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Maritime Environment: A Systems Approach

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FISHERIES STATISTICS
(million metric tons)

	1948	1955	1965	1973
Japan	2.5	4.9	6.9	10.7
USSR	1.5	2.5	5.1	8.6
China	N/A	2.7	5.7	7.6
Peru	--	.2	7.6	2.3
USA	2.4	2.8	2.7	2.7
World	19.6	28.9	53.3	66.0

*Note: 1970-73 Average - Peru 7.6
World 67.7

Source: FAO (1973), Yb. Fish. Statist., Vol. 34
Catches and Landings

TABLE 1

SELECTED INTERNATIONAL STRAITS

-- LEAST WIDTH

-- OCEANIC TRAFFIC

Strait	Least Width	Daily Traffic
English Channel	18	160
Danish Straits	2	30
Strait of Hormuz	21	100
Strait of Gibraltor	8	50
Dardenelles	1/2	30
Malacca	8	20
Lombok	11	N/A
Mozambique	15	20
Bashi	15	N/A
Florida	82	N/A
Windward Passage	45	20
Bab al Mandeb	14	N/A

Source: Department of State, Geographic Bulletin No. 3 Rev. October 1969.

TABLE 2

World Merchant Shipping
Selected Statistics

		1964	1968	1974
Total -	Gross Tons (Mill)	153 mill	194 mill	311 mill
	Number	41,000	47,000	61,000
Oilers:	Gross Tons	--	69 mill	130 mill
	Number	--	5,600	6,800
Oilers:	100-140,000 GT	--	12	419
	Over 140,000 GT	--	0	34
Ships:	Casualties (Totally Lost)			
	Gross Tons	558,000	760,000	919,000
	Number	249	326	363
*World Trade:				
laden ton miles		5,353 bill		15,100 bill
Total Oil		2,870 bill		11,355 bill

Merchant Shipping Fleets
(15 million tons or more)

	Liberia No.-Tons	Japan No.-Tons	Gr. Brit. & N. Ireland No.-Tons	Norway No.-Tons
1948	2 -	1,200- 1,000	6,000-18,000	1,900- 4,000
1955	400- 4,000	1,800- 3,500	5,600-19,000	2,400- 7,000
1974	2,300-55,000	10,000-39,000	3,600-32,000	2,700-25,000

	Greece No.-Tons	USSR No.-Tons	USA No.-Tons*	World No.-Tons
1948	400- 1,500	1,000- 2,000	5,200-29,000	29,300-80,500
1955	400- 1,000	1,200- 2,500	4,500-26,500	32,500-100,500
1974	2,700-22,000	7,300-18,000	4,100-14,500	61,200-311,500

*Note: No. - nearest 100
Tons - x 1000/nearest 500,000

Source: Lloyds Register of Shipping Statistical Tables 1974

(x) OECD Observer No. 71, August 1974.

Relative importance of minerals recovered from the continental shelf

		Number of operations	*Annual value (million $US)*	*Percentage of total*
Deep mining				
Iron ore	Finland, Canada	2	17.00	2.5
Coal	Canada, Taiwan, United Kingdom, Japan, Turkey	57	335.00	49.4
			352.00	51.9
Extracted from sea water				
Salt	Many countries	90+	57.5	8.5
"Magnesium"	United States, United Kingdom, Germany, U.S.S.R.	6+	64.7	9.6
Bromine	Several countries	7	22.6	3.3
			144.8	21.4
Dredged				
Diamonds	South West Africa	1	8.9	1.3
Iron sands	Japan	3	3.6	0.5
Tin sands	Thailand, Indonesia	3	24.2	3.6
Shells etc.	United States, Iceland	9	30.0	4.4
Sand and gravel	United Kingdom, United States	38	100.0	14.7
			166.7	24.5
Others				
Sulphur	United States	1	15.00	2.2
			15.00	2.2
Totals		217+	678.5	100

(After AA Archer, Economics of Off-shore Exploration and Production of Solid Minerals on the Continental Shelf, Ocean Management, March 1973, p.5)

TABLE 4

Functional Maritime Interest Groups

Groups	Subgroups	Elements	Element Count
Fisheries	Local/Coastal	Fin	1
		Shell	2
	Distant	Fin	3
		Shell	4
	Processing-Marketing		5
Maritime Transportation	Vessel Ops		6
	Ports/Entrepot		7
	Vessel building		8
Air Oceanic Transportation			9
Industry: Continental Shelf, Ocean Seabed	Petroleum, gas, sulphur	Domestic	10
		Domestic Independents	11
		Overseas	12
	Materials (sand, gravel)		13
	Metals	Nodules	14
		Placer	15
		Solution	16
	Process-Marketing		17
Industry: Shallow coast or littoral	Water essential		18
	Site incidental		19
Aquaculture	Animal		20
	Plant		21
Municipal Development			22
Waste Disposal*	Municipal		23
	Industrial	Water essential	24
		Site incidental	25

Note: *Waste disposal is considered an economic activity; as opposed to considering pollution as an economic cost.

TABLE 5

Functional Maritime Interests (Cont'd)

Groups	Subgroups	Elements	Element Count
Recreation	Beach Shore Activity		26
	Boating		27
	Fishing		28
	Tourism		29
	Non-Economic, Intellectual		
Basic Science			30
Aesthetics Preservation			31
	Military		
Military	Coastal Police		32
	Coastal Defense		33
	Global, general		34
	Strategic		35

TABLE 5

Federal Management Institutional Groups

Department Agency	Organization	Office, Function, Interest	Element Count
Defense	JCS		1
	CNO		2
	USA	Corps of Engineers	3
	USN	OCEANO	4
Commerce	NOAA (National Oceanic Atmospheric Admin)	Office of Coastal Zone Mgmt.	5
		Marine Fish Advisory Comm.	
		Natl. Marine Fisheries Service	6
	MARAD (Maritime Administration	Ship Design	7
		Ship Operations	8
		Port Planning	9
		Manpower	10
Transportation	USCG	SAR	11
		Safety	12
		Pollution	13
		Law Enforcement	14
Interior	Sports, Fish, Wildlife, Parks	Fish & Wildlife	15
		Bur. of Recreation	16
		Ocean Mining Admin.	17
	Energy & Minerals	Bureau of Mines	18
		Geological Survey	19
	Land & Water Resources	Bur. of Land Mgmt.	20
		Office of Land Use & Water Planning	21

TABLE 6

Federal Management Institutional Groups (Cont'd)

Department Agency	Organization	Office, Function, Interest	Element Count
State	Office of Marine Science and Ocean Affairs		22
	NSC Interagency Task Force on Law of the Sea (Bureau reps)		23
	Advisory Committee on Law of the Sea (Functional Interest reps)		24
National Security Council			25
Federal Maritime Commission			26
Environmental Protection Agency (Council on Environmental Quality)			27
Federal Aviation Administration (FAA)			28

TABLE 6

Federal Governance Institutional Groups

Committee	Subcommittee	Element Count
Senate		
Commerce	Merchant Marine	1
	Oceans & Atmosphere	2
	Natl. Oceans Policy Study	3
Foreign Relations	Oceans & Intl. Environment	4
Interior & Insular Affairs	Minerals, Materials, Fuels	5
	Water & Power Resources	6
Public Works	Air & Water Pollution	7
House		
Interior & Insular Affairs	Water & Power Resources	8
	Mines & Mining	9
Merchant Marine & Fisheries	Merchant Marine	10
	Fisheries & Wildlife Conserv. & Env.	11
	Coast Guard & Navigation	12
	Oceanography	13
	Panama Canal	14
National Oceans Policy Study	(Representatives from most other committees)	15

TABLE 7

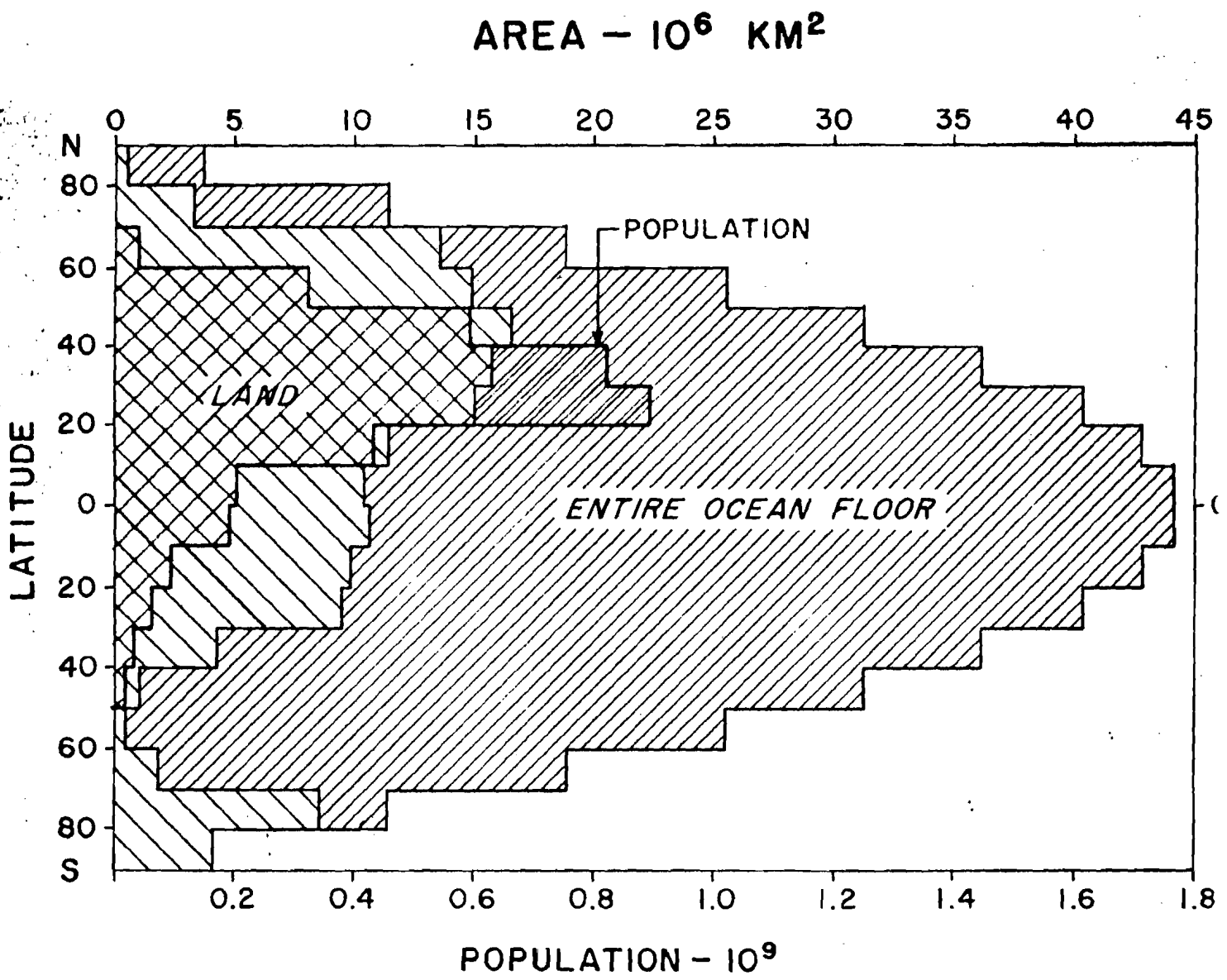
SELECTED INTERNATIONAL, MULTINATIONAL ORGANIZATIONS

1. General
   a. United Nations
   b. Organization of American States
2. Fisheries
   a. Food and Agriculture Organization (UN)
   b. Inter-American Tropical Tuna Commission
   c. International Commission for the Conservation of Atlantic Tunas
   d. International Commission for the Northwest Atlantic Fisheries (ICNAF)
   e. International North Pacific Fisheries Commission (INPFC)
   f. International Whaling Commission
3. Commerce
   a. Intergovernmental Maritime Consultative Organization (UN) (IMCO)
   b. International Civil Aviation Commission (ICAO)
4. Minerals
   a. Organization of Petroleum Exporting Countries
5. Military
   a. North Atlantic Treaty Alliance
   b. Southeast Asia Treaty Organization
6. Other
   a. South Pacific Commission
   b. International Hydrographic Organization

TABLE 8

LIST OF ILLUSTRATIONS

Land, Ocean, Population Latitudinal Distribution



(After K.O. Emery, "Latitudinal Aspects of the Law of the Sea and Petroleum Production," Ocean Development and International Law, Summer 1974. p. 137-150)

GA75-72.3 CDR ROCHE 4/9/75

FIGURE 1

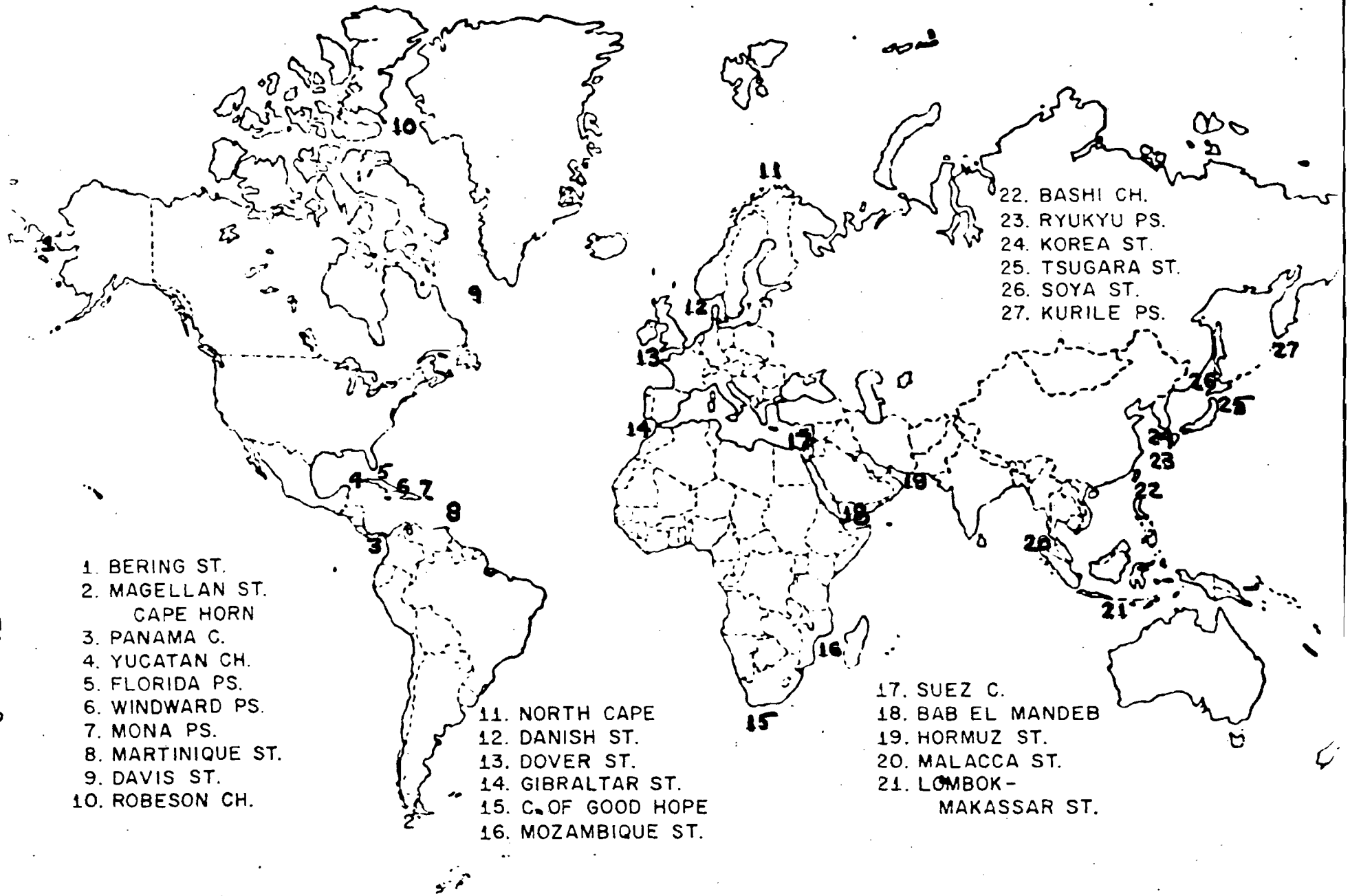


Figure 2

XVI

GA75-72.2 CDR ROCHE 4/9/75

Seabed Profile

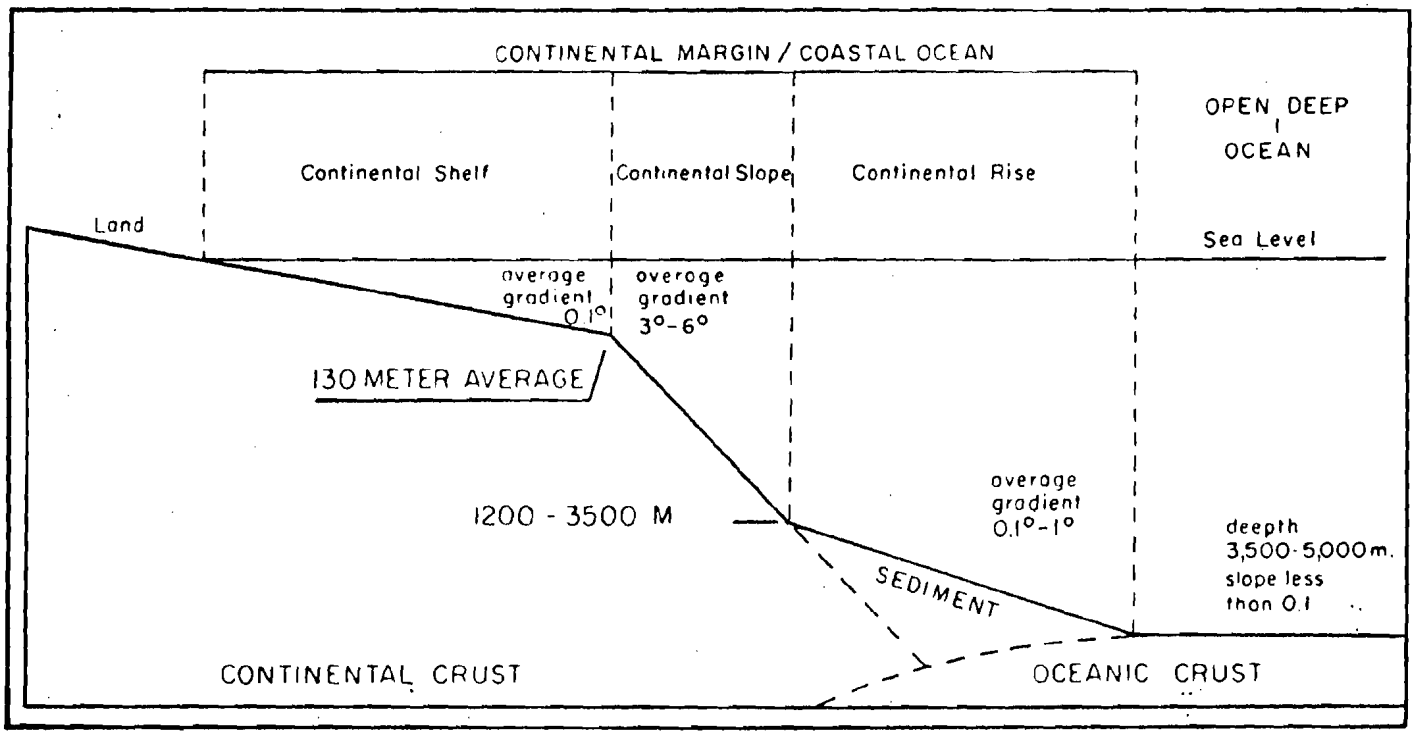
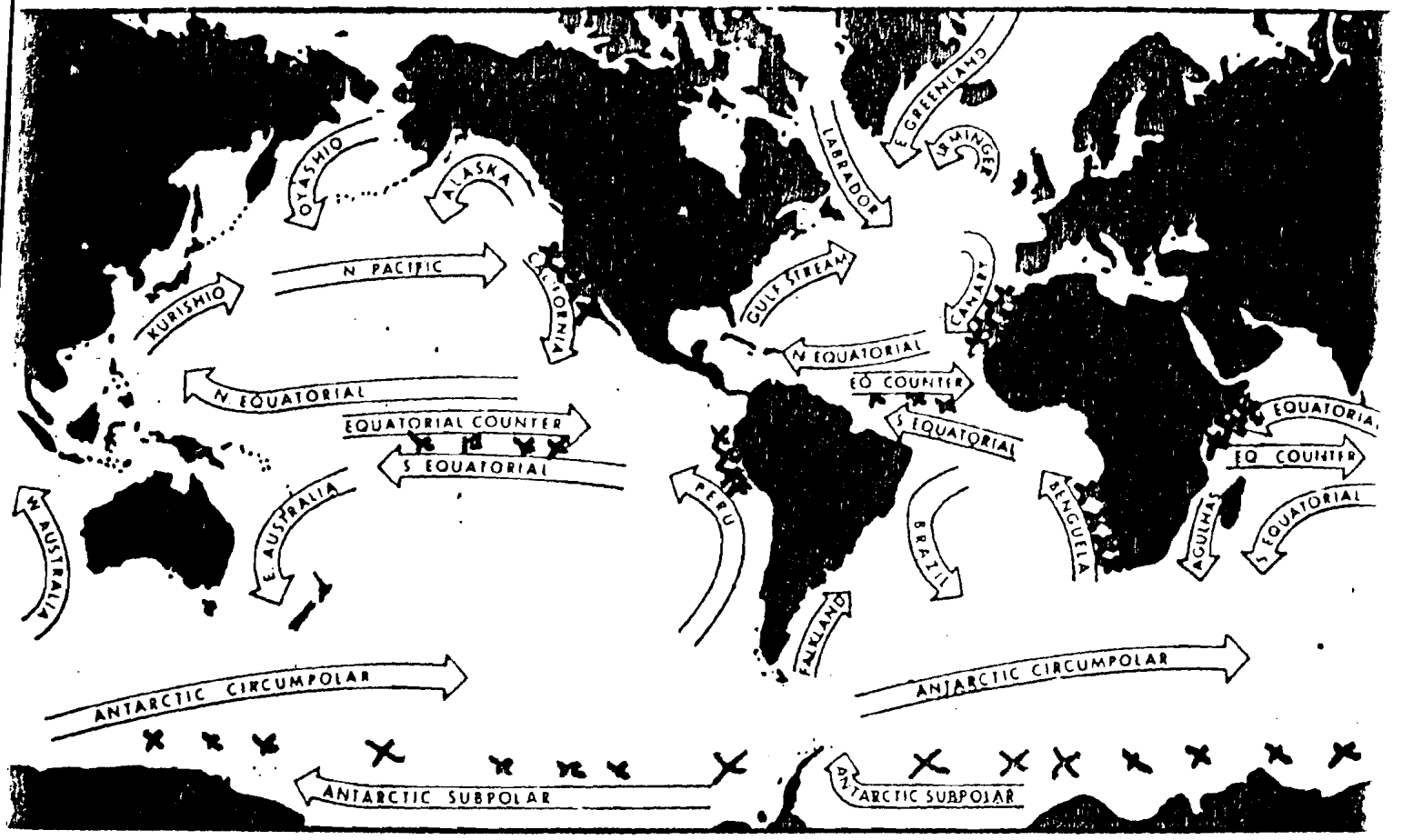


FIGURE 3



SURFACE CURRENTS OF THE WORLD

UPWELLING AREAS — XXXX

FIGURE 4

Ocean Biomass Distribution

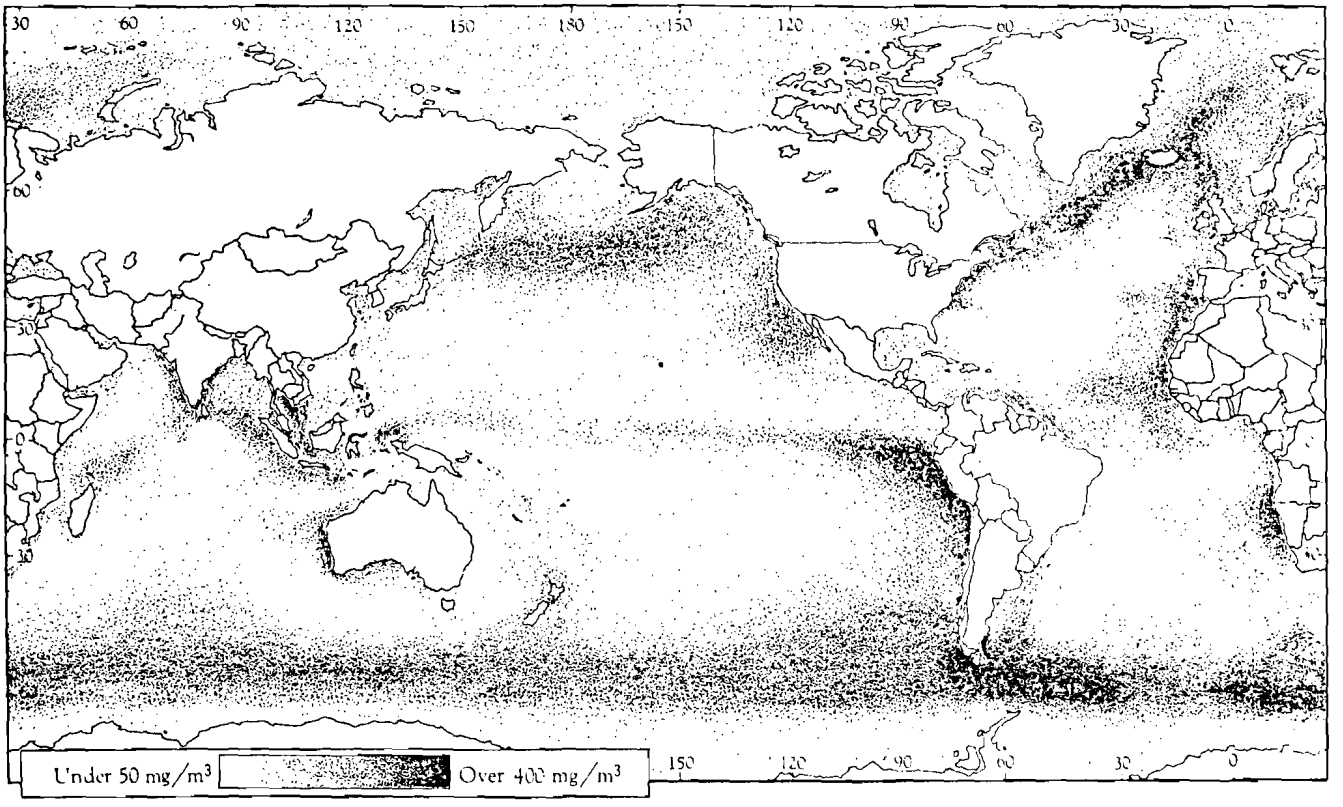
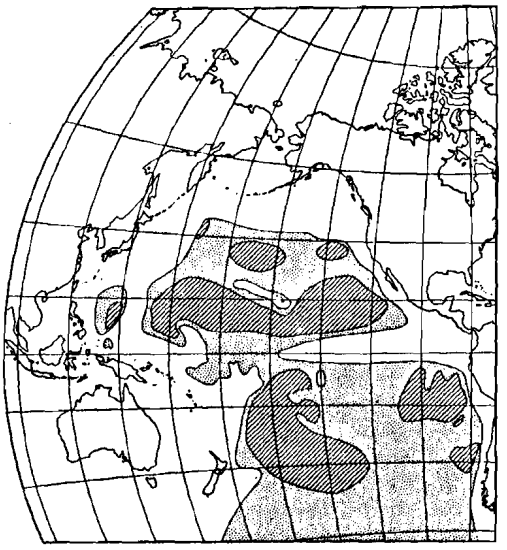


Figure 11. Estimation of standing crop of zooplankton biomass in upper 300 meters (in milligrams per cubic meter). (*Source*: FAO document FAO/57/7/4725.)

Figure 5

Manganese Nodules: Pacific Ocean



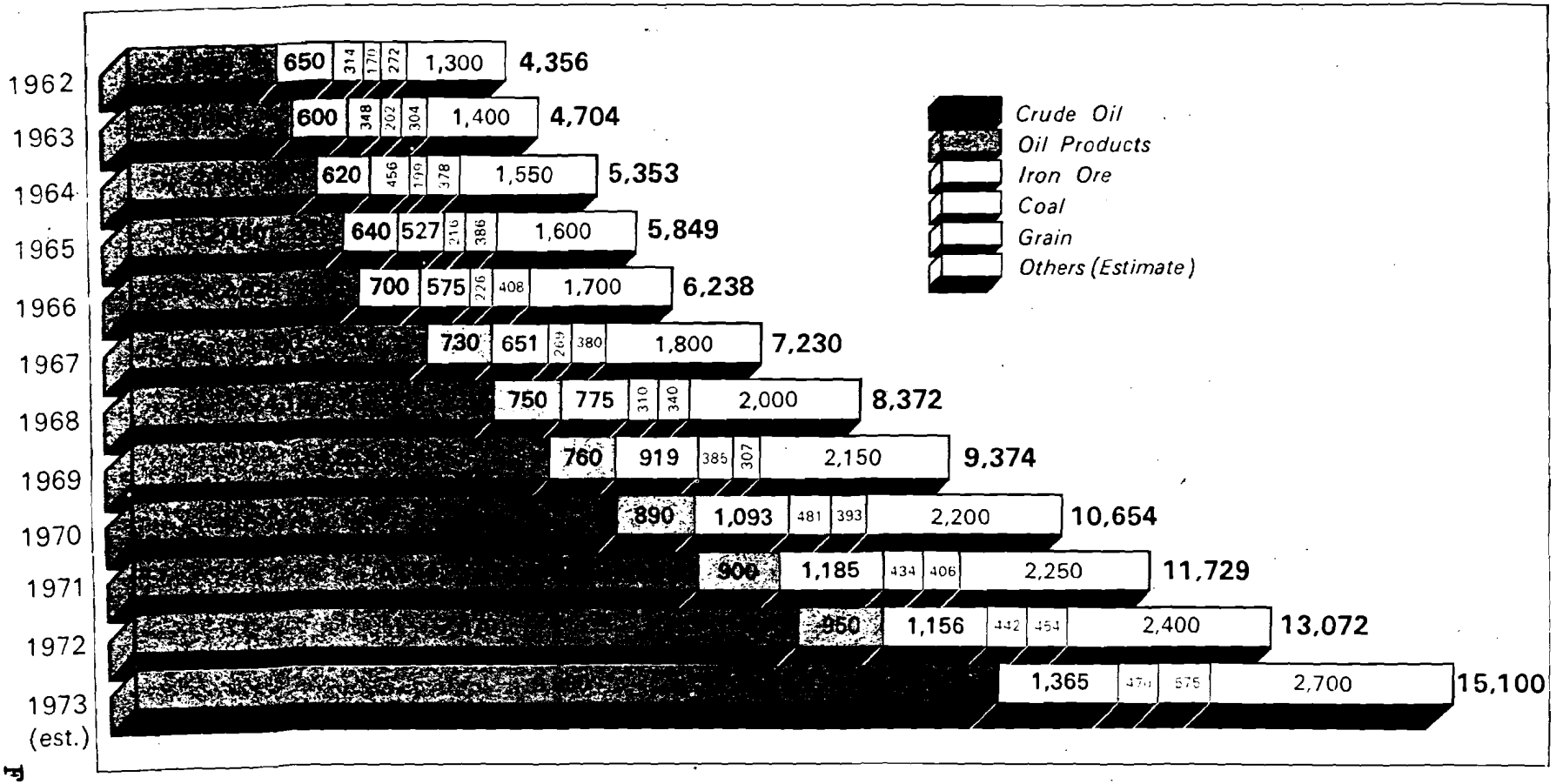
Generalized regional variations in abundance of manganese oxide nodules on the surface of the sea floor in the Pacific (Skormyakova and Andrushchenko, in Strakov and others, 1968, p. 128). Nodules are absent or sparse in blank areas and where present may be small or consist of films or coatings of oxides on other materials. They may cover as much as 20 per cent of the bottom in stippled areas, and 20 to 50 per cent of the bottom or more in ruled areas. Although the outlines of these provinces are generally consistent with the available data, bottom photographs and samples are not sufficient to infer continuity or absence of nodules in any given area.

(From Oceanography, Contemporary Readings in Ocean Sciences, R.G. Pirie ed., Oxford U. Press, 1973)

Figure 6

A. TOTAL TRADE ESTIMATE

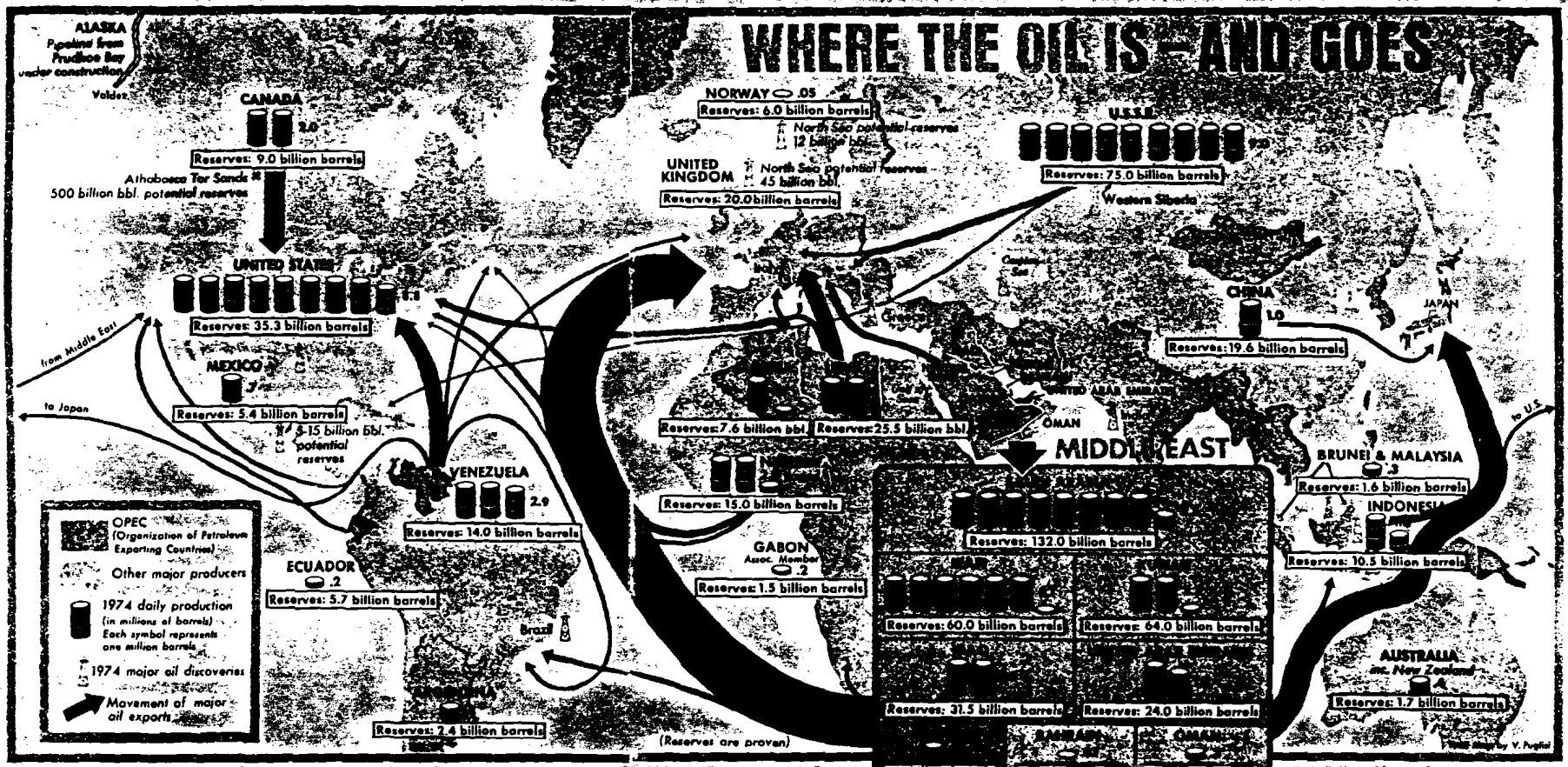
(in thousand million laden ton-miles)



Source. Fearnley and Eger's Chartering Co. Ltd. Review 1973: 1973 estimates with additional information from Fearnley and Eger and BP Trading Ltd.

• *Crube Oil and Oil Products*

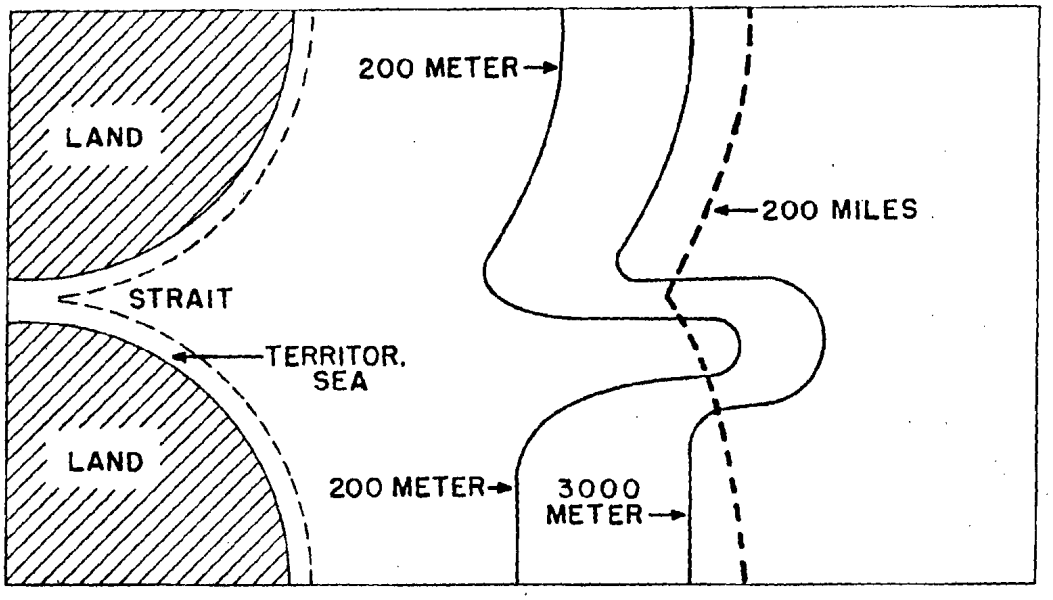
Figure 7



xxi-1

Figure 1.1

OCEAN SPACE SCHEMATIC



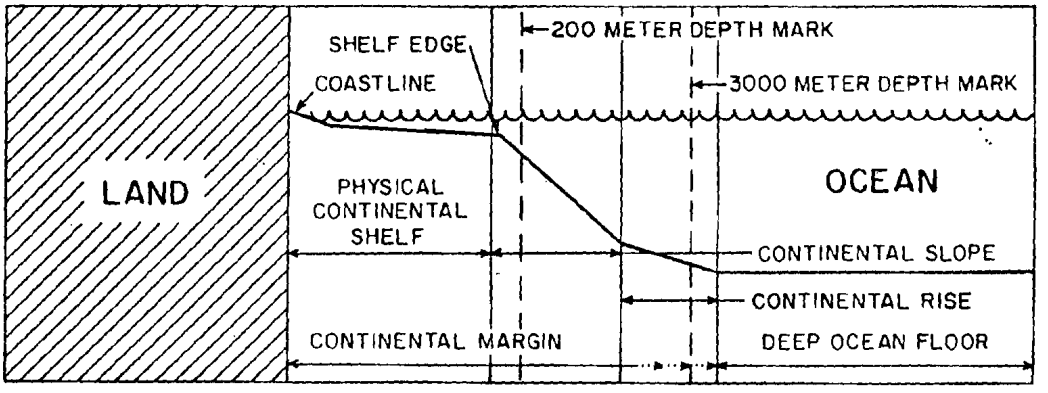
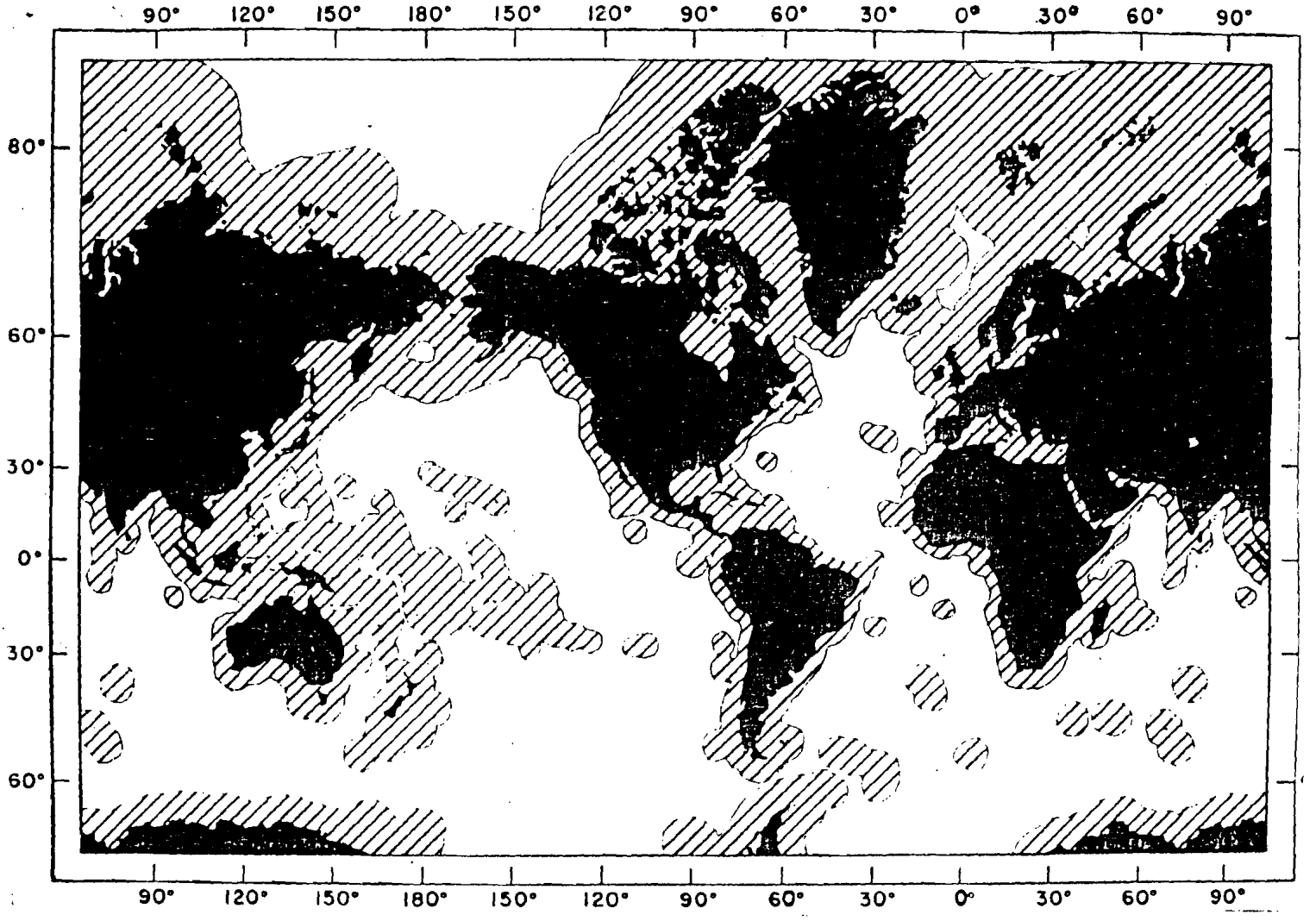


FIGURE 8

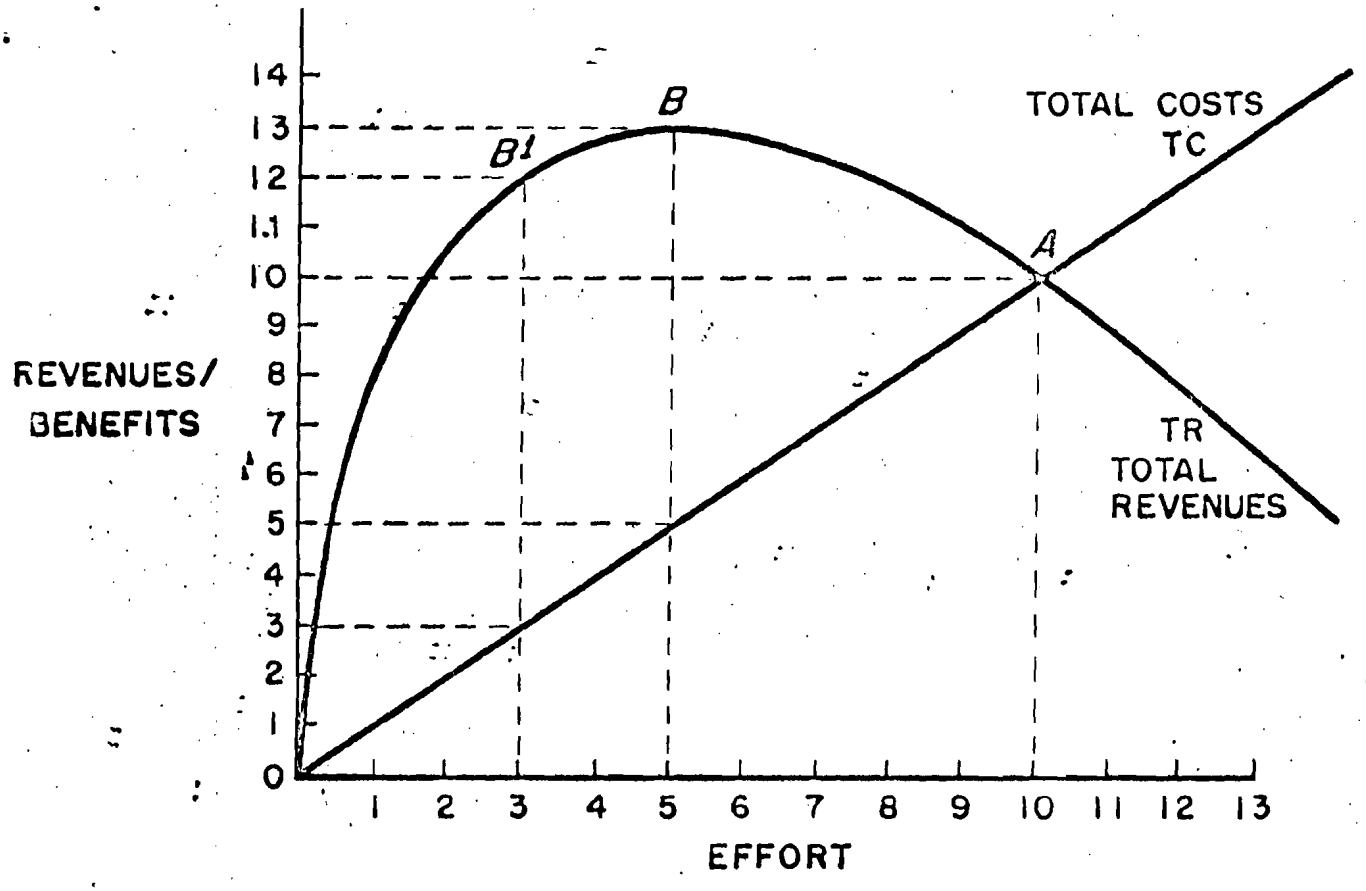
WORLD ECONOMIC ZONE



Courtesy of University of Rhode Island, Maritimes

FIGURE 9

CONSEQUENCES OF COMMON PROPERTY



THE RELATION BETWEEN REVENUES AND COSTS, SHOWING THE EQUILIBRIUM POSITION IN THE ABSENCE OF CONTROLS OR PRIVATE PROPERTY (A), AND THE BENEFITS FROM REDUCING EFFORT, OR USEAGE, TO THE LEVEL GIVING THE MAXIMUM GROSS YIELD (B), OR THE MAXIMUM NET (ECONOMIC YIELD (B^1).

FIGURE 10

MARITIME SYSTEM MODEL

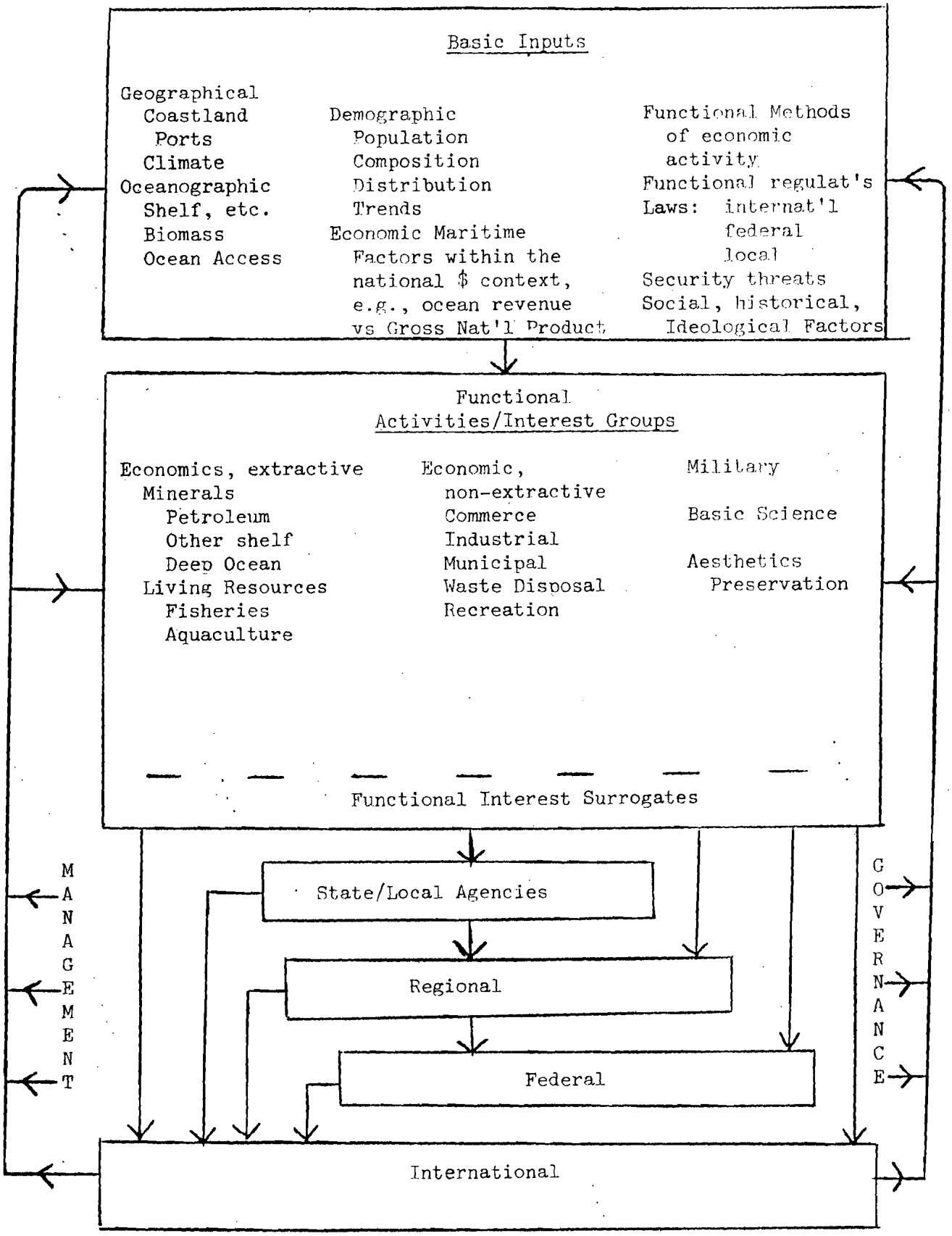
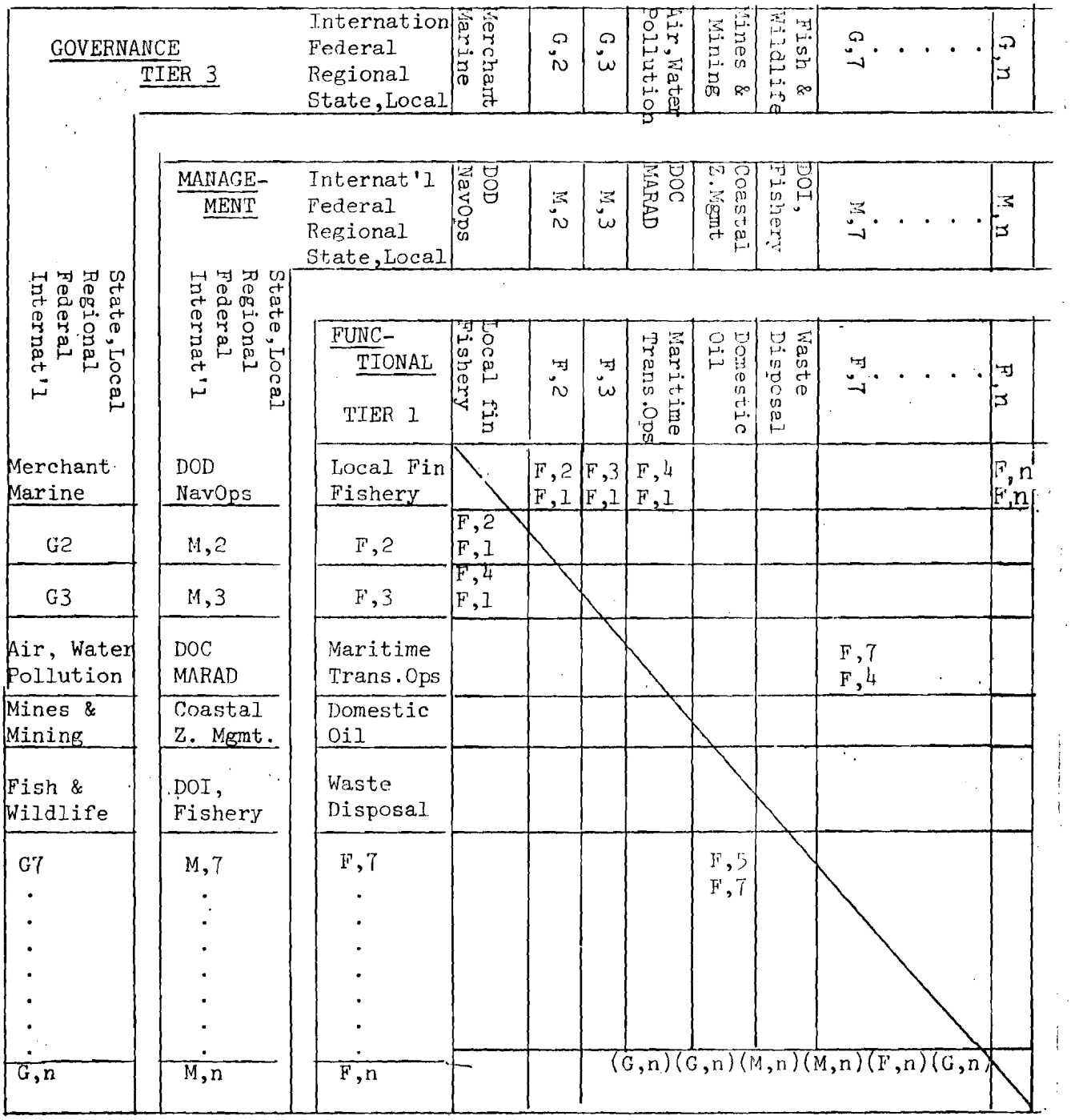


Figure 11

Marine Environment Management Matrix



Correlate each interest with each issue with respect to every other interest.

FIGURE 12

INTRODUCTION

SEA TECHNOLOGY's January 1975 issue inventoried leading figures for their viewpoints on the outlook for development of the maritime environment. Altogether the resultant observations noted great benefits and a litany of problems associated with dealing with the resources and uses of the ocean. Of special note for its management implications was Congressman Thomas M. Downing's call for a "coordinated mechanism" to review the issues, set forth plans, and propose solutions for the multitude of national ocean problems.[1]

The basis for the need for such a mechanism is the gross number and variety of maritime issues and interests. To cope with such an array of problems, it is necessary to address relations of similar activities between different states, of competing elements within each broad activity within each nation, of competing activities in general, and of several variations of those relationships.

Some maritime activities may be independent of each other, but most are in competition and some are supportive in one way or other with most other maritime activities. Fisheries and merchant vessels rarely are at odds over matters of ocean traffic. However, both those activities may object to obstructions related to offshore oil drilling. Both municipalities and fisheries complain of merchant vessel pollution. Companies of different states compete for offshore oil lease rights.

On the other hand, synergy and sublimation sometimes result from interworkings of maritime activities. Complexes of offshore platforms increase fish congregations. Power plant cooling pondstransmute thermal pollution into significant aquaculture resource. Municipal effluent may be used to enhance marine biomass productivity.

In all cases, the basic relationship between activities is that of their use of what is oftentimes common ocean space. The mechanism proposed here to address those relationships will encompass all maritime activities. However, this paper will take two short cuts.

The first will involve reliance upon a United States viewpoint in considering resources and activities. The United States not only possesses and uses a large proportion of the world's resources, but it contains within itself virtually the full range of maritime interests and perspectives. Therefore, while the general perspective attempted will be global, reference to a U.S. outlook will often be implicit.

Secondly, attention will focus primarily upon national perspectives about offshore interests with regard to their international implications. That it will not address the value of coastal industry, waste disposal, and other onshore activity is not to downgrade the coastal zone. Moreover, this should be a valid abridgment since many coastal zone activities can be traced back from their relationship with offshore activities.

Nowhere else will national positions about offshore maritime issues be as well illustrated as at the 1974-75 United Nations Law of the Sea Conferences. At those meetings, about 150 nations will strive to have their best national interests served in a universal treaty that covers 100 varied topics. While 15,000 bargaining positions are unlikely, there will be a welter of issues.[2]

With so many interests, it is worthwhile to characterize them, sometimes according to geographic position, politics, or ideology. However, pairings of disparate concepts may be equally useful: local-global; coastal-maritime, domestic-international; economic-military; resource use-non-resource use. And, concerning national perspectives, states may be categorized by their relative degree of access to the ocean: completely open, shelf-locked, land-locked.[3]

The United States, with its multiplicity of domestic interests and perspectives, has had to attend on a national scale to most of the issues that the Law of the Sea Conference considers on an international scale. How the United States arrived at a coherent position on those issues while considering its many divergent national interests has been a difficult and uncertain path.[4] It is such complex circumstances that demand a systems approach, the "coordinated mechanism" for coping with the maritime environment.

The mechanism should first include a systematic method which identifies and sorts all categories of maritime interests and their interrelationships. However, before that can be formulated, we must touch upon salient physical and social factors and processes which underly maritime activities and issues and which point up the importance of the maritime environment.

PHYSIOGRAPHY

A most frequently used maritime statistic is that the 139 million square miles of the oceans and seas represent 70 percent of the earth's surface. That fact, although dramatic, is a geographic overstatement. It engenders the image of 15 percent of the land divided from the other 15 percent by a vast body of water. On the other hand, such a land-water ratio is far from man's actual experience. Figure 1 illustrates the more refined fact that in the area where most people live, between 20 and 50 N. Latitudes, the ratio of land to water is nearly equal.

A second factor modifying sheer ocean size is the division of the ocean itself. The major world ocean is five parts Pacific, three parts Atlantic, and two parts Indian Ocean. Between those oceans and their adjoining semi-enclosed seas there are about eight critical passage points that are

either capes, straits, or canals. Obviously, the full use of ocean space is conditional upon use of those critical passage points illustrated in Figure 2.

The oceans are indeed large, but in actual usage their size is evenly balanced by related land masses. And, it remains a critical fact that in the coastal nations are located over 95 percent of the world's populations who are accessible to and who vitally use the oceans.

Besides the areal aspect, the ocean and its seabed must be looked at in profile. Many ocean characteristics are related to the nature of the seabed contour. This contour projects out from the continental land mass and extends under the ocean's waters at a flat 0.1 degree gradient as the continental shelf, then falls off relatively rapidly at a three to six degree gradient as the continental slope.

The slope is also integral to the continent and it extends down to the oceanic basin floor. However, part way up the slope is a sedimentary layer called the continental rise that covers a portion of the slope and overlays the edge of the ocean floor. The shelf, slope, and rise makeup the continental margin; the superjacent waters are called the coastal oceans (Figure 3).

While the features of the continental margin are characteristic of almost all coasts, their depths and their distances from shore vary considerably. For example, the

depth of the shelfbreak is typically 130 meters, but it may be as shallow as 75 meters and as deep as 350 meters. And, while the shelf is an average 40 miles wide, it may be as narrow as 10 miles on continental west coasts and as broad as 400 miles on their east coasts.

The remainder of the seabed, the deep or open ocean, consists of the sedimentary abyssal plane, trenches, rises, and ridges, all of which have an average depth of 11,000 feet in the Atlantic and 13,000 feet in the Pacific.

PHYSICAL PROCESSES

Processes that occur in each of the ocean's major subdivisions determine their resource content.

The first is essentially a function of currents that flow at the perimeters of major ocean basins (Figure 4). Interaction of currents with the continental margin or with other currents bring nutrients to the photic surface waters and bring about the productivity patterns in the ocean. Because of current patterns, biomass in the continental margin and particularly in upwelling areas is two to six times that of other ocean areas. And, except for some equatorial regions, the mid-ocean is a biological desert (Figure 5).

Of equal importance concerning the continental margin was its formation by the same geological processes as the land masses. As a natural prolongation with similar composition,

the margin contains the same mineral lodes as are in the land continents. In addition, the continental margin has accumulated large placer deposits of materials and minerals from land runoff.

There is little evidence of large continent-like mineral deposits in the deep ocean crust, and only a few signs of oil deposits have been found in the sediments of the flat abyssal plains. However, it is on the deep seabed where the unique manganese nodules occur. Precipitated over time from seawater, the nodules which cover large portions of the deep ocean floor contain 15 percent manganese and one to two percent nickel, cobalt, and copper (Figure 6).

FISHERIES

In historical terms, fisheries were one of man's first uses of the ocean and remain of great importance. Today's world fish catch, averaging about 68 million metric tons in the 1970's, represents 15 percent of the world's direct protein intake and also provides feed and fertilizer for land agriculture. Fish protein concentrate has potential, along with aquaculture in helping to increase the world's protein supply.[6]

More than 90 percent of the world's catch is taken in coastal waters. It is notable, however, most of the fish are harvested by foreign distant water fleets. It is estimated that U.S. fishermen account for only 16 percent of the total Northwest Atlantic catch.[7]

Since 1948 the world fishery catch has increased three-fold (Table 1). And, by further opening new fisheries such as in African and Indian Ocean waters, and by exploiting new species, it is conservatively estimated that the catch could again be doubled.

MARITIME COMMERCE

Man's second historic use of the ocean has been waterborn commerce. In 1973 the need to bring scattered resources to world markets was shown by the total world trade of 15,100 billion ton-miles, two-thirds of which was petroleum products. Figure 7 analyzes this trade data, and it depicts the relative volume of traffic on the world's sea lanes. Table 2 shows conservative data on traffic through straits, many of which are already considered congested.

Although the Very Large Crude Carrier and its associated Deep Water Ports are main features of modern merchant shipping, maritime commerce has grown in all respects. In the past quarter century, the number of merchant ships has doubled and tonnage has quadrupled. Equally significant, in the past decade the number of ship casualties (total losses) has increased by half, similar to that of net ship increases for that period (Table 3). Trends in waterborn commerce are expected to continue, with the increase for U.S. trade tonnage forecasted to double again by 1985.

OCEAN MINERALS

A more recent ocean usage, in terms of scale, has been exploitation of the seabed. Only in the second half of the 20th century have non-living offshore resources become of significance to man's mineral needs.

On the continental margin, concentrations of minerals are analagous to those on the continents. As Table 4 indicates, many important land minerals, from sand to diamonds, are found in the continental shelf. Hard minerals are significant but petroleum and gas are most valuable. According to a 1973 National Advisory Committee on the Oceans and Atmosphere report more than 100 billion barrels of oil have been found off U.S. shores while drilling 17,000 wells in the previous 25 years of exploitation.

During its short activity, the offshore exploitation has provided 18 percent of world oil and 10 percent of total gas production.[8] Currently, there are over 260 oil exploration rigs operating off the shores of most of the world's nations. In the future, offshore production is expected to provide half of world petroleum output.[9]

In the deep ocean, mining of manganese nodules is in its earliest phase. The first production site, announced in late 1974 by Deep Sea Ventures (a U.S.-based international consortium), is 1500 miles southwest of San Diego in waters

15,000 feet deep in an area covering 60,000 square miles. Production, to begin in the late seventies, is expected to be 1,350,000 metric tons of copper, comparable to 9 percent of U.S. imports in 1972.[10] A notable factor is that world usage of the metals found in the nodules is less than the 6 million-ton replenishment rate per year.[11]

RESOURCE AND USAGE DISTRIBUTION

A review of the maritime environment resources should lead to at least two findings. First, the ocean has become increasingly important in its economic role. Secondly, concerning both its new and its traditional resources and uses, the overwhelming majority occur in, or are dependent upon, areas close to the coastline. Few fish, except for tuna, are taken beyond 200 miles. Increased volume of shipping still results in highly vital traffic confluences in straits, canals, and along coasts. And, except for manganese nodules, significant ocean minerals are to be found only on the continental margin.

MILITARY

Although only indirectly economic in nature, another historic use of the sea has been that for military purposes. Naval tasks continue to include enforcement of coast and maritime laws, defense of shorelines, and, for some nations,

protection of overseas interests. Also, modern warfare introduced the deployment of strategic missile-firing submarines into the ocean environment.

Changes in world navies have consisted not so much in numbers of ships but in the count of independent forces. Super-power navies have doubled with accession of the USSR to that status. And, such lesser navies as those of China and Iran are becoming significantly more formidable, particularly in view of their restricted areas of operation.

Transition involves not only the forces but the scope of naval tasks. In the past the primary concern of seapower for the ocean was as a medium of merchant shipping lanes and as the battle area of naval operations. Now the ocean may represent the source of conflict in boundary disputes, and, it becomes extensive territory to be defended.

OCEAN SPACE

The space used by the numerous maritime activities should be analyzed according to its dimensions. Lateral division is a relatively simple matter of equidistance rules of geometry. The vertical dimension admits of division into five clearcut strata: the subsoil, the seabed, water column, water surface, and the atmosphere.[12]

Space division become more difficult when considering the methods of defining and positioning vertical boundaries to form specific legal widths of various maritime zones. These areas have a natural, but sometimes merely general, relation to the nature of the seabed. In terms of distance from the coast or in depth of the seabed, the following are the zones under current discussion:

	Zone	Limits/Definition
1.	Territorial Sea	Arbitrary; commonly 3 or 12 miles
	Contiguous Zone	Arbitrary; U.S. applies to 12 miles for fisheries and for other law enforcement rights.
	Continental Shelf	Arbitrarily at 200 meter isobath
2.	Continental Margin	a) Arbitrarily 2500 to 3000 meters, or b) 200 miles.
	Economic Zone	Some one, or combination, of the above elements; sometimes refers only to the seabed and subsoil.
3.	Open Ocean	Complement of the above space; "that beyond national jurisdiction"
4.	International Straits Zone	either a special type of territorial sea or a special part of international waters -- depending upon viewpoint.
	Miscellaneous:	
5.	Patrimonial Sea	Latin American reference similar to the economic zone.
	Fisheries Zone	Often to 200 miles.

Some attention should be made to the development of the limits for the continental shelf and the continental margin. Rather than use the actual shelf edge, the 200 meter isobath came into usage as a convenient number as well as one that would include most shelves of most states. The same rationale, reinforced by most probable locations of petroleum deposits, led to the 2500 or 3000 meter isobath to define the outer edge of the continental margin.

Those conventions in using the highest common denominator were directed at gaining the widest general acceptance while having some basis in geomorphology. A final effort at consensus has been arbitrarily to extend the "continental margin" out to 200 miles; that limit not only includes most real margins of most states but also gains the acceptance of many states that have narrow natural continental margins. Still, parts of margins of some countries, the U.S. for one, extend out beyond 200 miles. A likely consequence is that the legal continental margin will extend out to 200 miles or to 3000 meters, whichever is furthest from the coast. These spatial aspects are stylized in Figure 8; the world "economic zone" is depicted in Figure 9.

SOCIAL PROCESSES

The varied designations of ocean zones are partly an expression of man's attempt at legal regulation of the maritime environment. But they are only representative of a broad range of national initiatives and international laws of the sea, some of which are outlined in Appendix I.[13]

A review of those items reveals several points. Most of the laws are less than ten years old; none are more than 25 years old. Further examination shows that they attempt peacemeal to address most activities in all dimensions of the oceans either by multi-national or unilateral approaches. International law has little precedent for such an occurrence.

The reason is that there have been significant changes, both in the kinds and the degree of ocean usage over the past three decades. Underlying those changes has been the geometrical growth of world population - doubled over the previous 20 years to 3.7 billion and expected to double again before the year 2000. At the same time, numerous advances in technology have provided those populations with the capability for tremendously increased usage of the ocean.

Another worldwide factor that both intensified and fractionalized ocean activity has been the increased number of new states with national interests in their local maritime environment. Since the first Law of the Sea Conference in

1958, there has been an increase by 50 in the number of sovereign states. Not only the new states but all of the smaller, less developed states have in general had an increasing awareness of the benefits to be gained, or lost, in the usage of their coastal oceans.

FINITE OCEAN

Specific maritime effects of those broad trends have been enumerated earlier. Fisheries, commerce, mineral exploitation, and military activity have recently increased by factors of two to four, and similar increases are forecast again by the end of the century.

Whatever the multiples of increased maritime usage may be, it is becoming likely that the ultimate carrying capacity of the oceans may be about to be reached. When that critical stage is reached it becomes victim to the consequences of being a common property resource.

A common property resource is one to which all enjoy free access: each individual therefore will receive separate benefit from his use but the cost of the activity is born by all users and the public in general. No one will husband the resource because the return to the individual always exceeds the individual cost. Figure 10 illustrates the waste caused by this process in which individual activity will be expanded until total costs equal total benefits.

This process often causes exhaustion of the resource as well. The classical example given is that of each herdsman adding to his stock until a pasture is overgrazed. Whatever grass his stock does not use today may be taken by another, therefore the rational herdsman increases his stock whenever possible. Thus, the so-called "Tragedy of the Commons", is the inexorable compulsion to misuse the resource.[14]

While some disagree with forecasting such a commons tragedy for the oceans, there is considerable evidence and opinion to support that attribution concerning minerals, commerce, and fisheries. Several kinds of whales have been overfished; and currently herring, haddock, and flounder are considered endangered species. Maritime pollution is reaching global proportions: the Mediterranean Sea is threatened; the second RA expedition reported "tarlike lumps as big as prunes", oil muck, and miscellaneous debris throughout most of its mid-Atlantic crossing.[15] And, although part of a larger energy problem, the exploitation of offshore minerals must be subject to close control.

It was in such a context that the Senate National Ocean Policy Study was initiated in late 1974. The study is a profound and extensive Congressional recognition of the critical need for conservation and management of the ocean resources.[16]

OCEAN INTEREST GROUPS

The ocean may be protected from misuse, just as the plains were finally protected from exhaustion by permits, use taxes, private property fences, and similar measures. But where the basic land problem was not so much who would use the prairie but how much it would be used, the problem of ocean usage must first begin with merely accounting for those various interest groups that use the ocean. Herein lies the initial aspect of a systems approach to the marine environment.

Identification of ocean interest groups will be related to institutional and jurisdictional levels as well as to functional activity. Enumeration will strive to be definitive and exclusive: the smallest elements seek to represent groups that might pursue goals or practices that would be at odds or at least indifferent to the well being of other groups.

The first class of interests are naturally related to the outputs or uses of the ocean. From the broad categories of mineral resources, living resources, non-extractive economic, and non-economic uses such as the military, Table 5 divides the functional maritime interests into 35 discrete elements.

This treatment assumes that each economic activity would also be considered for its labor and entrepreneurial viewpoint. On the other hand, the elements may have associations or lobbies to act as surrogates for their constituencies.

The second major class of interest groups is that of the government institutions that represent functional activities. In addition to government levels, these entities may be according to their two jurisdictional purposes. One purpose is "management", the control or regulation of the operations of the functional activities; the other is "governance", the setting of policy relating to each functional activity. Generally speaking, governance is embodied in the legislature, and management rests with the executive branch of government.

Tables 6 and 7 outline 43 various federal entities according to their jurisdictional purposes. The institutional groups can be categorized according to functional, geographic, or administrative orientations. Additionally, these organizations must be considered also to have bureaucratic as well as formally chartered objectives.

Besides the federal organization, there are other institutional levels to be considered. States have analogous agencies with similar goals. And, growing in prominence, there are intra-national, regional organizations such as port authorities, river basin commissions, and sectional organizations. Selected international organizations are listed in Table 8. Figure 11 outlines an overall maritime system.

NEW OCEAN JURISDICTIONS

From a review of those interests and their various usage of ocean space, it should be clear that significant changes have occurred in maritime jurisdictional concepts in current times. Traditionally ocean space was divided into two clearly delimited zones that were of absolute character. Next to each coastal state was its territorial sea of narrow width in which the only dilution of national sovereignty was the international right of innocent passage. Beyond that limit was the expanse of high seas area in which existed freedom of navigation, overflight, fishing, or whatever man desired to do with little restriction.

Where formerly there were but those two zones, current practice has led to three: the old territorial sea remains, but in place of the "open ocean", there is an economic zone (or continental margin or coastal ocean), and an international ocean. The economic zone and the international ocean are characterized by mixtures of national jurisdictions, international rights, and international restraints.

Although the Law of the Sea Conference will attempt to put these concepts together in a universal, comprehensive code of maritime laws, its work in some ways will only be a confirmation of actual practice. Those who doubt that assertion would do well to examine the practices of the United States, considered by some as the foremost proponent of freedom of the high seas.

For example, the U.S. gives de facto acknowledgement to extended claims of other nations such as Brazil's 200 mile fishing jurisdiction. It has also selectively extended its own jurisdictions. Even before it acceded to the trend toward 200 mile economic zones, it had declared an exclusive national fishing zone to 12 miles, customs zones to 62 miles, and restricted air defense control zones to 500 miles.[17]

This trend toward extended national jurisdictions, which the United States has alternately led or acquiesced to, has taken on a generally uniform shape. The essential trade-offs and give-ups made between international and coastal interests are compared in the following two columns:

Transitions Toward Mixed Maritime Jurisdictions

Traditional	Current Trend
1. Territorial Sea: 3-12 miles, sovereignty absolute with innocent passage permitted.	1. Territorial Sea - ...Universally extended to 12 miles, otherwise no change.
2. Open Ocean/High Seas: Freedoms: cable laying navigation overflight fishing Other uses subject only to multilateral agreements re: specific activities, e.g., pollution ship safety resource utilization	2.a. Economic Zone to 200 mi.-Same freedoms retained except fishing. ...Otherwise coastal state has national jurisdiction. ...Coastal state responsibility: resource conservation, share unused resources, enforce pollution and safety measures. 2.b. International Ocean - ...An International Ocean Authority to set standards for activities, and control resource use.
3. Straits: Free Transit	3. Straits: Unimpeded transit provided flag states guarantee pollution and safety standards, plus payment of toll or tax to cover straits costs.

These trends are outlined not as a fresh discovery, but merely to summarize them and to note their general acceptance and suggest means to make the best of them. The extension of mixed jurisdictions and multiple usage will continue to increase; the objective to be sought then is to serve the valid interests of national pressures while retaining the beneficial freedoms of international usage.

UNIVERSAL MARITIME ISSUE

As mentioned earlier, the point upon which maritime interests hinge is their degree of use or non-use of common ocean space. Therefore, the next systems step after identifying the interest groups is to formulate all fundamental aspects of space usage into a single framework. Such a universal maritime issue, against which relations of all ocean activities my be tested, is submitted as follows:

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...with respect to what other interests, and...

2. Jurisdictional

...What organizations are to have jurisdiction over the activities in each zone?

Once specific questions are fitted to such a framework, the fundamentals may be expanded in detail depending on the matter at hand and the knowledge available. However, each activity in ocean space must consider all the elements of the universal issue regardless of the detail of information available.

MARITIME ENVIRONMENT MANAGEMENT MATRIX SYSTEM (MEMMS)

The universal maritime issue should assure thoroughness in viewing the matter at hand. However, the need still exists for a system by which "other interests" are all considered. Such a system could be a large simple X x X matrix of all the activities reviewed above. The matrix would provide a process by which each interest could be evaluated with respect to each issue with respect to every other interest group. Figure 12 partially illustrates such a matrix.[18]

Use of the matrix without machine assistance would be difficult; but failure to use some such tool will also lead to oversights. Often information would be sketchy; but discovery of its lack would be useful in itself.

The matrix could be the basis for group constituencies to identify constraints in group goal programs. And, coordinating organizations might refer to it in applying group expert-polling techniques, such as the Delphi method, in defining super-group goals.

The process may seem obvious. On the other hand, there is evidence that such methods are not being used. Until late 1973, the Department of State Advisory Committee for the Law of the Sea did not include a member representing the fisheries interests. Delays have occurred in offshore

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APPENDIX A

Initiatives and International Law of the Sea

1. Area Jurisdictions

a. International Convention on Territorial Sea and Contiguous Zone, Geneva, April 1958 . . . defined the low water level as baseline from which to measure but did not define the breadth of the territory.

b. International Convention on the Continental Shelf, Geneva, April 1958 . . . defines "continental shelf" as extending a depth of 200 meters or to where the depth admits to exploration of the seabed resources.

c. International Convention on the High Seas, Geneva, April 1958 . . . declared "high seas" freedoms as those of navigation, of fishing, to lay submarine cables, and of overflight.

d. UN Declaration of Principles governing the Sea-Bed and Ocean Floor beyond the Limits of National Jurisdiction, 1970 . . . claimed that such resources to be the "common heritage on mankind and to be managed by an international regime.

e. USA: Outer Continental Shelf Lands Act, 1953 . . . confirmed sovereignty over seabed resources, on the continental shelf; extended jurisdiction for pollution prevention.

f. Chile, Ecuador, Peru: Declaration of Santiago, 1952 . . . claimed sovereignty over the area extending 200 miles from the coast.

g. USA: Act establishing a Fisheries Zone Contiguous to Territorial Sea of the U.S., October 1966 . . . claimed exclusive fisheries rights in the contiguous zone up to twelve miles from its coastline.

2. Regulation of Activities

a. Fisheries

1) International Convention on Fishing and Convervation of Living Resources of the High Seas, 1958, . . . generally endorsed conservation.

2) Northeast Atlantic Fisheries Commission (NEAFC), 1969.

3) International Commission for Northwest Atlantic Fisheries (ICNAF), 1971.

4) International Convention for High Seas Fisheries of the North Pacific Ocean, 1952, Amendments to 1974 . . . to manage fisheries.

b. Pollution

1) International Convention for the Prevention of Pollution of the Sea by Oil, 1954, with amendments to 1971.

2) Convention for Prevention of Marine Pollution by Dumping from Ships and Aircraft, 1972 . . . to control waste disposal.

3. Canada: An Act to Prevent Pollution of Areas of Artic Waters . . . adjacent to Canada, 1970 . . . claimed pollution control to a distance of 100 miles.

c. Other Activities

1) International Treaty on Prohibition of the Emplacement of Nuclear and Other Weapons of Mass Destruction on the Seabed and Ocean Floor, February 1971 . . . self-explanatory.