Given the difficult jurisdictional environment in which this forum would operate, it is essential that the Commissioner or Chairperson in charge be a person of widely recognized expertise and wisdom. Such a body must have the status and moral

authority to resolve conflicts and carry out long-term planning. Thus, it is essential that it be given sufficient support for the policy development, coordination, communications, and consensus-building activities that underpin sustainable management of the marine environment. This body would be characterized by efficiency in reducing the presently confusing array of committees; effectiveness and problem solving. This and similar concepts require further consultation.

The committee strongly urges governments give serious consideration to this proposal. They believe it offers the best hope for resolution of existing and impending conflicts, and of overcoming the present impediments to good management.

The Pacific Ocean is a link to all other Pacific Rim nations. It is a vitally important heritage to be used for the economic and social betterment of all Canadians, and mankind, while maintaining the physical and biological resources of the ocean and its shoreline for future generations to enjoy. This is the **vision** that has emerged from the SPARK Oceans process.

This vision and the associated recommendations have resulted from substantial discussions among the science, technology, and industrial communities of the West Coast. We now seek a wider consideration and discussion by all those with ocean and coastal interests.

II. MAJOR CONCLUSIONS AND RECOMMENDATIONS

The major conclusions and recommendations arising from the strategic framework are given below. They provide the basis for actions to realize sustainable objectives and new job and wealth creation from ocean and coastal activities. **Many additional conclusions and recommendations on specific issues can be found at the end of each chapter** and in the original sectoral working group reports.

Integration of Oceans and Coastal Management

There are strong interconnections between oceanic coastal systems, their users, and the consequences of various uses. These linkages are more pronounced than in terrestrial systems. They make it necessary to coordinate the management of ocean activities, marine technology development and the planning of ocean sciences activities. Uncoordinated approaches have and will lead to conflicts between various uses, inefficiency in innovation and the use of science and technology, and decreased social, cultural, and economic returns, and a lack of responsible stewardship towards our oceanic and coastal heritage. The SPARK initiative is a first step towards the realization of these goals.

It is therefore recommended that:

- **The federal, provincial, local, and First Peoples governments, marine industries, and other marine users cooperate to create a lean and efficient mechanism that allows coordination of all aspects of the oceanic and coastal resources of Pacific Canada. We refer to this mechanism as "the Oceans and Coastal Forum."**

- **The government of British Columbia, in consultation with all marine users, investigate the development of a coastal resource management strategy within this forum.**

The Coordination of Federal Responsibilities

The federal government has clear responsibilities for protection of the marine environment, environmental impact assessment, fisheries, transportation, exploration, defence, and surveillance, and administers many laws and regulations pertaining to the oceans and coastal areas. Effective coordination between federal departments at a West Coast level, with the governments of British Columbia and First Nations, and those involved in diverse ocean activities is essential for protection of the ocean environment, sustainable management objectives, and to realize the many economic

opportunities for ocean-based activities.

It is therefore recommended that:

- **The federal government cooperate with the provincial government and all marine users towards establishment of an Oceans and Coastal forum or equivalent body to resolve existing impediments to sustainable management and new job and wealth creation.**

- **In consultation with user groups, the federal government initiate actions to change existing policies and programs to realize the oceanic and coastal management objectives, and job and wealth creation identified in the report.**

Leadership by British Columbia in West Coast initiatives

In the past, the government of British Columbia has deferred to Canada in the administration of the oceans and the coastal zone in transport, fisheries, exploration, environmental issues, coastal infrastructure, and many other issues.

The growing significance of coastal and ocean issues to the economic and social future of British Columbia makes it necessary for British Columbia to take initiatives with a fresh, comprehensive, and well-coordinated approach to marine science, technology, industry, and management. The obligations of both levels of government to the ocean environment and the development of sustainable use practices, in the fisheries and other coastal activities, demands a much higher and coordinated level of cooperation between both levels of government than has previously existed.

It is therefore recommended that:

The government of British Columbia take the leadership in establishment of an Oceans and Coastal forum or equivalent body to resolve the identified impediments to sustainable management, and that they cooperate with the government of Canada and other levels of government to initiate actions to change existing policies and programs to realize oceanic and coastal management objectives, and job and wealth creation identified in this report. The SPARK initiative is a first step in this direction.

Establishment of an Oceans and Coastal Forum

Marine policy and program development is stagnant. This severely constrains the development of new sustainable management practices and new job creating opportunities from the ocean. Many examples of excellent potential in oceans activities emerged in the course of this review. However, in nearly all cases the

structures necessary to assess resources and manage ocean development do not exist or have not been implemented. Overcoming this fragmentation and developing **policy and structure** are essential prerequisites for Canada and British Columbia to realize the potential of their western ocean.

The integration of ocean administration is essential:

- to develop sustainable use strategies;
- to protect the existing base of ocean wealth creation, and to release the potential for new wealth and job creation;
- to reduce inefficiencies, duplication and to cover existing deficiencies of government activities.

It is therefore recommended that:

Consultation start immediately towards realization of an Oceans and Coastal Forum or equivalent body. A strengthened SPARK Oceans committee with federal, provincial, and balanced participation of other marine interests proposes to carry this process forwards in 1993. In working towards these objectives, a committee would:

- **Continue to broaden the networking among all West Coast marine interests using the present document as a basis for discussion.**
- **Organize meetings and working groups to bring concerned parties together to seek solutions to marine problems and find a way forward.**
- **Define action plans arising from this report relating to sustainable management, marine science and technology, and job creation.**
- **Coordinate a West Coast perspective on Pacific-wide ocean opportunities in science, technology, and economic activities.**
- **Provide networking support to coastal communities to plan for future marine activities and related human resource development.**

The SPARK Oceans initiative, having reviewed all facets of marine activities on the West Coast, provides a discussion document and strategic framework on the basis of which all interests can consider the way ahead.

It is therefore recommended that SPARK and the Science Council of British Columbia take the following actions through 1993 and 1994:

- **Release the Strategic Framework for wide discussion and solicit responses from all marine interests.**
- **Make a dossier of the Framework sectoral reports and working papers available to those interested in future marine activities**

- **Prepare action plans for 1993-94 to guide activities towards:**
  - **The establishment of an Ocean and Coastal Forum**
  - **Pacific Rim ocean science and technology initiatives**
  - **BC-based ocean technology positioning in global markets**
  - **Sustainable management of the ocean and coastal zone**
  - **Community-based initiatives in marine activities and the related Human Resource Development needs.**
- **Bring together all concerned ocean and coastal interests to discuss the way forward towards sustainable management of the western EEZ of Canada**
- **Finalize Action Plans for 1993-1994 with milestones**

Marine Research

British Columbia has an outstanding base of expertise in diverse ocean sciences and other studies. The federal institutes and laboratories and all three universities are engaged in a wide range of ocean-related research in the sciences, technology, transportation, engineering, economics, and the social sciences. These capabilities have substantial unrealized potential to participate in ocean technology development, innovation, and ocean and coastal problem solving.

International and global programs in ocean research are of increasing importance in the understanding of global climate and oceanic processes as well as contributing new knowledge of direct importance to economic and business activities and of national strategic significance. It is therefore important that Canadian and West Coast scientists are enabled to participate in these long-term programs with a North Pacific and Arctic focus.

It is therefore recommend that:

- **Long-term policies, priorities, and programs for Canadian participation in Pacific Basin ocean science programs be developed by working groups under the direction of the Oceans and Coastal Forum and/or the Science Council of British Columbia.**
- **The federal government, in consultation with the above group, develop policies to direct the long-term funding of Pacific Basin ocean science programs linked to clear social and economic objectives.**
- **Opportunities for the use of advanced technologies in ocean science and environmental monitoring be investigated.**
- **The Oceans and Coastal Forum investigate opportunities to link interdisciplinary research to the needs of industry and business.**

Marine Technology

Over the last fifty years British Columbia has developed a diverse capability in marine technology, ranging from aquaculture systems to advanced special purpose vessels, remote sensing technology, and autonomous subsea vehicles. More than 350 West Coast companies in marine technology produce combined annual revenues of close to $500 million. These knowledge-intensive industries have a huge opportunity to compete in the emerging Asia-Pacific and global markets for marine technology, servicing the increasing uses of the Exclusive Economic Zones of Asia-Pacific nations. Many of these (small) companies are at a critical point in their development and face severe competition in the global marketplace. The viability of this sector is important to i) sound management of the resources within our own Exclusive Economic Zone, and ii) for technological and business interaction between Asia-Pacific and Canada. An international strategy for marine technology will require the focused support of government in private sector initiatives in the marketplace.

It is therefore recommended that:

- **The Science Council of British Columbia, in cooperation with an Oceans and Coastal Forum, take the lead in developing action plans for a marine technology strategy focused on defined opportunities within the Pacific Basin marketplace.**
- **The marine technology industries of British Columbia and Canada implement networks to provide ongoing market intelligence access to technology and innovations and opportunities for cooperative activities (consortia, alliances, etc.) in the marketplace.**
- **A working group of export-ready companies review the adequacy of the merchant banking and financing support for international market development with the objective of integrating federal and provincial initiatives and making them more responsive to the needs of industry..**
- **The relevant government agencies and programs, including British Columbia Trade Development Corporation, External Affairs and International Trade, Industry Science and Technology Canada, Western Economic Diversification, the National Research Council, and the Science Council of British Columbia cooperate with the marine technology industry towards realizing a "Team Canada" approach to the marketing of marine technology and services in Asia-Pacific, to be backed by integrated intelligence gathering, technology development, testing and regulatory approvals and the necessary basic science activities.**
- **Government agencies in Canada review and restructure their procurement policies to lend support to local companies competing in global markets so they can point to domestic use and**

showcasing of their technologies.

- **Better use be made of advanced technology in the ocean science, monitoring, surveillance, fisheries management, and other responsibilities of government agencies.**
- **The Science Council of British Columbia reviews the adequacy of its present funding mechanisms for marine technology and strengthens the available pool of funding by integrating their activities with those of other funding agencies.**

A Peace Dividend

In the past, a substantial part of national expenditures on marine science and technology went towards National Defence, in particular the threat of nuclear submarine warfare. This threat has diminished and international defence priorities are in a state of flux in responding to global peacekeeping. Other maritime nations (the United Kingdom, U.S.A., and France in particular) have made special efforts to transfer sophisticated subsea defence technologies into environmental monitoring and other applications. The potential for investment in the development of dual (defence and civilian) applications technology in Canada should be examined.

It is therefore recommended that:

- **Canada make a special effort to define civilian environmental, fishery surveillance, and other relevant applications of military technology that already exists.**
- **A long-term assessment be made of opportunities to link technology development in defence, environmental monitoring, ocean science, fishery surveillance, drug countermeasure and marine safety to maximize the economic and social returns from technological efforts.**
- **A review be carried out of all national fleet requirements for defence, surveillance, transportation, coast guard, rescue, safety, environmental monitoring, ocean science, and fishery management to identify opportunities for new, innovative technological solutions to existing needs and for advanced, multi-purpose craft.**

Marine Biological Resources - Fisheries and Aquaculture

The living resources of the Western Ocean sustain major economic activities in the commercial, recreational, subsistence and ceremonial fisheries, and aquaculture. The present regulations, policies, and programs that govern these activities are complex and in a state of flux. In total, they fall short of the requirement for sustainable management of these living systems to the extent that the future biodiversity and health of some stocks is under threat. At the same time, opportunities for

diversification and increasing the value of harvests are not being pursued. Innovative culture-based activities and aquaculture, with the potential to increase supplies to global seafood markets, are inhibited by outdated policies.

It is therefore recommended that:

- **British Columbia, Canada, and all ocean user groups cooperate in a process to:**
  - **identify the sustainable objectives needed in the management of all coastal and offshore fisheries;**
  - **develop action plans to rehabilitate particular stocks that are under threat (e.g. of coho, chinook, ling cod, and abalone);**
  - **develop new fisheries for underutilized species;**
  - **identify ways to allow the involvement of coastal communities in the sustainable management of their surrounding coastal areas; and,**
  - **allow community-based pilot schemes in new inshore fishery management strategies to proceed.**
- **The British Columbia Ministry of Agriculture, Fisheries, and Food take the lead in developing strategies for an integrated, profitable seafood industry in British Columbia using fisheries, culture-based fisheries, and aquaculture to supply high quality products to global markets within the objectives of sustainable management.**
- **British Columbia Ministry of Agriculture, Fisheries, and Food take the lead in discussions with DFO to bring about reform of outdated and restrictive policies that are inhibiting the development of new culture-based fisheries, especially for shellfish.**
- **The West Coast fishing and aquaculture industries act to ensure the privatization of the fisheries and aquaculture technology consortia initiated under the ISTC Seafood and Marine Products Sector Campaign. This would provide a pool of funding for the development of new technologies that increase the value of seafood products in the marketplace.**

Non-renewable Marine Resources

The Western Exclusive Economic Zone of Canada contains aggregate, mineral, and oil and gas deposits of strategic long-term significance to the country. This zone is poorly understood, mapped, and explored. There are currently no major exploratory activities underway, and Canada's participation in existing activities, such as the Ocean Drilling Program, is uncertain.. A federal and provincial moratorium on offshore oil and gas exploration has prevented exploratory activities for hydrocarbon

resources. The absence of any environmental framework for aggregate or mineral exploration and mapping has inhibited private sector investment and interest.

The Exclusive Economic Zones of other countries in the Pacific Basin are being mapped, explored, and resources are being tapped to meet economic, social, and environmental objectives. There are strong arguments for Canada to carry out the basic scientific and exploratory activities to document resources within our EEZ[1] and to build a long-term knowledge-base that would allow exploration while protecting the marine environment.

It is therefore recommended that:

- **The federal and provincial governments negotiate a joint management agreement to govern the exploration and development of non-renewable resources.**
- **A working group be struck to develop a plan for mapping and documentation of the non-renewable resources of the Western EEZ and to establish conditions for lifting of the moratoria.**
- **An associated working group plan the environmental management of offshore exploratory activities from a perspective of sustainable management and advise on policies, programs, and regulatory structures.**

Mapping and Exploration of the EEZ

All activities within our EEZ are dependant on a sound knowledge-base. The technologies and capabilities exist within British Columbia to map the EEZ and establish an interactive Marine Information and Management System. This is essential for sustainable management and the development of new economic activities.

It is therefore recommended that:

- **The Oceans and Coastal Forum bring the Canadian Geological Survey, the Canadian Hydrographic Service, the Provincial Ministry of the Environment, CORE, and relevant university and industry capabilities together to define the mapping and informational priorities for our Western EEZ and launch a comprehensive program.**

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1 Exploration and development of these resources as appropriate could contribute billions of dollars to the national economy each year and provide an "engine" for marine research and technology development.

- **The Georgia basin should be a primary focus of these activities.**
- **In the context of the above activities, the international market potential of these capabilities and technologies be examined and a strategy developed.**

The Responsibilities of Marine Industry

The diverse marine industries of the West Coast, including those involved in seafood production, transportation, tourism, marine technology, and the service sector will provide the future job and wealth creation related to marine activities. Collectively and individually, they will set the pace for reform and realization of the identified objectives.

It is therefore recommended that all the West Coast marine industries:

- **Carefully consider their obligations to participate in stewardship towards the marine environment; otherwise they will be impeded in realizing economic objectives.**
- **Take the initiative in developing their industrial strategies and corporate strategies in ways that respect the principles of sustainable management of the ocean environment.**
- **Pressure governments to also recognize the necessities of implementing actions towards integrated sustainable management of the ocean and coastal environment as a framework for economic activities.**
- **Monitor government actions towards reform of the policy and structural impediments to new job and wealth creation based on marine activities.**
- **Define and implement the requirements for them to compete in the global marketplace with a special focus on Pacific Basin opportunities.**
- **Look to building the alliances, linkages and networks that they will need to compete in the Pacific Basin marketplace.**

Human Resource Development and Sustainable Management

In the future, sustainable management of marine resources, exploration, use of advanced technologies and new marine business all have substantial requirements for people with numeracy, literacy, and a good understanding and respect of the marine

environment. Though there is a good base for scientific and technical training and education in the Southern Mainland, the delivery of education, training, and human resource development to many coastal communities is inadequate to meet these challenges. Urgent attention needs to be given to human resource development as an important and essential component of all marine activities training from fisheries to tourism.

It is therefore recommended that:

- **The government of British Columbia survey the needs of all coastal communities (native and non-native) in human resource development for future marine activities and investigate ways and means to better deliver existing programs.**
- **All marine-related proposals should be required to outline the Human Resource development needs associated with that proposal.**

Coastal Communities

The coastal communities of British Columbia are the gateways and home-bases for all marine activities. They have a special role to play in the realization of the social, cultural, and economic values of the ocean and the coastal zone. Many of them have only a basic infrastructure: poor development of port and harbours, administrative systems, and the educational and training needs for all marine activities. Unless their needs are met, our ability to better manage or create new wealth from the ocean and coastal areas will be limited.

It is therefore recommended that:

- **A coastal community network be created to facilitate community-based planning of marine activities and to ensure their full participation in resource allocation questions.**
- **The community futures, and other programs be used to assist coastal communities in planning for diversified marine activities.**
- **Urgent attention be given to the delivery of the necessary Human Resource Development and Training to the Coastal Communities to ensure their active participation in sustainable management and diverse marine-related economic activities.**
- **The Provincial Ports and Harbours Initiative be reactivated by the government of British Columbia as a component of economic diversification.**

Marine Tourism

Marine Tourism is a rapidly growing, but potentially volatile, component of the coastal economy of British Columbia. Continued growth will be dependant on international perceptions of the health of our marine environment, the abundance of our sport fish resources and the beauty of the coastline. Poorly-planned growth in the coastal areas will seriously damage this important sector of the economy (through messages of untreated sewage, fishery resource depletion, ill-planned urban growth, and a degraded coastal environment.) Integrated coastal management to set aside key habitats and areas, sustained local fisheries, community involvement and the planning of coastal infrastructure needs (including harbours, moorage, telecommunications, safety and reservation systems) are all essential to the continued growth of marine tourism.

It is therefore recommended that:

- **Special attention be given to identifying the sustainable management needs of individual stocks of key sport species, including the Southern Georgia Strait coho, certain chinook stocks, steelhead trout and ling cod, and implementing the necessary actions.**
- **The needs of marine tourism be included in the development of Coastal Zone Management plans and in coastal action plans for sustainability.**
- **Coastal communities should be encouraged to develop local tourism strategies as part of their economic diversification activities and as a community contribution to action plans for sustainability of coastal areas.**
- **Urgent attention should be given to human resource development in coastal communities as an integral part of both sustainable management activities and marine tourism development.**

TABLE 15-1: Estimates of economic impacts of ocean activities in British Columbia and their potential for growth (excluding research and development)

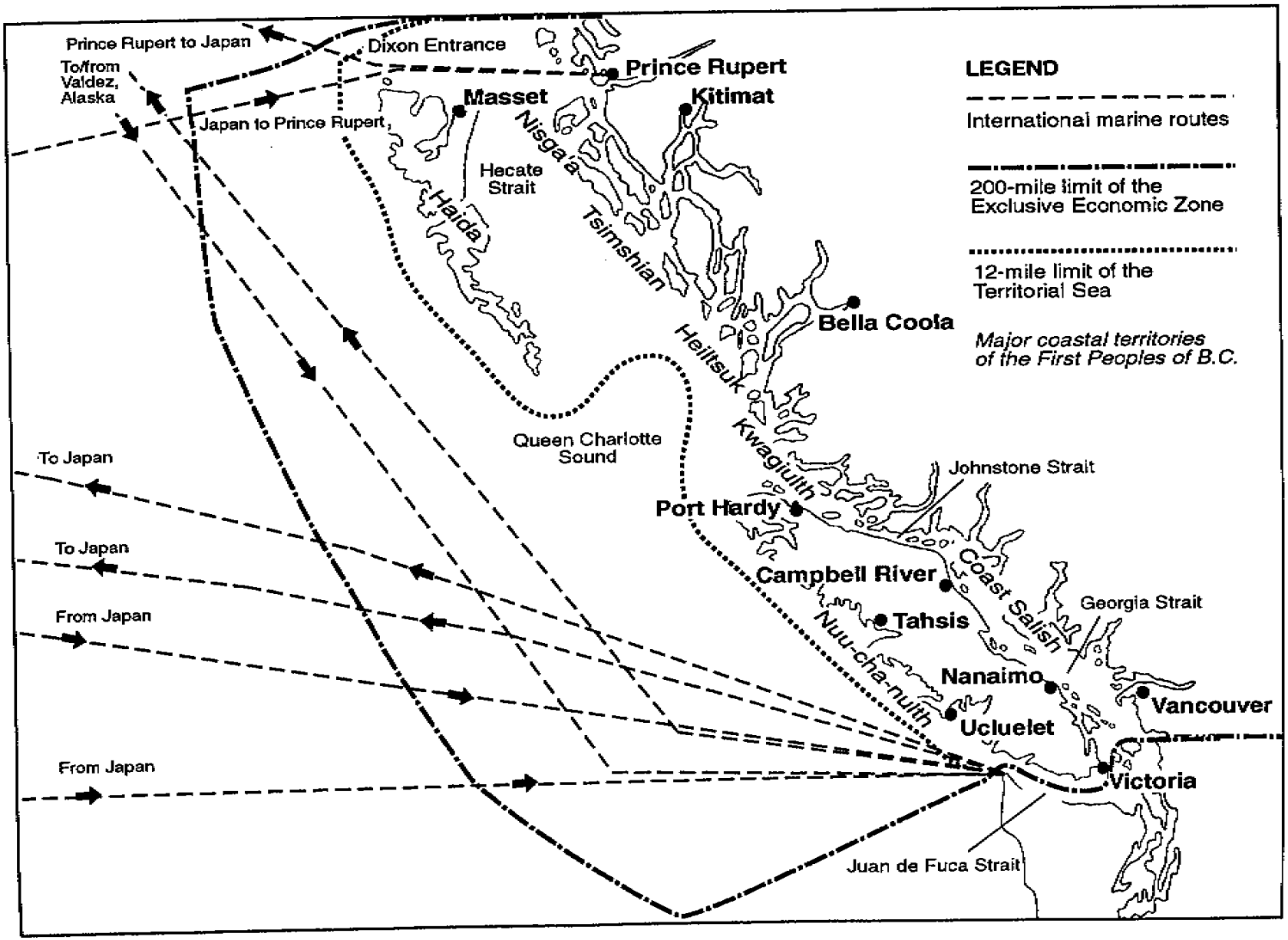
OCEAN ACTIVITY	PRESENT IMPACTS 1990$ (Millions)	YEAR 2000 Potential (Millions)	COMMENTS ON GROWTH Potential
TECHNOLOGIES			
INFOTECH	50	150*	High
ELECTRONICS	40	100*	Medium
SUBSEA ROBOTICS	100	300*	High, but dependant on ocean activities
ENGINEERING MISC.	50	100*	High, but dependant on ocean activities
ENVIRONMENTAL	10	100*	High, but dependant on ocean activities
BIOTECHNOLOGY	1	10*	High, but dependant on ocean activities
SHIP BUILDING & REPAIR	50*	75*	Low, but related to port & coast activities
OCEAN SERVICES	50*	100*	Medium, related to global market access
RECREATIONAL TECHNOLOGIES	125	250	
Technology Impact TOTAL	476	approx 1,085	±
RESOURCES (within the Western EEZ)			
FISHERIES	946	1,250*	Underutilized and value added
MARINE Extracts, special products	--	50*	
AQUACULTURE	110	250	Requires policy, lease access & market demand
OIL & GAS	0	Considerable (Exploration)	High, policy
MINERALS	0	50*	High, requires policy & regulatory infrastructure
Ocean Resources TOTAL	1,056	1,600*	
OCEAN TRANSPORTATION Port activity	1,151	1,726*	Dependant on trade through BC ports
Ferries, etc.	300	450*	Dependant on tourism & economy
TOURISM	782	1,200*	Dependant on access to resources & infrastructure
TOTAL Impact	3,765	6,061	

Technology growth rate estimates are based on current trends in the growth of sales. Where these estimates are speculative or dependant on many variables, they are starred. Unstarred figures can be supported by economic analysis of that activity area in British Columbia. Further documentation and discussion of projections is contained in SPARK Oceans working papers and sectoral reports.

TABLE II-1: Matrix of Sectoral Marine Opportunities at the International, National, and West Coast Levels

	International	National	West Coast
Science	• Expanded participation in and funding for global programs, atmosphere, marine, and geosphere	• Funding for long-term marine science programs • National priorities • Pacific, Arctic, & Atlantic	• Knowledge support for sustainable management • A West Coast view of science priorities • Multi-year plans
Marine Technologies	• Identification of markets • Consortia, alliances • Marketing networks	• Industry, government cooperation • Coordination & focus in innovation • Marketing & networks	• Industry/government instigating contracts, development, testing, & permits • Networks
Sustainable Management of Oceans and Coastal Resources	• Continued involvement in UNEP & other global programs • Global monitoring systems • International agreements	• Institutional reforms • Policy development • Linkages, environment, economic & social programs	• Pursuit of action plans in all sectors • Institutional reform • Priority for urgent problems
Fisheries and Aquaculture	• International agreements on conservation • Fishery stock assessment • Cooperation on marine products & biotechnology	• Regulatory reform, policy development • Underutilized species • Government & industry cooperation in fish stock assessment	• Action plans for sustainable management • Community involvement • Underutilized stocks • Culture-based fisheries
Strategic, Non-renewable Resources	• Identification of Asia-Pacific opportunities for offshore technologies, energy & environment. • Continued participation in ODP • International network for technology marketing	• A regulatory framework for offshore activities • Mapping of continental shelves & strategic resources • Technological/marketing networks	• Integrated regulatory framework • Mapping of shelf resources & exploration • Exploration
Transportation	• Benchmarking & international competitiveness • Promotion of the maple leaf route	• Competitiveness • National strategy for intermodal systems to 2050 • Use of EDI and other technology	• Port & harbour infrastructure, terminals • Use of advanced technologies • Ports & harbours policy
Tourism	• Recreational technology • Market initiatives	• Planning of infrastructure needs	• Community-based planning for tourism • Sportfish stock conservation • Environmental quality • Recreational technology
Total	**Strong Canadian presence in global marine industry, science & technology**	**Sustainable management, identification of strategic resources, & knowledge-intensive industry development**	**Sustainable management, economic diversification & international markets for technology & resource-based products**

THE WESTERN CANADIAN EEZ AND TERRITORIAL SEAS OF B.C.



1.0 INTRODUCTION

Oceans represent about seventy percent of the earth's surface. British Columbia lies on the edge of the largest and most diverse ocean with a coastline of 27,200km and with 6,500 coastal islands. This coast has been used for transportation and harvesting of fisheries for millennia by the first peoples. It has played a key role in the more recent economic history of the province and has experienced both sustainable uses by the First Nations and the often less than sustainable exploitation by generations of fur traders, whalers, commercial fisheries, and logging operations.

The Pacific ocean off the British Columbia coastline exerts a great influence on our climate. We discharge many of our wastes into it. It plays major roles in the international and local transport of people and goods between many Pacific Rim countries and Canada. It is also used in recreation, communications, and defence. Linked to the other oceans, our coastal waters contain vast resources both renewable and non-renewable. The environment and resources within the 200 mile Exclusive Economic Zone of Western Canada, and within the 12 mile limit of the territorial seas of British Columbia are the collective responsibility of the people of Canada and British Columbia.

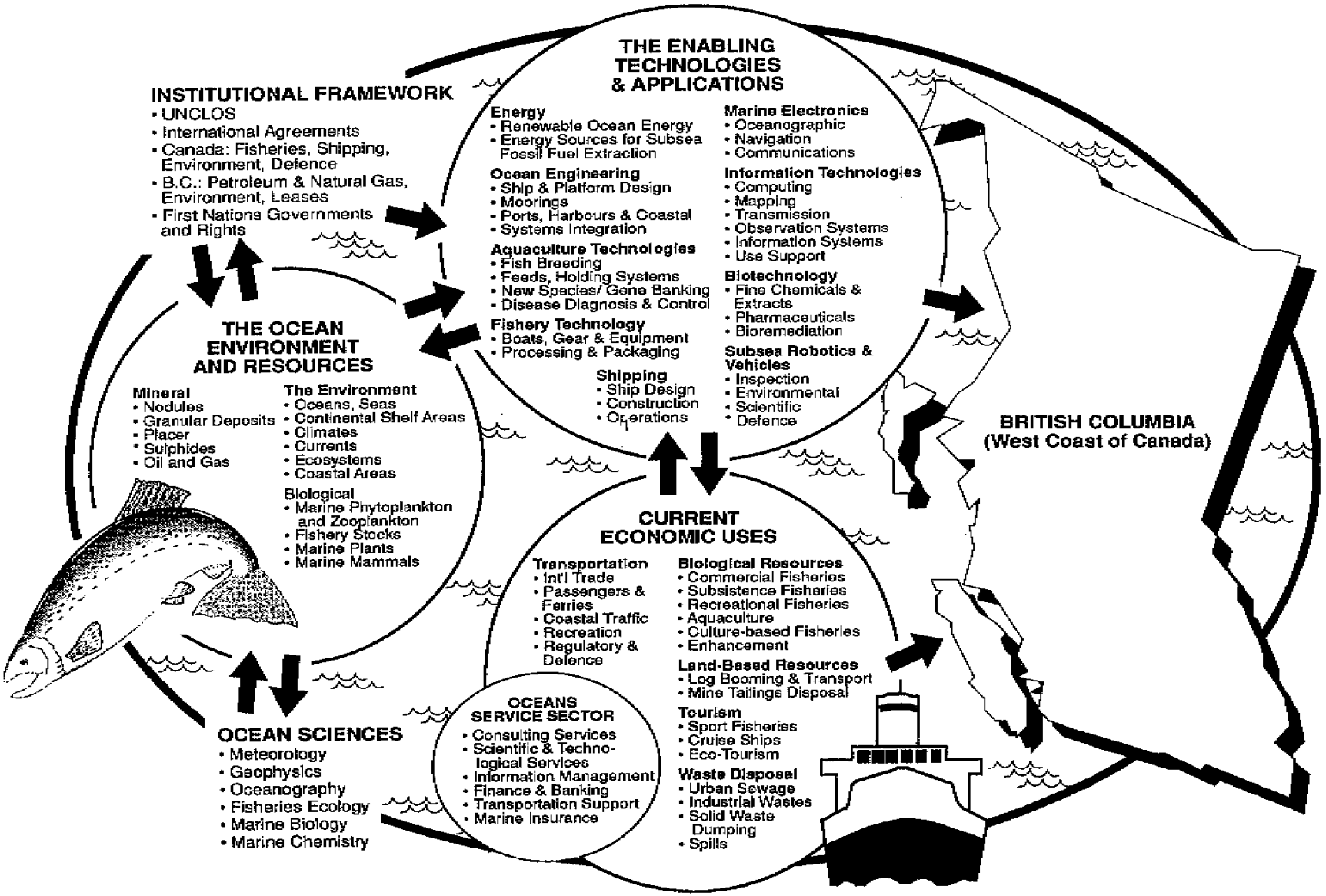
The diversity of ocean environments, resources, uses, and associated technologies is very great. At the same time, there is strong interrelatedness between the various aspects of oceans and their uses. Many complex models have been developed to provide a better understanding of these uses. Within the present overview we have adopted the organization of ocean topics shown in **Figure 1-1** in order to facilitate discussion of the issues of sustainable management and future wealth creation in British Columbia. Each of the components: The Legal and Regulatory Framework, Science, Resources and their uses, Economic uses, and the enabling technologies, all interact with each other. It is impossible to review or discuss any one component without reference to the influences of the others. This becomes especially important when issues related to sustainable uses are under review. The ocean sciences, the legal and regulatory structure, technologies, and ocean uses are all relevant to sustainable management. This report will focus on the emerging enabling technologies as tools to assist the conservation of the ocean environment as well as a means of new wealth creation.

In view of the potential of the ocean and coastal zone to make significant contributions to job, and wealth creation in Canada, the SPARK Oceans Committee was established in March 1992. This committee commenced the assembly of a strategic framework for Ocean Industry Science and Technology in June, 1992. This report, and the various SPARK working papers, listed in **Appendix II**, document the present contribution of ocean-related activities to the economy of British Columbia. The great potential to increase this contribution is reviewed along with the necessity of protecting the ocean environment and ensuring that its uses are sustainable. Many people, involved in a wide range of marine activities and living on the coastline of British Columbia were involved in this process. This report also identifies opportunities and outlines an action plan to bring all marine interests together to manage these waters in a sustainable way, and to realize this potential.

Figure 1-1

THE DIVERSITY AND INTERRELATIONSHIP OF ISSUES

Reviewed within the Oceans Strategic Framework
from a West Coast Canadian perspective



2.0 THE SPARK OCEANS PROCESS

The SPARK Oceans Committee was set up early in 1992 to identify the opportunities in ocean industry, science and technology. This committee made a proposal to assemble a strategic framework as a first step in this process. Core funding was provided by SPARK in April, 1992, and external contributions were negotiated with the British Columbia Ministry of Economic Development, Small Business and Trade, and the British Columbia Ministry of Agriculture, Fisheries, Food, the Federal Department of Fisheries, and Oceans, Industry, Science and Technology Canada, and the National Research Council. Work on the Oceans Strategic Framework commenced in June 1992.

Central to the concept of developing a strategic framework was the active involvement of ocean industry, non-governmental organizations, the universities, colleges, and governments. The purpose is to allow British Columbia and Canada to participate in future ocean opportunities on a global scale while ensuring protection of the ocean environment.

Major contributions of time, knowledge, and personnel were made by the ocean specialists from industry, non-governmental organizations, universities and colleges, and government agencies. Thus, this report, together with the sector working papers, represents a compendium and consensus of all these sectors and the wealth of knowledge available from the participants.

A draft report was circulated in December 1992 and an Oceans Forum attended by 150 persons with ocean interests was also held to review the findings. The names of those who contributed are listed in **Appendix I.**

2.1 THE WORKING GROUPS ON OCEAN ACTIVITIES AND OPPORTUNITIES

To facilitate the overview of oceans potential, a series of working groups were set up. The original mandate of the SPARK Oceans activities was to review and make recommendations on:

- the present status of private sector, government, and university activities in marine industry, science, and technology in British Columbia with particular attention to strengths and weaknesses, and the economic significance of these activities.
- the R&D innovation, technology transfer, educational and training requirements for the ocean sector to achieve its full potential and objectives.
- the industrial, scientific, and technological opportunities in the ocean sector into the next century with specific reference to global and Pacific Rim opportunities for British Columbia.
- develop a strategic framework report for ocean industry, science, and technology based on available information in consultation with industry, the scientific community, and relevant government agencies.

SPARK Oceans was also requested to make recommendations on ocean-related issues relevant to governments, including:

- a coordinating mechanism for ocean activities on the West Coast.
- the context against which governments can evaluate ocean development proposals coming from the private sector and academia;
- the provision of a forum for industry to table opinions on constraints to ocean innovation and to identify solutions and to facilitate communication between participants in different marine activities on opportunities of mutual interest;
- a means to reconcile the many different perspectives on oceans activities.

2.2 THE RATIONALE FOR AN OCEANS STRATEGY

Several compelling reasons drive the SPARK Oceans' efforts to bring together a common vision for British Columbia and Canada regarding our oceans. They are:

- The ocean environment dominates global processes. An understanding of it and maintenance of its wellbeing is essential to our future.
- The oceans contain strategically important resources, yet these are poorly understood and mapped, and we have not developed strategies for their utilization that respect the principles of sustainability.
- Canada is part of an increasingly global economy, with increased competition in natural resource exports and manufacturing markets. Our oceans are a bridge to this global economy and especially the diverse market opportunities in the Asia-Pacific region.
- The recognition of aboriginal rights and the many claims by the First Nations of the British Columbia provide an opportunity to develop sustainable policies for fisheries, aquaculture, tourism, and other marine activities.
- The Canadian (land-based) economy faces slow economic growth and continued elevated levels of unemployment. The oceans have great potential for new wealth creation. This requires the use of appropriate technologies, and the development of a framework for sustainable ocean use.
- Government ability to fund initiatives in ocean industry science and technology is decreasing rapidly at a time when problems are increasing and international competition is fierce.
- Canada, and British Columbia in particular, has a substantial base of ocean-related industry, advanced technology, and skilled personnel and services. This will be eroded unless they participate in global opportunities.
- The present administration of oceans in Canada is fragmented. There are many unresolved jurisdictional issues and a lack of policies.
- An adversarial relationship between industry and government agencies has resulted in numerous impediments to international market development and competitiveness.

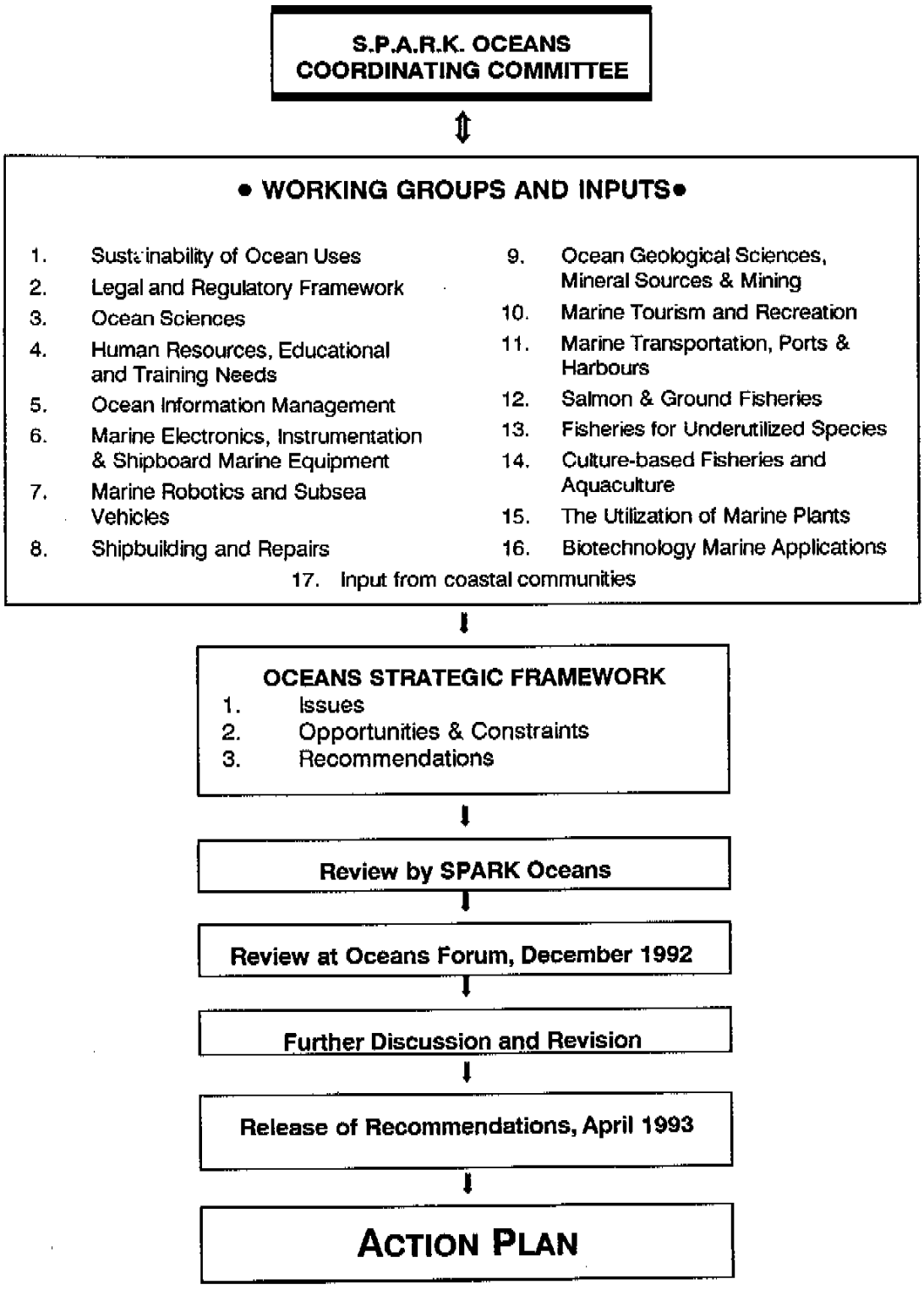


FIGURE 2-1: SPARK OCEANS STRATEGIC PLANNING PROCESS

3.0 THE LEGAL AND REGULATORY FRAMEWORK

The laws and regulations relating to oceans and coastal uses have direct impacts on sustainable use strategies. The present legal and regulatory framework for management of ocean resources on the West Coast was reviewed, and alternatives more in keeping with the concept of sustainability were considered.

The present legal/regulatory framework that is in place was found wanting in several areas critical to sustainable management. These include:

- The separation of environmental protection statutes from the regulation of marine industries. This makes the coordination of environmental protection and regulatory policies difficult.
- Jurisdictional and other legal uncertainties within the regulation of marine activities. These allow undesirable practices to continue in the disputed areas, and create barriers to new, innovative ocean activities that fit the criteria of sustainable use.
- An inadequate, isolated environmental assessment system that does not yet provide for the evaluation of many oceanic and coastal resource development projects, nor for coastal community participation in decision making.
- A regulatory environment out of line with the recognition of native rights. This is especially critical in the area of fisheries and detracts from the implementation of sustainable management programs.

Current environmental protection statutes

The current **environmental protection statutes** regulate marine environmental quality by concentrating on the effects of human uses of the oceans rather than on the uses themselves. This approach is the result of the traditional view in common law of the environment as an entity separate from the economic forces which act upon it. It ignores the need to regulate the environment and the economy in tandem, which is a central element of sustainability (See **Chapter 4**, The Marine Environment and Sustainability).

Fisheries

The most important marine resource sector are the fisheries. Their overriding characteristics are diverse user groups with distinct agendas and vulnerability to the actions of other ocean user groups, in particular pollution from urban and industrial sources. Regulation of this industry is vested almost entirely within one federal department, the Department of Fisheries and Oceans. The local representatives of this department are invested with wide powers for the management of the resource

at the species level. This is inadequate because marine species are part of complex, dynamic systems as has been recognized by recent reforms in New Zealand (See Chapter 4). From the point of view of sustainability, the Fisheries Act regulations fail to recognize the economic and social significance of new marine activities, including aquaculture and marine tourism. The recent recognition of native rights in the fishery, and other sea claims by aboriginal peoples, will bring major changes to the structure of fisheries and other coastal activities. No plan to manage ocean resources can succeed without addressing these issues, and ensuring the participation of all ocean stakeholders. The present administration of the Fisheries Act is not adequate to this task.

Marine tourism

The expanding ocean tourism industry is also vulnerable to competing uses of the marine environment, and the needs of the sport fisheries (See **Chapter 11**) for access to resources are not well recognized. This vulnerability could be addressed through the inclusion of a **tourism perspective** in decisions regarding coastal site allocation and water quality management. Such inclusion does not yet exist in current legislation. Coastal zone management programs could provide a higher profile for the needs of tourism in decision-making.

Non-renewable resources

The possibility of subsea mineral, oil or gas extraction has not yet been integrated into any plan for the management of coastal resources, owing largely to legal uncertainties. A regulatory framework for oil and gas exploration has been developed, but has not been implemented. A **moratorium** on mineral exploration and development off the British Columbia coast has inhibited basic exploration and mapping. As well, the current provincial mining laws do not apply to the seabed environment. The uncertainty about jurisdiction of seabed and mining rights between the federal and provincial governments, and native bands are issues that must be resolved before any use of these resources is possible.

Transport

Accidental or deliberate discharges of oil and other pollutants and pests from marine transport activities can impact on many other resource uses. These are the most important aspect of transport in the sustainable use of oceans. At present, concerns such as vessel traffic routing, discharge regulation and spill cleanup procedure are addressed federally, with very little provincial input, and largely in one comprehensive piece of legislation. At present, there are separate federal and provincial initiatives to combat catastrophic oil spills. However, these plans, under the Canadian Coast Guard and the provincial Ministry of Environment are not integrated. Institutional factors, rather than weaknesses in the legislation itself, stand in the way of incorporating transport policy into a broader coastal resource management plan.

As well as regulation of specific industries, the potential impacts of projects and

activities are regulated through a process of environmental assessment. A successful **environmental assessment** system will be applied in a universal and mandatory manner to all proposed projects beyond a certain size, it must also be effective in screening out unacceptable proposals. Neither of the present provincial or federal environmental assessment schemes, while well-intentioned, satisfy these criteria.

This review identified numerous legislative and regulatory barriers to sustainable development of ocean resources. It concludes that only a **formal policy and management advice body**, with representation from federal, provincial, First Peoples, industry, and all other marine interests, can coordinate the management of so many competing resource uses and interests into a truly sustainable management plan. For lack of a better title this concept is referred to as "**The Oceans and Coastal Forum**". This coordinating mechanism would be characterized by i) Efficiency, i.e. it would not add to the present complexity but simplify it; ii) Effectiveness; and iii) Problem solving. The concept requires further discussion and definition.

Other models of marine management systems were examined, but were found to be inappropriate for Canadian jurisdictional arrangements or unsuitable for the vast number of issues which must be addressed. Less formal arrangements were also considered, but were found inadequate because of their non-binding nature. The essence of sustainable resource use requires the careful integration of all variables into one rational plan.

4.0 THE MARINE ENVIRONMENT AND SUSTAINABILITY: THE KEY TO OCEAN USES

Introduction

More than half of the world's population lives within 60km of a shoreline. The coastal environment, including the oceans and seas and adjacent coastal land, forms an integrated whole essential to the life support systems of this planet. The coastal areas contain diverse and productive habitats that are important for human economic activities, subsistence, and settlements.

The marine environment is also a dynamic medium that respects neither property nor administrative boundaries. Despite many national, regional, and global efforts, current approaches to the management of marine and coastal resources have not always been managed in a sustainable way. The recent United Nations Conference on Environment and Development, Rio de Janeiro, 1992[1], considered these issues at a global level and reached a consensus on the key elements of sustainability and the actions necessary for its achievement.

The situation on the West Coast of Canada is a microcosm of these global issues, except that **we have an exceptional wealth of marine resources and habitats, and have not yet experienced the more extreme consequences of human activities on the marine environment.**

The Western Coast of Canada

British Columbia has 27,000km of coastline, and more than 6,500 coastal islands. Increasing demands are being placed upon the ocean and related coastal areas of the Province. Conflicts between resource uses and within resource sectors are becoming increasingly common. Particularly heavy stress is being placed on coastal areas where the population is increasing. The waters and adjacent uplands of the Georgia basin are experiencing tremendous population and development pressures that are expected to continue or accelerate over the next twenty years.

Growth management issues involving transportation, waste disposal, open space preservation and housing also affect coastal areas. Some issues have attained international profile and significance such as migratory birds and fish harvesting, sewage disposal in the Straits of Georgia and Juan de Fuca, oil spills and fishing boundary disputes in Dixon Entrance.

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[1] UNCED Agenda 21, Chapter 17, "Protection of the oceans, all kinds of seas... and coastal areas, and the protection, rational use, and development of their living resources.

The most critical issues affecting coastal areas of British Columbia include the deterioration of marine water quality, loss of critical habitat and biodiversity, spatial land and water use conflicts, oil spills, the establishment of marine parks and protected areas, fishery disputes, port and industrial siting.

In addition, the management of our coastal resources suffers from a lack of systematic information, conflicting and overlapping jurisdictions, lack of coordination in government programs, poor integration of land and water management, lack of an ecosystem perspective in resource management, and limited opportunities for the involvement of local governments, communities, and First Nations.

Coastal resource management in British Columbia is primarily driven by a sectoral approach to resource use, determined largely by the existing federal-provincial jurisdictional and regulatory framework. Over the last twenty years this approach has been supplemented by project-specific referral systems. These systems have become the dominant form of decision-making for allocation and management of coastal resource uses. Environmental impact assessment and review panels and public inquiries dealing with coastal issues have helped shape coastal resource policies. Over the past fifteen years there has been a growing reliance on special task forces and committees to deal with complex, inter-jurisdictional issues, particularly in special areas of the coast. These have often involved formal agreements between several levels of government.

In the face of these issues there is increasing recognition of the need for the development of an over-arching Coastal management strategy. Yet, **despite numerous studies, Task forces and Commissions over the past twenty years, reform of coastal resource management has received no commitment**. The most significant changes in coastal management have been in special areas, such as estuaries where management programs have been implemented (Fraser, Cowichan, and Squamish). While these have produced some localized benefits they fall far short of a coordinated and integrated approach to marine and coastal resource management.

A sustainable use strategy

The provincial government has recognized the inadequacies of the established mechanisms for allocating resources and making land-use decisions. It recently established the Protected Areas Strategy and the Commission on Resources and Environment (CORE) to address the issue of protected areas and to develop a land use strategy and community-based decision-making process for resource uses. The main emphasis has been addressing contentious natural resource issues in upland areas. Many coastal issues that are, or promise to be, critical problems are receiving inadequate attention. In addition, there are strong interactions between coastal marine and land-based activities that require attention.

The lack of a comprehensive open sea and coastal resource management strategy severely limits our ability to plan and effectively manage resource allocation and use.

Without such a strategy, we cannot ensure that the sustainability of coastal environments and economies is taken into account in planning and management of upland activities. We are in danger of foreclosing options and opportunities to sustain a viable Coastal zone.

4.1 HUMAN IMPACTS ON THE OCEAN

The industrialization of British Columbia, the growth of its population and discharge of wastes into the ocean, have caused environmental problems. In recent years, these problems have led to concern among ocean user groups, and the closure of some coastal areas to harvesting. These problems have been extensively reviewed by the scientific community and have been the subject of many reports, and inquiries. Recently a state of the environment report was published on the Lower Fraser River Basin which highlighted many of the concerns related to the discharge of British Columbia's largest river into the ocean. A state-of-the-art environment review of the entire British Columbia coastal zone is beyond the scope of this report, but the following sources of human impacts on the sustainability of the coastal and high seas environment were identified.

Sewage

As human population has increased, so has the direct discharge of human and industrial wastes into the ocean. The Greater Vancouver Regional District alone discharges more than one billion litres per year. This area is installing secondary treatment facilities, but some coastal cities and towns have no treatment and discharge raw sewage. The ocean and our coastal waters have a substantial capacity, in some regions, to assimilate organic wastes, but other coastal users, especially the shell fisheries are concerned. As the coastal population grows (especially in the Georgia Basin) the need for comprehensive solutions and effective use of treatment technologies will increase.

One aspect of sewage discharge of immediate concern is the discharges from coastal marine craft, especially recreational craft, anchored in harbours and sheltered bays. These seasonal sources have been implicated in the contamination of some shellfish beds and swimming areas. This has led to calls for new regulations to require sewage holding tanks on craft with toilets and galleys. Such regulations have implications for craft design and construction and would require the appropriate infrastructure for land-based disposal.

Urban and agricultural runoff

Oil, chemical, and other runoff washed from urban streets, industrial areas, and agricultural lands and carried to the ocean by storm drains and natural drainage are also a source of contamination. The majority of coastal oil pollution results from runoff, not ship discharges or leaks.

Pulp and paper mill discharges

There are six pulp and paper plants discharging into the Strait of Georgia alone. Use of chlorine in bleaching the pulp produces organochlorine compounds. Over 300 such compounds have been identified in plant effluent. New pulp and paper regulations aim to eliminate organochloride discharges by 2002. This has resulted in large investments by the companies in waste treatment. Though there is controversy over the damage caused by some of the effluent components, considerable evidence to their toxicity, persistence, and wide distribution throughout food chains exists. A comprehensive approach to these problems is necessary to manage the huge costs and potentially diverse impacts.

Oil spills and other pollution from ships

On the high seas, oil tanker safety, oil spills, and other pollution falls under the International Maritime Organization (IMO) MARPOL Convention. The standards set by this convention are produced by consensus of the member nations and are not necessarily adequate. Within the EEZ, the Canada Coast Guard oil spill contingency plans and British Columbia oil spill contingency plans for shorelines are in place (but not yet integrated) and have been the subject of several inquiries and reports.

A major cause of accidents is human error and negligence. The use of advanced navigational systems and other technologies such as double hulled vessels can reduce these risks, but only some of these precautions have been implemented to date. In addition there is increasing concern about the safety of vessels under flags of convenience in Canadian waters. The IMO has not been able to exercise full control in the setting of standards. In 1991 alone, 19 large vessels were lost at sea. In some cases, structural failure related to corrosion or poor design may have been factors. These problems and potential sources of pollution may not be solved until Canadian and U.S. authorities insist on inspection at North American ports of call.

Ocean-dumped nuclear wastes

Canada has not dumped any nuclear wastes at sea but, until 1970, the USA and other countries dumped radioactive waste in deep water in special drums and storage tanks. This practice is now controlled by the London Convention on Ocean Dumping. A report recently released by Russia[1] has revealed that prior to the demise of the Soviet Union there was extensive dumping of nuclear wastes produced by that nation's nuclear naval ships and submarines in the Arctic and Pacific waters of Russia. To date, the dump sites have not been accurately mapped, nor has the long-term risk to the ocean environment been evaluated. This situation requires international cooperation and the capabilities of the ocean sciences and the subsea technology industry to evaluate the threat and plan remedial programs.

1 Yablokov Commission, Parliament of the Federation of Russia, 1992

Long range transport of contaminants

Pacific ocean currents are quite capable of bringing contaminants from distant sources, to impact on local marine plants and animals. Traces of some pesticides, industrial contaminants, and some radioactive wastes have been detected in marine organisms thousands of miles from possible sources. Even though Canadian sources are not involved, these occurrences emphasize the importance of international cooperation in environmental management of the marine environment and of, effective and high-standard domestic programs which support international efforts. ("Act locally, think Globally.")

Impacts of excessive harvesting

Occasionally, excessive and sustained commercial harvesting of marine animals can trigger catastrophic collapse of their populations and loss of genetic diversity. For example, there is good evidence that the average size of the Chinook salmon landed in British Columbia has been decreasing as a result of selection of the larger fish in harvesting activities.

Impacts of pollution on other ocean uses

Pollution is the most serious threat to sustained economic use of our coastal areas. In British Columbia, pollution from land-based sources has caused documented cases of:

- loss of viability of fisheries and aquaculture production;
- closure of commercial fisheries;
- closure of subsistence fisheries;
- loss of the biodiversity of marine ecosystems;
- contamination of marine animals and other organisms in complex food chains;
- adverse impacts on tourism and aesthetic value;
- loss of sustainable uses of the ocean's environment;
- damaging our "pristine" image in the eyes of potential international markets;
- global-scale contamination of marine food chains with pesticides and hazardous chemicals.

4.2 SUSTAINABILITY AND THE MARINE ENVIRONMENT

In this report, **Sustainability** is referred to as a process or state that can be maintained indefinitely (IUCN definition). In socio-economic terms, this means maintenance of the well-being of the present generation and retention of future options for our children (Bardach, 1990). **Sustainable Use** is using renewable resources at rates within their capacity for renewal, growth, and reproduction.

A wide consensus has emerged that open ocean and marine coastal sustainability will involve the principles that are the basis for the Global oceans strategy agreed on at the United Nations Conference on Environment and Development, Rio De Janeiro, 1992. The challenge is to translate these principles into practical tools for

management of new ocean and coastal areas. They include:

- maintaining the stock of biological wealth, including the life-supporting ecosystems that sustain productivity of biological resources;
- the full participation of aboriginal communities and recognition of their entitlements in the marine/coastal environment;
- promoting technology and management practices that increase the benefits from marine/coastal resources;
- using economic policy to help retain natural wealth and assess economic tradeoffs, This includes the use of market incentives, in addition to regulatory means;
- adopting an anticipatory cross-sectorial integrated approach to decision-making. That is: link economic, environmental, social, and ethical aspects of decisions and seek a balance;
- fostering administrative systems that reflect these values. This includes the development of policies and management strategies to address the unique features of the marine/coastal environment; and,
- ensuring that education, awareness and participation of all interests are integral components in the administration and coordination of sustainable use.

These principles must become the basis for making decisions governing the marine environment of British Columbia, contributing to, and deriving support from, the UNCED Global Oceans strategy. In this strategy, coastal states are committed to integrated management for areas under their jurisdiction by the provision of an integrated policy and decision-making process, the identification of existing and projected issues, the monitoring of impacts, promoting environmental accountability, and providing access for concerned individuals and groups. The realization of these goals requires the establishment of a new cross-sectoral coordinating and policy developing entity which we call **The Oceans and Coastal Forum**.

4.3 THE ACTION PLAN FOR SUSTAINABILITY

Moving from the present situation and the existing ways of managing the coastal environment (sectoral and not well coordinated) towards sustainable objectives, is possible employing instruments of change. Four instruments of change have been identified as being critical to implementing sustainable use of the environment[1]. They are:

1 Instruments of Change for Sustainability. An agenda for Business and the Environment. Globe 92 Conference, Vancouver. These are based on the Bruntland Report which also identified these four key themes.

- policy and legislation;
- economics and finance;
- research and technology;
- communications, education, and training.

The SPARK Oceans activities over the last year have examined each of these four instruments of change as they relate to the marine environment on the West Coast of Canada. The conclusions clearly demonstrate that, with regard to sustainable objectives:

- **The present policies and legislation governing marine uses are not adequate for the future, and must be revised to both promote and accommodate change.**

- Our economic dependence on the ocean is threatened unless we adopt sustainable practices **and,** in the future, sustainable practices can provide an economic base for new wealth creation.

- Research provides the understanding of ocean processes. Technology provides the tools for observation, management, and appropriate use of the ocean.

- Communications, education, and training are essential to human awareness of the ocean environment and development of the skills necessary for sustainable management and use.

The components of sustainable ocean and coastal use actions plans are outlined in **Tables 4-1** and **4-2**. Some of these have already been acted on by responsible agencies. They now require a comprehensive structure to bring them together. This will enable us to move towards goals that are clearly defined and well understood by all interests.

The tools (technologies) for a sustainable strategy

Many new technologies with powerful capabilities to assist ocean and coastal management are emerging. The development and opportunities for these technologies are discussed in the relevant SPARK Oceans sector reports.

- Ocean observation systems: satellite platforms with multiple environmental sensors and many related earth stations, databases and airborne remote sensing;
- Geographic Information Systems and related information technologies;
- Ocean instrumentation systems;
- Bottom and mid-water survey systems including ROVs and AUVs with sonar, video, and other sensors linked to positioning and mapping systems;

Every effort must be made to ensure the most effective deployment of these tools in working toward sustainable management policies for the ocean coastal environment.

Many examples of available technologies (often developed by local companies) documented in this report have been poorly utilized by government or industry to solve existing problems.

These tools, in combination with the knowledge and skills of the coastal population (First Peoples, fishers, recreational and marine transport users) offer the best means to solve many coastal conflicts within a framework of integrated coastal management.

4.4 COASTAL ZONE MANAGEMENT: AN IMPORTANT ASPECT OF SUSTAINABILITY

The coastal economic zone is defined as the area off the Western coast out to the 200 mile limit. More than a decade ago, the ecological, economic, and social problems resulting from the fragmented and poorly planned coastal jurisdictions was recognized by the Canadian Council of Resource and Environment Ministers (CCREM). Since then, there has been little or no progress towards rectifying the situation. Meanwhile, the United States Federal Government, in partnership with states such as Washington and Oregon, have made substantial progress towards integrated management of their coastal areas.

The SPARK Oceans activities identified many of the essential tools for Coastal Zone Management (CZM) and some very important coastal issues that require rational policies. These include:

- major shellfish harvesting areas closed to commercial and local uses by pollution;
- the need to protect special spawning and nursery habitats that are the basis of fishery productivity;
- the preservation of the beauty of the coastline as a basis for expansion of the marine tourism industry;
- an appropriate allocation of fishery resources to sustain sport fisheries alongside commercial and subsistence activities;
- the allocation of leases for entrepreneurial activities such as aquaculture;
- the allocation of long-term area licences for the sustainable management of sedentary species;
- the provision of adequate resources to ports and harbours to allow them to compete internationally.

TABLE 4-1: Business Plan Elements for Sustainable Allocation, Use and Management of Marine Assets

Sustainable use of the West Coast marine environment requires the definition of:

- Objectives, in environmental, social, and economic terms;
  - Expected results, including plans to achieve these results, time-frames, and targets;
    - Activities necessary to achieve the expected results;
      - Measures of success that will define progress towards sustainability.
        - Investment and return on investment.

TABLE 4-2: Reforms and Structural Changes for Sustainability

The necessary reforms and structural change required for sustainability will include:

- The development of policies and legislation that assess and preserve existing capacities ("the existing pie"), that ensure that there is no net loss to environment or resources from this flow, and that permit "making the pie bigger" through net gains, efficiencies, and enhancement practices.
  - Inventory of the existing resources and state of the environment reporting.
  - Inventory of existing allocations, uses, total allowable catches, and other rights of use.
  - A cooperative review to ensure that common information and data systems; common coordinated research plans and a common consultation forum is put in place.
- Strategies and investments that enhance sustainability, including:
  - Assessment of resource carrying capacity and assimilative capacity.
  - A cooperative resource allocation process, including:
    - an allocation forum and process;
    - a management forum and process;
    - waste management protocols and enforcement.
- A comprehensive forum of all stakeholders to participate in the identification and resolution of disputes[1].

[1] We believe this objective is best pursued by building on the existing SPARK Oceans consultative process. The end result of wide and full consultation of all coastal and ocean stakeholders would be the establishment of an Oceans and Coastal Forum or equivalent body.

The economic context

The following economic activities in the coastal area of British Columbia exert pressures on the marine environment:

- The salmon, herring roe, roe on kelp, geoduc, urchin, clam, and many other commercial, sport, subsistence and ceremonial fisheries.
- A large part of our expanding tourism industry. In particular, sport fishing, eco-tourism, and cruise ships.
- Routes and anchorages for coastal marine traffic, including ferries, barging, and recreational traffic, in addition to 60 million tonnes of international shipping each year.
- Direct and indirect discharge of human agricultural and industrial wastes.

Many of these uses are coming into increasing conflict with each other. A sustainable coastal use strategy would provide a basis for the resolution of these conflicts with minimal loss of eco-system diversity and health, while allowing opportunities for diverse economic activities and the creation of new wealth.

4.5 FISHERIES AND SUSTAINABLE MANAGEMENT

The administration of fisheries needs to be closely linked to the sustainable management of all coastal resources. The proposed Oceans and Coastal Forum concept, involving all coastal users, could play this role. At present, the fisheries management in the West Coast of Canada is complex and tries to balance many conflicting commercial user needs. Fresh initiatives are needed to bring all fishery interests together to develop sustainable use management plans for commercial, sport, subsistence, and ceremonial fisheries. Efforts must be made to focus the attention of all user interests on the integrated, long-term management needs of our fisheries within a framework of sustainable use rather than the short-term needs of particular interest groups.

In this respect, New Zealand has recently introduced an integrated and sustainable fisheries management policy and proposed legislation that indicates substantial progress towards the principles outlined above. In the New Zealand case, clear principles and objectives have been set for fisheries management and processes established to protect the resource while allowing ceremonial, recreational, and commercial activities[1].

[1] Sustainable fisheries report of the Task Force to the Minister of Fisheries on the Review of Fisheries Legislation, New Zealand, 1992.

4.6 THE GEORGIA BASIN FOCUS

The Strait of Georgia is a unique inland sea, containing several major ports. It is one of the most important salmon producing areas in the world, sustaining both large commercial and sport fisheries. Most of the British Columbian shellfish cultivation industry is based within the Strait of Georgia.

More than 60 million tonnes of goods are shipped out of Canada via the ports of Vancouver and the Fraser river. The coastal areas and, in particular, the Fraser river basin carries a rapidly expanding population (**Table 4-3**), and most of the industrial production in British Columbia. Details are further documented in the relevant chapters of this report, and in SPARK Oceans sector documents.

The Georgia Basin, in particular its inland sea between Vancouver Island, the mainland and to the southern extremity of Puget Sound, is facing unparalleled pressures. This finite environment, more than any other location on the West Coast, requires the application of sustainable management practices, otherwise accelerating depletion of resources, and increasing pollution and environmental degradation, can be expected. Several scientists have pointed out that the present uncoordinated multiple jurisdiction in the Strait is analogous to the situation in the Great Lakes in the 1950s, just prior to the rapid downward spiral of the Great Lakes environment which resulted in the near-total collapse of the commercial fisheries, and severe food chain contamination.

Many of these trends have been clearly identified by environmental organizations, and many separate programs have researched specific issues in pollution and fisheries. However, there has been no overall coordination. Many gaps exist in our basic knowledge of the Strait.

New initiatives concerning the Georgia Basin

Until recently, most attention has been focused on the problems of the Fraser estuary and the Fraser basin, which received attention within the federal Green Plan. This resulted in a series of studies by the Westwater Institute of the University of British Columbia and various government agencies into the state of the environment and the management options. This led to the signing of the Fraser Basin Management Program (FBMP) agreement in May, 1992, by the federal government, British Columbia, and local governments. They agreed to develop an integrated management plan for long-term sustainability in the Fraser Basin. The goal of the program under a 19 member management board is to promote sustainable development in the Basin by balancing economic, social, and environmental values, and advising on policies and program priorities. The FBMP extends to the Fraser estuary, but does not address coastal issues.

The provincial government has asked the British Columbia Round Table on the Environment and Economy to initiate a consultation process providing advice on the management of the Georgia Basin as a whole and the protection of the quality of life

for future generations. In January, 1993, the Round Table sponsored a workshop to address sustainability issues in the Basin. A report is expected in the summer of 1993.

Clearly a comprehensive approach based on wide consultation is necessary, prior to any focus on specific initiatives. This will require the involvement of all levels of government, First People Nations, all industry sectors, and all users of the Straits. Our report provides input to this process from a marine perspective, and identifies the issues that need to be addressed within a strategy of sustainable management.

Mapping of the Strait of Georgia

A first step towards the development of sustainable management practices will be the development of an integrated base of information on the marine environment, contiguous and compatible with the information base used by the Commission on Resources and Environment (CORE). This will require the compilation of detailed, geo-referenced GIS information on the Strait of Georgia. The existing information, collected by the Canadian Hydrographic Service, provides a basis, but much more detailed information on the sea floor of the Strait of Georgia is required. Considerable expertise exists within local marine technology companies and government agencies.

Mapping is essential to the development of coastal management strategies in fisheries, aquaculture, waste disposal, parks and protected area strategies, exploration for mineral resources, seismic stability, and many other uses.

CONCLUSIONS

A coordinating entity involving all ocean and coastal stakeholders (the "**Oceans and Coastal Forum**") is required to move all sectors towards sustainable management objectives and to direct the necessary changes in policy, legislation, development activities, research, community involvement, education, and training.

- Multi-sectoral action plans including policies, expected results, activities, and identified targets (see **Table 4-1**) are needed to move from discussions into activities that will aim at more sustainable uses.

- Greater emphasis must be put on awareness, education, and training as an essential prerequisite of sustainable management.

- The Oceans and Coastal Forum should be especially charged to ensure that long-term sustainable management needs in the fishery are addressed alongside the needs of coastal communities for ceremonial, subsistence, recreational, and commercial uses.

- The monitoring and remediation of coastal pollution sources is a priority in order to sustain tourism, coastal fisheries, and aquaculture.

- The development of integrated sustainable management for coastal fisheries, aquaculture, enhancement, and culture-based fisheries is needed. This requires cooperation between the federal and provincial governments, First Peoples, and all fishery users towards long-term strategies for conservation while at the same time allowing the development of a sustainable seafood industry.

RECOMMENDATIONS

The SPARK Oceans process in consultation with all levels of government and all stakeholders should take the responsibility for defining an "Oceans and Coastal Forum" structure, which will move all marine activities in Western Canada into a sustainability framework.

- Comprehensive Action Plans for sustainable management of the marine environment should be defined by each marine sector of activity under the coordination of the Oceans and Coastal Forum.

- A framework for open ocean and coastal zone management that respects the diversity of existing and future ocean uses should be drawn up by industry and the stakeholders in consultation with the federal and provincial governments under the coordination and facilitation of the Ocean and Coastal Forum.

- Business plans should be prepared relating to specific urgent issues as working models for sustainable management. (e.g. rehabilitation of coho stocks in the Strait of Georgia.)

TABLE 4-3: Population trends in the Georgia Basin
(Source: British Columbia Statistics)

Approximately 5 million people live around the shores of the Georgia Basin and Puget Sound at present. Over the last 30 years, growth rates in the Basin have risen more rapidly than in other areas of Canada.

Forecasts indicate that, over the next few years, this growth will continue at relatively high rates. Population in the Georgia Basin is expected to grow faster than the average provincial rate. During the five-year period between 1986 and 1990, Vancouver and Seattle/Tacoma were tied with the fourth highest growth rate (12%) among all metropolitan areas in the United States and Canada with populations over 1 million. Only Orlando, Sacramento, and San Diego experienced more rapid growth.

TABLE 4-3: Population trends in the Georgia Basin

	1980	1990	2000
British Columbia	2,666,000	3,132,500	3,912,200
Percentage change	8.08%	26.99%	58.60%
Georgia Basin	1,817,841	2,242,698	2,835,367
Percentage change	7.93%	33.15%	68.34%

Within British Columbia, population growth rates around the Georgia Basin are high. For example, between 1985 and 1990, the Lower Mainland population grew by slightly over 12% and in the 1980s, the population of the Gulf Islands doubled.

5.0 WEST COAST OCEAN SCIENCE & RESEARCH AND DEVELOPMENT ACTIVITIES

Introduction

Ocean science explores and explains the physical, chemical, and biological phenomena of oceans and their boundaries, contents, movements and interactions with other terrestrial systems. Some examples are marine geology and geophysics, marine biology and chemistry, fisheries ecology, physical oceanography and marine meteorology. The ocean sciences are essential for the management and sustainable use of our oceans, as well as providing crucial information on the role of oceans in the global environment.

All components of the ocean are more closely linked than those of terrestrial systems. To understand the various living and non-living parts of the oceanic ecosystem, and the interaction between the ocean and its surroundings, studies involving long time scales, broad spacial dimensions, and coupled reactions must be considered. Credible plans for sustainable development of oceanic resources must build on an understanding of the ecosystems of which these resources are an active part.

The growth of marine science

The growth of interest in marine sciences on the Pacific coast has mirrored that of Canada's growing concern with managing its oceanic margins. Federal government agencies took the lead in establishing the Pacific Biological Station (PBS) devoted to fisheries, defence (the Pacific Naval Laboratory, now DREP, in Esquimalt), ocean hydrography (the Canadian Hydrographic Service), physics and chemistry (the Institute of Ocean Sciences, in Sidney, British Columbia), marine geoscience (the Pacific GeoScience Centre, also in Sidney), and pollution (the Pacific Environment Institute, in West Vancouver).

University involvement started with marine biology at the University of British Columbia and the Victoria College. In 1949 the University of British Columbia Institute of Oceanography was set up, followed by the Bamfield Marine Station, developed by a consortium from the three British Columbian, and two Albertan universities. The University of British Columbia Institute of Oceanography gained world-class status through its work in physical, biological, and chemical oceanography. In 1979, the Department of Oceanography was formed. Since then, degrees in oceanography have been available at both the undergraduate and graduate level. More recently, a School of Earth and Ocean Science was founded at the University of Victoria. This was followed by a program in Earth and Ocean Sciences at the University of British Columbia. Currently, an important initiative is underway to establish a national centre, the Canada Centre for Climate Modelling and Prediction in British Columbia. The Royal Roads Military College in Victoria trains Canadian

Armed Forces officers in the ocean sciences relevant to naval requirements.

Science for ocean management

As we move towards managing our oceans, we realize the complexity and variability of the oceans, as well as their role in the global environment. These variations may be natural or the product of human activity. For example, migration routes of Pacific salmon are influenced by environmental conditions; perhaps the disappearance of the North Atlantic cod is, at least partly, due to environmental factors. Much more information is needed to determine the causes of such variations. The difficulty and the cost of gathering information about ocean properties has always limited oceanographic research: interpretations and theories are formulated on the basis of a minimum of information and often applied beyond their realm of relevance for lack of alternatives. Progress towards acquiring more information about the oceans has gone hand-in-hand with technological developments such as electronic sensors, deep-sea diving capability, acoustic methods, and satellite remote sensing. These technologies continue to open new capabilities for sampling the ocean. Innovations in sensing and sampling the ocean and its inhabitants for information on physical, chemical, and biological properties will lead to improved understanding of the ocean ecosystem and provide better means of verifying theories about its functioning.

While we once dealt with oceanic problems on a local or regional scale, it is now imperative that we enter the new era of global-scale environmental monitoring. This requires commitments of considerable resources, equipment, and advanced technologies beyond the budget of any one group of nation. One example where global oceans data is essential is seasonal and long-range climate prediction. Studies have show that seasonal climate anomalies may be predicted a year or more in advance. For example, the 1992-93 El Niño was predicted a year in advance. El Niño has major impacts on the fish stocks in the equatorial Pacific, agricultural production in Australia, the Americas, and even on the financial performance of some ski resorts. Prediction of similar events can provide important economic and social benefits, but reliable flows of data describing the states of the global ocean are required.

The shiptime problem in oceanographic research

Oceanographers have traditionally learned about the ocean through observing programs from shipboard. Only through the direct measurement with instruments from ships or the collection of samples of water, biota, or sediments has it been possible to unravel some of the mysteries of the oceans. Until recently, ocean scientists in British Columbia, including those at universities, were able to share time on several good oceanic research vessels. However, the *Parizeau* has recently been relocated to the Atlantic coast, and budgetary constraints within the Department of Fisheries and Oceans have severely curtailed the availability of the DFO fleet to researchers. The *Vector*, originally designed and funded partly for academic research, was removed from availability during the spring of 1992, precipitating a crisis for university-based ocean research. Although representations have been made by the

academic community to the Minister of Fisheries and Oceans and to the Natural Science and Engineering Research Council, the problem of unavailability of ships for academic ocean research remains unresolved.

Oceanic research studies usually involves teams of faculty, staff and graduate students, and complex equipment. Such studies must be planned a considerable time in advance to ensure proper preparation and coordination. To add to the scheduling problems, some processes can only be studied at a particular time of the year. The uncertainty of shiptime availability has made planning impossible. This is very unsatisfactory for long-term ocean science programs of national and international significance.

In other countries, naval, coast guard, and fishing vessels play a significant role in oceans research. Although new automated and remote-sensing technologies offer the possibility of reducing the need for ship time, some measurements and sample collection will still require the expense of operating oceanographic vessels. The complex topography of the British Columbia coast may make in-situ measurements necessary there long after systems have been developed for open ocean use.

The development of new sensing and instrumentation systems to reduce the need for expensive ships use should be a high priority for ocean scientists and marine technology companies, with support from governments. New systems could fit several conceptual categories. Some may be automatic systems that can be sent or allowed to drift to a remote location and automatically collect a sample of water, biota, or sediment, or make a measurement of an ocean property. Other *in situ* measurement systems may be moored at a location for long periods of time and report back their observations regularly. A third class of system senses ocean properties from a distance; remote sensing instrument systems, which use light, or other electromagnetic or acoustic waves to interrogate the oceans.

Acoustic remote sensing methods have shown promise in many areas, and will play an increasing role in monitoring the oceans. Acoustics systems can see into and through the oceans, although ships are needed to deploy the systems in some cases.

Satellite remote sensing systems provide information about the ocean surface without having to go to sea. Receiving stations exist at MacDonald Dettweiler Associates (operated jointly with the University of British Columbia) and at IOS. Most other research institutions are developing facilities for interpreting satellite imagery. The use of ocean acoustic and satellite remote sensing is likely to intensify in the future, but the complexity and ambition of ocean modelling grows faster than the rate of innovation in software and hardware. Basic ocean research in British Columbia requires the best computers and software. Opportunities abound for increased partnerships between British Columbia industry and the ocean science community to develop application packages for ocean research and management.

5.1 NATIONAL AND INTERNATIONAL PROGRAMS

Because of the interconnections of all ocean processes, international, global-scale projects are essential, and represent the culmination of networking and cooperation that starts at the local and national levels.

At the national level, University of British Columbia and Simon Fraser University scientists participate in the Ocean Production Enhancement Network (OPEN), one of the Networks of Centres of Excellence, linking projects on the West and East coasts of Canada. They also collaborate with colleagues at the Pacific Biological Station. Aspects of biological oceanography are parts of much larger international efforts.

The World Ocean Circulation Experiment (WOCE) and the Joint Global Ocean Flux Study (JGOFS) are some of the internationally coordinated projects. British Columbian scientists at the UBC IOS, and UVic have been very active in the development of these programs in Canada, spearheading funding efforts, participating in national and international committees and conducting active research programs.

In order to predict the evolution of future climates, it is necessary to know how the global environment will respond to continued man-made emissions of carbon dioxide and other greenhouse gases. The oceans play the major role of determining the rate of change of the climate, probably by being the largest sink of carbon dioxide.

WOCE is an eight-year research program which aims to understand the role of oceanic heat transport in the climatic system, and to provide the basis for ocean climate modelling. About 40 countries are contributing to WOCE as a component of the World Climate Research Programme of the World Meteorological Organizations, the Intergovernmental Oceanographic Commission (IOC) of UNESCO, and the International Council of Scientific Unions (ICSU). Countries are providing ships, drifters, satellites, and modelling efforts towards this internationally coordinated program.

JGOFS is addressing the oceans' role in the global carbon cycle. Its program complements that of WOCE. JGOFS scientists are concerned with carbon fluxes into the ocean, from the atmosphere, how the biological, chemical, and physical processes redistribute that carbon and how some eventually settles out to the ocean floor.

The ocean drilling program

The Ocean Drilling Program (ODP) is the world's largest and most successful international earth science program. Nineteen nations contribute to the program (Russia having temporarily withdrawn owing to a lack of funding). The annual budget is about $45 million. The USA contributes 55% of the budget. Canada and Australia belong to the program as a consortium contributing 5% and 2% of the budget. In $1990, this represented about $2.5 million Canadian. The ODP maintains

the *JOIDES Resolution*, a state-of-the-art deep sea drilling vessel in a series of fundamental investigations of the structure of the earth's crust and the sea floor. This work has provided sedimentary records spanning several million years and shed new light on the history of climate and biological productivity in the Pacific Ocean. The project has also yielded information of strategic economic significance to Canada at a very low cost[1]. For example, in 1991, drilling off Vancouver Island identified thick layers of metallic sulphide deposits (see **Chapter 12**). This has stimulated interest among international mining companies. This program is now threatened by the withdrawal of $1.1 million in funding support by the Departments of Energy, Mines and Resources, and Industry, Science, and Technology Canada. This situation **demonstrates the capricious nature of support of long-term strategically important science programs in Canada, the lack of relevant policies, and the weakness of multiple agency funding mechanisms without clear leadership.**

A global ocean observation system

Recent advances in science and technology lead to the possibility of designing and implementing an operations system for monitoring the global ocean, an essential component of widespread sustainable development of ocean activities.

Under the auspices of the IOC of UNESCO, a long-term plan to develop a Global Ocean Observation System (GOOS) is emerging. **It may take twenty years to plan, finance, and establish a GOOS.** The system, as envisioned, includes measurements from satellites and *in situ* sensors, data transmission, data processing and modelling. It will consist of a number of sub-systems or modules each with specific objectives including climate change and variability, living marine resources, coastal zone protection, management, and development, health of the ocean, and ocean services.

Each module would be implemented according to needs and findings. The information collected would be essential to the sustainable use and sustainable development of ocean activities, particularly in coastal areas.

British Columbia scientists are involved in these and other international programs. Indeed, as a scientific community, British Columbian ocean scientists have a high international profile in spite of the fact that they operate under severe budgetary limitations.

Pacific-oriented organizations include the Pacific Science Association, a forum of Pacific Rim countries with considerable ocean-related interests, and the newly created North Pacific Marine Science Association (known as PICES), which has a secretariat at IOS in Sidney, British Columbia.

All these International programs concerned with the Pacific Ocean are important to

[1] Estimated to be less that 10% of the annual operating cost of an all Canadian program and without the capital costs of a drill ship.

British Columbia's climate, fisheries and other marine interests. Federal government agencies have finite funds to invest in research and must distribute them to meet the needs of the various regions of Canada. Often the needs of one region will result in limited funding in another. It is important for British Columbia to identify those international ocean research programs which will supplement federal assistance, and further the goals of sustainable management.

Ocean science and industry

Ocean research programs and ocean industry tend to operate in different worlds. Industry needs the support of strategically important science programs in order to create long-term economic benefits; and the technological needs of research programs in data collection, and analysis could be better satisfied if there was greater cooperation with industry. **The creation of industry-science working groups** within an overall coordinating mechanism would be beneficial. For example, a Working Group on the development of innovative sensing techniques, bringing together electronic, remote sensing, and biotechnology industry with leading ocean scientists could focus on new technologies for monitoring the ocean; and a seafloor drilling working group could cooperate with the mining industry.

TABLE 5-1: University-based R&D Related to oceans and marine activities (estimates for fiscal year 1991-1992)

Budget estimates do not include faculty salaries.

Facility & Program	Est. Annual Budget 91/92 ($1,000s)
NSERC Grants	
UBC	4,950
University of Victoria	1,700
SFU	910
NSERC TOTAL, Universities	7,560
British Columbia MAETT/Science Council	1.0
Other Marine Contract Work	n/a
TOTAL Estimate	8,560

TABLE 5-2: International ocean research & monitoring programs relevant to Canada's Pacific interests[1]

PROGRAMS AND EXPERIMENTS		Duration and Theme	Canadian and/or BC Participation
1.0	World Climate Program (WCP) and World Climate Research Program (WCRP)	Global climate change 1980-?	UBC, UVic & DFO
1.1	World Ocean Circulation Experiment (WOCE)	1985-1997 Ocean circulation	UBC, UVic, DFO, & Royal Roads
1.2	Tropical Ocean and Global Climate Atmosphere Program (TOGA)	Tropical Ocean Climate 1985-1994	Some from UBC
1.3	Global Energy and Water Cycle Experiment (GEWEX)	Planned for late 1990s	UBC, SFU
1.4	Arctic Climate System Study (ACSys)	1992-?	UBC, UVic, & SFU
2.0	International Geosphere-Biosphere program (IGBP)	Planned	Yes
2.1	Joint Global Ocean Flux Study (JGOFS)	1990-97 Flux of carbon-related elements	UBC, DFO, UVic
2.2	Land-Oceans Interaction in Coastal Zone (LOICZ)	1993-	UBC, UVic, DFO, ?
3.0	Ocean Drilling Program (ODP)	In progress	UBC, UVic, PGC
4.0	Ridge Inter-disciplinary Global Experiments (RIDGE)	Ongoing Mid-ocean ridge dynamics	EM&R-PGC UVic. IOS
5.0	Inter-governmental Oceanographic Commission (IOC, UNESCO)		DFO-Ottawa
5.1	Global Ocean Observing System (GOOS)	Planned	DFO-IOS
5.2	Integrated Global Ocean Services System (IGOSS)	In place	DFO-IOS
5.3	Global Sea Level Observing Station (GLOSS)	In Place	DFO-IOS
5.4	Global Investigation of Pollution in the Marine Environment (GIPME)		Environment Canada & DFO

[1] These programs are of fundamental importance to understanding ocean processes, and provide the basis for sound ocean management. In spite of the long-term and high-return to Canada on this type of investment, funding is uncertain for some of these programs. Clear policies are needed to guide Canadian participation.

TABLE 5-3: Federal government expenditures in British Columbia-based R&D facilities and programs related to oceans and marine topics. Fiscal Year 1991-1992[1]

Budget estimate includes salaries and funds from all sources.

Department & Facility	Est. Annual Budget 91/92 ($1,000s)
DFO	
Pacific Biological Stn.	
West Van. Lab.	
Cultus Lake	20,820
Institute of Ocean Sciences	
(i) Oceanography	10,084
(ii) Hydrography	5,573
(ii) Research Ships	5,074
SUBTOTAL	36,073
Energy, Mines, & Resources	
Pacific Geosciences Centre	5,123
Dept. of National Defence	
Def. Research Estab. Pacific (DREP)	
Annual Budget	14,200
Research vessel ops.	n/a
Outside contacts	3,600
Environment Canada[2]	
Atmospheric Envir. Service	
Canadian Wildlife Service	
Envir. Protection	292
NRC Laboratories	2,000
NRC Industrial Assistance	(estimate)
Dept. of Transportation and Canadian Coastguard	No Estimate
TOTAL Federal Expenditures (excluding Coastguard & NSERC)	66,766

[1] Based on Information from DFO Institute of Ocean Sciences and "Canadian government R&D organizations in BC," prepared by STC Enterprises, April 1992, for PACST.

[2] Marine research and monitoring activities estimated to be 10% of total budget, Green Plan monies NOT included.

5.2 A BRITISH COLUMBIA PERSPECTIVE ON GLOBAL SCIENCE

Because most ocean-related research in British Columbia has been funded from federal sources, current activities in ocean science have a national or international rather than provincial perspective. Definition of provincial interests in ocean research would greatly assist coordination of efforts within the province focused on the Pacific Ocean environment. These are surprisingly diverse, reflecting the many ways ocean sciences are important to present provincial economic activities, including weather forecasting, fisheries, aquaculture, marine tourism, and many future economic opportunities. It is very much in the long-term interests of all British Columbians to ensure that federal expenditures reflects these present and future priorities.

The creation of a **provincially focused Ocean Science & Technology Forum, linking research, teaching, and industrial groups** would greatly help planning and collaboration between the various scientific research sectors, and provide valuable advice to the federal government on the strategic significance of national and international programs. The Science Council of British Columbia, or a new Oceans and Coastal Forum would be the logical sponsors for such a forum.

While most international programs are coordinated at the federal level, there may be occasions when federal and provincial priorities do not align. **British Columbia should make a greater effort to gain representation in international ocean science programs and other organizations of interest to the province (the Pacific Science Association, for example), and ensure that appropriate policies are developed to guide long-term funding.**

5.3 THE PEACE DIVIDEND IN OCEAN SCIENCE & TECHNOLOGY

In the past, the majority of investment in ocean science and technology development in the NATO countries went to defence and warfare needs. In Canada, much important work on hydroacoustics, underwater vehicles, associated software, and other topics has been funded by the Department of National Defence.

With the demise of the USSR and the emergence of new independent states on the Pacific Rim, the needs in defence technology are changing. Many technologies originally developed for military use are being applied to civilian uses, especially for environmental monitoring and protection. This phenomenon is often categorized as a Peace Dividend. Both the UK and the USA have specific policies aimed at redirecting defence programs into areas which can be applied to both defence and civilian uses. These include environmental protection measures, assistance to industry, technological competitiveness, and other dual purpose technology developments with the private sector.

Examples include:

- The EUROMAR projects (pan-European marine technology development projects under EUREKA) which encourage defence technology to move into civilian areas. The work of Marconi modifying an advanced torpedo into an autonomous underwater vehicle for ocean monitoring is a EUROMAR project.
- The German federal office for defence technology developed a new fuel cell for their submarines. This air-independent power source has not only many civilian underwater applications, but is now being tried for pollution-free automotive applications.

In Canada, there are opportunities to increase cooperation between the Defence Research Establishment and civilian scientists in joint projects. Such cooperation can fund new environmental or dual environmental-military technologies. Possible areas for cooperation include: hydroacoustic technology for fish stock assessment, sea floor mapping techniques, autonomous underwater vehicles, and wider use of vessels and submersibles for research.

CONCLUSIONS

- The ocean science activities based in British Columbia are important at the international, national, and local levels. They contribute to our understanding of the global ocean which strongly influences the global environment and climate. They provide a knowledge-base for more sustainable management of the adjacent high seas and coastal waters. They provide critical information for national defence and coastguard activities. Finally, they provide information of immediate and long-term importance to many economic activities, including marine transportation, fisheries, aquaculture, tourism, and forestry. Therefore, ocean science activities should be funded in a coordinated manner that balances the above-mentioned needs.

- There are many opportunities to improve the management of our ocean resources through science and technology. This requires the development of working linkages between resource users, managers, and the science and technology communities.

- Policies are needed to assist in priority setting in long-term ocean science and to ensure adequate Canadian and British Columbian participation in international programs of long-term strategic significance.

- There are many opportunities for university/industry/government partnerships in developing new ocean technology for observations (remote, acoustic, satellite, *in situ*, automatic vehicles) and communications.

- The management of Canadian Pacific science affairs from Ottawa, where Pacific Rim regional interests are distant and not well understood or appreciated, is very

unsatisfactory. Regional science awareness of Pacific issues must have a higher profile in decision-making.

- The present paucity of ship time and lack of multi-year plans for ship time (which is essential to most ocean science projects) is a major problem at present. It threatens British Columbian participation in important ocean science programs. Solutions to these problems should be pursued at several levels:

  - Pending the establishment of a coordinating mechanism for Oceans, the Science Council of British Columbia should foster discussions between university ocean scientists, DFO, NSERC, and other federal agencies and the Ministry of Advanced Education, Technology and Training towards policy development for ocean science and securing a multi-year plan for allocation of sufficient ship time to allow priority ocean science projects to proceed.

  - This body should also coordinate identification of other ways of providing the ship time that has been traditionally provided by DFO vessels. The possibility of using the vessels of other government agencies (the Coast Guard and DND), ships of opportunity (commercial seagoing vessels able to accommodate some ocean science activities), leased vessels, ocean-going fishing boats, and other solutions needs investigation.

  - Given the costs of constructing new special-purpose ships, the construction of multi-purpose vessels with scientific and regulatory functions should be considered.

  - The proposed Oceans coordinating mechanism, or interim body, should develop consortia and urge government to create a special fund for the development of technologies that reduce the need for expensive ship time in ocean monitoring. This would include new remote sensing applications, the use of hydroacoustics, unmanned robots, and underwater vehicles.

  - A forum should be established to encourage greater interaction between ocean scientists and marine technology companies, for the development of marketable technologies. Research funding should encourage such innovative interactions, and emphasize market opportunities for industry.

  - An international perspective, with emphasis especially to understand the Pacific basin, is essential in ocean science and technology, and the development of a knowledge-base for the sustainable management of, and stewardship towards, the oceans.

  - Particular efforts must be made to bring the small, but important, Canadian marine technology industry into Pacific Rim activities. Too often, the contacts are government to government or between scientists only. In the future, a broader involvement of all Canadian interests is essential to encourage

innovation and Pacific Rim market development by British Columbia-based groups.

- Opportunities for dual defence-civilian marine technology applications need to be explored and encouraged in defence expenditures. Current funding constraints and the rapidly increasing relevance of the ocean sciences to Canada make this necessary. Other countries refer to these linkages as a "Peace Dividend." Such an initiative would seek to involve Defence research and operational capabilities in solving civilian problems in ocean information management and collection, remote sensing, environmental monitoring, and other topics important to Canada. This would also assist industry in developing competitive products with market potential.

RECOMMENDATIONS ON OCEAN SCIENCES

- An Oceans coordinating mechanism (and an interim coordinating body) is needed to guide policy development, coordinate science activities and guide activities aimed at:
  - Establishment of West Coast priorities for ocean sciences in coastal waters and the North Pacific Ocean.
  - The development of innovative new ocean monitoring technologies to reduce the dependence on ship-based information.
  - Increased interaction between local technology companies, the universities and government laboratories in the development of innovative new ocean technologies for environmental monitoring, fisheries management, and ocean exploration and mapping.
  - The growth of Pacific Rim cooperation in ocean science, technology development, environmental monitoring, exploration, and coastal management technologies.
- The government of Canada has a responsibility to pursue the:
  - Development of long-term policy and plans for the allocation of shiptime and to develop innovative technologies to replace the dependency on ship platforms.
  - Efficiencies and opportunities arising from promotion of dual-purpose (defence and civilian) ocean technologies.
  - The long-term fleet requirements of federal agencies for defence, surveillance, Coast Guard, fishery protection, science and strongly promote the development of innovative alternatives and multi-purpose advanced craft.
  - The establishment of an oceans coordination mechanism, "**The Oceans and Coastal Forum**" for the West Coast.
- The government of British Columbia and SPARK can:

- Coordinate the establishment of, and participate in, an oceans coordination mechanism involving a wide range of marine interests on the West Coast.

- Ensure that a provincial policy on ocean sciences is developed and that it gives regard to coastal and Pacific-wide concerns and strategic needs.

- Assist the development of innovative technologies in support of ocean science, technology, and industry through the focusing of Science Council of British Columbia programs on these objectives and coordinating these efforts with federal sources of support.

6.0 HUMAN RESOURCES, EDUCATION & TRAINING

Introduction

As the uses of oceans become more diverse and the demands of ocean management increase, the needs for special ocean-oriented skills, knowledge, and technology will increase. Human resource development in British Columbia is currently receiving well-deserved attention. Recently, several reports have highlighted issues and identified a policy framework for human resource development[1&2]. The requirements for marine industry, science, and technology are an especially important subset of the overall requirements for marine industry, science, and technology in knowledge-intensive industries.

A SPARK Oceans working group reviewed British Columbia's ability to produce the highly-trained people needed in marine activities, and surveyed the current status of human resource development in coastal communities.

6.1 AVAILABILITY OF EDUCATION AND TRAINING

The universities, colleges, and technical institutes in British Columbia offer a wide range of relevant courses. Though few formal programs are specifically designated as marine or oceans-oriented, courses in the basic subjects and skills needed by ocean industry are well represented. (Environmental technology, engineering skills, information technology, etc.) Most of these courses are offered in the Southern Mainland, and some in Nanaimo, Campbell River, Prince Rupert, and smaller centres along the coast. Community colleges and university extension programs also deliver some special courses to a few smaller communities.

While certain companies sometimes experience difficulties in hiring staff with specialized skills, there are no major gaps in the training opportunities in the Southern Mainland. It must also be said that low growth in the marine sector has produced low demand for such special skills to date. **This situation will change very rapidly if new ocean activities are initiated. Demand for skills and training would probable outstrip the supply of trained persons, and the availability of appropriate courses.** This happened during the initial development of salmon farming in the late

1 Critical Human Resource Issues in the Knowledge-Based Industries in British Columbia. Human Resource Task Force SPARK Initiative, July 1992.

2 British Columbia Human Resource Development Project Report of the Steering Committee, November, 1992.

1980s[1].

Concerning the availability of educational and training courses outside of the Southern Mainland, and especially in more remote coastal communities, the situation is very different. **Local availability of all ocean-related education and training in these communities is very inadequate.** The graduated laddering or articulation of courses to enable continued upgrading of skills is also poorly developed. People in these communities wishing to upgrade skills in fishing, seafood processing, aquaculture, marine tourism, or other marine businesses are not well-served by courses only offered in the Southern Mainland. They have to travel considerable distance and incur considerable expenses to receive training.

Full use of existing distance education systems, advanced information technology, and modern telecommunications will be necessary to ensure the delivery of courses, programs, and knowledge into the coastal communities and to make education and training more "user friendly".

At present, the education and training of human resources to support marine industry science and technology lacks public visibility, focus, and articulation with existing systems. Students could make better choices in educational and training programs if this situation was remedied.

Within the context of the economic development and diversification of our coastal communities, this is a very high priority issue. It is at least as important to the future of these communities as is the development of their transportation, water, or sewage infrastructure, yet receives less attention by society. The future of these communities requires attention to all their infrastructural necessities, including education and training.

Public education in oceans

Public Education, the offering of non-credit courses and programs to the general public, is important in the context of oceans. These courses are valuable because they provide background information on ocean subjects which are intrinsically interesting and inform the public about the marine environment and marine activities. This helps to produce a better informed electorate, which, in turn, helps to shape public policy. For example, in less than twenty-five years, public education on marine mammals has revolutionized public attitudes, policy, and law on whale fisheries, and led to a recent ban on high seas drift-netting. Public education will be an essential component of all sustainable management strategies.

At present, there are few facilities that offer such courses to the public. The ones that do emphasize marine biology and oceanography. Bamfield Marine Station, the

[1] Spence, J. A., 1987. The delivery of Education, Training, Extension and R & D to the Emerging Aquaculture Industry. Ministry of Aquaculture and Fisheries, Victoria. 70 pages.

Institute of Ocean Sciences, and the Vancouver Aquarium for instance all offer public education. The Aquarium alone reaches an average of 15,000 school children annually and also offers courses in adult education designed to mix science with an appreciation of nature.

In addition, some NGO's (Non-Governmental Organizations) play an active role in research and education, primarily in informing the public on the importance of specific issues, and advocating change. However, special interests presentations to the public may not be balanced by the alternative viewpoints of other ocean users or the objective facts of science.

6.2 THE IMPORTANCE OF HUMAN RESOURCE DEVELOPMENT

The present levels of basic education

A formal survey of our coastal communities' ability to meet the future skill and education requirements for more knowledge-intensive marine activities was not possible. However, most of these communities have skill and educational profiles similar to those of other resource-based communities in British Columbia. A recent National Round Table on Human Resource Development in the seafood industry identified deficient literacy and numeracy skills as basic impediments to development; and a recent COFI study indicated that 50% of forestry industry workers had difficulty understanding written material at a Grade 4 level. At secondary levels, the availability and standards of maths and science leave much to be desired.

These low levels of basic education will impede any efforts to train and develop people for future work in intensively managed fisheries, aquaculture, tourism, and diverse marine services and technologies.

This basic education must be given top priority. It will require the participation of the coastal communities and industry in organizing flexible educational programs.

Special opportunities related to fishery co-management, stewardship, and First Nation sea claims

The First Nations on the coastline of British Columbia have a long tradition of skilled use of ocean resources. Legal judgements such as the Sparrow decision have resulted in moves by both levels of government to increase First Nations participation in fisheries and coastal management. Education and training are recognized as vital components of successful co-management. Training will focus on the emerging methods for sustainable management of fisheries in the face of the increasing pressures on coastal resources.

These training packages must be delivered alongside co-management strategies and claims negotiations so that First Nations may participate in the local sustainable management of fishery resources. However, there is also a need for a much more

comprehensive approach to Education that provides a philosophical background for these new concepts of sustainability and coastal management to all coastal users. This approach to education and training must show an understanding of the different cultural attitudes to the environment, resources, science and health that exist along our coastline.

Training for the marketing of ocean technologies

New technologies develop quickly and companies, especially small ventures, often lack the training needed to effectively market and promote their intellectual property. In an extremely competitive marketplace, British Columbian companies need people with the interpersonal skills to evaluate export opportunities, to identify niche markets, and to provide effective product differentiation.

Marketing and other interpersonal and entrepreneurial skills are rarely part of course requirements or options in engineering, marine biology, computer science or oceanography. Yet many people in these field will be called upon to perform marketing and public functions at some time in their careers. Broad-based entrepreneurial training, possibly as a joint venture between industry and educational institutions, would significantly aid ocean industry development in the Pacific Rim marketplace.

The marketing of training capabilities in British Columbia

With rapid advances in the use of marine technology, there atre increased demands for specialized training. Canadian intellectual and technical training expertise in ocean topics can be marketed more effectively, both domestically and internationally. A partnership between industry and the academic community would enhance such marketing efforts and could be considered as a support activity to overseas sales of West Coast technology.

Additionally, existing training facilities can be opened to wider global markets for training. For example, the Pacific Marine Training Institute (PMTI), one of five major public marine training establishments in Canada, has excellent expertise and a waterfront facility whose classrooms are empty after the end of the official school year. Similar under-used facilities exists in other educational institutions as well. Year round use of these facilities would make the large public investments in existing facilities and staff more cost-effective. Efforts should be made to tap the demand for training in ocean-related skills.

CONCLUSIONS ON HUMAN RESOURCES, EDUCATION, AND TRAINING

- Urgent attention must be given to the delivery of basic educational and human resource development needs into coastal communities is a prerequisite for future participation in diversified marine activities.

- A coordinating mechanism is needed, as part of a wider ocean management and development initiative, to bring together the various elements involved in ocean-related, human resource education and training. Ocean management and development should become priorities for British Columbia. The coordinated interaction of ocean industries and the training institutions will be especially important in ensuring that we can protect the ocean environment, that industry becomes internationally competitive, and that we fully involve the coastal communities in new ocean-related opportunities.

- This coordinating mechanism should also assess ocean training at all levels, and especially with regard to:

  - The balance of investment in educational resources, from apprenticeship programs to post-graduate research.

  - The quality of training in relation to other countries with a marine focus.

  - The development of overseas markets for our ocean education and training capabilities.

  - Advice to educational institutions for modifications to existing programs and the development of new programs based on anticipated needs.

  - The provision of upgrading, mid-career and in-house adult training to marine activity employees.

  - The development of a broader range of public education and distance education programs in oceans and coastal issues for delivery to coastal communities.

  - Promotion of an integrated perspective on sustainable use of the ocean in all training and education programs.

- A wide range of marine-related courses are available in the Southern Mainland and Southern Vancouver Island.

- The delivery of education and training to the more remote coastal communities is inadequate and requires upgrading, especially to assist in First Peoples fishery co-management initiatives and in the development of sustainable management practices along the coastline.

- Existing marine training facilities can by better used by opening them to clientele from Pacific Rim nations. Internationalizing marine training and human resource development in British Columbia will also advance Pacific Rim initiatives in Ocean technology development and marketing.

RECOMMENDATIONS

- A strategy to address the human resource, development and training needs of the coastal communities is required. This should involve coastal communities, local chambers of commerce, regional districts, and the relevant ministries and departments.

- Appropriate training programs in fisheries management and seafood cultivation, harvesting, and processing are required to accompany the negotiation of interim fishery co-management and stewardship agreements in British Columbia.

- A prospectus of all the marine-related education and training programs in British Columbia should be developed for coastal communities and overseas trainees who may wish to train in British Columbia.

- The Ministry of Advanced Education, Technology, and Training should review the articulation and "laddering" arrangements around all marine programs in the schools, community colleges, and universities to ensure that they serve the needs of the coastal communities.

- A comprehensive strategy for improving public education in all aspects of the ocean environment and ocean activities is needed on the West Coast. A coordinating mechanism is needed to bring the federal and provincial governments, and all interested parties, together to develop programs.

7.0 MARINE CENTRES AND RELATED PROPOSALS FROM COASTAL COMMUNITIES

The use of marine technology in support of ocean science, ocean environmental monitoring, fisheries, coastal surveillance, and other marine activities is increasing rapidly. In response to this, coastal communities and regional interests have put forward new proposals to act as a focus for their future marine activities. These proposals include the following:

- **The Pacific Marine Technology Centre Proposal, Victoria.** The Pacific Marine Technology Centre Society in Victoria representing industry and the University of Victoria with input from the DFO Institute of Ocean Sciences and DREP has prepared a Business Plan for a Pacific Marine Technology Centre in Victoria harbour. This centre would accommodate some companies involved in technology development, provide a standing exhibition of British Columbia marine technology for visitors, and would be involved in educational, public awareness, and training activities. Already, the city has provided a site. Discussions are ongoing towards defining the scope and funding for the concept.

- **The Pacific Institute of Deep Sea Technology (PIDST).** This group was incorporated in 1991 to pursue the definition of an international institute of marine activities based on the Southern Mainland. Discussions have been held with the City of Port Moody regarding possible cooperation with their initiatives to develop a waterfront site in Port Moody. Other locations on the waterfront in Vancouver are also being investigated. A Vancouver location is proposed to forge interdisciplinary links with the universities and across the Pacific. The board of PIDST contains senior level representation from many quarters, including the Vancouver Port Corporation, the local Universities, British Columbia Institute of Technology, and corporate interests. Planning activities are ongoing towards defining this proposal.

- **The Port Moody Initiative.** The city of Port Moody has a long history of involvement in marine activities. They have started planning for development of a waterfront site. Discussions have been held with local industrial interests, and other parties, concerning possible tenants for a facility on this site. Some funding has been obtained to prepare a Business Plan. The focus of the activities would link the needs of local industries to marine research and development issues, and to local coastal zone management initiatives.

- **The Port Hardy Marine Resource Society.** This society was founded in 1991. It brings together a wide range of ocean interests in this coastal community. PHMRS has raised funding for an executive director and has embarked on several projects including a very successful series of workshops on coastal inshore fishery development that have attracted native and non-native participants to discuss

their mutual interests.

Planning is underway for further programs linked to marine conservation, sustainable uses of the oceans with particular emphasis on the educational, training, and technological support needs of the mid-coast of British Columbia.

- **The Prince Rupert Marine Centre initiative.** The chamber of commerce in Prince Rupert, in cooperation with First Nations, the University of Northern British Columbia, NW College and other local interests, has initiated planning towards a marine centre to support local ocean management and economic diversification needs. There is a strongly articulated awareness of the lack of such capability on the North Coast. This centre could become a North Coast Centre for research and training in sustainable fishery management and other topics important to the North Coast.

- **The Alberni-Clayquot Regional District.** Located on the west side of Vancouver Island, this region is addressing its future needs by organizing a conference on the theme of coastal communities and their fishery needs. This conference has arisen out of local frustrations with impediments to proposed marine activities including underutilized fisheries, aquaculture and marine tourism.

- **Bamfield Marine Tourism and Education.** This community has benefited from a close working relationship with Bamfield Marine Station. They are now working on a proposal to develop a centre that would attract the public for courses and field education related to the marine environment and provide for diversification of tourism away from the very intensively used West Coast Trail and Pacific Rim National Park.

CONCLUSIONS

Further proposals from other coastal communities can be expected as they look to diversifying their local economies away from a dependence on forestry or commercial fisheries. These proposals have common characteristics:

- They are concerned with the management of marine resources and have local knowledge and expertise to contribute to sustainable objectives.
- They relate to a vision of sustainable marine-based activities;
- They all require increased access to ocean information for decision making;
- They are seeking to define their educational, training, and technological support needs for economic activities in the oceans;
- They experience shortcomings in the local education, training, and support infrastructure and are taking their own initiatives;
- They require additional resources to carry out their planning activities and identify a way forward;

- Many involve a wide range of community interests, including native and non-native, industry, tourism, and local governments, education and research.

These coastal communities have an important role to play in coastal resource management and they will be the "base stations" for any future marine activities. Their needs must be addressed as an essential and integral part of any future marine strategy. The North and Mid-coast areas and North and West Vancouver Island are particularly poorly served.

RECOMMENDATIONS

- Assistance be given to coastal communities, to pursue economic diversification linked to innovative marine opportunities especially in new fisheries, tourism and aquaculture.

- A network should be established to link the mutual interests of these coastal communities. The new regional program of Science Council and SPARK could help to initiate this network.

- Special efforts are needed to deliver the appropriate educational and training programs in marine-related human resource development and training to coastal communities.

- Government policy should recognize the special interests of coastal communities in management of the coastal environment, marine resources, tourism, and other economic activities.

- Special consideration should be given by DFO to the allocation of special quota, leases or licenses to needy coastal communities for purposes of economic diversification.

8.0 THE ENABLING OCEAN TECHNOLOGIES

Introduction

The history of ocean use and exploration is the history of technological developments in surface and submarine transportation, ocean harvesting, and economic and defence uses of the oceans. Because the oceans are perceived as a hostile environment for humans, ocean technologies are rigorous and often very innovative, with wide application into otner uses.

The use of ocean technologies is now recognized as critical to protection of the ocean environment. In recent years, many new information, electronic, and robotic technologies, and a wide range of biotechnologies have emerged. These technologies greatly expand the range of tools available for ocean management and development. They are outlined in **Table 15-2.** In addition, advanced technology systems are being developed that can be applied to the many complex issues we face in expanding our uses of oceans. These systems and their components are outlined in **Table 15-3.** In the future, major opportunities will relate to the development of special application systems, each assembled from many constituent technologies. This requires a high level of inter-company, intergovernmental, and, indeed, international cooperation in the development, proving, and marketing of these new applications.

The status of the major enabling ocean technologies in British Columbia is summarized below. These are the findings of the various SPARK Oceans working groups concerning the different aspects of marine technology in Western Canada.

8.1 OCEAN INFORMATION TECHNOLOGY

A common theme throughout discussions on marine science sustainable management practices and marine resource development is the need for improved access to information and the need for improved data bases for decision-making and environmental impact assessment. In spite of the fact that Canada is surrounded by oceans, we have been slow to apply information technologies to understand and use the resources on our coasts and in our oceans. Yet we have the scientific, technological and industrial strengths to take advantage of these opportunities. These are outlined in greater detail in the working group report list in **Appendix II**[1].

The Ocean Information technology industry in British Columbia includes those companies which obtain all, or part of their revenues through products or services in

[1] The Ocean is Our Front Door: Report of the Oceans Information Technology Working Group, September 1992.

information on the oceans or which provide information to optimize resource management, transportation, recreation, and other uses of the oceans.

The Working Group identified three outstanding areas of opportunity which could be acted on immediately to develop coordinated applications. These are ocean observation systems, ocean information systems, and ocean use support systems.

Ocean observation systems

Ocean observation systems involve many data collection technologies including floating probes, Autonomous Underwater Vehicles (AUV), low flying aircraft and satellites carrying sensors with various capabilities. Ocean remote sensing is becoming very important as we realize how much influence is exerted by our oceans on the environment. The increasing number, range and cost-effectiveness of aircraft, satellites, buoys, and autonomous underwater vehicles is rapidly expanding the collection of data on our oceans. The international organization of global-scale research and ocean monitoring initiatives all require improved instrumentation, data collection, storage, and processing. On the West Coast we have firms with world-class abilities in all of these strategic areas. We can build on these strengths.

The climate dependence of wealth creation in British Columbia

Much of the economic wealth of British Columbia is derived from climate-dependent activities, such as transportation, forestry, fisheries, agriculture, and aquaculture. Provision of improved information on seasonal and longer term climate variations and scenarios of climate change would be very valuable to these sectors. Such information would also provide a basis for policy development related to energy and water. Furthermore, since climate is a global phenomenon there are opportunities for British Columbia-based companies to provide services based on value-added climate information to international markets.

Ocean information systems

Ocean information systems include the processing, interpretation, and display of ocean data, the integration of ocean and other data to provide valuable information to users, and access by users with interpretative skills to information. One important tool, Geographical Information Systems (GIS), is a computerized data base management system for capture, storage, retrieval, analysis, and display of spatial data. Another revolutionary tool, Global Positioning Systems (GPS), uses electronic measuring and positioning systems to provide accurate worldwide positioning with simple to use, easily transportable receivers. These two key technologies are revolutionizing the surveying and mapping industry. Over the last two decades the capabilities and costs of ocean information systems, through the applications of tools such as electronic charts, databases, digitized geographical information systems (GIS), and global positioning systems (GPS), have improved dramatically. The user base is increasing accordingly. To estimate the market size, one only needs to examine a world map to see the amount of coastline and look at trends in marine

traffic and activities.

An Ocean GIS is unlike a typical Land Information System (LIS). Oceans are dynamic; their databases must be also. Dynamic data such as temperatures, salinity, sea state, vessel locations, fish stocks, and oil spills must be captured and displayed in all three dimensions. On the West Coast we have particular strengths in collecting data by remote sensing methods and processing that data into useful information by applying advanced, locally developed, GIS software. Applications such as electronic charts for marine navigation have been developed for commercial use by local interests. The potential global market for these services is large. One need only consider the extent of the world's coastlines to estimate its potential size.

Ocean-use support systems

Ocean-use support systems optimize the use of the oceans for transportation and resource management while creating minimum environmental damage. Data and documents are being translated into electronic forms and flashed around the world on Valued Added Networks (VANs). This Electronic Data Interchange (EDI), applied to shipping, would significantly benefit the international shipping community, and attract more business to the West Coast.

To be internationally competitive, such systems must be implemented in Canada. The Canadian transportation industry faces the challenge of deploying integrated multi-modal transportation system, enhanced by EDI, to reduce costs and expedite the flow of goods through Canada's ports, terminals, and transportation systems. This can most effectively be accomplished by forming an "EDIPORT PACIFIC" to transship goods efficiently and swiftly into and out of Pacific Canada. Implementation of the EDIPORT Pacific concept is discussed in the chapter on transportation.

8.2 MARINE ROBOTICS AND SUBSEA VEHICLES

Background

The status and opportunities in this area are outlined in detail in the SPARK Oceans review listed in **Appendix II**[1]. Approximately 62 companies constitute the Marine Robotics and Subsea Vehicle (MR&SV) industry in British Columbia. They produce innovative and specialized, high-quality devices for worldwide subsea applications. Several British Columbia companies, being the first to introduce new technologies to the marketplace, have created their own markets and now have the largest share of those worldwide markets. An economically healthy Marine Robotics and Subsea Vehicle industry brings direct benefits to the British Columbian and Canadian economies. This industry plays a significant role in moving Canada from a resource-based to a knowledge-based economy, and will be essential in many aspects of marine

[1] Strategic Framework Report for Marine Robotics and Subsea Vehicles. Survey of industry status and world market opportunities. 77 pages.

management in the future.

The Marine Robotics and Subsea Vehicle industry in British Columbia covers a complex spectrum of subsea technologies. Specifically, British Columbia companies provide:

- Manned submersibles (including tourist submarines);
- Remotely-operated vehicles (ROVs);
- Autonomous underwater vehicles (AUVs);
- One-atmosphere diving suits;
- Subsystems for the above vehicles;
- Service companies which use the above equipment.

Gross revenues for the Marine Robotics and Subsea Vehicle industry in British Columbia are approximate $62 million annually, with foreign sales accounting for an estimated 55% ($34.1 million) of the total. Because of their small size, British Columbia's Marine Robotics and Subsea Vehicle companies have difficulty with the high costs of research and development of new products. International marketing efforts are also difficult because of economic nationalism and the high cost of global marketing.

The timing and direction of technological refinement and optimization in the established ROV and manned submersible markets is determined by market demand. AUVs are not yet well-established in the marketplace. Research and development in AUVs is directed at providing the basic capabilities for successful autonomous and tetherless operations in the oceans. As the commercial viability of AUVs is proven, the trend in unmanned, underwater vehicles will shift from (tethered) ROVs to (tetherless) AUVs.

Opportunities

Economic development in coastal areas, particularly in Asia-Pacific, offers many opportunities for marketing British Columbia's Marine Robotics and Subsea products and services.

Offshore oil and gas production facilities in Asia-Pacific, North Sea, Brazil, China, West Africa, and Canada are the primary markets for inspection, construction, maintenance, and environmental monitoring applications (See Section 12.3).

Bathymetric and other surveys using unmanned subsea vehicles are more economical than surveys involving manned launches. Governments are the chief customers. The factor limiting growth in this area is the slow response of government departments to new technologies. As governments adapt to these systems, subsea vehicles will become increasingly in demand for survey applications.

NATO Navies use subsea technology in mine-countermeasures and other defence applications. French companies have dominated this market because they were first

to develop a capable product and received well-coordinated support from the French government. Approximately 10% of available ROV models were made specifically for mine-countermeasure operations. Innovative mine-countermeasure vehicles which supersede existing capabilities could see potential sales of $147 million to Western Bloc navies. Automated fleet and harbour patrol subsea vehicles is another military application that, in the future, may see increased demand and development.

Subsea mining exploration and extraction has become a major market for subsea technology. Manganese nodules, aggregate, placer and polymetallic sulphide deposits are significant minerals awaiting exploration. The price of minerals influences the mining industry's desire to explore subsea deposits however, in general, the demand for subsea mining will increase with reduced land-based resources and increasing land-based environmental problems.

Telecommunication cable burial and retrieval is an expanding market for subsea technology. The main centres of activity are in the Atlantic Ocean between North America and Europe and in the Pacific between North America and Asia-Pacific. Cable burial and deburial is a well-established market and many products are already in existence.

The tourist submarine industry is well established in warm water tourist centres. Currently, the major sites are located in Asia, the Caribbean. Florida. Hawaii and the east and west Mediterranean. British Columbia companies built and manage 46% of the tourist submarines worldwide and are projected to maintain or improve this share in the future. The U.S. Jones Act on shipping impinges on Canadian tourist submarine manufacturers because it prohibits submarine hulls for port-to-port travel in the U.S. from being made outside the U.S. This was not changed by the free trade agreement.

Many Asia-Pacific countries, such as Australia, Malaysia, Indonesia, Korea, Japan, and Taiwan have initiated major long-term ocean resource and technology development programs. British Columbia's Marine Robotics and Subsea Vehicle companies have an opportunity to provide their products and services to these countries. Environmental applications, mineral and oil and gas exploration and extraction, fisheries stock evaluation and harvesting, oceanographic studies, mine-countermeasures and other defensive military roles are of particular interest.

The market potential for AUVs far exceeds their availability. The key reason for this is that current AUVs lack adequate energy supplies, control systems, and communication links. Companies which make gains in any of these three areas should see substantial competitive advantage.

Mapping of the ocean floor and water column is a prerequisite for other marine robotics applications. Although many sensor and manipulator manufacturers in British Columbia grew because of demands from local subsea vehicle manufacturers, the markets for component subsystems (sensors and manipulators), in some cases

exceed the markets for the complete vehicles.

Worldwide, there is a high demand for many applications in environmental monitoring, estimation, and deep water fisheries harvest-guidance capabilities. Specifically, subsea technology is required for: ground truing of sonar estimates, identification of populations and harvesting process, and automated reseeding techniques. These same technologies and capabilities also have applications in the aquaculture industry world wide.

Marine Robotics and Subsea Vehicle technologies have many potential cross-sector the applications, such as inspection and cleaning (for biofouling and fatigue) in storage tanks, sewer pipes and cooling tunnels in nuclear power plants. Robotics and their teleoperative aspects will also be in demand in the forestry sector, the space industry, and for assistance with disasters.

CONCLUSIONS

- Marine Robotics and Subsea Vehicle companies in British Columbia have the opportunity to develop technologies for many strategically significant applications in oceans and other hostile environments.

    - In the short-term these include: subsea structure inspection, mine-countermeasures, scientific data collection (sensing and sampling), cable/pipe burial/deburial, surveying, subsea structure construction (manned), and fisheries studies.

    - In the long-term: subsea mining, fisheries harvesting, fleet and harbour patrol, and subsea structure construction (unmanned) will be important.

- In support of the above applications, British Columbia companies have opportunities to focus on developing special subsystem technologies, including the following applications: acoustic communications, energy source enhancements, intelligent control and mission planning systems, manipulator capabilities, navigation subsystems, optical and acoustic imaging technologies, propeller-based propulsion subsystems, release/retrieval/docking systems, sensors and sensor fusion, tether-based improvements.

8.3 THE BRITISH COLUMBIA MARINE ELECTRONICS SECTOR

A more detailed profile of this sector is provided in the marine electronics report listed in **Appendix II**[1]. The marine electronics products of British Columbia-based companies fall into three categories: oceanographic, communication, and navigation.

[1] An Overview of the British Columbia Marine Electronics Sector. With recommendations. Marine Electronics Working Group report. 22 pages.

Their combined annual sales is about $40 million, with 40 firms and more than 500 people directly employed. Offshore oil and gas and commercial fishing no longer drive British Columbia's marine electronics industry. There has been very little growth over the last two years, and the local markets for this sector are very small. The leading manufacturing and technology development companies market their products internationally.

Oceanographic markets

The oceanographic market is becoming more oriented towards the delivery of services in offshore, inshore and inland water applications. Oceanographic companies have recognized that they need to capture a greater share of the gross revenues of major monitoring contracts, and this entails offering "turnkey" services to national and international clients across the globe.

Throughout the globe a new appreciation of our limited water resources and our heightened environmental awareness is increasing the market for resource management and water monitoring. Oceanographic products and systems can be used for pollution and environmental monitoring in bays, estuaries, rivers and lakes. The demand to reapply technologies and expertise originally developed for deep water use to environemtal applications is growing. This is compensating for a slow revival of demand for oceanographic services from the offshore oil industry.

Successful oceanographic firms are moving beyond the continental US to develop new customers. Particularly strong growth is occurring on the Pacific Rim and in European markets. The Pacific Rim offers substantial opportunities in this area as many developing countries undertake major civil engineering and industrial installations. In Europe, increased environmental monitoring and coastal and inland clean-up operations (especially in Eastern Europe) have opened new markets for monitoring instrument systems and services in addition to the treatment technologies.

Two major international initiatives also provide market opportunities. The Global Climate Observing System (GCOS) is being designed to measure climate variability and change, while the Global Ocean Observing System (GOOS) is being developed to provide comprehensive monitoring of ocean conditions, including pollution.

In Canada the federal government's "Green Plan" initiative offers real opportunities to British Columbian firms and, in British Columbia, tighter provincial pollution controls could encourage the use of technologies originally developed for oceanography.

Navigation markets

New world standards for electronic charts and advanced navigational systems are being introduced over the next 5 years. This means the navigation market is undergoing a structural change. While vessel owners and the marine industry itself are inherently conservative in applying new technology, the global market will adopt

systems and products which cut operating costs and reduce the risk of groundings and collisions.

Operators of ferries and high value/high risk vessels are the best potential entry points for new navigational technologies. Policy moves which encourage new systems have already been made by the German and Norwegian governments.

Technologies are migrating across markets. Examples include aviation products modified for marine use, and complex vessel traffic systems applied to air traffic control applications. For simpler navigational products such as auto pilots, reducing costs have opened the recreational market. This has compensated for declining demand among commercial fishing industries.

Communications markets

New standards for data and channel switching and mandatory use of satellite beacons, are also driving forces for change in marine communications. Global markets valued at over $100 million already exist for emergency systems. As telecommunications and computer technology are applied to data and voice broadcast techniques more opportunities are opening in niche markets.

Competition and threats

Companies in British Columbia marine electronics sector are exposed to global competition and rapid technological change. Common threats include:

- Entry of lower-cost, competing products from Japan and Korea;
- Competition from satellite and remote sensing;
- Incentives given to foreign competitors by their governments for carrying advanced navigation and safety systems;
- Decline of commercial fishing worldwide;
- Introduction of global communication systems;
- Dramatic cost reductions as new technologies and processes are applied to traditional marine markets.

Oceanographic

Oceanographic firms are facing increased competition in the offshore instrument sector from larger established US and Japanese companies now entering the market. Despite a customer base in British Columbia, Quebec the Atlantic provinces, Canadian firms have not yet captured a significant share of the US market.

Navigation

Large US and European navigation firms are already well established and supply the global markets with advanced navigational systems. Firms in the UK, Germany and Norway are out-spending Canadian companies in marketing, research, and development. This aggressive growth is often driven by the pro-active policies of

their governments.

Communication

Japanese companies dominate the price sensitive UHF/VHF market for inshore radio systems, however US firms maintain strong market positions in the HF sector. Canadian suppliers of value-added HF systems have maintained ownership of selected market niches which extend into all segments of the short-wave market. HF systems should continue to play a role in long-range communications, despite existing satellite networks and future global communication systems such as Motorola's Iridium Project. Market niches for HF will remain where low operating costs make satellite systems impractical.

Competition to supply generic satellite system products, such as EPIRBS, can be expected to be intense as major international firms vie for market share. Only larger Canadian communication firms are likely to emerge with meaningful shares of these markets.

The factors required for success in marine electronics

Success in marine electronics depends on similar factors whether a company is addressing the oceanographic instrument, marine electronics or marine communication markets.

- Strong marketing resources, deployed to exploit specific market opportunities, are essential. All firms in the sector sell into global marketplaces. Marketing plans must identify and attack market niches with experienced staff and adequate resources. For many smaller companies forming alliances with larger international partners may be the only way to achieve market share.

- A key element in marketing success for small and medium-sized companies is their ability to access information on marketing opportunities, requests for proposals, tender offers, notices of contracts, *etc.*, and act on them. These marketing networks provide new models of inter-firm cooperation. They are used effectively by small and medium-sized companies in Europe and elsewhere. At least 10 countries and 15 US states have implemented policies to encourage flexible networks. Priority must be given to trying different network models and linking British Columbia companies to existing international market-oriented networks in the marine technologies. A recent study by British Columbia Trade and Development Corporation reviewed several different models[1].

- The technical quality of products and services must be world class. Firms must rapidly adopt and apply new technical specifications and standards to products

[1] Flexible Networks Consultants report for BC Trade and Development Corporation, January 1993.

directed at global markets. Companies need to secure ongoing funding for product development if they are to establish and maintain technological advantage.

- If companies are to be strong both in technology development and marketing, they must rapidly achieve the size and stability to rank as world-class competitors. No companies in the British Columbia marine electronics sector have yet achieved this goal.

8.4 MARINE APPLICATIONS OF BIOTECHNOLOGY

Introduction

Biotechnology is of such strategic importance to key sectors of the modern economy that its opportunities cannot be ignored by either industry or government. Canada, together with Japan, the USA, and the EEC countries have all declared biotechnology research a high priority. This should also apply to marine applications of biotechnology, but this sector is at a much earlier stage of investigation than other opportunities in biotechnology. Only Japan has made major investments in a long-term strategy to investigate the industrial applications of marine biotechnology.

Marine biotechnology involves the use of biological materials from the sea to produce goods and services. It includes the extraction of chemicals, including drugs and other useful compounds from aquatic plants and animals, and the modification of marine organisms to enhance their biological characteristics.

Biotechnologies include the manipulation of genetic material, cell fusion, cell culture, fermentation, bio-catalysis, and process engineering. British Columbia has high-level skills in these key technologies, which may give it a competitive edge. Nevertheless there are problems. Many of the companies in areas such as food, chemicals, and pharmaceuticals are subsidiaries of multinationals which do their research elsewhere. Few British Columbia companies have the resources to invest in prospective compounds with long-delayed returns. British Columbia's apparent advantages lie in the range of marine organisms and environments available and in its intellectual capital in related fields.

One example of the potential of marine biotechnology is pharmaceutical opportunities. Many marine animals and microorganisms available from this coastline produce biologically active compounds that need to be explored for their potential pharmaceutical value, applications as cell biology tools, and other uses. The pharmaceutical industry is a knowledge intensive, high-profit, non-polluting industry. It would fit very well into a mature, diversified British Columbian economy.

The majority of drugs in clinical use today were developed from compounds isolated from natural land-based sources (terrestrial plants and soil microorganisms). Marine animals and microorganisms are an under-explored resource for the discovery of pharmaceutical lead compounds. They have already yielded lead compounds that will

result in clinically useful drugs in the near future. Every successful drug used in human medicine represents a potential $100 to $500 million annual sales for the product.

The potential opportunities for marine applications of biotechnology can be grouped into the following areas:

- Aquaculture and fisheries management through genetic manipulation, improved nutrition, and disease control, growth promotion and the control of reproduction;
- The identification and extraction of pharmaceuticals and other biologically active compounds from marine organisms;
- Fine chemicals (specialty chemicals, food additives, polysaccharides and adhesives) extracted from marine organisms;
- The extraction of high value components from marine plants. (This topic is reviewed in more detail in the section on marine plants.);
- Commodity chemicals and other bulk products extracted from Marine organisms;
- Pollution control, biomediation, and effluent disposal using microbial digestion of sewage and contaminants; and,
- Fouling control (through natural chemical deterrents).

Strategies for Marine Biotechnology

Any successful strategy for marine biotechnology will require integration of the following essential elements[1]:

- A long-term focus on essential and strategic research by established centres of excellence at the universities and the NRC institutes of biotechnology.
- A focus on research and development which supports wealth generation from applications of marine biotechnology.
- Industrial partnerships involving large firms who have world status, medium companies who are firmly established and growing, and small emerging firms who are developing promising new processes or products.

These above elements provide a framework for developing particular opportunities in marine biotechnology on the West Coast of Canada.

Within this framework, the following strategic path is recommended:

- Assess the needs of industry, including the seafood processing, aquaculture, and

[1] Identified in Biotechnology Program Strategic Directions, National Research Council, Canada. November, 1992.

effluent generating industries who are potential customers. Establish research priorities reflecting the size and opportunities of these companies. This process must include on-going networking and knowledge exchange with industry.

- Build the necessary market intelligence gathering capabilities (networking) to gather market information, direct and support client service, and seek out new business opportunities. This should be linked to other market intelligence networks proposed for West Coast Marine Technology. and the current activities of the biotechnology alliance of British Columbia.
- Focus research programs on areas strategic to maintaining competitiveness in global biotechnology markets.
- Nurture strategic partnerships and alliances between research institutes, small companies, and larger sources of capital. These partnerships have great potential to generate the knowledge on which industrial innovation is based.
- Ensure that existing policies and regulations do not unnecessarily inhibit the development of opportunities in marine biotechnology.

CONCLUSIONS AND RECOMMENDATIONS ON MARINE TECHNOLOGY

There are strong similarities in the opportunities for all marine technologies. Many of them will also be used in an integrated manner in marine technology systems (see Section 15.4). For this reason, the conclusions and recommendations are given together.

The ocean information technologies

- The deployment of multi-modal electronic data interchange (EDI) for all the major ports, terminals, and transportation linkages in Canada is a priority, and also requires an "EDIPORT CANADA" umbrella, with an "EDIPORT PACIFIC" established on the West Coast. User business practices need to be carefully analyzed and an appropriate EDI system designed to respond to those needs.

- It is important to build on our industrial strengths, to ensure the commercial development of ocean information systems and services on the West Coast for a global marketplace. Government procurement policies need to support export-ready companies and the employment of their highly skilled individuals. Current purchasing policies need to be reviewed to ensure that they support this principle. Annual lists of the technological needs of Crown agencies and government ministries could be made available to local technology developers to assist them in identifying opportunities. A reasonable percentage of annual agency procurement budgets could be targeted for purchases from local technology developers.

- Growth in activity and investment in remote sensing and *in situ* data collection

technologies for global climate modelling associated with a British Columbia-based Climate Integration and Prediction Centre would benefit local scientists, engineers, and industry. A multi-partite Working Group on ocean observing and information systems should be set up to link marine technology in British Columbia to international programs on oceans monitoring.

- Emerging market needs for value-added data need to be assessed. Marketing expertise can be transferred in through international strategic alliances. Consortia or flexible networks could be used to combine the talents and limited resources of smaller companies to collect market intelligence and assess market needs for product development.

- The Working Group recommended that an Ocean Policy Task Force ("Oceans and Coastal Commission") be set up, with representation from industry, university and all levels of government. Its responsibilities would include policy development related to marine resources, setting standards, and coordinating activities. The Task Force would also be charged with identifying data gaps, overlapping efforts, and with recommending how to make more effective use of oceans information systems in all marine activities. Their mandate would include the adoption of data standards compatible with international standards, the identification of important coastal and ocean time series databases, the creation of a dynamic atlas of ocean information, the efficient dissemination of information to all ocean users, and review of copyright and intellectual property rights.

The real benefits of information technologies applied to our oceans will come through their use in commercial activities. Faster communications and applications of information about global climate systems, marine resources will benefit all of the primary industries upon which our economy is based. To remain competitive in a global economy we need to embrace the applications of information technologies in the marine environment as rapidly and rationally as possible.

Marine Robotics and Subsea Vehicles

- As a basis for the proper management of the Georgia Basin. Governments need to initiate, the complete and extensive mapping of the Georgia Strait sea floor. This would provide important information as well as development opportunities for local companies, and would assist the proving of technologies for the Asia-Pacific market place.

- The Marine Robotics and Subsea Vehicle industry should create working groups to review:

    - The feasibility, desirability, and necessity of an independent cooperative marketing body run by and for the marine research and subsea vehicle industry.
    - Amount and conditions of available funding for subsea technology research.

  - Common interests, requirements and accomplishments in Marine Robotics and Subsea Vehicle research areas, and the feasibility of establishing an ocean-technology program in British Columbia.

- The companies should consider the formation of consortia when motivated by well-defined market opportunities. These consortia should be supported with matching R&D funds.

- Government support for Marine Robotics and Subsea Vehicles should focus on applied research projects, direct assistance of marketing efforts, loan guarantees, and international services. Government funding in British Columbia on third-party marketing studies not closely linked to the specific needs of individual companies or consortia, is not useful.

- The original Unsolicited Proposal program should be reinstated to facilitate government/industry interaction.

- It would greatly assist industry if all provincial and federal government departments published annually, in a single document, a list of technical problems they encounter. Local innovative companies can then offer solutions or assistance.

- Companies who are the end-users of Marine Robotics and Subsea Vehicle technology can contribute to the research and development of new products by having a portion of their operating licence fees or taxes directed to a fund which supports innovative Marine Robotics and Subsea Vehicle projects.

- An electronic mail support service should be made available to interested Marine Robotics and Subsea Vehicle companies to improve their inter and intra-company communication and to allow for feedback and referrals among government institutions, universities, and the industry. If the concept proves useful, the service should be expanded to allow access for all ocean-technology industries in British Columbia.

- The provincial government should establish a provincial agency in charge of oceans and inshore waters to address issues related to the sustainable management and use of these resources and the role of advanced technologies in resource management.

Marine electronics

In addition to opportunities for cooperation with the federal government, the provincial government has a unique chance to promote British Columbia's marine electronics sector by its own policies and through actions by provincial agencies and crown corporations. The mechanisms by which the British Columbia government can help this sector grow are:

- Enhancing the international marketing efforts of British Columbia marine electronics firms through active lead generation and market support by provincial trade representatives worldwide; and by expanding the export assistance programs of British Columbia Trade and Development Corporation.
- Mandating the provincial departments, agencies and crown corporations to become more receptive to innovative technical solutions involving local companies. Specific examples include the following:
  - the British Columbia Ministry of the Environment could support an analysis of environmental monitoring opportunities arising out of their responsibilities, and could adopt pollution monitoring standards which employ advanced oceanographic technology;
  - the British Columbia Ferries Corporation could commission, and act on, an independent assessment of the costs and benefits of advanced navigation and communications systems in terms of safety, efficiency and economy; and,
  - provincial agencies and crown corporations involved in remote operations could accelerate their acquisition and use of advanced communication systems and emergency beacons.
  - the Provincial Ports and Harbours Policy could be implemented, this would stimulate the use of new technology for safety and navigation.
- They can encourage the establishment of industry consortia, alliances, and flexible networks which increase the effective size of firms so they have a reasonable chance of being internationally competitive.
- They can fill the void left by reduced federal activity in the marine equipment and services sector with well directed provincial initiatives. Any support to industry should concentrate on:
  - Companies driven by market-oriented product or service sales as opposed to contract research and development activities.
  - Companies or groups that have arranged sufficient marketing resources for them to compete in global markets.
  - Companies that, through their competitive advantages, records of achievement and management abilities, can be expected to be successful on an international scale over the long-term.
- The British Columbia Government can continue to improve public and industry access to technical expertise in our universities and actively promote the transfer of technology from academic researchers to commercial ventures.
- They can lobby the Federal Government to ensure that support services to West Coast marine traffic, such as hydrographic surveying by the Canadian Hydrographic Service and vessel traffic management by Transport Canada, are maintained at levels which enable British Columbia's to remain at the forefront marine navigation and communication systems.

In all the above cases, close coordination between federal and provincial agencies is essential and federal and provincial policy development should reflect these needs.

Marine biotechnology

- There are existing opportunities for the application of biotechnology to seafood processing and the treatment of industrial wastes being discharged into the ocean.
- The British Columbia biotechnology alliance should be used to assess the opportunities for biotechnology applications to i) increase the value of the fisheries, ii) assist in sustainable stock management and iii) improve the efficiency of aquaculture ventures.
- Opportunities for extracting useful compounds from marine products need to be investigated at a pilot and commercial scale on the West Coast. Changes in present fisheries policies that discourage "industrial" fisheries are needed.
- A discovery network for drugs from the sea at academic institutions in British Columbia should be investigated. This network would work closely with established drug companies in the screening of marine organisms for bioactive compounds. There may be special opportunities for Canadian-Japanese cooperation in this regard.
- Possibilities for international cooperation in marine biotechnology research linked to the development of commercial opportunities in British Columbia should be investigated.
- Environmental management and monitoring applications of marine biotechnology (e.g. DNA probes for plankton analysis) need to be investigated.
- The British Columbia Biotechnology Alliance should be supported in developing a strategic network in aquatic biotechnology.

The existing National Aquatic Biotechnology Network (AQUATECH) should be spun out of DFO central administration to the private sector with sufficient seed funding to enable the private sector to develop the existing AQUATECH linkages into a market-driven strategic network.

9.0 BOATS, SHIPBUILDING AND SHIP REPAIR

Introduction

This sub-sector includes boat design, naval architecture, boat construction (small craft under five tonnes displacement), shipbuilding (vessels over five tonnes), and ship repairs. A number of long established, self-sufficient companies make up this sector. They have designed and built the wide range of coastal vessels found on the British Columbia coastline, specialized craft for world markets, as well as providing services and technology world-wide. In addition, there are many smaller companies servicing the recreational sector (see Section 11, Marine Recreational Technology.)

Boat and ship design

British Columbia-based companies such as R. Allen Ltd. and P. S. Hatfield Ltd. have a world-wide reputation in boats and ship design, ranging from arctic-icebreaking supply vessels, offshore tugs, and high speed fireboats, to deep-sea trawlers, and recreational boats.

All these companies use advanced software and computer-aided design systems. They compete in the global marketplace. Local and national markets for their services are small, but important. World-wide shipping is undergoing rapid technological and engineering changes. These are driven by the need for improved efficiency, safety, and new cargo and customer demands for specialized vessels using advanced materials and technologies.

On a world-wide basis, several trends are discernable:

- Canada does not have the capacity to produce very large ocean-going bulk carriers and is not competitive in the construction of ocean-going freighters. These large vessels with a high labour content can be produced more cheaply in Asian yards.
- The demand for specialized craft for offshore resource extraction is closely tied to the price of offshore exploration and production which in turn is tied to the price of crude oil.
- New advances in bridge/navigation technologies, propulsion units, and the automation of cargo handling are increasing demands for advanced cargo vessels which will require matching changes in port and terminal technology.
- The rapid expansion of the cruise ship industry and recreational boating around the Pacific Rim has led to rapid growth in this sector.
- The development of fast coastal ferries and related system technology has

emerged in recent years in competition with other modes of transport.

- With the decline of the nuclear submarine threat, naval requirements for ships are also changing towards fast, multi-purpose vessels. Opportunities on the West Coast need to be evaluated in light of the above trends.

Boat building

Small yards on Vancouver Island and in the Southern Mainland produce aluminium, fibreglass, and wooden-hulled boats for recreational activities, sport fishing, inshore fishing, and aquaculture. No formal estimates of their sales volume were available, but recreational boat manufacture and repairs alone are valued at more than $100 million per year (Section 11.2) with a considerable export component. Opportunities exist to increase the linkages between these yards and the technology community to assist innovation and their competitiveness.

Shipbuilding, floating structures, and repairs

The shipbuilding industry is concentrated in yards in North Vancouver, the Fraser River and in Victoria and Esquimalt. In 1990, a new ship repair unit and jetty were completed at the National Defence facilities in Esquimalt at a total cost of $90 million.

The 1990 export value of ships, boats, and floating structures from British Columbia was $32.1 million with most of this being sold to the USA, and some small sales to Japan and other markets. With the exception of ferry construction, new ship building is a sporadic activity driven by special orders. This situation is only likely to change if there is significant new ocean activity requiring specialized platforms for special purposes, such as research, monitoring, surveillance, inspection, and drilling.

British Columbia and other Canadian yards are operating well under their capacity and are dependant on repairs, conversions, and for ferries and specialized craft for environmental and surveillance purposes.

In 1989, the British Columbia Ferries Corporation commenced a ten year expansion program totalling $550 million. One super ferry has recently been completed and another is under construction plus two smaller vessels, and in 1990, $71 million was spent on ferry modifications and upgrading.

Ship berthings, loading, unloading, storing and reclaiming facilities

British Columbian engineering firms have been world leaders in the design of ship berthing, loading, unloading, storing, and reclaiming facilities in all parts of the world over the past three decades. Today they are continuing with a strong presence in this field. In addition to projects on our West Coast, major design projects have been undertaken in the U.S., Europe, Far East, South and Central America, and Africa;

these are all international-scale projects. Recently, a major project for the Port of Los Angeles known as "2020" has been secured and active proposals are currently in process in Mexico, Alaska, and the U.S. Much of this successs has been due to the innovation and conceptual abilities of British Columbian engineers and technicians. The capital cost of facilities designed by British Columbian engineers over the past 15 years exceeds $1.5 billion and the value of engineering to these specialty design teams is well above $100 million[1].

Canadian Arctic oil and gas activities

Considerable design expertise for drilling, exploration, and production structures in the Beaufort Sea has been provided by British Columbian engineers. These structures have included artificial islands and massive floating concrete structures. In addition, local technology companies and the scientific community have played major support roles in related environmental and scientific investigations. Any further activity in the Arctic will provide opportunities for British Columbia-based shipbuilding, marine engineering, and technology and marine science.

Future opportunities in Shipbuilding

Other countries competing with Canadian operations provide substantial subsidies to their yards. France, Italy, Spain, Norway, Germany, and the UK provide price subsidies ranging from 10% to 25%. Canada has eliminated subsidies, but has provided yard upgrading and improvement grants. New competition in shipbuilding is also established in Korea, Taiwan, and China.

Importing complete ships into the USA is prohibited by non-tariff barriers. The "Jones Act" of 1920 requires that all vessels in US domestic trade must be built in the USA and operated under the US flag. This has not changed with the free trade agreement. However, tariff barriers on the repair of commercial vessels will be phased out by 1998.

Against this background, future opportunities will be very much linked to Canadian ocean activities and global niche market opportunities. These areas will be of special interest given Pacific Rim growth trends and need to be examined in detail. They include:

- recreational craft with many special applications (see Tourism and Recreational Technology);
- fast ferry systems;
- specially designed fast craft for coast guard, rescue, surveillance, and emergency applications;
- specialized service craft for offshore oil and gas development needs in the Pacific Rim and Arctic Ocean;
- specialized craft for military defence, coastal surveillance, and interdiction.

[1] Estimates from Marine Engineering Companies in British Columbia.

RECOMMENDATIONS

- Niche market opportunities for special craft in global markets should be investigated by local companies and supported by Canada and British Columbia.

- Global market opportunities arising out of the well-developed ferry systems and associated technologies within British Columbia need to be further investigated.

- The advantages of an international, flexible marketing network to British Columbian companies in ship and boat building, repairs, and servicing should be investigated.

10.0 SEAFOOD AND MARINE PRODUCTS ON THE WEST COAST

Introduction

The use of products from living organisms in the oceans is of increasing importance to mankind. British Columbia is especially well-situated to greatly increase its economic use of these living ocean resources within a framework of sustainable use. The fisheries for conventional, underutilized and unutilized species, aquaculture, enhancement activities, extensive mariculture and marine plant harvest and cultivation will be considered in this section.

Increasingly, a combination of these activities are used to ensure a continuity of product supply to the marketplace. This is very evident in Asia-Pacific where both natural and artificial recruitment (enhancement) sustain large fisheries. In British Columbia, salmonid enhancement has helped maintain some salmon stocks at exploitable levels in spite of decreases in natural production. The production of seafood and marine products involves a continuum of activities ranging from fisheries to aquaculture and biotechnology.

10.1 COMMERCIAL FISHERIES

Apart from transportation, the main focus of marine economic activity in British Columbia is the commercial fisheries. The Pacific Coast fishery sector contributes significantly to the provincial gross domestic product. Commercial fishing is the fourth largest primary industry after forestry, mining, and agriculture. The seafood processing industry accounts for over 25% of all food manufacturing activity in the province.

Salmon, herring, and halibut are the mainstays of the commercial fishery sector, representing about 80% of the total wholesale value. Although wild salmon production has increased significantly, competitive world salmon markets have eroded the economic value of this resource in recent years[1], while lower quotas are reducing the returns from the halibut fishery. The herring fishery has remained relatively strong, with significant increased returns.

The fishery sector continues to grow through diversification into new species, with expansion in the groundfish sector by 20% in the last year, and the development of shellfish fisheries. These fisheries have each doubled their share of the sector in the last five years.

[1] Including competition from cheap fish from Russian waters which have been opened to international fishing companies in return for hard currency. There are increasing concerns that these harvests will not be sustainable.

The industry is very export-oriented, with all of the herring roe produced, over 60% of groundfish and salmon production, and a substantial portion of shellfish production being exported.

Over the last sixty years, the fish processing industry has become predominately located in a few urban centres. Since 1930, the over-exploitation of resources, seasonality of the fisheries, and DFO management policy all contributed to this urbanization. At the present time a very high percentage of the processing capacity in British Columbia is located in the Lower Mainland or Prince Rupert. However, diversification is now occurring, with the growth of specialized plants for low-volume, high-quality products along the coastline. Employment in the fishery is highly seasonal, peaking in the summer, with 20,000 licensed commercial harvesters, operating on over 6,000 fishing vessels. The tonnage landed, and wholesale values by species in the fisheries of British Columbia is shown in **Table 10-1.**

The processing sector employs as many as 9,300 people at season's peak in 160 processing facilities, operated by 192 companies. Automated processing technology continues to reduce the labour requirement for processing. Employment is expected to shrink, while skill requirements increase. In this situation it is important, in addition to diversification of the fisheries, that value be added to seafood products in British Columbia prior to their export. This will require attention to emerging market demands and the application of innovative new technologies in seafood processing.

Fisheries: underutilized species

For many decades a few lucrative fisheries, confined largely to high-value species such as salmon, herring, and halibut, have sustained the British Columbia fishing industry. Diversification of the commercial fishery sector towards stocks that are abundant but poorly utilized offers new economic opportunity to the provincial economy, and, in particular, coastal communities. A policy for these species based on sustainable use and using new technologies for processing, adding value, and market development offers the possibility of significant growth in fishery revenues.

Status of knowledge of underutilized species

Over the last few years a series of studies carried out within the Seafood and Marine Products sector campaign of ISTC and by the Underutilized Fisheries Development Centre have documented the state of knowledge and commercial potential of stocks within western Canadian waters. The values of the short-term potential harvests are given in **Table 10-2.** In all cases, the estimated catch is well within the quota allocations that could be expected on the basis of conservative stock estimates. An improved knowledge-base on all the listed stocks could result in even greater levels of harvesting being possible.

A conference on underutilized species identified a potential of some $125 million in

TABLE 10-1: Quantity and value of British Columbia fish Landings by species, 1990

	LANDED QUANTITY (Tonnes)	LANDED VALUE ($1,000s)	WHOLESALE VALUE ($1,000)
Salmon	92,466	263,413	564,290
Herring	41,280	81,473	169,273
Halibut	3,784	21,065	27,763
Groundfish			
Dogfish	4,109	2,045	2,714
Flounder	143	82	120
Hake	79,453	12,833	12,905
Lingcod	5,054	3,667	9,241
Pacific Cod	6,233	3,375	7,433
Pacific Ocean Perch	5,595	2,981	3,745
Pollock	676	185	1,492
Rockfish	22,143	15,462	23,604
Sablefish	5,125	19,434	29,248
Skate	183	37	96
Sole	7,041	5,469	12,664
Turbot	2,602	601	2,031
Other groundfish	440	396	10,743
SUBTOTAL	138,797	66,567	116,036
Shellfish			
Abalone	50	1,347	1,051
Clam	2,651	5,567	8,631
Crab	2,167	9,311	11,281
Geoducks	3,992	10,582	16,152
Octopus	197	657	406
Oysters	4,547	3,613	4,595
Sea urchins	3,639	2,901	10,680
Shrimp & Prawn	2,701	9,643	11,996
Other shellfish	1,577	2,394	3,861
SUBTOTAL	21,521	46,015	68,653
Other Species			
Sturgeon	9	16	40
Tuna	275	830	901
Other	234	564	441
SUBTOTAL	518	1,410	1,382
TOTAL	313,852	479,943	947,397

new wholesale value within the next five years for new fishery products from British Columbia waters. Well established market demand for these species is known to exist, especially in Pacific Rim nations and in the USA.

The realization of this potential requires further quantitative assessments of fish stock strength, and a cooperative effort between fishery managers and industry to develop allocation and harvesting strategies that are sustainable and maximize the value of these resources.

The following underutilized/non-traditional fishery resources: could readily be utilized if the identified constraints were acted on:

Species	Constraints on Development
Pelagics:	
Pomfret	Stock information, harvesting and processing technology, and marketing
Dogfish	Technologies for by-product utilization
Pacific Saury	Stock information, processing technology and marketing
Pollack	Processing technology
Groundfish:	
Dover Sole	Automated processing technology
Thornyhead	Stock information, automated processing technology
Grenedier	Stock information, processing technology and marketing
Arrowtooth flounder	Stock information, primary and added-value processing technology
Shellfish:	
Squid	Stock information, processing technology
Munid Crabs	
Euphausiids	Stock information, processing technology and market development
Octopus	Processing technology
Box Crabs	Stock assessment
Butter Clams	Harvesting and value-added technology
Venus Clams	Processing technology and marketing
Scallops	Harvesting and processing technology
Mussels	Out growing technology

The fish processing sector has an opportunity to develop new value-added products and improve product utilization by use of technology in the development of surimi-based fish products, seafood drying for Asian markets, the development of marinated seafood products from low-valued fisheries.

Conclusions

Extensive reviews involving industry and both levels of government have identified significant potential in fisheries for species that are, at present, underutilized or unutilized. The major requirements to realize the potential of these under-utilized species have also been identified. They need to be addressed by industry and

government as a prerequisite to the development of sustainable and competitive new components of the commercial fishery.

- The implementation of federal policies to support the development of underutilized/non-traditional fisheries based on sustainable harvests.

- Establishment of an "envelope of funds" to specifically assist technology development and technology transfer on selective harvesting methods, new processing techniques, and value-added technology to be applied to these species.

- Policy support for integrated market development strategies for underutilized/non-traditional species that maximize the value of the resource to coastal communities[1].

- The application of known fish processing technologies to these species.

- The development of advanced monitoring technologies to assist in the assessment of stocks of these species and to provide an improved knowledge-base for management.

Marine plants - an underutilized resource

The First Peoples have made extensive use of marine plants, particularly in using roe-on-kelp and black weed (*porphyra*) as trade items. Other seaweeds are used as medicines and in ceremonies.

The current marine plant harvest industry on the West Coast can be grouped into four categories: herring spawn-on-kelp fishery, dried product for human consumption, fresh product for human consumption, and manufacture for fertilizer, plant growth promotion and other uses.

At present, there is limited activity in the screening of local marine plants for fine chemical production. Seaweeds are also used to mitigate environmental damage. Newport, Oregon, is exploring the use of the red alga *palmaria* in denutrifying sewage. Algae and algal extracts are also used to detoxify waters contaminated with mine tailings.

Although there are no large-scale harvesting activities underway in British Columbia, all significant kelp beds (*Macrocystis* and *Nereocystis*) in British Columbia have been inventoried by the provincial government. This system is based upon aerial surveys

[1] See references in Sections 4 and 7 to economic diversification in coastal communities. The recent actions by the government of the U.S.A. and the State of Alaska in allocating quota to remote Alaskan coastal communities (Community Development Quota) is also relevant.

TABLE 10-2: Estimates of short-term potential economic benefits to British Columbia from harvests of underutilized and unutilized species and use of processing technologies. Source: BCMAFF, 1992

	SPECIES	POTENTIAL LANDED VALUE $millions	FURTHER PROCESSING VALUE $millions		
			DRYING[1]	MARINATION	OTHERS[2]
Pelagics	Pomfret	6.6	--	--	--
	Dogfish	3.3	2.0	--	1.3
	Pacific Saury	0.3	--	--	0.44
	Pollack	0.6	--	2.2	0.89
	Herring (male)	--	--	--	0.2
	Chub Mackerel	0.2	--	--	0.2
SUBTOTAL		10.8	2.0	2.2	3.03
Groundfish	Thornyhead	.33	--	--	--
	Grenedier	.15	--	0.88	--
	Arrowtooth	1.54			
	Flounder	0.4	--	--	9.9
	Skate	1.1	--	--	2.2
	Dover Sole		--	--	1.9
SUBTOTAL		3.564	0	0.88	14.0
Shellfish	Whelks	Potential to be determined			
	Opal Squid	0.5	1.1	--	--
	Nail Squid	4.4	--	--	--
	Munid Crab	2.8	--	--	--
	Euphausiids	22.0	Processing technology needed		
	Octopus	1.3	1.55	--	--
	Box Crabs	Low volume/high profit niche market			
	Clams	1.1	--	--	1.25
	Venus Clams	Low volume/high profit niche market			
	Tanner Crabs	High volume fishery			
	Purple Urchins	(1991 landed value $85,000) 10x harvest increase possible			
	Scallops	Low volume/high profit niche market (1989 value: $324,000)			
	Jellyfish	High volume fishery requiring drying technology			
SUBTOTAL		32.1	2.65	--	1.25
TOTAL of All Species		46.064	4.65	3.08	18.28

[1] Includes salting processes.
[2] Other includes breading, smoking, surimi, analog extrusion, canning, etc.

Landed wholesale values could be increased by at least fifteen percent with the development of fisheries for whelk, box crab, venus clam, tanner crab, purple urchin, scallop, and jellyfish species. Drying and other processing technology could enhance value of euphausiids, jellyfish, and other species several fold.

coupled with ground-proofing. Over 12,000 hectares of kelp bed along 780km of British Columbia's shoreline have shown growing stocks of over 600,000 wet tonnes of kelp. Small kelp beds are inventoried as requests to harvest are made.

Business planning for marine plant harvesting is impeded by the present licensing policies. Licenses are issued on an annual basis. Although provincial policy states that diligent users benefit from an 'evergreen' provision and get first right of refusal for the same area and quota, conservation needs and other uses in an area may proceed issuance of a licence in a given year. Modifications in the licensing of marine plant harvesting to allow longer term privileges are necessary for investment in commercial operations.

Current constraints to the development of the marine plant industry are:

- high labour cost relative to other countries with large marine plant resources;
- the remoteness of major kelp stocks, thus making their acquisition more costly;
- concern for impacts of large-scale harvesting on fishery resources and the marine environment;
- the current attitudes of the public regarding the exploitation of a visible resource;
- lack of investment because of short-term licensing.

Seafood processing

The structural strengths and weaknesses of the West Coast fish processing industry vary by species. In general, the industry has significant advantages in both salmon and herring processing, its two largest fishery products. The industry has access to abundant natural resources, and export and inspection regulations which have resulted in a safe, high-quality product, a factor which is internationally recognized. The industry has at its doorstep one of the largest seafood markets in the world, the United States. Opportunities for new economic development in the groundfish and shellfish sectors and in new product development are substantial.

Our strategic disadvantages stem from the present high costs of raw materials. These result from short fishing seasons, inflexible management policies, resource cycles, and high input costs, due in part to excess fleet capacity in the salmon fishery. Trade-related problems such as tariffs and restricted or prohibited exports to such countries as New Zealand, Australia, and the EEC impact negatively on this predominantly export industry. Management policies will need to be more responsive to the market-driven nature of the industry in the future within the obligations of sustainable management.

The recent Seafood and Marine Products sector campaign, coordinated by ISTC, has identified many interesting new opportunities and technologies for seafood development. The consortia developed under this campaign should now be moved

into the private sector and maintained by the seafood industry as a source of funding for innovative new processing technologies.

The future objectives within the processing sector will include:

- A focus on the technologies to process low-volume, high-value products, especially those based on underutilized stocks.
- The technologies to encourage the production of added value products from our fishery resources.
- Technologies to further increase the utilization of the resource and reduce waste products (see **Figure 10-5**).
- A focus on consumer-friendly products aimed at specific target markets.

Outlook

The demand for fishery products is growing steadily but the competition in these markets will also increase. The industry's established markets (i.e. Japanese markets for herring roe) will also come under extreme pressure from other sources of supply that are emerging onto world markets. Only a small proportion of the local industry is prepared for increased competition. Special efforts need to be made to minimize the impacts of international competition.

Present Government policies in the fisheries are major constraints to achieving global competitiveness; as well, trade barriers pose significant problems. These can only be overcome by the cooperative efforts of governments, fishers, processors, and sellers. In this situation, research and development, and the application of technology to increase efficiency and maximize quality are the key to future success.

Fishing -- Mainstay of the Seafood Industry

The fisheries of British Columbia now face a greater range of pressures and changes than ever before. These impact on all facets of the industry: questions of resource ownership, conservation, harvesting, processing, and international marketing. The future viability of the industry as a major component of the British Columbia coastal economy will be closely linked to the maintenance of the competitive position of the industry. Within this necessity, the following issues will have to be addressed by all levels of government and stakeholders in the industry.

Policy Issues

The most debated policy issues in the fishery today relate to the aboriginal fishery strategy and native stewardship issues. These issues are complex and are evolving rapidly. They will be a major component of land claims negotiations that are planned or underway. No attempt was made to consider these issues other than to recognized that they will have a profound impact on the fishing industry. Relevant aspects are treated in the chapters on **Coastal Communities** and **Human Resource Development.**

There is a need for a cooperative approach to fisheries management in which government managers and the users effectively coordinate the timing of resource harvesting and the market demands. License and quota systems that allow fishers discretion in the timing of harvesting to match the optimal market demands are an example.

The sustainable management of our fishery resources based on a sound knowledge of stock biology is essential. It must also be recognized that the ever-changing ocean environment will also cause fluctuations in the strength of stocks. Efforts in sustainable management will also increase the security of resource supply to the seafood industry and stabilize the employment and social benefits from the fishery, avoiding the problems being experienced as a result of the East Coast Cod stock collapse.

Within this basic obligation towards sustainable management, industrial competitiveness is only possible if industry are allowed to set their own agenda of market-driven development.

An additional complication in policy development are the demands from coastal communities for a voice in management decisions, allocation decisions, and decisions related to wealth creation (see Chapter 7). These are valid aspirations that need to be balanced against the dangers of using very finite fishery resources to achieve ever-increasing social and economic objectives.

Harvesting

With the increasing concerns about the sustainability of our wild fishery resources, attention is needed to the development of new harvesting technology that is selective, reduces by-catch and damage to remaining stocks, and permits the landing of high-quality products.

The offshore fishing opportunities that have been identified will also require the development of specialized, efficient, and environmentally acceptable harvesting technology.

Technological factors

The pacific coast industry has been slow to develop new technologies or innovative products, largely because existing technologies and products have in the past satisfied market and profit requirements. Most technological innovation has been related to improving existing processes, rather than oriented towards new products. Global markets are providing increased competitive pressures on our traditional products, and offering a challenge to industry to make more effective use of available technology to obtain greater economic benefits from finite fishery resources.

Human resource development

These issues are discussed in general terms in Chapter 6, but they are of particular significance to the challenges faced in the fishing industry today. Industry working groups have identified the urgent priority of:

- New training programs to enable the present workforce to develop the skills necessary to use new technologies in harvesting and processing.
- Programs in English as a Second Language (ESL) for the recent immigrant component of the workforce to facilitate the adoption of new techniques, increased worker safety and productivity.
- Retraining for members of the work force displaced by new technology and the restructuring of the fishing industry.
- Programs to improve management and marketing skills in the seafood industry.

Marketing

The decisions made by buyers and consumers in the marketplace are important to the future strength and well-being of the West Coast Seafood industry. It is therefore important that governments assist the positioning of the West Coast industry in world markets by:

- Providing support for the generic promotion of British Columbian and Pacific Region seafood.
- Negotiating the reduction of trade barriers for Canadian seafood exports.
- Assisting industry in the development of specialized consumer-oriented packaging for seafood.

Resolution of the above issues will requires the evolution of efficient but comprehensive coordinating mechanisms to bring governments and diverse stakeholders together. At present these are more than 40 industry consultative committees linked to DFO in research, management, and allocation questions, and additional committees advising British Columbia on seafood issues. Yet there is no single comprehensive structure that integrates resource management, socio-economic objectives, and marketing to create a healthy, competitive industry.

Fish stocks and fish stock assessment

The Biological Sciences Branch of DFO in Nanaimo directs the management of fisheries. The scientific basis for management is supplied by the biological stations in Nanaimo and West Vancouver, with the Institute of Ocean Sciences providing necessary oceanic information. The essence of DFO's management strategy is to preserve fish stocks and to enhance them. It also allocates the use of the various fish stocks among the native food and ceremonial fishery, commercial, and sport fisheries.

The status and trends of fish stocks is beyond the scope of this report, but has been

the subject of many research studies, commissions, and reviews. A standing Pacific Stock Assessment Review Committee within the DFO Biological Sciences also monitors the status of stocks. In general, the West Coast stocks are in much better shape than East Coast stocks, and the current revenues generated by the salmon, herring roe, and halibut fisheries attest to this.

However, the working group in this area observed that there are many opportunities to improve the knowledge-base of the fisheries. This knowledge is an essential prerequisite to sustainable management and to maximizing wealth creation and community socio-economic benefits from the fishery. Fishery science, stock assessment, and decisions on quota and what level of harvesting is sustainable is a complex mixture of biology, statistical analysis, modelling, and judgement. Current efforts are limited by the high cost of doing research at sea and by increasing constraints on government programs. New, efficient ways of collecting the vital information need to be explored.

Relevance of subsea and marine technologies to fish stock assessment

Elsewhere in the world, increased harvesting of fish stocks has frequently resulted in depletion and, often, catastrophic collapse of fish stocks. Accurate quantitative information on the biomass, growth, numbers, distribution, and migrations, *etc.* of aquatic animals is essential for sustainable use practices and the rational allocation of these resources to commercial, recreational, and subsistence or ceremonial uses. Many technologies have been developed which can provide quantitative information on fish stocks.

Some technologies developed by British Columbia companies in marine technology have direct relevance to fish stock assessment problems. In the summer of 1992, SPARK Oceans organized meetings between the subsea technology industry, fisher groups and government scientists to review opportunities. The main conclusions were:

- Advanced subsea acoustic and electronic technologies have great potential for assisting the sustainable management of fisheries and optimizing the economic value of these fisheries.

- Many relevant acoustic technologies exist in British Columbia companies and in civilian and defence research laboratories. The particular information needs of user groups and fishery managers need to be defined and systems developed that can be used in the field.

- Much effort will be required to develop, test, and apply these techniques for the sustainable and optimal management of the fisheries. By far the most difficult task will be in convincing fishery managers to make better use of these systems and to modify present fishery management structures to make routine use of these technologies.

- Funding is required to carry out the development, field testing, and ground-truth verification of techniques and systems that would have a market potential.

- Much more effective use could be made of advanced technology in management of upstream migrating salmon stocks. Technologies and systems exist but fishery managers appear reluctant to implement these systems.

- The funding of technology development and field testing should involve the fishery industry, managers, technology developers, and existing funding sources. Some sources of up-front financing are needed for the development and demonstration of these techniques.

- A broad-based interdisciplinary consultation process is essential in the development and adoption of these technologies. This process must involve technology suppliers, fishing industry representatives, fishery co-management interests, fishery managers, and government agencies supporting innovation, and economic diversification.

- The market potential for field-tested technology packages is difficult to define, but there is no doubt that calibrated packages would have applications in sustainable fishery management world-wide. Only Norway, the UK, and Japan are doing any serious work in this field.

These technologies could make a significant contribution to the achievement of sustainability in our fisheries. The long-term value of this to the British Columbia economy would be substantial.

10.2 AQUACULTURE

Aquaculture activities are becoming an important component of the seafood industry in British Columbia. They can be grouped under three headings:

Aquaculture - the intensive cultivation of an organism through its life cycle with ownership of the animal and a crown tenure for use of part of the ocean.

Extensive Aquaculture - (usually of shellfish) in which stocks are managed to increase production. There is private ownership of the stock.

Enhancement Activities or Culture-based Fisheries - in which juveniles are released to the wild to help sustain a common property fishery or other managment techniques are used to increase productiuon or the recruitment of juveniles.

In British Columbia, the commercial aquaculture of salmon, oysters, clams, scallops, and mussels takes place, and other species are under development. The industry is serviced by an infrastructure of service companies including: equipment suppliers, fish

feed producers/importers, pharmaceutical/laboratory/research and development suppliers, professional services suppliers, and seafood processors. There are strong cross-linkages to the wild fisheries in processing and use of transport vessels, etc.

More than 1,600 people are currently employed in marine aquaculture and in directly related industries. Salmon farms employ approximately 800 people full time, and shellfish and marine plant farms employ an additional 400 people. A further 2,000 jobs exist in the service companies.

Potential for growth

Throughout this decade, the aquaculture industry is expected to grow steadily as it responds to world market demands. The major aquaculture producer organizations have predicted that the industry's total output will be worth about $170 million annually by 1995 and increase to more than $250 million by the year 2000. Although salmon will continue to be the mainstay of production, major gains are anticipated in shellfish production with diversification into manila clams and other species, along with more comprehensive utilization of oyster farm tenures.

Geographic, economic, and social conditions in British Columbia all favour the continued development of aquaculture. The oceanographic conditions in many of British Columbia's coastal areas are well-suited for the culture of fish and shellfish. There is substantial productive capacity that is yet unrealized. The extent to which this potential is realized will depend on:

- The rate of expansion of seafood markets in North America and Asia-Pacific.
- The clarification of overlapping government mandates and jurisdictions that create confusion and uncertainty at the present time.
- The ability of British Columbia-based production to meet international competition.
- The diversification of aquaculture into the cultivation of new species. This requires a commitment to innovation and research.
- Rationalization of the government regulatory environment and the inclusion of aquaculture into an overall framework for protection of the coastal environment to remove the threat of coastal pollution and provide a mechanism for evaluating aquaculture alongside other user interests.
- Improvement of the oceanographic, biological science, and biotechnological research base. Many production problems and risks result from a lack of scientific knowledge. This knowledge is essential in siting decisions, minimizing environmental risks from algal blooms, disease control, and in increasing the efficiency of production.

TABLE 10-3: Aquaculture Production in British Columbia by Species 1988-1993

SPECIES		1988	1989	1990
Marine Salmon & Trout	Tonnes	6,590	11,883	15,486
	Value	$39,084,465	$59,739,000	78,646,000
Oysters: Pacific	Tonnes	3,702t	3,721t	4,546t
	Value	$2,725,000	$2,938,015	$3,612,357
Clams: Manila	Tonnes	30	31	39
	Value	$58,899	96,000	139,659
Mussels	Tonnes	6	3	4
	Value	$18,586	7,000	9,952
Scallops	No Commercial Production			
Marine Plants	No Commercial Production			
TOTAL VALUE		$42,605,922	$63,257,145	$83,022,279

SPECIES		1991(est)	1992(est)	1993(est)
Marine Salmon & Trout	Tonnes	21,884	22,400	24,027
	Value	$100,000,000	110,000,000	
Oysters: Pacific	Tonnes	4,482	5,000	Steady increase expected
	Value	$3,464,000	4,000,000	
Clams: Manila	Tonnes	151	200	
	Value	$554,327	700,000	
Mussels	Tonnes	*	Increases expected	
	Value	*		
Scallops	Pilot Commercial Production			
Marine Plants	No Commercial Production			
TOTAL VALUE		$104,695,000	$115,445,000	

Final figures are based on production reported and confirmed to the Ministry of Agriculture, Fisheries & Food. Estimates of salmon production and value are based on surveys conducted by the BCSFA.

* denotes less than three farms reporting and to maintain producer confidentiality, these numbers cannot be reported.

Salmon farming

Salmon farming is the largest component of aquacultural activities in British Columbia. A considerable amount of pioneering research on the rearing of salmon in net pens was carried out in British Columbia in the 1960s and 1970s at the Pacific Biological Station in Nanaimo. Although this led to the development of some early commercial efforts, none were successful. Much of the science carried out at the Pacific Biological Station was applied to the launch of the salmon farming industry in Norway and Scotland, and it was not until the European salmon industry became commercially successful in the late 1970s and early 1980s, that interest was reawakened in British Columbia. There was a wave of investment in commercial salmon farming driven largely by overseas sources of investment capital between 1986 and 1989. Many of these companies failed, but about 12 large integrated ventures, and some smaller firms, persisted and became the basis of the present industry.

In 1985, farmed salmon sales totalled about $1 million per year. In 1992, production was 20,500 tonnes with a sales value of about $132 million. Production is forecast to grow to 26,700 tonnes by 1995 with sales value in excess of $160 million (**Figure 10-4**).

Salmon farming is currently the fourth largest agribusiness sector in British Columbia and by 1995, it is expected to be the second largest, only exceeded in sales value by the dairy industry.

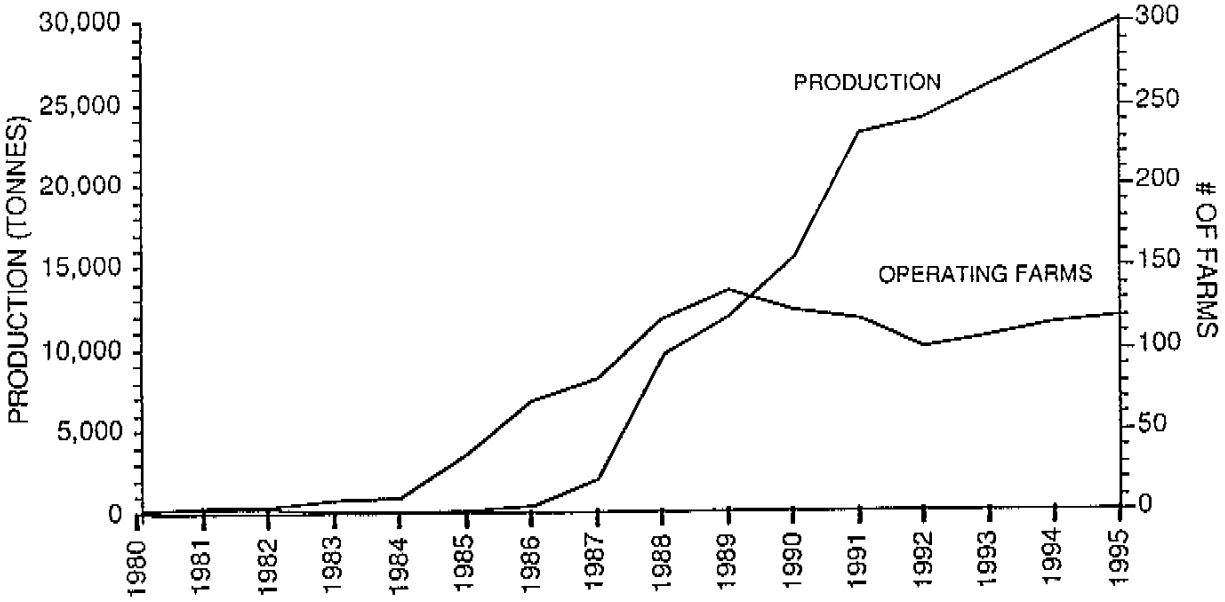


Figure 10-4: Salmon farming industry growth in British Columbia

Market development strategies in salmon farming

Now that the salmon farming industry has consolidated its production strategies, the focus is shifting to global market development. With an existing export base valued at over $100 million per year, this strategy provides an interesting example for other ocean sectors moving into the global marketplace. It is based on:

- Implementing marketing strategies to increase demand for British Columbia seafood products in the USA and other markets. This includes acquisition of improved market intelligence, harmonizing Canadian and international standards, and close coordination of the activities of all government agencies in cooperation with industry.
- The development and implementation of industry-driven quality assurance programs to enhance the image of British Columbia products.

The emergence of culture-based fisheries

To date, the development of aquaculture in British Columbia has been on the basis of intensive cultivation operations under private ownership. These operations will continue to be the mainstay of commercial aquaculture. However, they operate under a regulatory and ownership structure entirely separated from that of the coastal fisheries. In other countries, in particular Japan, aquaculture technologies are used to support natural fisheries that are intensively fished. In British Columbia the Salmonid Enhancement Program (SEP) also provides a good example. These culture-based or enhanced fisheries are a technological means of sustaining the productivity of fisheries, using various management practices and habitat protection while permitting ongoing commercial harvesting.

Recently in British Columbia, several new project proposals have emerged from fishermen's groups and native communities that propose to apply culture-based fishery practices to sedentary and inshore species such as geoducks, abalone, and ling cod. These offer great potential to increase the productivity of inshore and community-based fisheries. However, they face major impediments under existing fisheries policies and licensing practices that do not make allowance for such activities and in turn inhibit economic opportunities in coastal communities.

Extensive mariculture

Opportunities exist for expansion of seafood production in the application of extensive mariculture to new species such as abalone, geoducks, scallops, mussels, sea urchins and sea cucumbers, halibut, and other commercially valuable species.

Extensive (non-intensive) mariculture is the basis of much seafood production in Asia and is used in the production of the Pacific oyster and Manila clam in British Columbia. Extensive culture of oysters has virtually replaced the traditional wild oyster fishery, while extensive clam culture is used in maintaining a steady, year round

supply of Manila clams.

Extensive culture relies, for the most part, on the marine environment to raise and feed the animals. Hatchery-raised juveniles are seeded to their natural habitats, where they utilize the food and shelter afforded by the environment. The culturist tends the stock by culling, predator control, and substrate enhancement, and harvests generally by using conventional fishing methods. In this way, productivity is increased and costs are considerably lower than in intensive culture. The incentive for the aquaculturalist is the expectation of harvest rights.

In enhanced fisheries the stocks become common property upon release to the ocean and can be fished by anyone permitted to do so. However, until policy is clarified there is little incentive to private financing of enhancement and, hence, new technologies to increase production are not being utilized.

In British Columbia, provisions exist to provide culturists varying degrees of proprietary right through the tenuring of Crown aquatic land, limited entry fishery licensing, individual quota systems, and regional resource allocation and development authorities.

Shellfish aquaculture in British Columbia: present status and future potential

The British Columbia coast, with its temperate climate, productive waters and numerous well-protected bays and inlets, has an immense potential for mariculture. Most of the British Columbia coastline, however, is steep and rugged, with relatively little intertidal ground for traditional bottom culture of shellfish. Despite advances in grow-out technology for deepwater culture of bivalves, such as longline and raft culture, most of the current production of shellfish farms is raised on intertidal ground, at least during part of the grow-out cycle. Culture of the Pacific oyster, (*Crassostra gigas*), is the largest shellfish sector, but the farming of Manila clams, (*Tapes philippinarum*) is increasing and trials are being carried out with Pacific Japanese scallops, (*Patinopecten yessoensis*), and mussels, (*Mytilus spp.*) The potential for the enhancement or cultivation of halibut, black cod, ling cod, and other species is also being investigated.

CONCLUSIONS

The Shellfish farming industry is based on the culture of introduced species of bivalves. Pacific oyster and Manila clam farming, the largest sectors, have considerable potential for further expansion through improved seeding, husbandry, harvesting and processing techniques. There is a also potential for developing shellfish hatchery and nursery technology for species, such as geoducks, abalone, and sea cucumbers. However, government policies will have to be changed to permit the cultivation of these species on subtidal bottom areas.

For shellfish production to reach its full economic potential, it must be viewed as an integrated industry, with elements of fisheries, extensive aquaculture, and intensive aquaculture. Present government policies segregate the administration of these elements rather than allowing an optimal blend of all three, such that each species is managed to suit its conservation needs, production capability, and available markets.

Marine plant cultivation

The marine plant resources of British Columbia have long been recognized as a vast but underutilized resource that could contribute significantly to the economy of coastal communities. At present, little attention is being given to conducting studies relevant to understanding marine plant resources. However, the Kwakiutl Band Council (Fort Rupert) is evaluating seaweed standing stock and exploring means of enhancing *Macrocystis* stands for the roe-on-kelp fishery.

There have been marine plant cultivation activities in the past in British Columbia, although no cultivation is currently underway. *Porphyra* has been cultured for the manufacture of nori. Several companies attempted to establish nori farms. Two impediments to success were under-capitalization and inability to acquire an aquaculture tenure. The most ideally suited location for nori cultivation is in the populated Gulf Islands area. However, Canadian Coast Guard was reluctant to approve sites that may interfere with navigation.

Marine plant stock can be manipulated to increase production or to improve the output of a particular chemical. There has been some research on producing agars with specific qualities using stock selection and physiological modification, but again, no commercial activity in British Columbia.

In addition to Porphyra culture, there have also been attempts at the cultivation of *Laminaria saccharina* for manufacture of kombu. These activities have not continued because of under-capitalization and a lack of proven profitability with available technology in the present economic conditions. Given improved markets and available technology, marine plant cultivation offers opportunities for development along the coast of British Columbia.

Fisheries of the future

The West Coast fisheries in all their diversity will continue to be very important to the economy of British Columbia. As documented in this report, there is potential for further commercial, recreational, ceremonial, and subsistence use of these fisheries within a framework of sustainable management. The ways of managing fisheries to conserve natural stocks while producing seafoods for world markets is evolving rapidly on a world-wide basis. Especially interesting initiatives are taking place within the Pacific Basin Exclusive Economic Zones.

The major components of modern marine fisheries, seafood, and marine products

industries are shown in **Figure 10-5**. Fishing is only one (basic) component that provides for many other diverse activities. Aquaculture products that are dependant on fish meals supplement supplies of seafood on world markets (and allow conservation of wild stocks). More effective use is being made of by-products and new biotechnology industries extract high-value end products from marine organisms.

These interrelated industries make up a much more diversified and stable fishery than is possible with only traditional fishing. Within the last ten years, this diversification of the fisheries has strarted to occur along the coastline of British Columbia, with enhancement of five species of salmon, salmon farming, and the cultivation of at least three species of shellfish. The use of by-products to produce feeds and other products takes place on a small scale. There is, however, considerable scope for expanding these activities. Diversification into aquacultural activities is essential to maintaining supplies of commercial products to the marketplace while allowing conservation of the fisheries, but has been inhibited by inflexible government regulations, regulatory uncertainties, and lack of clear policies or vision.

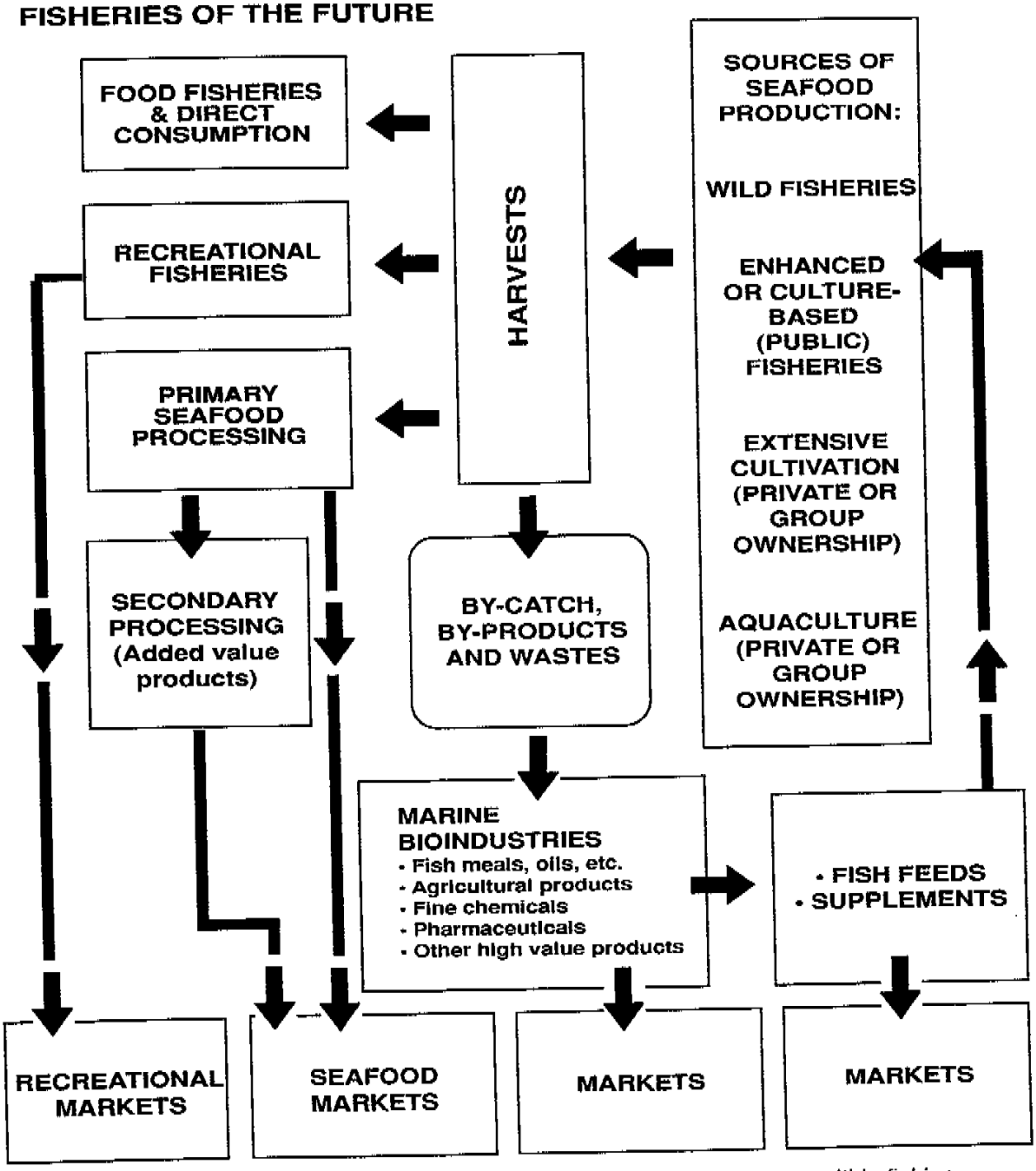
In the future, issues of sustainability and sustainable management must be addressed within a framework that recognizes all these complex linkages and seeks to optimize the consequent economic, social, and cultural benefits.

Government policy and regulations needs to more accurately reflect the market-driven nature of aquaculture alongside sustainable resource managment strategies for wild stocks and they should:

- Clearly define aquaculture as an agribusiness (farming) in legislation, including equality in taxation and incentives.
- Reduce overlaps and inconsistencies between various levels of government jurisdiction, including rationalizing the regulatory environment that was largely based on the managment of wild stock fisheries.
- Enhanced access to the varieties and quantities of aquatic species and stocks is necessary for production diversification. This requires an effective, but efficient regulatory framework.
- A high-quality aquatic environment is essential to the future of aquaculture. More comprehensive and consistent testing of our coastal waters for pollutants and toxins is needed.
- Aquaculture should be recognized as one source of commercial seafood production alongside wild harvesting and enhancement.

FIGURE 10-5

STRUCTURE OF THE SEAFOOD INDUSTRY
FISHERIES OF THE FUTURE



This figure shows the technological interactions that are developing within fishing industries at an international level. Issues of marine harvesting and sustainability need to be addressed in the context of the above complex interrelationships.

RECOMMENDATIONS ON FISHERIES AND AQUACULTURE

- A comprehensive framework for the sustainable management of all fisheries is needed. This would balance ceremonial, recreational, and commercial needs, and provide a voice for coastal communities in fishery management.
- Policies need to be developed to allow the development of underutilized and unutilized species. In this regard, special consideration should be given to the quota needs of coastal communities for economic diversification.
- The development of new techniques and procedures for fish stock assessment is a priority. SPARK Oceans should work to bring together technology developers, fishing groups, and DFO to define needs and to develop a strategy to improve the present knowledge-base on fish stocks in a cost effective manner.
- The market promotion of wild, enhanced, and aquacultured seafoods of the West Coast should be integrated. The British Columbia Ministry of Agriculture, Fisheries and Food should take the lead in bringing the different interests together for **an integrated seafood promotion strategy.**
- Develop a framework for marine plant utilization within a framework for sustainable management of marine activities.

11.0 MARINE TOURISM, SPORT FISHERIES, RECREATIONAL TECHNOLOGIES AND RECREATIONAL USES OF OCEANS

Introduction

The growth of Marine Tourism and the cross-sectoral linkages with marine communications, information technology and transportation that have spawned a growing marine recreational technology ("rec-tech"), industry on the West Coast were investigated. The marine tourism and recreational technology industry can be divided into a service sector and a rec-tech manufacturing sector. The service sector includes recreational fishing and other coastal experience activities.

Marine recreational technologies differ from other marine technologies in that their products are sold into mass consumer markets instead of specialized oceanographic, defence, and industrial markets.

Marine tourism activities are one of the fastest growing and potentially sustainable sectors of the British Columbia economy, and have been responsible for substantial job creation in coastal communities in recent years.

This review highlights development of this little-studied sector of the British Columbian economy and provides recommendations to encourage further development of the industry for the betterment of the province and its coastal communities.

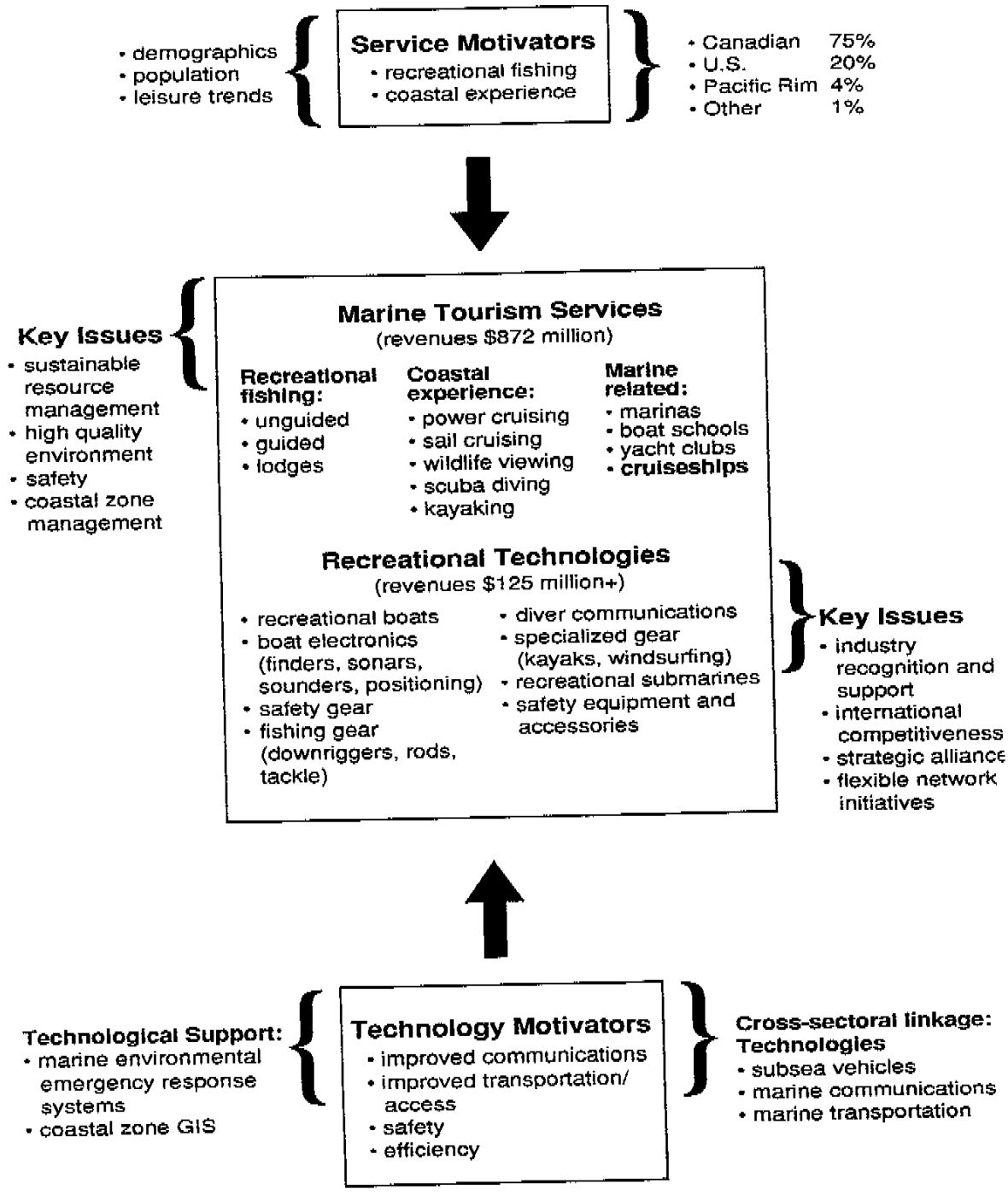
11.1 STRATEGIC FRAMEWORK OF THE SECTOR

Figure 11-1 illustrates the strategic framework of the Marine Tourism and Recreational Technologies sector. The sector is composed of sports fishing activities, direct coastal experience activities, cruise ship excursions, and indirect or related coastal experience services. The two primary motivations in marine tourism are sports fishing, and the desire for a coastal experience activity in a scenic marine setting[1]. More people are participating because of British Columbia's population growth, favourable demographics, and social trends toward outdoor activities, boating, and eco-tourism/wildlife interest.

[1] Marine Tourism in British Columbia: An Opportunity Analysis, ISTC/Ministry of Tourism, March 1991, p 1-4

Figure 11-1
Marine Tourism and
Recreational Technologies

A Strategic Framework



Sport fishing plays an important role in supporting the infrastructure on which Marine Tourism depends. Over 60% of marina users in the province reported that their primary activity was sports fishing[1]. Without a strong recreational fishing sector, development of other coastal experience activities would be impaired.

In the non-services portion of the marine tourism sector are manufacturers of recreational technology products. Development of this new industry is driven by a combination of "market pull" to supply the needs of the service sector and "technology push" as technologies are adopted from other applications in subsea, marine communications, and marine transportation.

The Marine Tourism and Recreational Technologies sector is complex because it involves a wide range of activities governed by a number of regulatory agencies and involves technologies derived from a wide range of other sources.

11.2 ECONOMIC IMPACT AND SECTORAL ANALYSIS

Overall, Marine Tourism has experienced a 10%+ annual growth in revenues over the past five years, and now accounts for over $780 million in revenue per year, not including $125 million sales from the marine recreational technology segment. The industry generates over 26,000 person-years in employment annually. At the current rate of growth, industry revenues will double by the year 2000. This is of strategic importance to the province's economy because this growth is potentially sustainable in the long term, because it does not rely on the heavy consumptive use of marine resources.

In British Columbia, the Marine Tourism industry is led by the recreational fishing activities which account for the bulk of industry revenues and investment, and provides the infrastructure for promoting coastal experience activities. Coastal experience services include power and sail cruising, wildlife viewing, scuba diving, and kayaking. As well, there are several marine-related activities such as marine attractions, yacht clubs, boat schools, float plane charters, and small craft harbours. The large cruise ship sector has experienced significant growth, and recent studies indicate a large potential market exists for small "pocket" cruise ships.

Rec-tech includes a growing group of companies that manufacture specialized products for the marine tourism industry, including diver communications devices and diver equipment, pleasure craft electronics (positioning, communications, depth sounding, fish finding), recreational submarines, recreational boats (design, manufacture, and repair) and boating accessories, specialized items such as specialized clothing (survival and floater suits), and fishing gear and tackle.

[1] Marine Tourism Survey, 1990

TABLE 11-2: MARINE TOURISM OPERATIONS: ECONOMIC IMPACT IN BRITISH COLUMBIA (Revenues per annum)

		(CDN $ Millions)
Sport Fishing	• angling revenue[1]	576.0
	• license revenue[2]	5.0
Coastal Experience[3]		
	• power cruising (under 2 days)	25.6
	• sail cruising	9.5
	• wildlife viewing	4.9
	• scuba diving	3.9
	• kayaking	5.0
Marine Related		
	• marine attractions	9.3
	• yacht clubs	5.0
	• boat schools	6.0
	• air charters	16.0
	• small craft harbours	1.5
Cruise	• ships (2+ days)	100.0
	• pocket cruisers (2+ days)	15.0
Rec-Tech[4]	• (not included in total)	{125.0}
TOTAL MARINE TOURISM (excluding rec-tech)		$ 782.7

1 1990 - Survey of Recreational Fishing, September 1992, DFO
2 1991 - DFO
3 Marine Tourism in B.C. Opportunity Analysis, March 1991, ISTC-B.C. Ministry of Tourism
4 marine recreational technology sector overlaps with the marine communications and marine transportation sectors covered elsewhere in this report and its impact is therefore not included in these numbers

Marine Recreational Fishing

The Department of Fisheries and Oceans' recent National Survey of Recreational Fishing found that, during 1990, expenditures in British Columbia on services directly related to tidal sport fishing was more than $575 million. In addition, the survey identified associated major purchases or investments totalling $300 million. Of the over 400,000 tidal anglers in British Columbia, 25% came from out of province.

The number of jobs generated by expenditures on services in the recreational fishery represented approximately 11,600 person-years of employment. An additional 5,090 person-years of employment can be attributed to major purchases and investments. These figures include both marine and fresh water recreational fishing, but the bulk

of these expenditures and employment are the result of salt water fishing.

The recreational fishery in British Columbia is based upon salmon, primarily the less commercially important chinook and coho species. Over the past 30 years, a harvest of about half a fish per angler-day has been maintained, indicating that the expectation of catching a sports fish in British Columbia's marine waters has remained quite stable. In 1992, approximately 1.4 million salmon were taken by marine recreational fishers. By contrast the commercial fishery takes between 14 and 40 million salmon per year. The enormous power and mobility of the commercial fleet allows it to fish the limits of abundance, so catches vary substantially according to fish population cycles.

Because sport fishery activity depends on the availability of recreational time, angler effort is spread over a far longer period than that of the commercial fishery. For these reasons, and because the fishery can be managed by bait/tackle restrictions, altering catch limits and encouraging release programs, the marine recreational fishery can more easily be run on a profitable, and potentially sustainable.

The net economic benefit of sport fisheries per unit weight of fish caught is estimated to be much higher than the direct economic benefit of commercial activities. This is due to the inefficiency of single hook angling, the cost of small craft, tackle, guides, accommodation, and licenses, and the limited access to fish stocks for sports fishers. The annual catch per recreational license holder is only 4 fish verses 8,000 for commercial fishers. Also, although accounting for only 5% of the total catch,

TABLE 11-3: FISHING SECTOR IN BRITISH COLUMBIA: Combined Employment Impacts (in person-years - fulltime equivalent positions)

	Commercial Harvesting[1]	Processing[1]	Sport Fishing[2]	Aquaculture	Total
Direct	7,300	5,700	**6,630**	1,000	20,630
Indirect	3,650	2,850	**4,950**	1,000	12,450
Total	10,950	8,550	**11,580**	2,000	33,080
% of Sector	33%	26%	**35%**	6%	100%

1 Economic Impacts of Fishing in B.C., May 1990, Fisheries Council of B.C.
2 Derived from The Economic Impact of Recreational Fishing: Draft Report, September 1992, Department of Fisheries and Oceans.

recreational fishing represents 35% of the total employment in the fisheries sector and is growing[1]. Commercial fishing dominates the catch of the two species of salmon that the recreational fishery is dependant upon taking 75% of all chinook and 80% of all coho landed in the province[2].

A small increase in the recreational catch, in contrast to the commercial catch, has a large net impact on the economy and employment in the province. Moreover, the recreational fishery operates on an expectation verses a volume basis. In other words, the total number of fish caught is less important than the expectation of catching a fish, whether or not it is landed. The fishery can be fine-tuned by resource managers through spot closures, catch limits, and gear restrictions. Also, there is an increased movement toward catch-and-release fishing and emphasis on alternate species (e.g. ground fish and sharks).

Future sustainable development of recreational fisheries in British Columbia is dependant upon adequate infrastructure, the cooperative management of sportfish species, and protection of ever-diminishing spawning habitat. In the southern Straight of Georgia region (the location of 70% of all marine tourism operators in the province) limitations on recreational boat access, mooring, and transportation are already becoming limiting. New cooperative, community-based salmon management plans that incorporate commercial, aboriginal, and recreational stakeholders could reduce confrontation and emphasize protection of the resource.

Ironically, population growth, one of the main reasons for growth of recreational fishing, is a threat to fragile coho stocks in the rapidly developing areas of southern Vancouver Island. The spawning grounds for numerous small coho stocks in hundreds of small streams, are threatened by degradation and pollution caused by residential and industrial development.

Coastal Experience Sector

The coastal experience sector of the marine tourism industry has developed significantly during the last half of the 1980's. Driving this development are trends towards increased fitness, leisure & outdoor activities, eco-tourism and recreational boat usage. Demographically, these trends were supported by an aging population with increased disposable income. Between 1985 and 1990 recreational boat registrations increased over 30%. As a result most forms of coastal experience activity have experienced annual growth rates of between 5% to 15% annually.

This sector of the Marine Tourism industry totals over $200 million in annual revenues. It can be sub-divided into direct coastal experience services accounting for

1 Marine Tourism and Recreational Uses of Oceans, SPARK Oceans Working Paper, summaries of DFO Survey of Recreational Fishing, 1992.

2 Vision Statement, Sport Fishing Institute, November, 1992

$48.9 million in revenues per year (eg power & sail cruising, wildlife viewing, scuba-diving, and kayaking); indirect or related coastal experience activities accounting for $37.8 million in annual revenues (eg marine attractions/clubs/schools, marinas and air services dedicated to marine tourism operators); and the cruise ships, both large and small ("pocket cruisers") which account for $115 million in annual revenue.

In British Columbia there are 165 private marinas and 210 small craft harbours. About 70 businesses offer short and overnight power cruises while another 50 provide

TABLE 11-4: COASTAL EXPERIENCE OPERATIONS: ESTIMATED AVERAGE ANNUAL REVENUE GROWTH & EMPLOYMENT

		Growth/Annum	Person Years/Annum
Direct Coastal Experience			
	• power cruising	8%	430
	• sail cruising	8%	215
	• wildlife viewing	13%	175
	• scuba diving	12%	70
	• kayaking	13%	75
Indirect Coastal Experience			
	• marine attractions	-	285
	• yacht clubs	7%	95
	• boat schools	9%	120
	• marine tourism air charters	10%	180
	• small craft harbours	5%	200
	• marinas	12%	1250
Cruising	• ships	10%	10,000
	• pocket	5%	1,000
Total		10%+	14,095

Sources: Marine Tourism in BC: Opportunity Analysis, ISTC,1991
Survey of Air Charter Operators, 1989.
Survey of Boating Schools, 1989.
Survey of Yacht Clubs, 1989.
Guide to Federal Small Craft Harbours
Burns & Co. Estimates

sail cruises. A further 50 operators specialize exclusively in wildlife tours, 26 in scuba-diving operations. 15 businesses offer guided kayak trips. In addition, there are 46 yacht clubs and 31 boating schools. Also about 20% of the Province's households own recreational boats and 43,000 US recreational craft enter British Columbia waters each year on multi-day trips.

Growth in the coastal experience sector of the Marine Tourism industry will likely

continue at 10% or more per annum. They are non-consumptive and represent sustainable options for British Columbia's coastal communities. The population and demographic trends that supported this growth will probably continue because British Columbia has become a mecca for the over-fifty age group, and "lifestyle" seekers. Infrastructure development will play a key role in the growth of this segment as more small craft facilities and better communications and safety systems will be required. Growth is susceptible however to continued loss of wildlife habitat, marine environmental disasters and coastline clear-cutting.

Marine Recreational Technology

Marine recreation products represent the fastest growing segments of both the marine communications and marine boat building industries. Although these industries are covered in the discussion of marine technology elsewhere in this report, it is important to note the linkage to Marine Tourism activities.

The annual worldwide market for marine recreational communications is $2.5 billion dollars[1]. Growth of this sector is fuelled by new developments in low-priced radio, satellite, and hydro-acoustic communications including the following areas:

- navigation & position indication;
- marine distress and safety systems;
- underwater communication systems for divers;
- underwater identification systems (detectors,sounders);
- underwater video of marine events;
- vessel traffic management systems.

Marine rec-tech products differ from other marine communication and transportation products in that they are sold into mass consumer markets and not the niche markets associated with most scientific, defence, and industrial applications for marine high technology products. Markets for recreational diving and boating communications are huge and worldwide. For example, the estimated world market for one British Columbian product is $100+ million. Currently, this is the only company in the world selling an inexpensive recreational, diver-to-diver, communication system.

Recreational technologies also draw from the marine transportation sector, where it is estimated that there are over 100 firms in British Columbia engaged in the design, manufacture, and repair of recreational boats, amounting to annual revenues of $100 million and 1500 annual full time jobs.

Other specialized manufacturing directly related to the Marine Tourism industry includes sub-sea recreational vehicles, specialized safety gear ("floater" suits), and rod and tackle manufacture. Another British Columbian company has developed a

[1] Marine Communications: Trade and Opportunities, Canadian Centre for Marine Communication, 1990.

personal recreational submarine, which weighs only 600kg, can dive to 90 meters, selling for the price of a sports car. Innovative recreational products like this are opening large new markets in tourist resorts, diving clubs, and personal use.

This sector is responsible for at least $125 million in annual revenues and 1,750 full time job equivalents. These figures have not been added to the overall Marine Tourism revenue totals, but have been added to the marine technology contribution. Again, growth rates for products in this sector are quite high, ranging from 5% to 15%+ per annum.

CONCLUSIONS

Marine Tourism and Recreational Technology manufacturing sales and services are rapidly developing sectors of the British Columbian economy with some unique attributes. They are potentially sustainable for the long term, and offer opportunities for employment and economic expansion in coastal communities suffering from a loss of traditional resource-based jobs. The province's coastal resources are unique and are internationally competitive as a destination. They are also under-utilized and tourism uses do not receive the focused attention that is necessary for orderly growth.

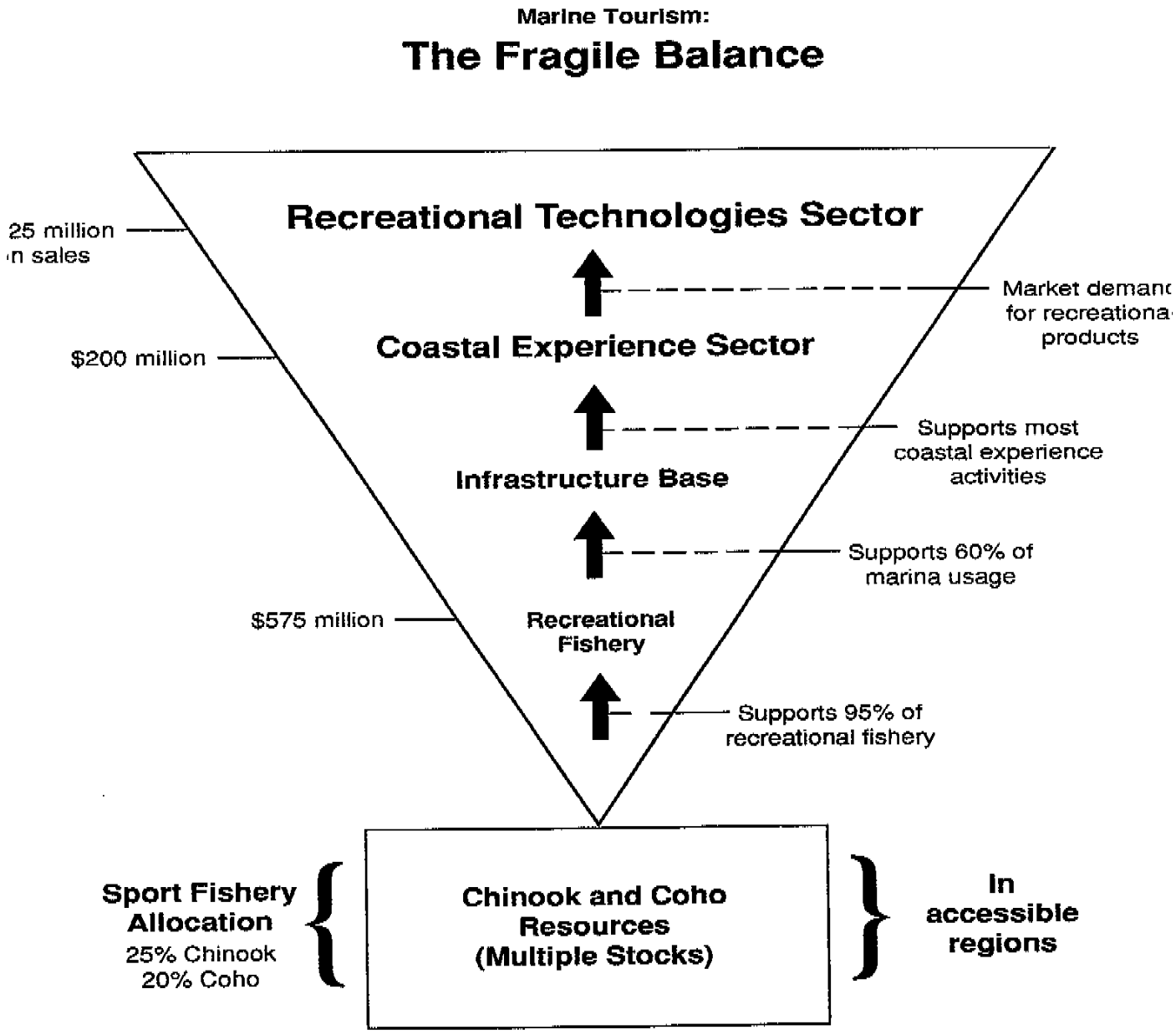
Future development of business opportunities associated with this industry are dependant on appropriate action to overhaul marine resource management systems. There is a timely opportunity for the development of sustainable management programs involving a balance of all stakeholder interests.

Government plays a key role in future development of the industry because they act as protectors of common property resources, and the arbiters of resource allocation. There is a need to overhaul out-dated resource management systems which have developed in an industry/stakeholder specific manner, and replace them with cooperative management systems that take advantage of **accountability** of local stakeholders in resource sustainability; **cooperation** between stakeholders to eliminate confrontation and to maintain resource sustainability; the **integration** of habitat protection and resource allocation; and provide opportunities to **tailor** marine resource management to meet local needs.

The need for action is immediate because the industry is threatened by over-exploitation of key recreational fisheries, degradation of irreplaceable habitat, and social conflict over use of our common marine resources.

Any overfishing in localized areas (of particular stocks) could lead to collapse and closure of these fisheries. This could have disastrous effects upon the Marine Tourism industry and the infrastructure it supports. No time should be wasted in developing a better information base for the management systems to protect British Columbia's marine resources.

FIGURE 11-5


Marine Tourism:
The Fragile Balance
Recreational Technologies Sector
25 million
n sales
Market demand
for recreational
products
Coastal Experience Sector
$200 million
Supports most
coastal experience
activities
Infrastructure Base
Supports 60% of
marina usage
$575 million
Recreational
Fishery
Supports 95% of
recreational fishery
Sport Fishery
Allocation
25% Chinook
20% Coho
Chinook and Coho
Resources
(Multiple Stocks)
In
accessible
regions

Collapse of the key recreational fishery stocks of chinook and coho is a possibility. Ocean-going steel-head trout have already been severely depleted and many coho stocks reliant on small spawning streams in southern Vancouver Island are in decline.

Decline of the recreational fishery poses a major threat to the Marine Tourism and Recreational Technology industry in British Columbia.
The results of this study indicate there is a need for integrated Coastal Zone Management to ensure, sustainability, protection of the resources, amenity values and development of the infrastructure required for continued growth of marine tourism. Also, Coastal Zone Management Plans need to be developed in conjunction with the economic diversification initiatives being undertaken by coastal communities in British Columbia.

There is an excellent opportunity to develop a thriving recreational marine technology industry in British Columbia alongside the growth of Marine Tourism. The markets for recreational technologies are mass retail markets that are growing steadily in North America and Asia-Pacific.

Recommendations on Sustainability

- As part of sustainable coastal management initiatives in the southern Georgia Strait, urgent priority must be given to the protection and rebuilding of coho stocks through long-range habitat protection. License fees from marine recreational fishing should be directed toward chinook and coho habitat enhancement and not general government revenues.

- The Department of Fisheries and Oceans, in conjunction with the recreational fishing industry, should develop an official catch and release program with associated awards/prizes for competitions based on live weight measurement.

- The feasibility of promoting new sport fisheries based on underutilized species (e.g. "dogfish" angling could be marketed as "shark" fishing, which is popular in many marine recreational fisheries outside of British Columbia).

- Fishery managers should use appropriate technology to improve information on the distribution and abundance of sports fish, ground fish, marine mammals, and marine invertebrates.

- Within an integrated framework of coastal management, specific coastal areas for recreational fisheries need to be identified and certain coastal locations need to be protected from resource harvesting to allow recreational scuba diving.

- Within Coastal Zone Management, habitat protection for key marine species should be emphasized and clearcutting of the coastal viewscape and waterways eliminated.

Recommendations on Community Development

- Within a framework of integrated Coastal Zone Management, recognize that coastal communities play a key role and that communities are best situated to solve local issues regarding resource allocation, development, and infrastructure.

- The present level of education, numeracy, and literacy in coastal communities may limit the acquisition of the skills important to the realization of sustainable management and the skills needed to participate in the business of tourism. Urgent attention should be given to human resource development and training in the context of coastal tourism and sustainability.

- Information on the economic and employment value of tidal sport fishing and marine wild life must be refined to permit and encourage a better understanding of the contribution of the sport fishery and wildlife viewing to coastal communities.

- The Community Futures Program of Employment and Immigration Canada should be used by coastal communities to develop local marine tourism strategies.

- First Nations communities and programs related to fishery co-management and stewardship should be made aware of the potential of Marine Tourism to contribute to economic diversification.

Recommendations on Policy Development

Under the Oceans and Coastal Commission umbrella:

- Form an industry, inter-ministry, and interdepartmental committee to foster sustainable development of the marine tourism sector in British Columbia by ensuring that the sector is adequately represented in resource allocation decisions.

- Undertake research to identify specific areas where recreational fisheries (for chinook and coho) should receive priority for integrated management.

- Fisheries management under the Department of Fisheries and Oceans should devote a similar priority to the needs of wild coho salmon as are devoted to the commercial species of salmon.

- Foster development of a comprehensive organization representing marine tourism and/or a flexible network initiative to represent the interests and needs of marine coastal experience operators.

- Develop and deliver the educational and training programs required to provide the skilled human resources for sustainable development of the marine tourism industry.

- Enact community Port Authority Program Legislation to provide for effective local planning, development management of the harbours and ports of the coastal communities.

- Develop a regional approach to commercial fish licensing and attempt to minimize mixed-species harvesting practices that lead to reduced biodiversity and extinction of small stocks.

Recommendations on Infrastructure

- Integrate the communication infrastructure requirements for marine tourism into the Green Plan - Marine Environmental Emergencies Response Strategy (MEERS) and ensure that MEERS can protect high-value marine tourism regions and resources.

- Provide incentives for private industry to develop the infrastructure (e.g. moorage access ramps and associated facilities) for recreational activities.

- Encourage coastal communities to develop plans for marine environmental conservation and accidents associated with greater recreational marine traffic.

Recommendations on Recreational Technology

- Industry and governments should focus on the product needs of markets in marine recreational technologies. These markets are strong and are supported by extensive retail sales outlets.

- The innovation of British Columbia-based technologies related to marine tourism (e.g. hydro-acoustic sport diver communications systems, electronic sport fishing, boating clothing and safety technologies) should be encouraged.

- The feasibility of a rec-tech flexible network to market British Columbia's expertise in this area should be investigated.

- The inherent suitability of British Columbia for expansion of Recreational Technology manufacturing and sales (healthy domestic and international markets and outlets, a tourism industry, a diverse technological base and small entrepreneurial companies) suggests that there is considerable potential for growth in this area of innovation, manufacturing, and retail sales.

12.0 MINERAL RESOURCES

Introduction

The ocean basins of the earth are a huge reservoir of minerals of great potential economic value to mankind. These deposits include aggregates, placers, manganese nodules, phosphorites, oil and gas, hydrothermal deposits, ferromanganese, oxide crusts and precious corals. Only limited exploration for these minerals has been carried out on continental shelf areas and on the high sea floor. However, several countries have exploration and technology development programs underway. Deep seabed mining interests have largely pursued manganese nodule concentrations on parts of the Pacific sea floor. There is much more activity within the Exclusive Economic Zones of maritime nations, with extraction of sand and gravel, corollaceous deposits for fertilizer, and gold placers by many countries.

12.1 MINERALS ON THE OCEAN FLOOR

Aggregate deposits of interest to British Columbia

There are known occurrences of sand and gravel all along the British Columbia coast, especially at or near river mouths. The Fraser River Delta is one large sand and gravel deposit in close proximity to the large Vancouver aggregate market. There are suitable sediments in the Queen Charlotte Islands. Some sources are too far away from any major markets to be considered economic in the near term; however, any large-scale coastal projects such as oil and gas exploration would create an instant market.

At present, there is insufficient information to establish an inventory of aggregates off the British Columbia coast. Programs for the future should attempt to identify major aggregate deposits and give indications as to deposit size, material's size distribution, and carbonate and silica contents. These programs should also identify environmental concerns related to exploitation, and carry out preliminary environmental assessments of possible development.

Utilization

In British Columbia land-based operations account for all the present aggregate supplies. There is little information on the ocean mining of aggregates in British Columbia, although two large scale operations dredged aggregates from the ocean floor for use in constructing the Roberts Bank coal terminal near Vancouver and the Ridley Island terminal in Prince Rupert.

At present, coastal aggregate deposits are not being investigated for a number of reasons, including:

- Lack of concise geological information concerning ocean deposits
- Dredging costs tend to be higher than drilling and blasting costs.
- The relatively unselective nature of dredging (i.e. you can't see what you are picking up).
- Good availability of land-based sources.
- Quality control problems associated with marine operations.
- Department of Fisheries could make permitting difficult.

The advent of ROV and AUV technology may change the economic factors that have inhibited subsea aggregate mining. The marine mining of aggregates is a question of economics, influenced by environmental and geographic considerations. The following sequence of utilization illustrates this:

- As communities grow, the demand for aggregate grows.
- New aggregate-producing facilities open near the market to satisfy demand.
- Urban growth gradually encroaches on land-based operations. Their expansion become impossible, and subject to major constraints.
- People complain of dust, noise, eye sores, and traffic associated with land-based aggregate production.
- Increasingly, restrictive by-laws force facilities to move farther and farther away from markets.
- Acute shortage of aggregates develops. Prices rise.
- Public sentiment changes. Production of aggregates from the ocean becomes an acceptable option.
- An environmental regulatory structure is required to protect marine environment.

The geographic influences on pricing are considerable. In the Lower Mainland, prices currently range from $5.50 per tonne to over $10.00 per tonne for special product. Transportation adds significantly to the cost of aggregates because they are a bulky, low-value commodity. A 1990 study determined that construction of an average 1500 sq ft. house requires about 114 tonnes of aggregate. In addition to this, ancillary structures such as roads, public buildings, and shopping centres require another 214 tonnes of aggregate per home. This totals 328 tonnes per home (constructed).

Ocean mining for aggregates is occurring and expanding on a global basis. Japan and the United Kingdom are world leaders. Each produces over 70 million tonnes per year from offshore sources. (Contrast this with British Columbia's total production of roughly 50 million tonnes.) In Japan, a total of 540 vessels were involved in offshore aggregate mining in 1988. Environmental and fishing concerns can be put into perspective when it is realized that the UK extraction requires only 9 sq km of the sea floor in any one year. It is reported that their costs are comparable to land-based operations in those countries.

In the UK, the offshore sand and gravel industry has grown rapidly in the last 10 years, and a systematic mapping program has delineated all sand and gravel deposits in their EEZ.

Ocean mining of aggregates has some advantages over land-based operations:

- Marine transportation costs are much lower than land transportation costs. Barges can usually deliver directly to distribution centres, which are often on waterfronts;
- Land reclamation is not required;
- No dust, noise, traffic, or other environmental problems in neighbourhoods;
- Does not involve valuable land which is more cost-effectively used for urban or recreational development;
- Deposits are so large that depletion is unlikely.

Given British Columbia's numerous known offshore deposits of aggregates and the existence of successful operations in other countries, it is reasonable to suggest that there is excellent aggregate potential in British Columbia that will be utilized as the population grows and pressures on terrestrial resources increase.

Placer minerals

Placer minerals are metallic minerals or gems generally found on beaches and near shore areas. They are resistant minerals that have been liberated by the breakdown of their parent rock, and carried into the ocean by natural erosion. All placer deposits occur within the EEZs of coastal nations. Placer mining for gold and various minerals on beaches and river banks has a long history and occurs yaround the world. Mining of placer deposits in offshore zones, however, is less common. There is considerable offshore placer mining of gold and tin in southeast Asia. The largest offshore placer operation in the world produced gold off the shores of Nome, Alaska between 1987 and 1991. This operation is well documented and cited by experts in the field as the best example of a commercial offshore placer mining that gave considerable attention to environmental impact assessment and local

employment. The developers were committed to responsible exploitation from the start. As a result, they developed a good rapport with the Environmental Protection Agency, special interest groups, and native peoples. Substantial environmental monitoring was carried out and regulations setting standards in the US were enacted as a result. These regulations could be the basis for equivalent environmental standards in British Columbia.

Exploration of the British Columbia coast has, until now, been mostly limited to qualitative (i.e. reconnaissance) methods. Three speculative occurrences of gold, thought to cover a large area, are know to exist off the southwestern tip of Vancouver Island. Other speculative gold deposits have been identified in the Queen Charlotte Sound, Hecate Strait, and the northeastern tip of Graham Island.

Three large occurrences of heavy minerals have been located between Vancouver Island and the Queen Charlotte Islands. These sediments cover hundreds of square kilometres, with heavy mineral concentrations of between 18 and 28 percent by weight. Sampling to date has been spotty. The most significant sediment components are the titanium minerals Ilmenite and Sphene. Zircon, Garnet, Magnetite, and Rutile are also present to a lesser degree. Shallow drilling into the sea floor has indicated that heavy mineral enrichment extends into the sea floor by at least several metres. These deposits compare favourably with those of mined beach deposits in eastern Australia. Australian companies have expressed interest in the British Columbia deposits but have been discouraged by the federal government's refusal to issue mineral leases.

In short, British Columbia has excellent offshore placer mineral potential; however, much more sea floor mapping, detailed exploration, and environmental impact assessment are required before extraction is possible. Such detailed work can only be done by the private sector. However, inter-governmental jurisdictional disputes and a lack of clear guidelines and regulations to govern such exploration and development activities inhibit any interest by the private sector in funding exploration.

Mineral Deposits

Although very little exploration has been carried out, already several very significant deposits of titanium minerals and metallic sulphide ores have been identified. Significant titanium deposits have been located in the Middlebank Sound, Broughton Archipelago and Graham Island areas. In addition, the Ocean Drilling Program (ODP) activities have identified thick metallic sulphide layers on the West Side of Vancouver Island. (See Chapter 5 reference to ODP)

If native land claim and federal and provincial jurisdictional issues can be resolved and, and the economic and investment climate is suitable, these deposits could provide major opportunities for extraction and processing. However, further exploration and characterization is necessary.

Manganese nodules

Manganese nodules are discussed here because global interest in these deposits may well present considerable market opportunities for Canadian subsea technology. Manganese nodules are potato-sized and contain high concentrations of manganese, nickel, copper, and cobalt. They are formed *in situ* on the sea floor and occur in deeper waters, commonly around oceanic islands. The only known occurrence within the British Columbia EEZ is in Howe Sound. These nodules are low in nickel and copper content and are therefore not seen to be economic in the near future. Manganese nodules have been recently discovered within the EEZs of some South Pacific Island nations, as well as that of the United States, and are considered more attractive than the British Columbia nodules due to their relatively high content of nickel and copper.

Interest in ocean mining developed in the late 70s and early 80s, and was focused on manganese nodules. During the late 70s, three pilot programs were undertaken by three different consortia. Since that time several countries around the world have maintained research and development programs in the field - notably Germany, France, India, Japan, Korea, Russia, and Finland. In the United States, the ocean mining consortia of the late 70s have reduced their activities.

By far the most successful pilot mining test on manganese nodules was carried out in 1978 by Ocean Management Inc. (OMI), an international consortium made up of American, Japanese, Canadian, and German researchers. The test represented fourteen years of careful planning. OMI converted the drill ship *Sedco* into a high-tech ocean mining machine which, during tests, recovered over 800 tonnes of manganese nodules from the sea floor south of Hawaii at depths over 5000 metres. This pilot operation clearly demonstrated the technical feasibility of deep sea mining. However, numerous technical problems would still have to be overcome before a commercial scale manganese nodule operation would ever come into play.

Recently, the Korean government has developed a thirty year strategy (to 2010) for deep sea mining, focusing on manganese nodules. This strategy involves cooperation with the U.S. Geological Survey, the enactment of laws governing offshore mining, the construction of a special research vessel, and an advanced technology program for mapping and sampling the seafloor. This program is motivated by the importance of minerals to Korean industry, and the lack of mineral resources within Korea.

12.2 OFFSHORE OIL AND GAS POTENTIAL

The coast of British Columbia and the Beaufort Sea[1] exhibit excellent potential for

[1] Many Beaufort Sea scientific and exploratory activities have involved British Columbia-based institutes, laboratories, and companies. The Arctic region provides opportunities for British Columbia-based marine industry, science and technology.

future oil and gas production. Continental shelf basins hosted by sandstone and carbonate rocks are usually targeted for exploration. Such composition occurs in the Queen Charlotte and Tofino basins along the British Columbia coast.

Exploration of British Columbia's waters began in 1958 when Richfield Oil Corporation drilled six onshore wildcats on the northeastern tip of Queen Charlotte Island. In 1963, Shell Canada began an exploration program which involved geologic mapping, aeromagnetic surveys and reflection and refraction seismic surveys. Between 1967 and 1969, Shell drilled 14 wildcats. Of these wells, eight were drilled in the Queen Charlotte basin and six in the Tofino basin. Minor shows of oil and gas were encountered in the Late Tertiary sediments in four out of eight wells drilled in the Queen Charlotte basin. In 1970, Shell entered into an agreement with Chevron Canada Resources Ltd., whereby Chevron would earn interest on Shell's offshore areas.

In 1972, the federal government imposed a moratorium to prevent crude oil tankers from travelling through Dixon Entrance, Hecate Strait, and Queen Charlotte Sound en route from Valdez, Alaska. A subsequent federal Order-in-Council indefinitely prohibited any further drilling in these waters. In 1981, the Province of British Columbia reinforced the moratorium when it placed an indefinite moratorium on offshore exploration in Johnstone Strait and in the Straits of Georgia and Juan de Fuca. As of September 1992, all of these moratoria are still in effect. They inhibit private sector involvement in sea floor exploration off the British Columbia coast.

At present, there is insufficient deep seismic data to properly interpret and understand the structural make up of the basins in British Columbia waters. Much more drilling is required in order to assess British Columbia's offshore hydrocarbon potential.

In contrast, an extensive knowledge base is being developed on the sea floor and continental shelf off Eastern Canada. This has brought many benefits in knowledge, technology, and employment in oil and gas exploration and some commercial exploitation in Nova Scotia. The commercial production of offshore crude oil in Canada began flowing in June 1992 from a rig 256km southeast of Halifax. The project is located in the Cohasset-Panuke oil field and is operated by Lasmo Nova Scotia Ltd. an independent oil company. While progress in the much larger and highly publicized Hibernia oil fields has been stalled by depressed oil prices, Lasmo expects the Cohasset project to be profitable with crude prices in the US$15 to US$20 per barrel range. This shows that a small project with tight management, in an environmentally sensitive area, may well be able to turn a profit where its "mega-project" counterparts may have higher costs.

The potential for offshore hydrocarbon development in British Columbia

Although the moratorium has prevented additional exploration in the West Coast

offshore, this area has technical potential for significant oil and gas reserves. For example, the Queen Charlotte basin, if proven to be oil productive, could contain pool sizes the magnitude of the North Sea or Alaska North Slope dimension.

Existing estimates of undiscovered oil potential range from 300 - 500 million barrels in the British Columbia offshore. Portions of this region also contain significant potential for natural gas. Natural gas volumes are estimated to equal the 20 TCF discovered in the province to date.

Although there may be no short-term need for these resources, they are of strategic significance to Canada and should be fully documented. This knowledge would then allow discussion of their socio-economic relevance to the coastal economy of British Columbia, and their inclusion in long-term planning to ensure that environmental social and cultural values are respected if and when society decides that they need access to these resources.

A research and development fund

One interesting feature of the lease allocation in the Norwegian North Sea sector was the establishment of an R&D fund to which foreign license holders paid 3% of their total development costs. This R&D fund has played an invaluable role in funding Norwegian R&D on a wide range of high-risk, new technology developments, including ocean and environmental technologies, aquaculture development and marine engineering projects. If a 500 million barrel development took place in British Columbia and an equivalent fund were established it could yield in excess of 100 million dollars for high-risk R&D by Canadian-based companies.

The relevance to coastal communities

The present socio-economic situation in many British Columbia coastal communities is not dissimilar to the situation in Scottish, Norwegian, and Shetland communities when North Sea oil development was launched. They were facing a decline in traditional sources of employment and were looking for opportunities to shift employment and training towards a higher technological content. To a great extent, this has occurred. Subsequent to the oil and gas development phase, the economies of these communities are much more diversified, with higher levels of skills and new technology-based companies.

The marine environment and offshore development

The mention of oil and gas exploration or submarine mining can elicit doomsday prophecies. Objective analysis indicates that oil and gas offshore developments can be carried out with minimal environmental risks or interference to fishing, aquaculture, or tourism activities. Adequate environmental protection rests with increasing our knowledge base and developing technology which will allow for responsible exploitation. To date, very little research has been done on the effects of ocean mining on the environment. In contrast, considerable environmental

assessment and planning work has been done with regard to oil and gas exploration and production off the British Columbia coast. Inadequacies in our knowledge have been identified and it is estimated that it would take five years of further research to fill in the gaps in our baseline knowledge. A Preliminary Environmental Assessment of Offshore Hydrocarbon Exploration and Development was prepared by a West Coast offshore exploration environmental assessment panel in 1986. This report provides the basis for further development of comprehensive environmental regime. The ability to control and manage the impacts of offshore exploration and development is dependant on the ability to predict with accuracy the effects of such activities. Oil and gas industry experience in Scotland, Norway, the Beaufort Sea, Nova Scotia, and Alaska has confirmed that impacts can be predicted from baseline data, and that offshore development can be carried out with minimal impacts.

In attempting to determine impacts, data must be collected over a long period of time. Collection of information over inadequate time spans can lead to inaccurate prediction. Natural variability (such as cyclical population changes of various organisms) can lead to erroneous predictions. It is for these reasons that the United Kingdom has not applied traditional impact assessment to offshore exploration or production. Analysts there have concluded that expensive, long-term baseline studies are impractical and have placed emphasis on monitoring the elements at risk while development is under way. Similarly, the Norwegian government has focused on marine pollution and monitoring of industry activities.

In Canada, the primary regulatory agency for oil and gas activities is the Canadian Oil and Gas Lands Administration (COGLA). The Department of Fisheries and Oceans also requires that industry provide the information necessary to evaluate the risks to fish and fish habitat. DFO then has a responsibility to minimize or eliminate any such risks.

A formal Environmental Impact Statement (EIS) would be required. The new Canada Oil and Gas Act also has far reaching and comprehensive provisions that relate to all aspects of offshore development including environmental impacts, liability and compensation.

We are currently in a unique position. We know that some day it will become economically feasible to extract gas and minerals from our oceans. We should not wait until economic pressures (such as increased oil and gas prices) force governments and scientists to quickly address the associated environmental issues. These issues should be addressed now within a comprehensive framework that will help to ensure the responsible exploitation of our marine resources.

The roadblocks to realization

The primary roadblocks to exploratory and knowledge gathering activities and discussion of any further options are the federal and provincial moratoria of 1972. These have a general impact in inhibiting the strategic exploration of our continental

shelf and its resources.

The jurisdictional issues between federal, provincial, and native governments, concerning ownership of the sea floor and associated resources must also be resolved. Environmental guidelines and an umbrella regulatory authority to oversee and manage mineral or hydrocarbon development can then be put in place.

The strategic evaluation of offshore oil, gas, and mineral resources by British Columbia and Canada requires:

- Lifting of the existing moratoria on exploration.
- The exploration of our continental shelf area, and mapping and documentation of the offshore environment and its resources.
- The resolution of jurisdictional issues related to the sea floor, jurisdiction in environmental impact assessment, and native land claims.
- The implementation of integrated and sustainable environmental management plans for the Western Canadian Exclusive Economic Zone that recognize the needs of exploratory and development activities.

12.3 PACIFIC RIM OFFSHORE OIL AND GAS DEVELOPMENTS

In the 1970s and 1980s the Gulf of Mexico and the North Sea in Europe saw major offshore oil and gas developments with small scale offshore activities ranging from the Beaufort Sea to Australia and Africa. In the 1990s, the action has shifted dramatically to the Pacific Rim.

In Asia-Pacific, more than 260 new offshore platforms will be needed by 1997, and an 8,000km Trans-ASEAN pipeline is being planned. The major fields, ranging from Sakhalin Island in the north, to Sarawak are summarized in **Table 12-1** and **Figure 12-2**. These exploration and production activities have been financed largely by Asian Pacific countries as part of a long-term strategy to achieve independence from Middle Eastern sources of petroleum, to sustain their rapid economic growth. They also see gas as a clean, environmentally acceptable, alternative to coal.

In addition to Asia-Pacific, the State of Alaska has recently leased large tracts in Cook Inlet near Anchorage (for $65 million) for exploration and development. These finds are among the largest Alaskan discoveries. They are estimated at 230 million barrels of oil and gas equivalent, resulting from the use of new geophysical technology in exploration.

These Pacific Basin developments provide a huge opportunity for Canadian expertise in many of the marine and environmental technologies and engineering services that are required in support of such offshore activities.

TABLE 12-1: Southeast Asia Offshore Oil & Gas discoveries in the 1990s and estimated size[1].

Area	Estimated Size of Find		Wells Drilled/Discoveries in 1990
	Oil Millions of Barrels	Gas Trillions of cu. ft.	
Australia Timor Sea			87/55
China	3,000+	5.0	390/55
Indonesia (Natuna Sea)	225	Very large 50+	145/?
Malaysia Sarawak	3,000+	59	?
Gulf of Thailand	25+	20	?
Vietnam (Dai Hong)	400+	Large	51/?
Russia, Sakhalin Is.	?	Very Large	?
TOTAL	Very High	165	

[1] Based on information from Offshore, November, 1992.

RECOMMENDATIONS

- An integrated regime for the sustainable management of the Western EEZ should be put in place. This will require the coordinated efforts of all levels of government and all groups with marine interests.

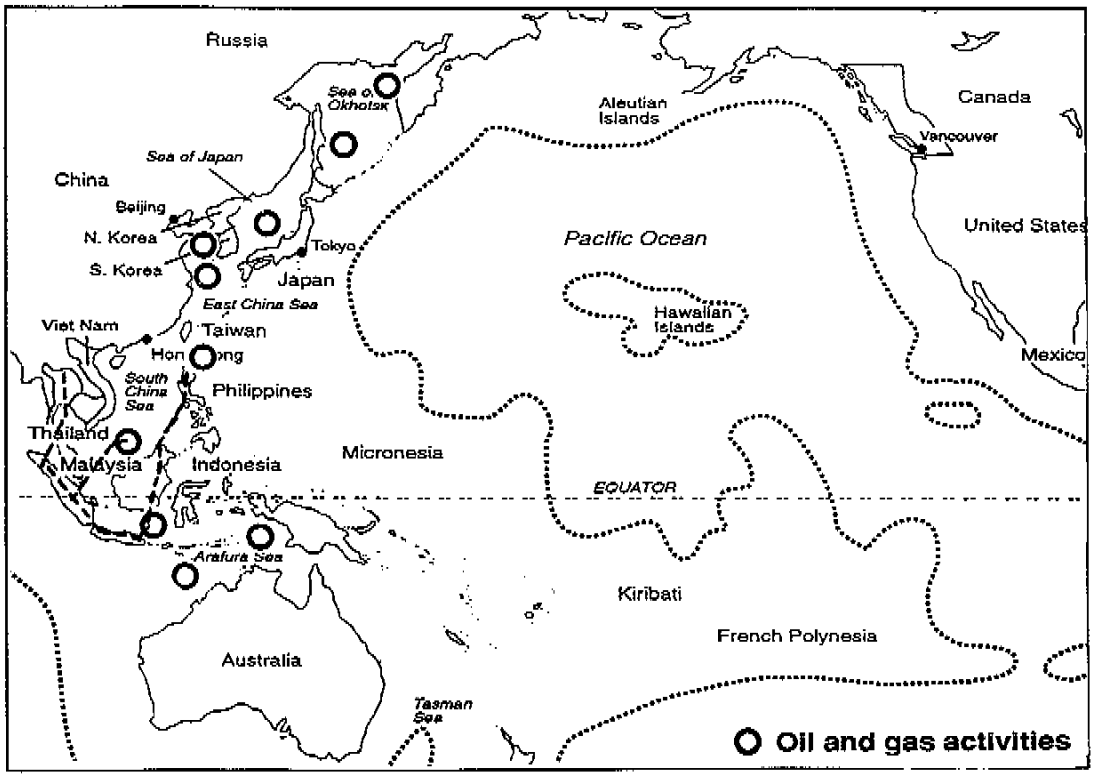
- The governments of British Columbia and Canada should cooperate to carry out the mapping and exploration of the Western EEZ for strategically important non-renewable resources and to document the biological resources, their biodiversity, environmental processes and sensitive areas.

- The recommended Oceans Coordinating mechanism should work towards establishment of a comprehensive environmental and management regime to govern offshore exploration and later on development activities.

- The governments of British Columbia and Canada are urged to cooperate with the marine technology and oil and gas technology communities on a strategy to develop markets for Canadian skills expertise and technology in Pacific Rim offshore activities.

- To facilitate the above, the existing federal and provincial moratoria on offshore exploration need to be lifted.

FIGURE 12-2 Asia-Pacific offshore oil and gas activities in the 1990's



Offshore Production Locations include: Russia (Sakhalin Is.), China, Vietnam, Thailand, Malaysia, Indonesia, Australia, and Myanmar.

Proposed trans-ASEAN gas pipeline linking the Philippines, Borneo, Java, Sumatra, Malaysia, and Thailand would be 8,000km long.

The drivers behind these new offshore activities include the need for energy independence, high annual GDP increases, high population density with increasing aspirations, and the environmental advantages of gas over other energy sources.

13.0 TRANSPORTATION AND LOGISTICS SERVICES

The Canadian gateway to the pacific

Throughout history, advances in technology have enhanced the value of oceans as a resource and as an opportunity for commerce. Advancing technology to realise the resource, communications, and transportation potential of the Pacific is a challenge and opportunity for Western Canada.

Canada can use its strategic location in the Pacific to advance its transportation and logistics service industries and its industrial base. The West Coast of Canada is strategically located on a great circle route from Asia to North America and acts as a gateway for interaction and commerce with Asia.

To take full advantage of this strategic location in North America requires supportive policies and programmes that recognize the importance of advanced technologies in increasing the efficiency of ocean transportation to and from the West Coast of Canada.

Transportation services and logistics systems

The movement of goods is no longer done in stages, each at least cost. Modern goods Transportation is an integrated logistics system coordinating inland transportation, port handling and shipping. Many different services and technologies are involved in the actual movement of goods. The quality and expense of each, and the efficiency of links between them determine the performance of the system.

Transportation services today are directed at serving the needs of end users, and are increasingly customer-oriented. The quality of service, especially service reliability, is a vital characteristic of competitive transportation systems. To be competitive, the best available technology is required at each stage.

The challenge is to provide improved, consistent logistics services. Therefore, new opportunities may exist for value-added logistics services.

The integration of transportation and related logistics services into systems has resulted in a greater importance being attached to the integration of transportation chains than ever before. For example, information and freight handling and transportation systems are designed to interface more effectively for the rapid and reliable throughput of freight. The efficiency of terminals becomes important since they are the throughput facilities of the system.

Services linked by common ownership or by contractual arrangements are common. Such services may be viewed as an integrated logistics chain within a system or

network.

The role of support functions

Individual logistics chains are supported by a variety of facilities and services that are provided in common to chains. Customs clearance services, for example, are required for all imports and exports. Port authorities may be involved, in part, in the provision of terminal and other chain specific activities or services. However, they also seek to promote or to provide facilities and services which enhance logistics services to port users generally. Services which have economies of scale or those that benefit from a diversity of users, warrant special support from a port. For example, electronic data interchange (EDI) is a technology that is facilitating major changes in logistics systems. As the value of EDI technology is increased by the size of the network, common-user networks will be preferred over proprietary systems. Therefore, port authorities need to be proactive in the development of common-user EDI systems.

The formation of an EDIPORT Pacific complementing the EDIPORT Atlantic in Halifax is necessary for Western Canadian systems to remain competitive in international transportation. Efforts towards this goal were started at least four years ago with the establishment of CANSIF, an intermodal users' group. The purpose of CANSIF was to lead the community towards the use of EDI. Since then, however, momentum has been lost. British Columbia has fallen behind competing ports and systems (most notably its closest large competitor: the port of Seattle) in the deployment of EDI.

The Vancouver Port Corporation must be credited for organizing a recent public forum on the subject of EDI. The task of moving forwards on EDIPORT Pacific is a complex one requiring the education, coordination, and input of all the players in port transportation systems, including: port authorities, terminal operators, freight forwarders, shipping agents, tracking, railroads, Canada Customs, and other federal agencies such as Agriculture Canada. It is important that the EDIPORT Pacific discussions and implementation be given a top priority by all concerned because of its strategic significance to the future competitiveness of marine transportation into and out of British Columbia.

Competitiveness and technology

The competitiveness of Canadian transportation and related logistics services is dependant on developing leading-edge technology in transportation and logistics chains, and in the facilities and services that support those chains. Aggressive strategies to search out tomorrow's solutions today are required. Port authorities might seek to benchmark local terminal performance against the best in the world, so that there can be an accurate assessment of where we stand and what our goals should be.

Technology and transhipment terminals

To compete in today's global markets, terminals need to keep abreast of competitive developments elsewhere. Today's terminals must incorporate leading-edge technology and engineering that provides:

- high reliability;
- space-saving in coastal areas where land is at a premium and cost are high;
- low capital costs;
- low operating costs;
- minimal product damage and attention to product quality;
- no product contamination;
- flexibility sufficient to handle today's needs as well as those of the future.

The major technological issues and trends in terminal design are outlines below.

Containers

Containers and container handling technology have revolutionized the handling of general cargo. Container handling continues to be improved by new technologies. The next step will be movement towards semi-automated, and fully-automated container handling. This automation will provide additional opportunities for the deployment of EDI technology in our ports and terminals.

In addition, shipping certain dry bulk commodities in containers, significantly reduce the environmental impacts and nuisance associated with bulk cargo.

Lumber

In they past three decades lumber shipments out of the West Coast have moved from loose to 100% packaged products. This has been accompanied by an increase in the average size of ships and use of modern open-hatch bulk carriers. The EuroCan terminal in Kitimat and the Lynnterm facility in Vancouver are good examples of large consolidated forest product facilities. However, these facilities continue to operated with mobile equipment and a high level of labour. The next stage in development is likely to be automated handling and the use of cranes and trolleys.

The Bulk Terminals

In the 1960s, the volume of sulphur from Alberta, Potash from Saskatchewan, and cooler concentrates being shipped to Japan increased greatly. This gave rise to the "dry bulk" intermodal terminals that handle most of the volume of resource-based raw materials that are shipped in and out of Canada through British Columbia ports each year (in excess of 50 million tonnes per year).

Increasing volume, and the greater range of products which require high-quality control, pose a challenge to the competitiveness of bulk terminals. New investments and engineering ingenuity will be required if present estimates by the Vancouver Port

Corporation are to be met. Increased volumes are expected at the following terminals:

- **The Potash terminal**
  Potash from Saskatchewan has major markets in China. As the Chinese population increases and becomes more self-sufficient in agriculture, more potash will be required as a fertilizer component. Considering that China has almost one quarter of the world's population and one seventh of the world's agricultural land. The increased shipments via British Columbia could be substantial.

- **The Sulphur Terminal**
  Sulphur, which is a by-product of natural gas production, has uses as chemical feedstock as well as being a component of agricultural fertilizers. Exports are likely to increase in line with potash and natural gas exports.

- **Petrochemicals**
  Petrochemicals from Alberta are a value-added commodity and exports are likely to increase driven by the rising affluence and population of Asia.

Pulp and Paper

In the last thirty years, pulp and paper handling has improved in parallel with that of wood products. Newsprint and kraft paper are highly sensitive to damage, so there has been an ongoing search for optimal handling techniques that reduce handling costs and damage.

In general, systems in use in British Columbia are semi-automated, but fully-automated systems are under development.

The Ocean Transportation of People

The ocean transportation of people in British Columbia has two basic components a) the marine ferries and fast ferries, and b) the marine tourism industry.

- **Ferry Systems**
  An overview of the trends in local and international ferry systems for transporting people is beyond the scope of this report, but some of the relevant enabling technologies are treated in other sections. Suffice to say that recently there has been important innovations in fast ferry systems. As coastal populations increase the demand for such systems can be expected to increase.

  The British Columbia Ferry Corporation provides drive-on/drive-off freight and passenger service on 24 routes between the Lower Mainland, Vancouver Island, and other coastal points. During the year ending March 31, 1991, the corporations carried 19.8 million passengers and 7.7 million vehicles, making BC Ferries one of the largest marine ferry networks in the world. As such, BC Ferries has the potential to be a very important base or "engine" to develop and

test a wide range of new and advanced technologies that may assist the efficiency or safety of ferry operations. The BC Ferries network could also be considered as a showcase for local innovative technologies that would assist British Columbian companies in accessing emerging Pacific Rim markets in ferry system technologies.

Australian shipbuilders have targeted Asian ferry services as a growth area[1]. There may be opportunities for British Columbian companies to develop niche market opportunities in servicing the growth of Asian ferry system.

- **Ocean Tourism**
  This topic is dealt with in the Marine Tourism Section. Tourism in British Columbia is a rapidly growing industry. However, the coastal infrastructure for docking cruise ships and pocket cruisers outside of the Lower Mainland and Victoria is a limiting factor, as is the infrastructure for sport fishing and coastal experience activities. Sport fishing is very heavily concentrated in the southern Strait of Georgia. The development of this infrastructure poses questions of coastal land availability and the need for integrated planning of the coastal transportation to allow people easy access to pursue marine activities of their choice.

The Ports of British Columbia

The port of Vancouver is the largest dry cargo port on the North American Pacific coast. Most of the international shipping in the province is handled through Vancouver, Prince Rupert, and the Fraser River port. However, shipping also takes place at a number of other harbours, including Nanaimo, Port Alberni, Campbell river, Powell River, Kitimat, Stewart, and Squamish.

These ports and harbours come under various federal or provincial jurisdictions. Many are competing with others for trade. There is no one agency with responsibility for managing all activities. It was therefore extremely difficult to get an accurate picture of the use of these ports, their technological and developmental needs, and of the impediments which prevent them from realizing their key role in the transport of goods and people. However, some issues emerged very clearly:

- There is a need to monitor the overall trends in ports and harbours activities on a province-wide basis. This will produce a clear picture of their capacity to provide an adequate land/sea interface for future ocean-related activities, especially wealth creating activities relating to marine transport, tourism, and recreational use of oceans, fisheries, aquaculture, and other ocean resource development and management activities.

[1] Oceans of Wealth?, 1989. A report by the Review Committee on Ocean Industry Science and Technology, Australia.

- They all face challenges in upgrading their capacity to provide future services, and in their competitive delivery of these services. Their efficiency and capabilities can have a significant impact on other industries that distribute goods to global markets.

- These ports also provide a focus for conflicts over coastal zone uses. Under the present complex and confused coastal administrative structure, they may have to deal with as many as sixteen federal agencies and fifteen provincial agencies, each with administrative mandates under different acts and regulations. Many examples emerged of difficulties in getting environmental permits for upgrading and modernizing facilities, dredging sediments, controlling waste disposal, and managing hazardous goods. This situation must be changed so ports can function and remain competitive while protecting the coastal environment.

- While the larger ports, such as Vancouver, have a clear vision of their future, and have done their own strategic planning, there is no evidence that any consideration has been given to the overall needs other ports and harbours along the coast. For example, their use of advanced technologies such as EDI networks and their needs for modern semi-automated or automated cargo handling capacity.

- Coordinated policies and appropriate programs are needed to encourage the management and development of ports along the coast of British Columbia Adequate, safe, efficient port facilities are essential to the conduct of all marine activities.

Vancouver as an international maritime centre

Several years of effort by the business community and provincial governments resulted in the passage, in 1991, of Bill C-18, which assists Canadian cities in becoming maritime centres. This allows foreign companies to run their business from Canada without being taxed on their worldwide earnings. At least one large group, Teekay Shipping Ltd., has already moved to Vancouver as a result. Negotiations are under way with other companies (including several from Hong Kong). This initiative is important in strengthening British Columbia's presence on the Pacific Rim. It could also be important in promoting economic activity in related services (insurance, finance, brokerage, *etc.*) and in providing market opportunities for local marine shipboard technologies.

The reality of Vancouver as an International Maritime Centre opens many possibilities for the development of activities in Vancouver that relate to associated Pacific Rim Maritime and Marine affairs. For example, the following initiatives could be linked to the international maritime presence in Vancouver:

- Shipping and marine engineering industry discussions of appropriate actions to improve marine safety (See Section 4.1).

- Long-term trends in Maritime activities throughout the Pacific Basin with the purpose of focusing on research technology requirements and economic analysis. This would provide an information base of research to enable shipping interests and ports and harbours to remain competitive.
- Research on the human resource development requirements for maritime activities.
- Research on the environmental issues related to maritime activities; with the purpose of identifying appropriate technology solutions to known problems. Present environmental concerns are placing an increasing regulatory burden on maritime activities (e.g. ballast water and bilge discharge requirements, the accidental transport of noxious pests, standards to ensure vessel safety, etc.).

RECOMMENDATIONS

- The government of British Columbia should implement a policy to encourage the good management and development of coastal ports of British Columbia. Adequate and well-managed ports are essential to the conducts of all marine activities.

- The deployment of EDI technology in transportation systems going through the ports of British Columbia is a strategic priority for British Columbia and Western Canada.

- All the participants in coastal transportation systems need an opportunity to consider the role of EDI and other advanced technologies in the future of coastal transportation.

- The capacities and technological needs of the ports and harbours of the British Columbia coastline should be inventoried with regard to current and emerging trends in ocean uses as a basis for planning port development.

- An independent agency or group should be charged with the responsibility of evaluating our ports and harbours against the best in the world. The results should be used to ensure the provision of facilities and services required for future trade and transportation.

- Ports and harbours are often a focus for conflicting land and coastal uses. They can no longer be managed according to a narrow mandate related to marine industrial development. They must be incorporated into a broader framework of coastal zone management that balances the importance of economic activities with marine environmental needs.

- The global and, in particular, Pacific Rim market opportunities for ferry systems should be carefully investigated. British Columbia has world-leading ferry system networks, operated by the BC Ferries Corporation and independent operators.

There are market opportunities in the rapidly growing Pacific Rim economies for technology systems related to ferry operations. These could provide interesting and unexplored opportunities for British Columbia-based know-how and technology.

- Efforts should be made to encourage technological partnerships between British Columbia Ferries or other ferry operators and British Columbia marine technology companies. British Columbia ferry systems should be used as a showcase and proving ground for local technology and to provide on-the-job training in the use of advanced ferry technologies. This would assist the global marketing of supporting technology and information systems by British Columbia-based companies.

14.0 SOVEREIGNTY, DEFENCE & SURVEILLANCE

Introduction

In the present review of ocean opportunities, no formal review of ocean issues in sovereignty, defence, or coastal surveillance was attempted. However, these are important issues in relation to ocean industry science and technology. Technologies of relevance to defence and surveillance are considered in the sections on ocean information technology, robotics and subsea vehicles, and marine electronics. Some general issues are reviewed below in order to establish their interaction with, and influence on, the overall challenge of ocean management. A long-term marine policy and strategy project is being carried out by the Centre for Foreign Policy Studies at Dalhousie University, Halifax, with inputs from DND and other federal agencies on defence and surveillance issues[1]. Many of their findings will also relate to the West Coast.

Sovereignty, defence, and surveillance

In Canada, all national defence issues come under the Department of National Defence (DND). DND maintains a substantial presence in British Columbia, primarily in establishments at Esquimalt, Comox, and other locations along the British Columbia coastline. In addition to their strategic importance, these establishments make a significant contribution to the local economy. The Defence Research Establishment Pacific (DREP) also carries out significant R&D on defence-related issues and provides support on oceanographical information for naval purposes.

A defence policy review in 1991 identifies defence, sovereignty, and naval responsibilities in Canada as the first priority of Canadian forces, although the new demands for international peacekeeping will undoubtedly have a major impact. The top priority of the Canadian naval forces is to maintain control over Canadian waters within the 200 mile EEZ. This implicitly includes surveillance, area clearance, the protection of shipping, and law enforcement in support of civil authorities. The support of civil authorities specifically includes important issues such as: the illegal drug trade, oil spills, and other acts of pollution, and the illegal exploitation of natural resources - all relevant issues within the western EEZ.

Canada, the USA, and the Pacific Rim

The coastline of British Columbia is sandwiched between two adjacent sections of the Pacific rim controlled by the USA. Cross-border cooperation is increasingly desirable

[1] Personal communication, F.C. Crickard, Project Manager, Canadian Marine Policy and Strategy Project; Centre for Foreign Policy Studies; Dalhousie University, Halifax.

in the planning of environmental protection and transportation. This also applies to defence and surveillance, which are managed by collective defence agreements between Canada and the USA.

On a larger scale, Canada and the USA are facing many major changes throughout the Pacific region. These changes are associated with the rapid industrialization and economic growth of China, Taiwan, South Korea, Hong Kong, and Singapore, and the emerging ASEAN nations of Malaysia, Indonesia, Thailand, and the Philippines. These nations are all moving rapidly into economic activities within their coastal Exclusive Economic Zones. Fisheries and Mineral Exploration on the high seas are also increasing.

The economic growth of Asia-Pacific will have profound implications for our national defence and surveillance policies, and also fisheries and environmental management, transportation, and telecommunications. It will also offer considerable opportunities for Canadian industry science and technology. A focused Canadian/Asia-Pacific foreign policy must be carefully constructed to recognize the importance of Asian Pacific trade, economic scientific, technical and cultural linkages.

The recent demise of the USSR and other shifts in the balance of power, including the growth of military power of several Asian countries will also have major implications for Canadian Pacific defence policies and, ultimately, implications for decisions on the technological and scientific support needed for defence and surveillance.

Points of contact between national defence and civilian ocean issues

In the present review, several issues emerged concerning interrelationships between the maritime responsibilities of DND and civilian ocean activities. These are:

- **The development of advanced ocean technologies**

  In the past, DND has been a major customer of many ocean technology developers in British Columbia. DND funding from the Defence Industrial Research Program (DIRP) has played a significant role in the development of subsea vehicles, acoustic and other electronic technologies.

  These technologies also have substantial potential for civilian applications in environmental surveillance and fish stock assessment. Consideration should be given to ways and means of increasing the spin off benefits of defence-related ocean research into civilian ocean science, environmental monitoring and fisheries biology. Current US and European plans propose a redirection of military technologies through technology transfer and utilization of existing expertise for commercial and environmental benefits as well as a focus on new technology with the potential for dual or multiple applications.

- **Cooperation between DND and federal and provincial agencies in defence, environmental and fisheries surveillance.**

  New information technologies, using satellites, GPS technology, and electronic mapping, provide powerful tools for understanding the ocean and for protecting strategic ocean resources. In the past, civilian and defence research and development have been conducted with separate sources of funding and objectives. Opportunities for integrating funding, defence, environmental, and fisheries surveillance need to be reviewed. Dual application technology areas will provide a maximum return on public investment.

- **The scientific ship time dilemma**

  Oceanographic research is still dependant on the availability of ship time for scientists. At present, DFO bears much of the cost of operating scientific ships for both government and university scientists, but their funding is declining. This puts a severe constraint on long-term offshore oceanographic programs in British Columbia. In other jurisdictions, for example Chile, the navy plays a considerable role in providing ships for offshore fish stock assessment and fishery surveillance. Opportunities may exist for increasing cooperation between DND and the scientific community in ocean science, environmental and regulatory programs. Furthermore, the federal government should examine the total cost of all Canadian fleet requirements for defence, regulatory purposes, marine safety, marine research, and environmental monitoring, and consider ways and means to achieve maximal efficiency and benefits from this fleet. New satellite and sub-sea observation technologies need to be examined as cost effective additions to the fleet that could greatly expand the effectiveness of surveillance.

CONCLUSIONS

Sovereignty, Defence and Surveillance issues will become increasingly important in the North Pacific Basin as the economies of Pacific Rim countries continue to expand and diversify.

A foreign policy update is needed by Canada to encompass the new realities of Asia-Pacific and to allow a positioning of Canadian interests in this region. Emerging opportunities in trade, investment, science, and technology, and sound management of the North Pacific Environmental need to be recognized in this process.

The Pacific Ocean provides a common linkage between Canada and other Pacific Rim Nations and the challenges of protecting the marine environment and properly managing its renewable and non-renewable resources provide a huge opportunity for Canadian Ocean Science, Technology, and Industry.

RECOMMENDATIONS

- Canada should examine the opportunities for accelerating the transfer of marine technology developed for defence purposes into civilian applications.

- Opportunities for developing advanced marine technologies with multiple applications in defence, surveillance, fishery protection, environmental monitoring, and environmental research should be carefully reviewed.

- Foreign Policy focused on the emerging opportunities in the Pacific Basin needs to be developed by Canada. To this end it is recommended that the Federal Government recognize the significance of future business linkages to Asia-Pacific and the importance of coordinated efforts in demonstrating stewardship towards the North Pacific Marine Environment, inside and outside our Western EEZ.

15.0 NEW OCEAN WEALTH CREATING OPPORTUNITIES: A SYNTHESIS

15.1 THE PRESENT

At present, ocean activities directly contribute more than $3.7 billion to the economy of British Columbia each year. Slightly more than one third of this figure is from transportation activities into and out of Vancouver, Fraser Port, Prince Rupert, and the smaller ports and harbours in British Columbia. One third is the income from commercial fisheries and aquaculture, and slightly less than one third is the combined economic impacts of tourism, the ocean technologies, and the ocean service sector.

In total, these ocean activities directly contribute about 5% of the total British Columbian GDP (approximate estimate)[1]. **The growth potential of the oceans and marine activities is, however, very high in comparison to many other sectors of the British Columbia economy.** Oceans activities could become as large as the present manufacturing sector within ten years, and could rival the present size of the entire goods producing component of our economy (about $20 billion per year), if mineral and oil and gas exploration activities were initiated. Development of these resources would also accelerate development of ocean technologies and services within British Columbia. All this could happen within a framework of sustainable use of the ocean, if the conditions necessary to the realization of this potential are encouraged by the governments of Canada and British Columbia.

15.2 DEPENDENCY OF GROWTH IN EXISTING SECTORS

If existing impediments to the more effective use of biological resources and the use of new technology in sustainable environmental management are not removed, then growth in ocean activities over the next decade will probably continue to stagnate, or be hesitant. In some sectors, such as fisheries and tourism, certain economic activities could decline sharply unless effective sustainable management policies are instituted.

On the other hand, **if an effective, integrated ocean and coastal administration is created, then the wealth creating potential of the West Coast of Canada could be enormous, into the next century, and beyond.**

15.3 OCEAN RESOURCES POTENTIAL

Potential revenue generation from both the biological and geological ocean resources is much greater than the value of ocean technologies alone. To a great extent, the

[1] The 1989 GDP of British Columbia was $67,565 million with Agriculture providing about $600 million Gross Domestic Product, Mining, $1,872 million, and Manufacturing $9,502 million . BC Statistics Review, 1991.

TABLE 15-1: Estimates of economic impacts of ocean activities in British Columbia and their potential for growth (excluding research and development)

OCEAN ACTIVITY	PRESENT IMPACTS 1990$ (Millions)	YEAR 2000 Potential (Millions)	COMMENTS ON GROWTH Potential
TECHNOLOGIES			
INFOTECH	50	150*	High
ELECTRONICS	40	100*	Medium
SUBSEA ROBOTICS	100	300*	High, but dependant on ocean activities
ENGINEERING MISC.	50	100*	High, but dependant on ocean activities
ENVIRONMENTAL	10	100*	High, but dependant on ocean activities
BIOTECHNOLOGY	1	10*	High, but dependant on ocean activities
SHIP BUILDING & REPAIR	50*	75*	Low, but related to port & coast activities
OCEAN SERVICES	50*	100*	Medium, related to global market access
RECREATIONAL TECHNOLOGIES	125	250	
Technology Impact TOTAL	476	approx 1,085	±
RESOURCES (within the Western EEZ)			
FISHERIES	946	1,250*	Underutilized and value added
MARINE Extracts, special products	--	50*	
AQUACULTURE	110	250	Requires policy, lease access & market demand
OIL & GAS	0	Considerable (Exploration)	High, policy
MINERALS	0	50*	High, requires policy & regulatory infrastructure
Ocean Resources TOTAL	1,056	1,600*	
OCEAN TRANSPORTATION Port activity	1,151	1,726*	Dependant on trade through BC ports
Ferries, etc.	300	450*	Dependant on tourism & economy
TOURISM	782	1,200*	Dependant on access to resources & infrastructure
TOTAL Impact	3,765	6,061	

Technology growth rate estimates are based on current trends in the growth of sales. Where these estimates are speculative or dependant on many variables, they are starred. Unstarred figures can be supported by economic analysis of that activity area in British Columbia. Further documentation and discussion of projections is contained in SPARK Oceans working papers and sectoral reports.

growth of the ocean technology sector will be linked to ocean resource development. It has been clearly established that the value of the fisheries sector could be almost doubled by increasing the value of existing species harvests and making more effective use of underutilized species. Realization of this requires significant changes to DFO policy and the establishment of a more comprehensive data-base for fish stock assessment. Offshore oil and gas exploration and development and, in the longer-term, offshore mining require effective use of ocean technologies. Realization of this potential requires a consistent long-term approach by governments to ocean management.

Exploration and development activities would also have substantial spin-off benefits in ocean technologies and the service sector, in addition to tax and royalty revenues. It may even be possible to relieve governments of some of the burden of funding research and development by creating a special R&D or other special-use funds as a component of ocean lease contracts.

15.4 POTENTIAL MARKETS FOR OCEAN TECHNOLOGY

The potential markets for ocean technology are in the support of scientific and economic activities within the Exclusive Economic Zones of the world's coastal nations. The total area of these 200 mile EEZ marine nation claims amounts to about 40% of the area of the world's oceans. A large part of this EEZ area is in the Pacific Ocean, associated with the large and small islands of Asia, Micronesia, Melanesia, and Australia. The remaining high seas come under international jurisdiction as defined by UNCLOS.

Many of these island states in Asia are extremely crowded, with very limited land-based resources. As a result, they all show rapidly increasing trends in use of their EEZs for fisheries, aquaculture, oil and gas production, mineral development, transport, cable laying, waste disposal, and tourism. Some of these uses are conflicting, but all demand a high level of understanding of these EEZ areas and, in particular, the shallower continental shelf areas. Growth trends are especially evident in marine transportation, telecommunication, tourism, and offshore mineral development. These are documented in previous chapters in the various SPARK sector reports. This increasing use of Pacific EEZ areas requires increased management to minimize user conflicts and to protect the environment. This, in turn, demands increased knowledge and information on these areas. These forces will be the basic drivers of marine technology markets. Canada, and especially British Columbia, have access to a wide range of advanced marine technologies and services within industry, the universities, and government laboratories as listed in **Table 15-2.**

Marketing efforts led by individual companies or government market promotion agencies have generally focused on individual products of narrow clusters of technology types. **Increasingly, markets in ocean management will require integrated approaches to the development and use of these technologies,** and coordinated efforts in the development of systems and applications using emerging and existing ocean technologies. Examples of the system integration of ocean technologies are given in **Table 15-3.**

Table 15-2: Categories of British Columbia-based marine technologies reviewed by SPARK Oceans

Marine Technology Class	Applications
1. INFORMATION TECHNOLOGIES	
• Ocean observation systems	Data collection, climate, environment, fisheries defence
• Ocean information systems	GIS, GPS, electronic navigation, etc.
• Use support systems	EDI systems
2. SUBSEA ROBOTICS & VEHICLES	Data collection, exploration mapping, inspection, resource management, tourism.
3. MARINE ELECTRONICS	
• Instrumentation	Oceanography, environment, etc.
• Communications	Shipping, defence, tourism, fisheries, etc.
• Navigation	Shipping, defence, tourism, fisheries, etc.
4. OCEAN ENGINEERING	
• Offshore resource	Oil and Gas Mineral development
• Ship design & construction	Bulk transport, fishing, ferries, defence
• Cable & pipeline laying	Communications, transport, etc.
5. BIOTECHNOLOGY	
• Marine extracts	Food, feeds, pharmaceuticals
• Molecular Techniques	Stock identification, enforcement, etc.
• Aquaculture	Fish production
• Bioprocessing	
• Remediation	
6. RECREATIONAL TECHNOLOGY	Mass recreational markets:
• Clothing and survival gear	North America, Asia-Pacific, and
• Equipment for communications, safety and navigation	Global
• boats	

Table 15-3: Integration of marine technologies

EXAMPLES		
1.	COMPONENT TECHNOLOGY	Electronic components, software, etc.
2.	SUB SYSTEMS	Robotic arms, sensors, propulsion units.
3.	SYSTEMS FOR VARIOUS APPLICATIONS DEVELOPED BY USER	ROVS, GPS
4.	INTEGRATED MULTIPLE SYSTEM PACKAGES FOR SPECIAL APPLICATIONS	Systems for cable inspection, fishery assessment, etc. using ROVs, GPS, GIS, special software, etc.

Most British Columbia companies deliver products and services at the first two levels. A few of the larger companies market systems for various applications. User groups with special management needs will require packages of multiple systems developed and proven for special applications. This requires inter-company and networking and close cooperation between governments, developers and users to identify, develop, and market these special applications.

15.5 SUMMARY OF NEW WEALTH CREATING OPPORTUNITIES RELATED TO OCEANS INTO THE 21st CENTURY

In this report only those ocean wealth-creating opportunities that can be managed on a sustainable basis, or that can be pursued without significant impact on other ocean sectors or loss of biodiversity, have been considered.

The potential for growth depends on the removal of existing impediments and the creation of a sympathetic, well-coordinated, administrative framework that can protect the ocean environment while allowing wealth to be created from ocean resources. For example, an administrative framework has been developed for offshore oil and gas exploration on the West Coast, but it has not yet been implemented owing to the existing moratorium. New ocean technologies play an extremely important role in environmental prediction and ocean management. They provide powerful new tools for understanding ocean systems and the information on which rational management decisions can be based. In addition these technologies, developed by British Columbia-based companies, can be competitive in Pacific Rim, and global markets.

If an integrated, long-term approach is taken to these ocean opportunities, then by early in the next century, West Coast oceanic and coastal economic activities could well be increased as follows:

- The enabling ocean technologies (including electronics, information technology, robotics and subsea vehicles, and biotechnology) could increase by a factor of 3 to $900 million per year. This is based on estimates of the international trends in the markets for these technologies.

- Fisheries and aquaculture, by improving the knowledge base for stock assessment, increasing the value of the harvested resource, developing under-utilized fisheries, and diversifying culture-based activities, and realizing the opportunities for marine products. This area could increase to at least $1,500 million per year.

- Transportation of goods and tourism, and other non-consumptive uses could increase by a factor of 2 to $3,000 million annually. Provided that supportive policies and the necessary infrastructure are put in place.

- The exploration and utilization of ~~gas~~ oil and gas potential. Present economic activity in exploration and production is zero, but future technological, infrastructural, and employment benefits could provide substantial contributions to the British Columbia economy, estimated in billions of dollars, rather than millions.

- The exploration and utilization of mineral resources within the 200 mile EEZ and on the high seas.

Therefore, the total future economic contribution to Canada and British Columbia of ocean-related activities within a framework of sustainable use, could be at least in excess of $7 billion per year, if both levels of government act to resolve the present uncertainties and provide for effective coordination.

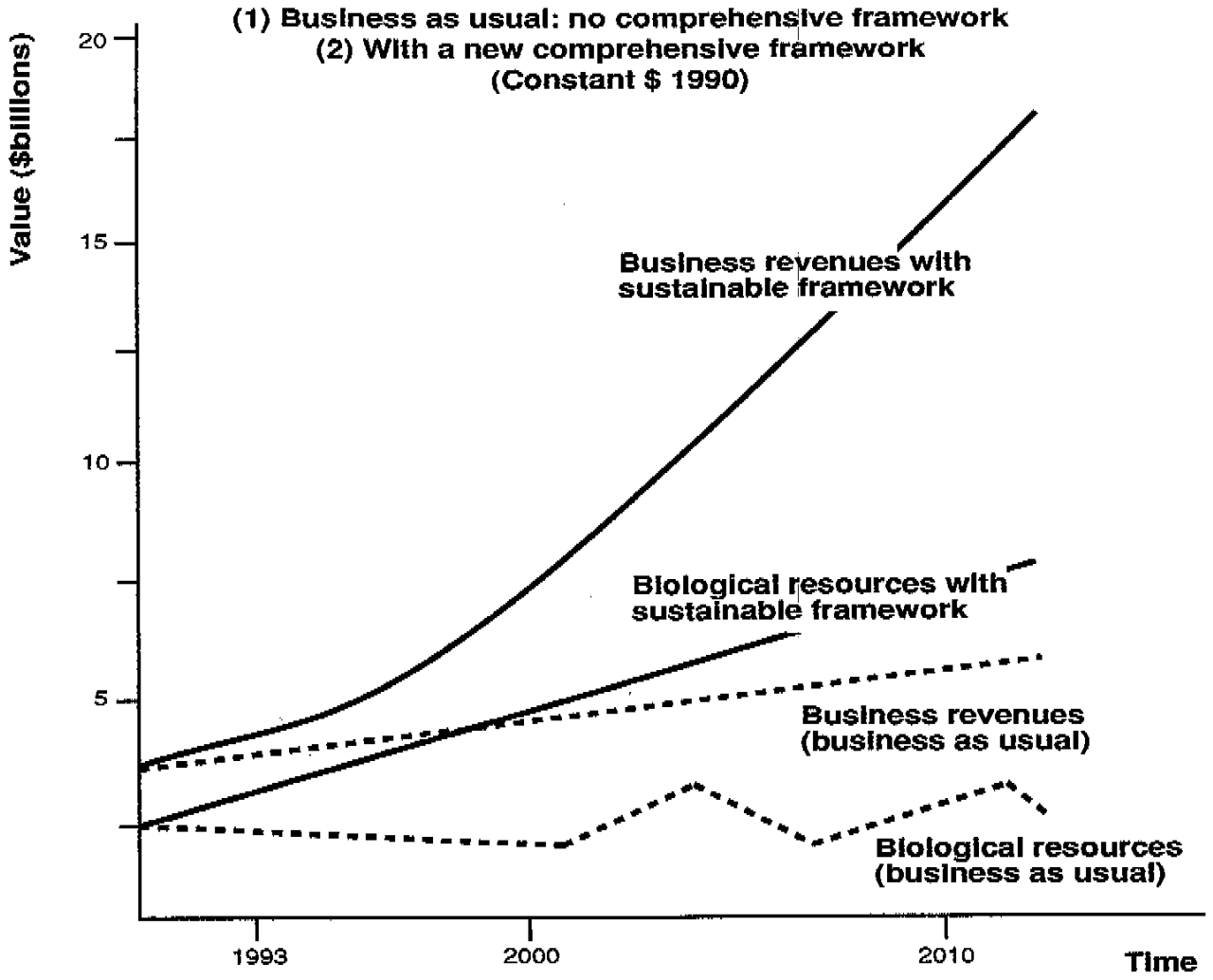
Future marine activities offer exceptional opportunities to strengthen the revenue base of all levels of government on the West Coast. Most of the above mentioned activities would attract substantial investment to the West Coast, and many would generate additional earnings in global markets. Also, governments, in exercising their responsibilities in the management and uses of natural resources, would be expected to establish appropriate royalties or license fees for all commercial users.

In short, these activities provide a unique opportunity to expand the taxation base for all levels of government, while participating in long-term activities that are compatible with the identified objectives of sustainable use of the marine environment.

The key to realizing this potential lies in the adoption of an integrated framework for sustainable management. This is a long-term objective that, for success, requires the acknowledgement and participation of all ocean users. This in turn will only happen through relentless communication, education, and awareness. The importance of this process to the future economic (and social) well-being of British Columbia is illustrated in **Figure 15-4.** With no change, we fail to build on our existing resource wealth or realize the potential of business revenues. Within a comprehensive

Figure 15-4

Trends in Marine Business Revenues and Value of Marine Biological Harvests Under Two Scenarios



framework that allows decisive action, there is enormous potential for business andeconomic diversification.

In conclusion, the West Coast of Canada has many unique opportunities related to oceans. This coast is also fortunate in having a rich and diverse ocean environment within the territorial control of Canada. Unlike other regions of the world, most of these resources have not been depleted or devalued by human activities. However, human populations and urbanization are growing and the environment and resources face increasing pressures. This places a heavy responsibility on the citizens of British Columbia and Canada to ensure that this wealth is not squandered and that this heritage is sustained for the enjoyment of future generations.

This report, arising out of the SPARK process, proposes a framework to enable all participants in ocean activities to move in this direction and seize the opportunity for sustainable use of our ocean heritage.

Table 15-5: Wealth Creating Opportunities in the Ocean Technologies and Major Requirements

OCEAN TECHNOLOGY FIELD	SCOPE FOR BC GROWTH to 2000	REQUIREMENTS
INFORMATION TECHNOLOGY		
Observations systems and applications	Yes	Deployment for fishery, aquaculture, and coastal management use by agencies
Information systems	Yes	Integration into ocean and coastal management systems
Use-support systems	Yes	EDI adoption by ports and terminals. Evaluation of competitive trends, ports and harbours
SUBSEA ROBOTICS & VEHICLES		
Environmental monitoring	Yes	Effective use by industry & government
Inspection	Yes	" "
Fish stock assessment	Yes	" "
Sea floor mapping	Yes	
MARINE ELECTRONICS		
Instrumentation	Yes	Use by government & Crown agencies in reference contracts
Communications	Yes	
Navigation	Yes	Marketing to private sector
MARINE BIOTECHNOLOGY		
Fisheries: sustainable management	Yes	Develop industry/DFO cooperation
Aquaculture	Yes	Diversification of aquaculture
Remediation	Yes	Commitment to clean up pollution

OCEAN OPPORTUNITIES FOR THE WEST COAST OF CANADA

APPENDIX I

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Mulvenna, Alan
Imagenex Technology Corp.
Port Coquitlam, BC

Munro, David
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Mykletun, Jostein
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Needham, Ted
British Columbia Packers Ltd.
Courteney Bay, BC

Novotny, Anthony
Biomed Inc.
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O'Rourke, Patrick
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Pomeroy, Kathleen
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Pomeroy, Richard
Seamount Technologies Inc.
West Vancouver, BC

Poon, Albert
Ocean Pine (Canada) Ltd.
Vancouver, BC

Powell, David
Home Oil Company Limited
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Prescott-Allan, R.
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Rawicz, Andrew
Andrew Engineering Inc
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Renavd, Ken
Blue Frontier Adventures Inc.
Ganges, BC

Rendle, Derek
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Reynolds, G. Garnet
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Port McNeill, BC

Ridgewell, Barry
Vitron Systems Inc.
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Roberts, David
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Roch, Michael
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OCEAN OPPORTUNITIES FOR THE WEST COAST OF CANADA

APPENDIX II

OCEAN SECTOR REVIEWS AND WORKING PAPERS

OCEAN USES

10 **Ocean Transportation Issues.** Working Group Report Draft.

11 **The Tourism and Recreational Potential of Oceans.** Working Group Report.

OTHER RELEVANT REPORTS FROM SPARK OCEANS ACTIVITIES

12 **Subsea Technology Applications for Fish Stock Assessment** - 10 pages plus appendices.

13 **Coastal Community Ocean Initiatives and Needs** - a SPARK review.

OCEAN USES

10 **Ocean Transportation Issues.** Working Group Report Draft.

11 **The Tourism and Recreational Potential of Oceans.** Working Group Report.

OTHER RELEVANT REPORTS FROM SPARK OCEANS ACTIVITIES

12 **Subsea Technology Applications for Fish Stock Assessment** - 10 pages plus appendices.

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OCEAN OPPORTUNITIES FOR THE WEST COAST OF CANADA

APPENDIX III

MARINE ACTIVITIES IN WESTERN CANADA
- agencies and participants

MARINE ACTIVITIES IN WESTERN CANADA: AGENCIES AND PARTICIPANTS

PARTICIPANT & RELEVANT GROUP	ROLE OR ACTIVITY
Federal Agencies	
Agriculture Canada	
• Ship and commodity inspection	Ship inspection
• Veterinary drugs	Approval and use
• Fish feeds	
• Pests and diseases	Ship inspection
Coast Guard	
• Planning & Programming	
• Fleet Systems	
• Aids & Waterways	
• Harbours & Ports	
• Search & Rescue	
• Telecommunications & Electronics	
• Ship safety	
• Vessel Traffic Services Centre	
Canadian International Development Agency - CIDA	International aid, including marine topics
Communications Canada	Marine communications
• Ship Radio Surveys	
Customs	Customs
• Tariff & Rates of Duty	
• Marine Operations	
• Registrar of Shipping	
Energy, Mines, & Resources Canada	
• Geological Survey of Canada	Sea floor mapping, minerals, drilling

Environment Canada	Environmental quality
• Atmospheric Environment Service	Marine forecasts
• Conservation & Protection • Environmental Protection, Oil or Chemical Spill Reporting • Canadian Wildlife Service • Canadian Parks Service	Environment & Protected areas
External Affairs & International Trade Canada	International relations and trade
Federal Environmental Assessment Review Office	Environmental assessment
Fisheries & Oceans	Fisheries & aquaculture
• Science Branch • Fisheries Branch	
• Management Services Branch	Co-management
• Program Planning & Economics Branch	Habitat protection
• Salmonid Enhancement Program • Small Craft Harbours Branch • Biological Sciences Branch • Inspection & Special Services Branch	Science, etc.
Health & Welfare Canada	Seafood safety
• Health Protection Branch	
Indian & Northern Affairs Canada	First Peoples claims
• Comprehensive Claims	
Industry, Science & Technology Canada	Marine technology
• International Trade Centre	
• Seafood Sector Campaign	Seafood industry development
National Defence	National defence
• Canadian Forces • Defence Research Establishment Pacific	
National Research Council	Engineering and industrial research

Natural Sciences and Engineering Research Council	University marine-related research
Pacific Pilotage Authority	Pilotage
Transport Canada • Policy & Coordination	Policy
Transportation Safety Board of Canada • Marine Safety	Marine safety
Vancouver Port Corporation	Port of Vancouver administration
Western Economic Diversification Canada • Economic Diversification	Economic diversification

Provincial Agencies

British Columbia Ferries Corporation	Coastal ferries
Islands Trust	Gulf Islands Zoning
Ministry of Advanced Education, Training & Technology • Sciences & Technology Division • Universities and Provincial Institutes Branch, College Programs and International Education	
Ministry of Agriculture, Fisheries, and Food	Fisheries development, seafoods, aquaculture
Ministry of the Attorney General	Legal and jurisdictional
Ministry of Environment	Environmental
Ministry of Health	Coastal health risks
Ministry of Lands and Parks	Tenures

Ministry of Native Affairs	
Ministry of Tourism	Tourism
Ministry of Transportation and Highways	
Science Council of British Columbia	Applied R&D Strategic Planning

First Nations Tribal Councils

(Some coastal bands are independent and are not affiliated with any tribal council.)

Group	Location
Nisga'a Tribal Council	North Coast
Tsimshian Tribal Council	North Coast
Haida Nation	Haida Gwai
Haisla Nation	North Coast Kitimat
Heiltsuk Nation	Mid coast
Oweekeno/Kitasoo Nuxalk Tribal Council	Mid coast
Kwakiutl District Council	Vancouver Island, Johnston South
Nuu-Chah Nulth Tribal Council	West Coast of Vancouver Island
First Nations of South Island	Southeast Vancouver Island
Mid-Island Tribal Council	East Vancouver Island
Sliammon, Sechelt, Squamish, Musquem, & other bands	S. Georgia Strait & S. Mainland

Universities

University of British Columbia	Oceanography, marine biology, and many other disciplines with marine content
University of Victoria	Oceanography,

	Climate change, engineering, marine biology
Simon Fraser University	Marine Institute, engineering, aquaculture

Colleges and Institutes

British Columbia Institute of Technology	
Malaspina college, Nanaimo	Aquaculture fisheries
North West college, Prince Rupert	Training
North Island College	Training
Pacific Marine Training Institute	

Non-Governmental Organizations

Save Georgia Strait Alliance	
Greenpeace	
West Coast Environmental Law Association	

Commissions and Other initiatives

The Commission on Resources and the Environment (CORE)	Land use strategy and community-based planning, etc.
Round Table on the Economy and Environment • Georgia Basin Task Force • Communities Task Force	Sustainable management Consultations
Oil Spill Advisory Committee Task Force	

Other Organizations and Groups

- Industry Associations - shipping, services, etc.
- Fishing Industry Associations
- Aquaculture Associations
- Labour Unions
- Regional districts & economic development associations
- Chambers of Commerce
- Marine Transportation and related services
- Sport fishing organizations and companies
- Tourism-related organizations and companies
- The major international and coastal ports and harbours in British Columbia:

NAME	COMMENT
Campbell River	Tourism, fishing, commodities, coastal, aquaculture
Fraser Port	Commodities, fishing
Bella Bella	Fishing & coastal
Masset	Fishing & coastal
Kitimat	Aluminum and commodities
Nanaimo	Mixed Traffic
Powell River	Timber & pulp products
Port Alberni	Timber & pulp products
Port Hardy	Fishing, aquaculture
Prince Rupert	Port Authority, commodities, fishing, & tourism
Stewart	Timber
Squamish	Timber
Tahsis	Timber
Tofino	Tourism, commercial fishing
Uculet	Fishing offshore
Vancouver	Vancouver Port Corporation, all goods, fishing
Victoria	Ferries & tourism
Zeballos	Timber and fishing

OCEAN OPPORTUNITIES FOR THE WEST COAST OF CANADA

APPENDIX IV

LIST OF ACRONYMS

LIST OF ACRONYMS

ASEAN	Association of Southeast Asian Nations
AUV	Autonomous Underwater Vehicle
CCREM	Canadian Council of Research and Environmental Ministries Centre located at Saanich, BC.
CORE	Commission On Resources and Environment
CZM	Coastal Zone Management
DFO	Department of Fisheries and Oceans, who administer the Fisheries Act.
DIRP	Defence Industry Research Program
DND	Department of National Defence Canada
DREP	Defence Research Establishment Pacific, administered by DND
EDI	Electronic Data Interchange
EDIPORT PACIFIC	A proposed concept to coordinate use of EDI on the West Coast
EEZ	Exclusive Economic Zone
EM&R-PGC	Energy, Mines, and Resources (Canada) Pacific Geosciences Centre located at Saanich, BC.
FBMP	Fraser Basin Management Plan
GDP	Gross Domestic Product
GEWEX	Global energy and water cycle experiment
GIS	Geographic Information System
GOOS	Global Ocean Observing System
GPS	Global Position System
HF	High Frequency
IGBP	International Geosphere Biosphere Program
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission of UNESCO
IOS	Institute of Ocean Sciences of DFO at Saanich, BC.
IUNC	International Union for the Conservation of Nature. The parent organisation of the World Conservation Strategy, headquarted at Glan, Switzerland.
ISTC	Industry, Science, and Technology Canada
JGOFS	Joint Global Ocean Flux Study
MAETT	Ministry of Advanced Education, Technology, and Training
MAPLE LEAFROUTE	Concept of transportation routes across Canada
MR&SV	Marine Robotics & Subsea Vehicles
NRC	National Research Council of Canada
NSERC	National Sciences and Research Council of Canada
ODP	Ocean Drilling Program. An international program of scientific exploration of the ocean floor.
OMI	Ocean Management Inc.
PACST	Premier's Advisory Committee on Science and Technology
PBS	Pacific Biological Station of DFO Nanaimo
PICES	The North Pacific science organization, secretariat is located at IOS
ROV	Remotely Operated Vehicle
SEP	Salmonid Enhancement Program
SFU	Simon Fraser University
UBC	University of British Columbia
UHF	Ultra High Frequency

UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environmental Program
UNCLOS	United Nations Conference on Law of the Sea
UNESCO	United Nations Educational, Social, Cultural Organisation
UVic	University of Victoria
VHF	Very High Frequency
WCP	World Climate Program
WOCE	World Ocean Climate Experiment