Accounting for Marine Economic Activities in Large Marine Ecosystems

Marine Policy Center

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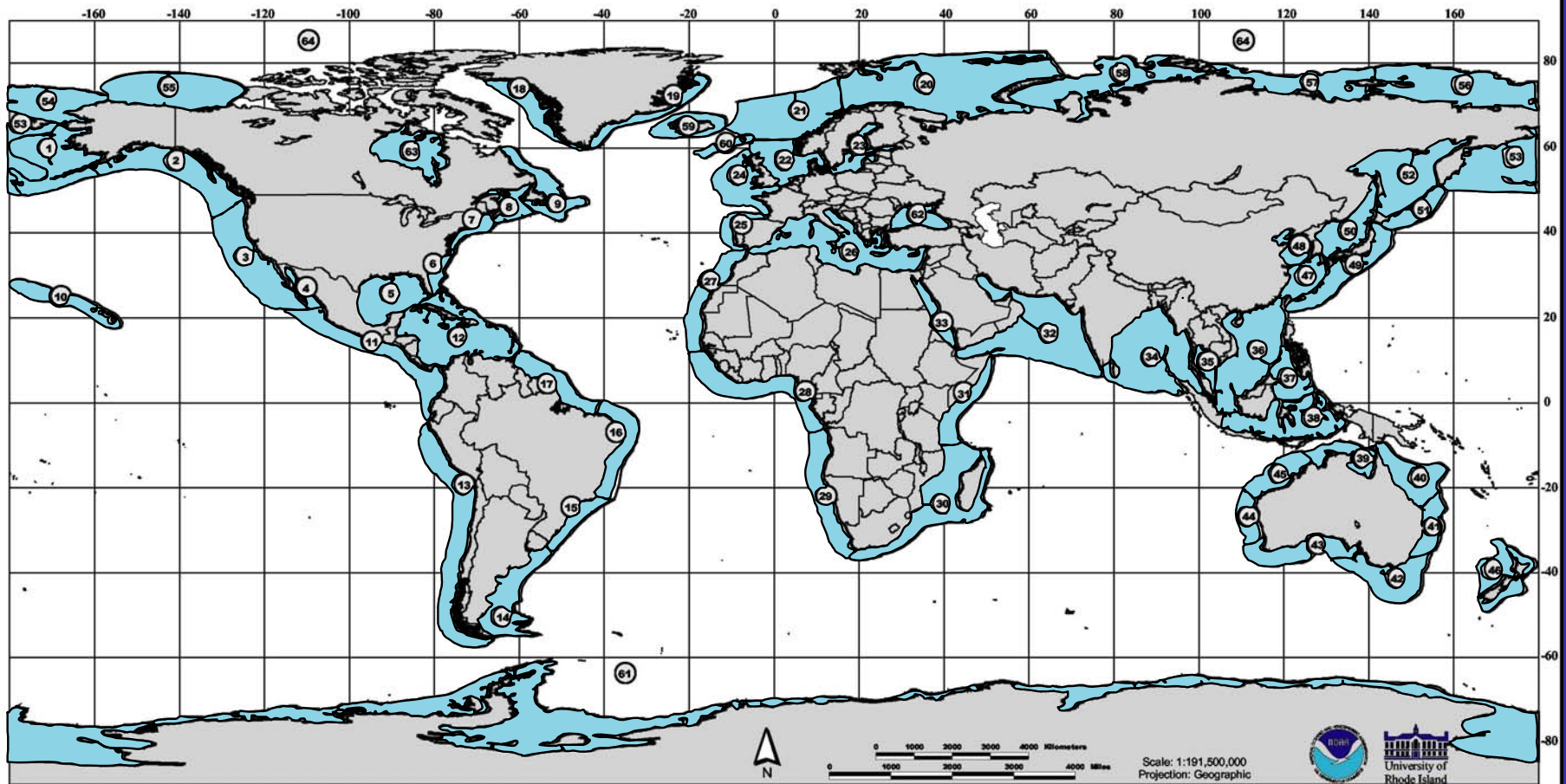Tom Grigalunas
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Large Marine Ecosystems of the World

Scale: 1:191,500,000
Projection: Geographic

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Primary Productivity

SeaWiFS: Annual Primary Production (g C/m2)

0   45   90   135   180   225   270   315   360   405   450
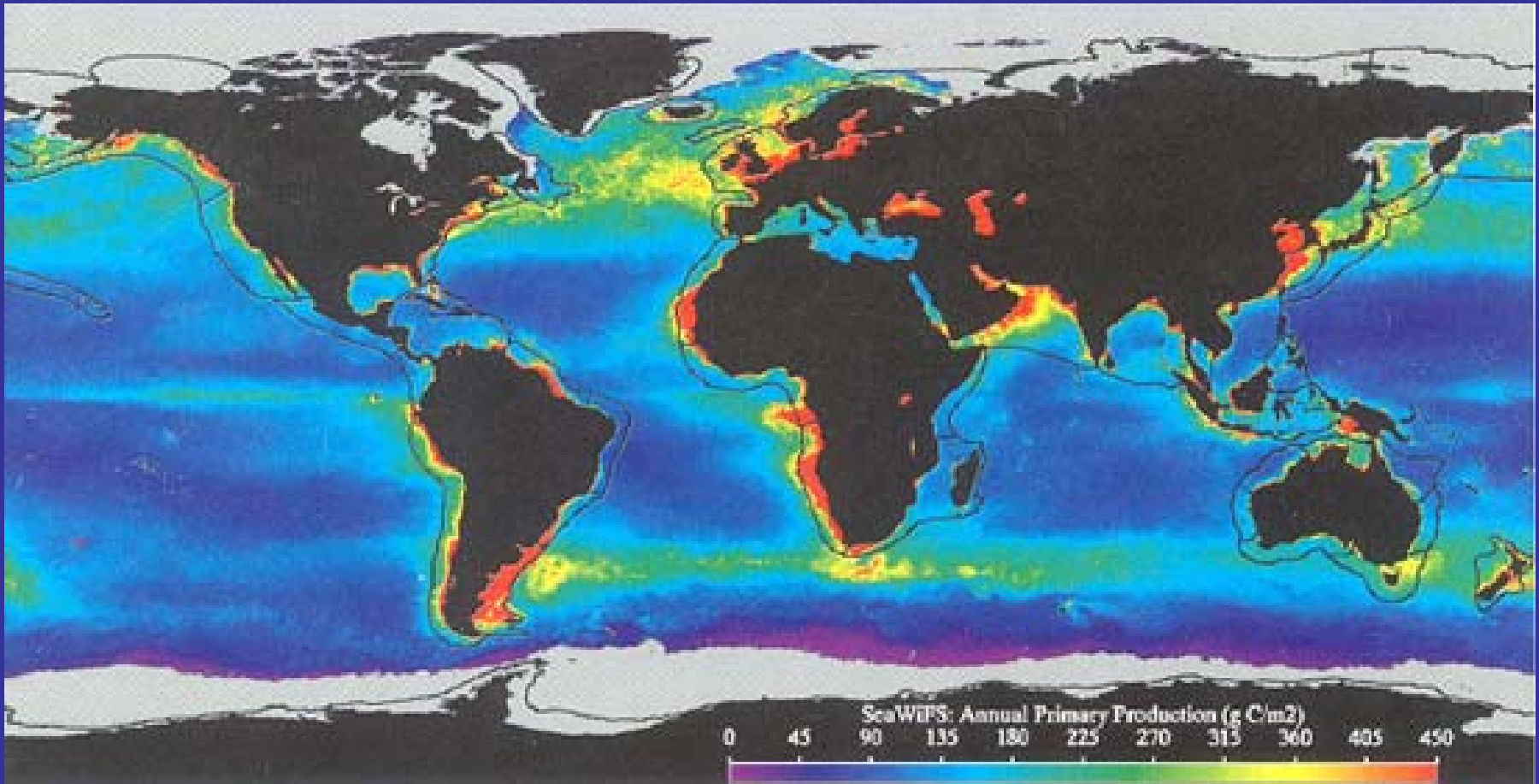
Five Module LME Approach
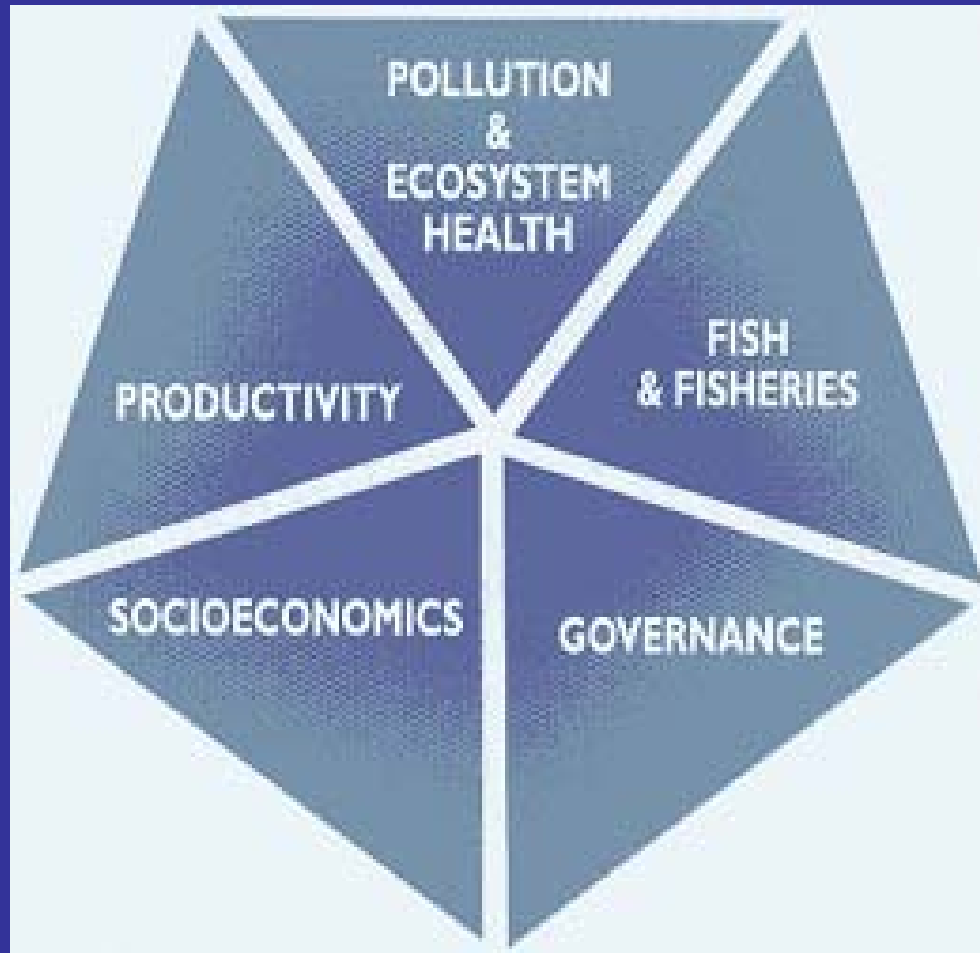
Socioeconomics

Analysis of the socio-economic characteristics has received relatively little attention to date.

Although a general framework for monitoring and assessing the socio-economic aspects of LMEs has been developed (*viz.*, Sutinen 2000), few detailed studies grounded in empirical data have been undertaken.

We take an initial step toward the development of a global overview of the socio-economic aspects of LMEs.
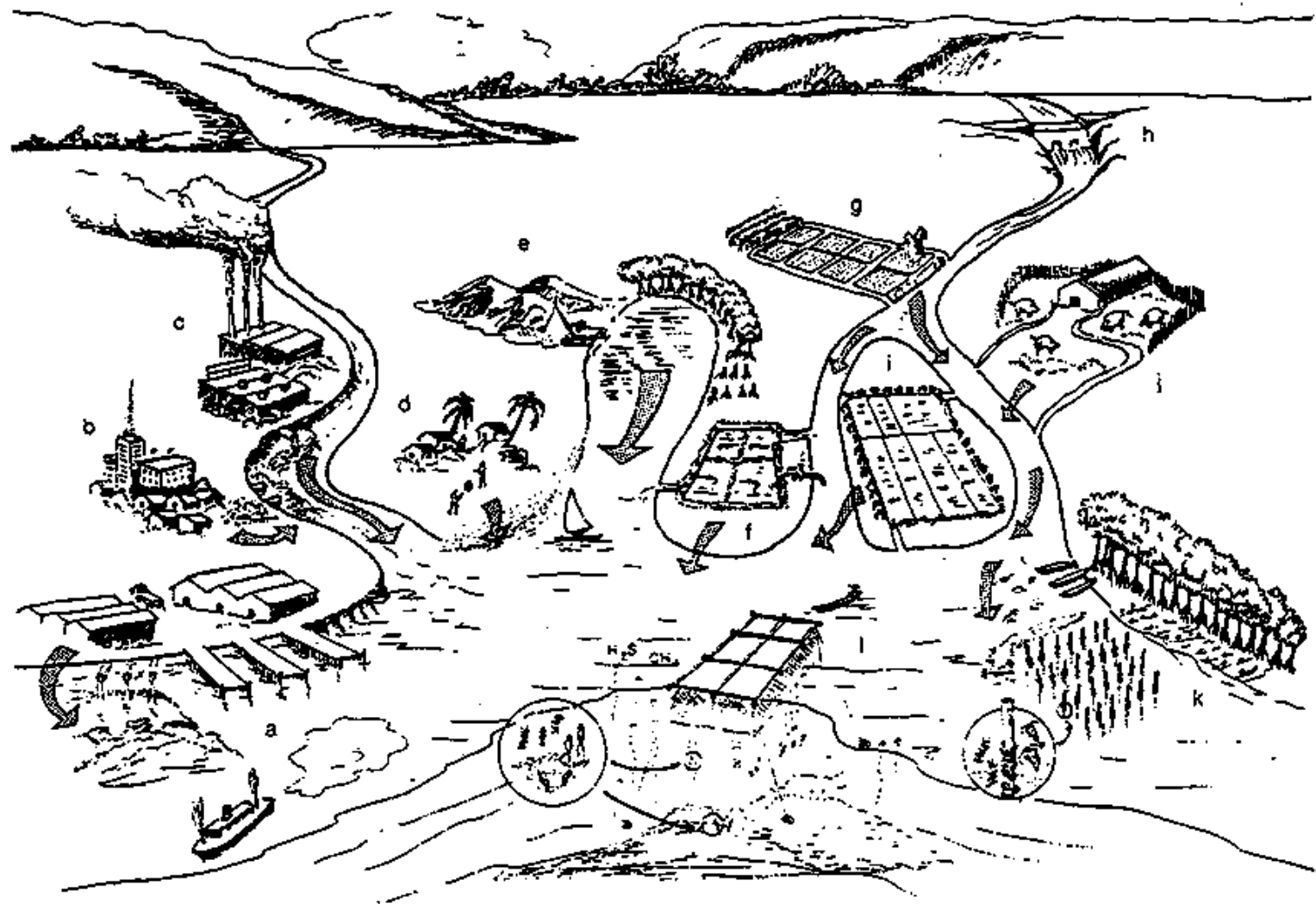
a. Oil slicks and domestic wastes from ports
b. Domestic wastes from urban settlement
c. Heavy metals, chemicals from industrial sites
d. Solid and domestic wastes from beach resorts
e. High suspended solids from sand mining
f. Nutrients and organic matter load from shrimp farms
g. Pesticides and nutrients from agriculture
h. Alteration of coastal hydrologic regime caused by freshwater discharge from reservoir
i. Pesticides, nutrients and organic matter load from fish farms
j. High organic wastes and drugs from piggery
k. High suspended solids in mollusk farms
l. High suspended solids and nutrients from cage farms

Ecosystem Functions and Services

Function	Service
1. Regulation	
gas regulation	air quality
climate regulation	favorable climate
water regulation	irrigation
soil retention	erosion prevention (forest and wetland)
waste treatment	detoxification (wetland and ocean)
2. Habitat	
habitat	habitats for plant and animal species
3. Production	
food production	seafood from ocean
4. Information	
aesthetic information	enjoyment of scenery
recreation	
spiritual information	use nature for spiritual purposes
science and education	

Reference: de Groot *et al*. (2002)

Ecosystem Management

Social Objective:

Max [Benefits – Costs] over time

Subject to economic and ecological constraints

Sustainable?

Social Cost = total cost = internal cost + external cost

Internal cost = economic costs (capital and labor)

External cost = environmental and ecological cost (externalities)

Market failures occur when markets do not reflect the full social costs or benefits of a good. (e.g., the price of gasoline does not fully reflect the costs, in terms of pollution, that are imposed on society by burning gasoline.)
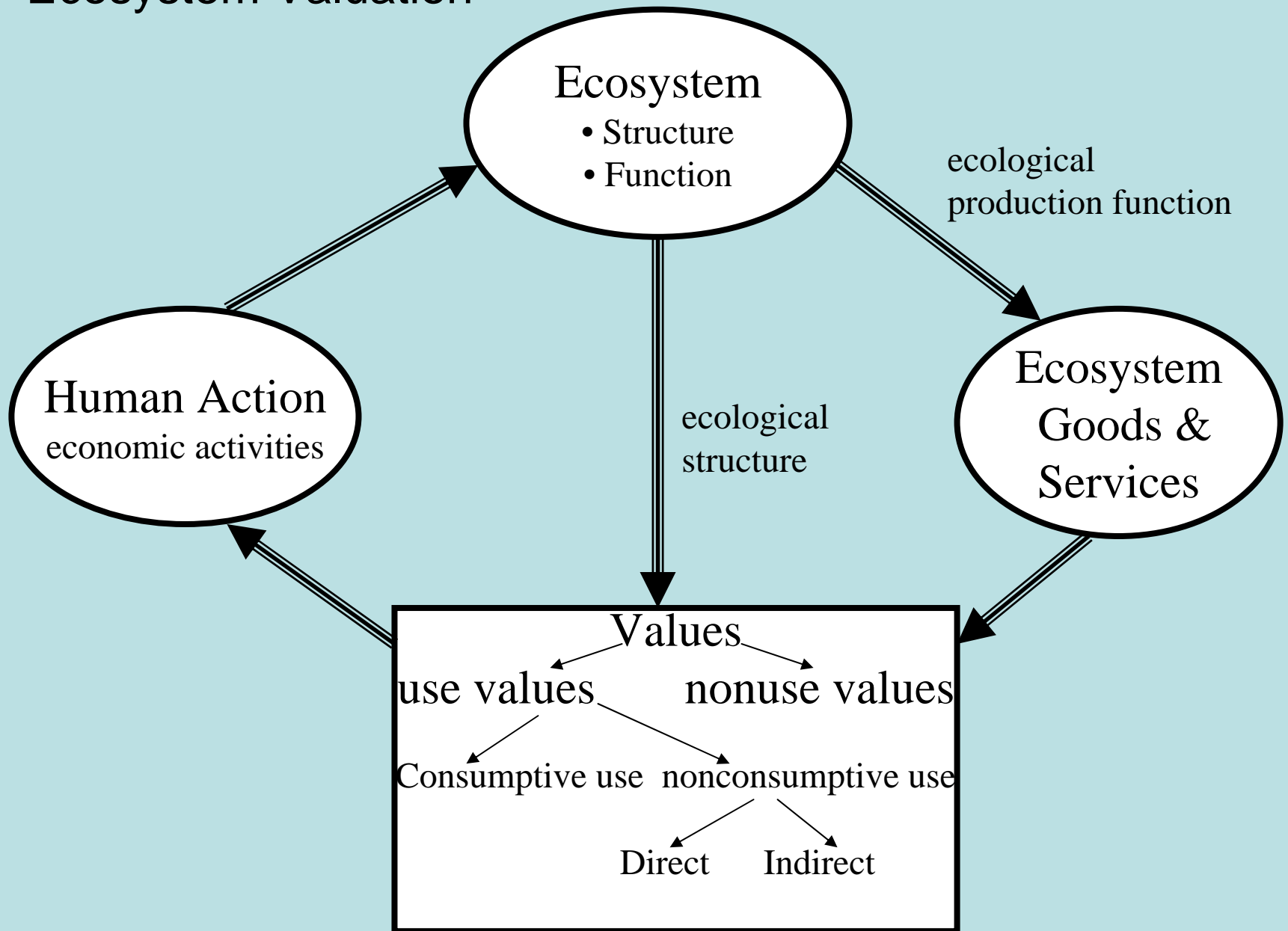
Resource valuation *vs.* Ecosystem valuation

Resource management	=>	Ecosystem-based management
Resource valuation	=>	Ecosystem valuation
Partial analysis	=>	System analysis
(partial equilibrium)		(general equilibrium)
Single resource (e.g., fish)	=>	Ecosystem (e.g., food web)
Resource	=>	Production function of ecosystem
A few links	=>	Multiple links
Shadow value (resource rent)	=>	Shadow value (include non-use values)

Ecosystem valuation requires: more information
multidisciplinary team
complex modeling

Ecosystem Valuation

Ecosystem
- Structure
- Function

ecological
production function

Human Action
economic activities

ecological
structure

Ecosystem Goods & Services

Values

use values   nonuse values

Consumptive use   nonconsumptive use

Direct   Indirect

Reference: NRC (2004)

Policy Questions:

- Can the level of economic development in an LME region be considered to be sustainable?

- Are the nations participating in the relevant LME capable of financing programs of sustainable management themselves?

Five Marine Industry Sectors

- Marine fisheries and aquaculture
- Tourism
- Shipbuilding
- Shipping
- Offshore oil

Marine Industry Indictors

Indicator	Unit	Year
Human Development Index (HDI)	Dimensionless	2002
Fishery landings	Metric tons (MT)	2003
Aquaculture production	Metric tons	2003
International tourism number of arrivals	Number of visitors	2004
Shipbuilding orderbook[*]	Gross Tonnage (GT)	2nd quarter 2004
Shipping cargo traffic	Metric tons[**]	2002
Merchant Fleet[***]	Deadweight tons (DWT)	Jan. 1, 2004
Offshore oil Production[****]	Average Barrel/Day	2004
Offshore rig count	Number	Dec., 2003

Marine Industry Index (I_{ij})

$$I_{ij} = \frac{x_{ij} - min(\,x_j\,)}{max(\,x_j\,) - min(\,x_j\,)} \qquad (1)$$

Marine industry activity indicator variable j

Nation i

Measure x_{ij}

Sector-Level Weighted Average Index (AI_i):

$$AI_i = \sum_{j=1}^{n} w_j I_{ij} \qquad (2)$$

n is the number of indicators in the sector and w_j are weights assigned by the analyst or decisionmaker across related marine activities in the industry sectors, and $\Sigma w_j = 1$.

National-Level Weighted Average Index (TAI_i)

$$TAI_i = \sum_{k=1}^{m} v_k \, (\, AI_i \,) \qquad (3)$$

m is the number of industry sectors and v_k is the weight assigned by the analyst or decisionmaker for marine industry sector k.

TAI_i can be interpreted as the overall "intensity" of nation i's marine activities.

Marine Industry Indictors

Industry Sector	Activity Weight (v_k)	Indicator	Indicator Weight (w_j)
Marine fishery and aquaculture	1/5	Fishery landings	1/2
		Aquaculture production	1/2
Tourism	1/5	Number of international visitors	1
Shipbuilding	1/5	Orderbook (ships on order)	1
Shipping	1/5	Cargo traffic	2/3
		Merchant fleet	1/3
Offshore oil	1/5	Production	2/3
		Rig count	1/3

LME Marine Industry Activity Index (*MAI*)

$$MAI_{LME(RSP)} = \sum_{i=1}^{s} l_i TAI_i \qquad (4)$$

LME Socioeconomic Index (*SEI*)

$$SEI_{LME(RSP)} = \sum_{i=1}^{s} l_i HDI_i \qquad (5)$$

l_i is the percentage share of nation i's coastline length relative to the total coastline length of all s nations bordering the LME.

Fishery and Aquaculture Index

Large Marine Ecosystems of the World

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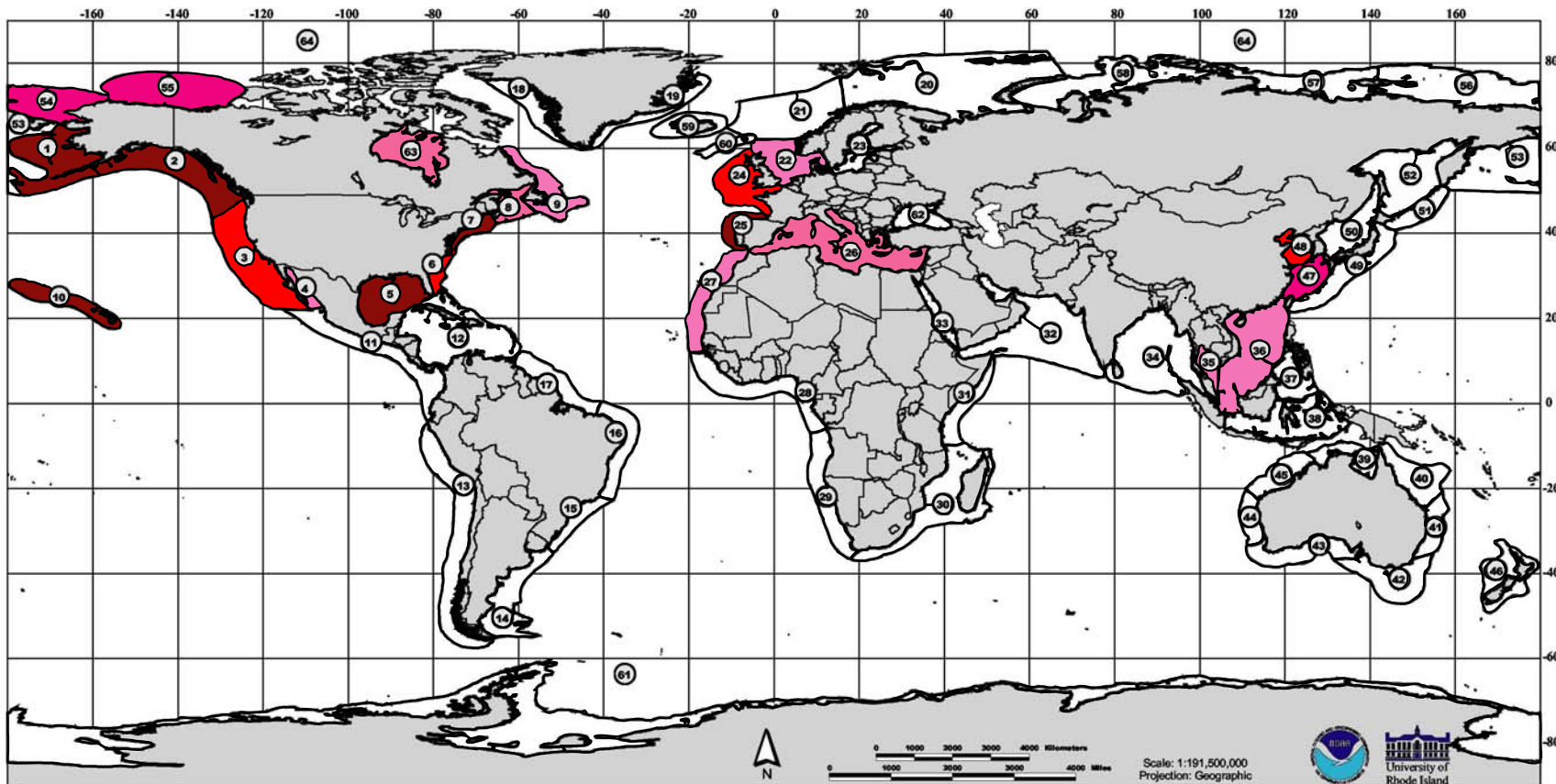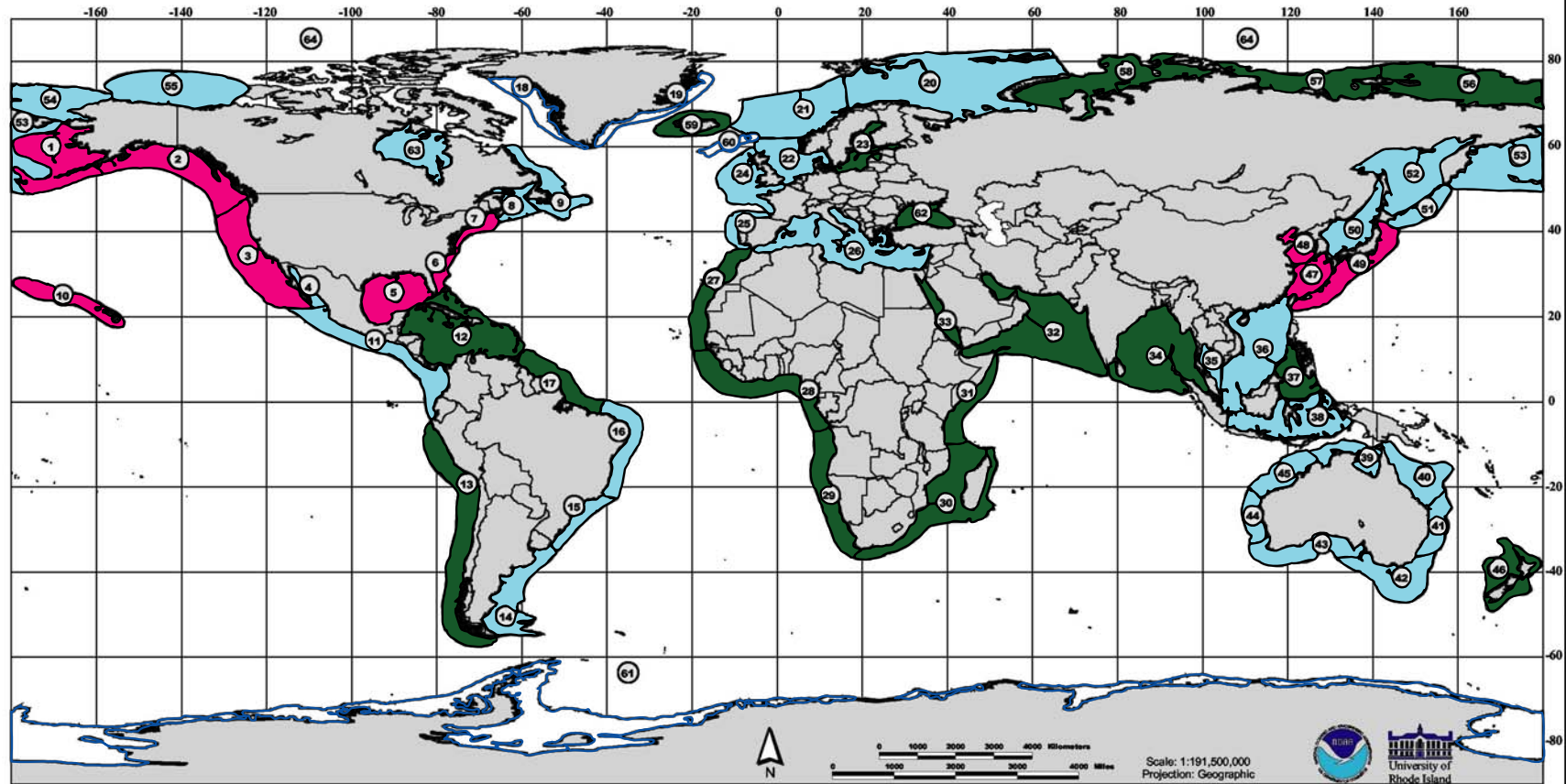# Shipping, Shipbuilding, and Offshore Oil Index

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Marine Industry Activity Index (MAI)

Large Marine Ecosystems of the World

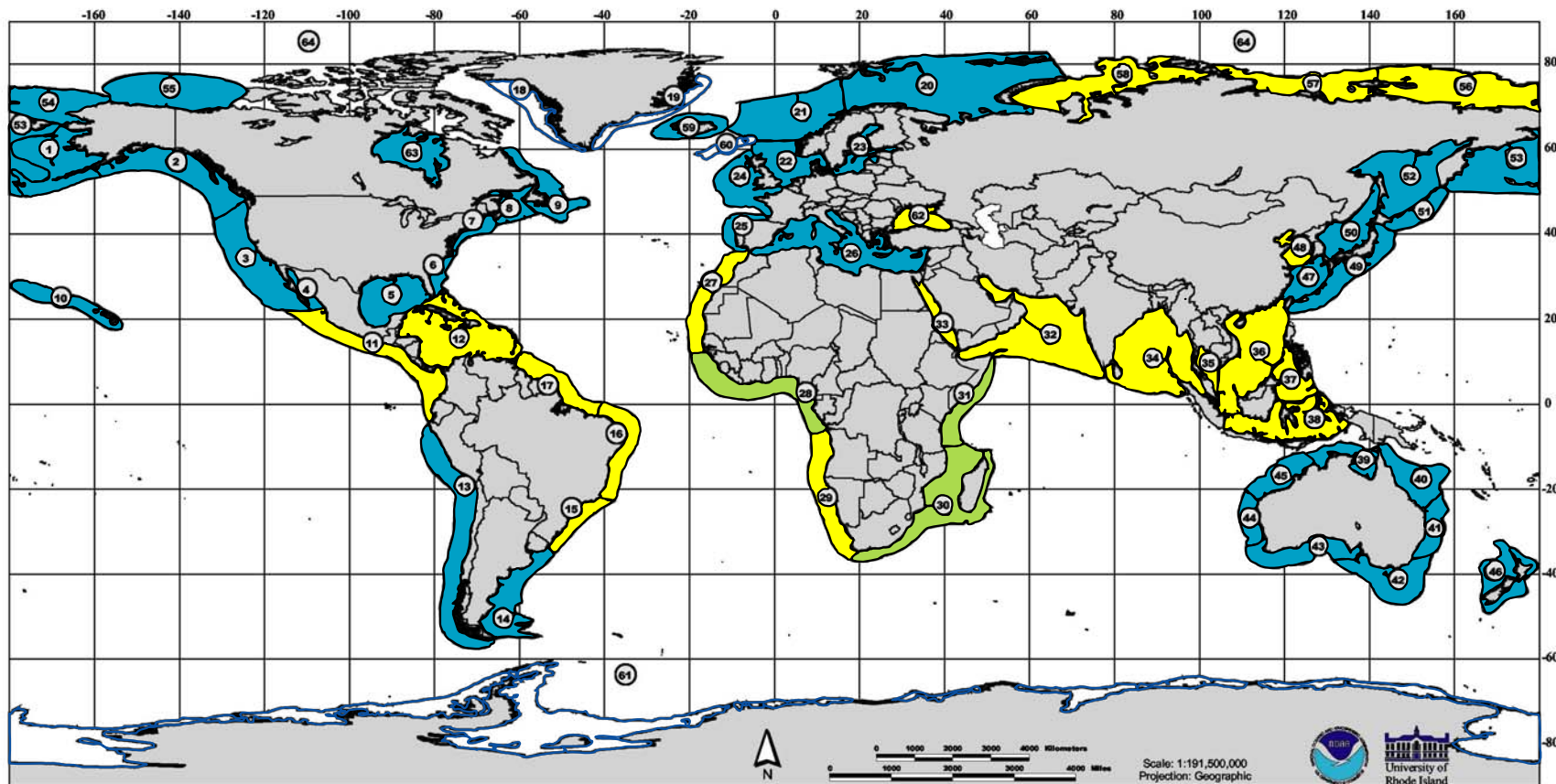|				
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Socioeconomic Index

We use Human Development Index (*HDI*) reported in the United Nations Development Program's *Human Development Report* (UNDP 2004).

HDI is a measure of a nation's socioeconomic development. It is based upon three key indicators: life expectancy (at birth); education (*i.e.*, adult literacy rate and combined gross enrollment ratio for primary, secondary, and tertiary schools); and GDP per capita (purchasing power parity in US dollars).

Socioeconomic Index (SEI)

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Relationship between Marine Industry Activity and Socioeconomic Development
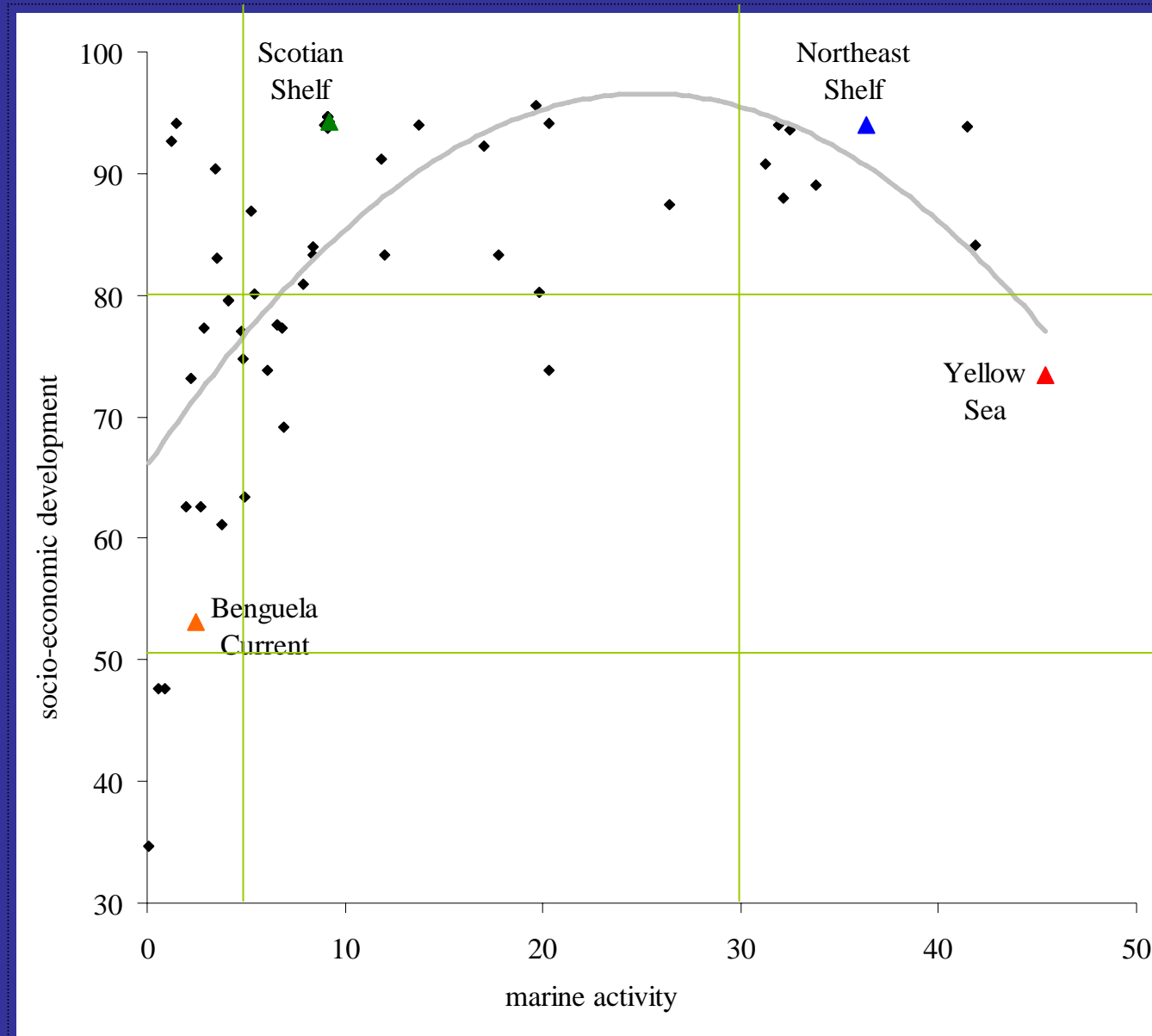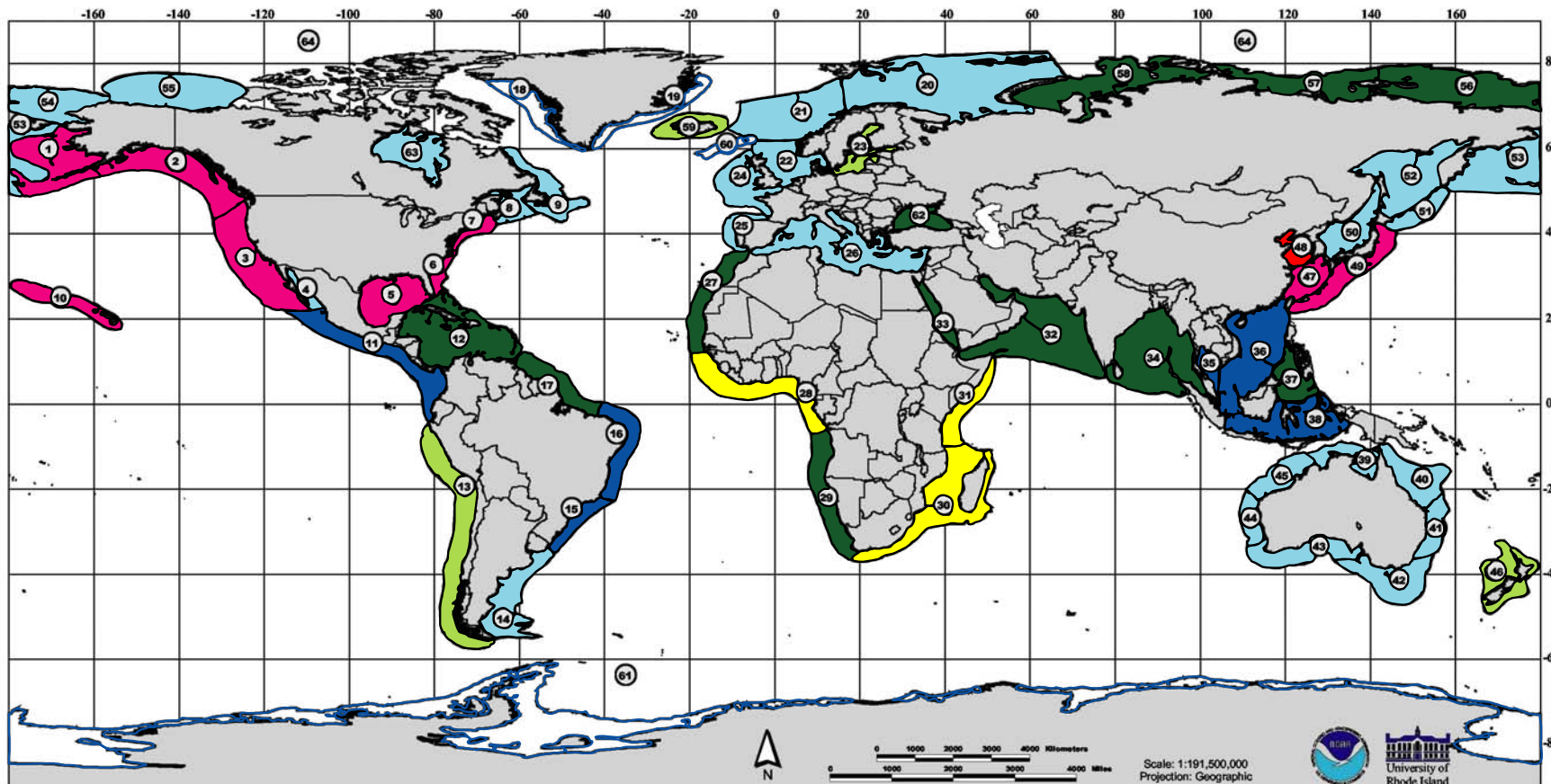
To Identify Problem Areas

Typically, regions with high levels of marine industry activities demand high levels of management attention to address issues related to resource depletion, environmental degradation, and multiple use conflicts.

This is particularly true in regions with high marine activity levels and medium levels of socioeconomic development. Efforts must be made to coordinate economic development and environmental and resource protection.

Regions with low socioeconomic development levels and low marine activity levels at the present deserve international assistance in preparation for possibly rapid development in the future.

Classification of LMEs

Large Marine Ecosystems of the World

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University of Rhode Island

Limitations

Most existing data are compiled at the national level, making it impossible to develop an LME-specific assessment for the entire world. To improve our understanding of a specific region, it is vital to develop additional detailed study of the region.
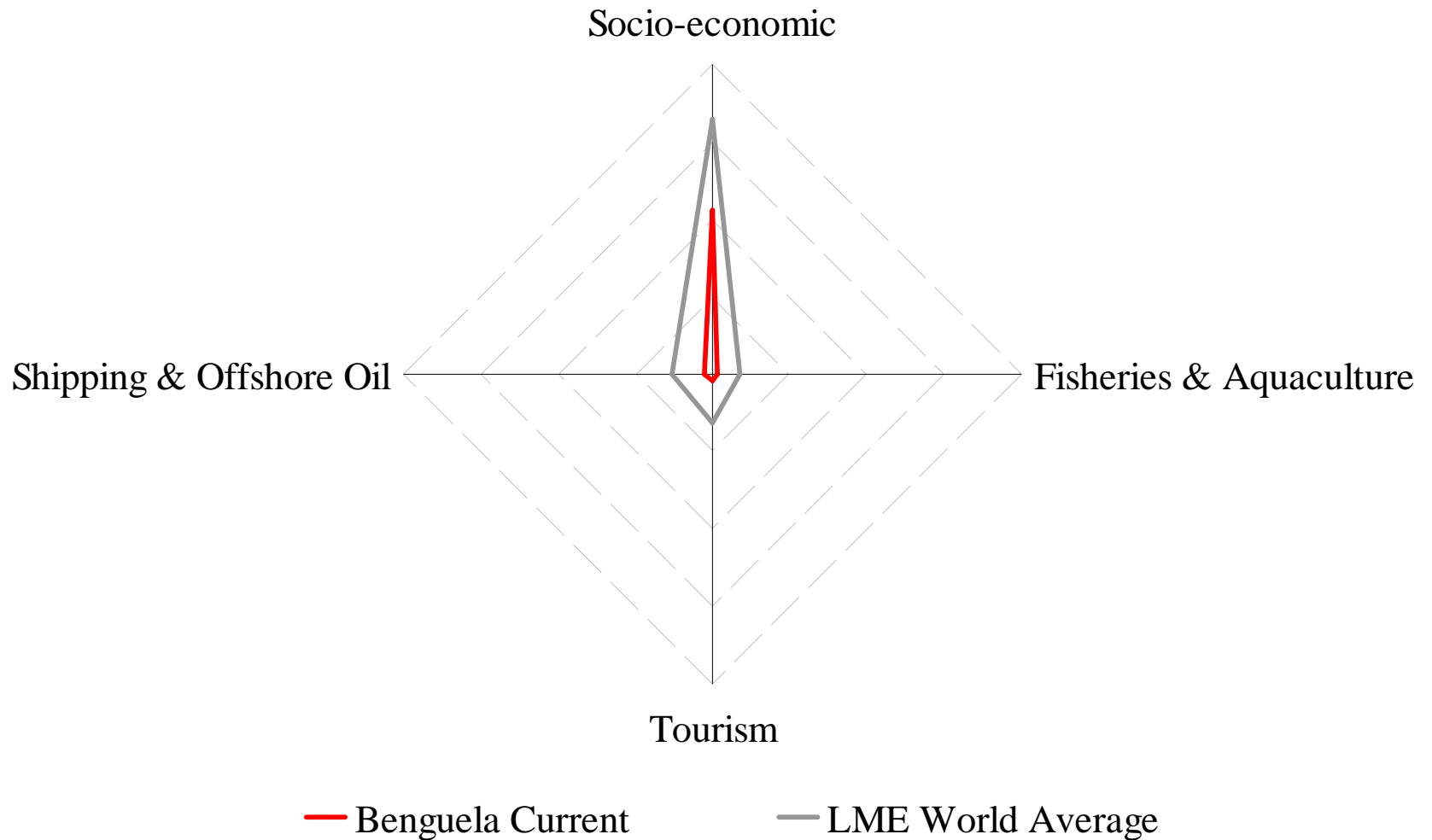
Project report includes two case studies:
Benguela Current LME and Yellow Sea LME

The Benguela Current
large marine ecosystem
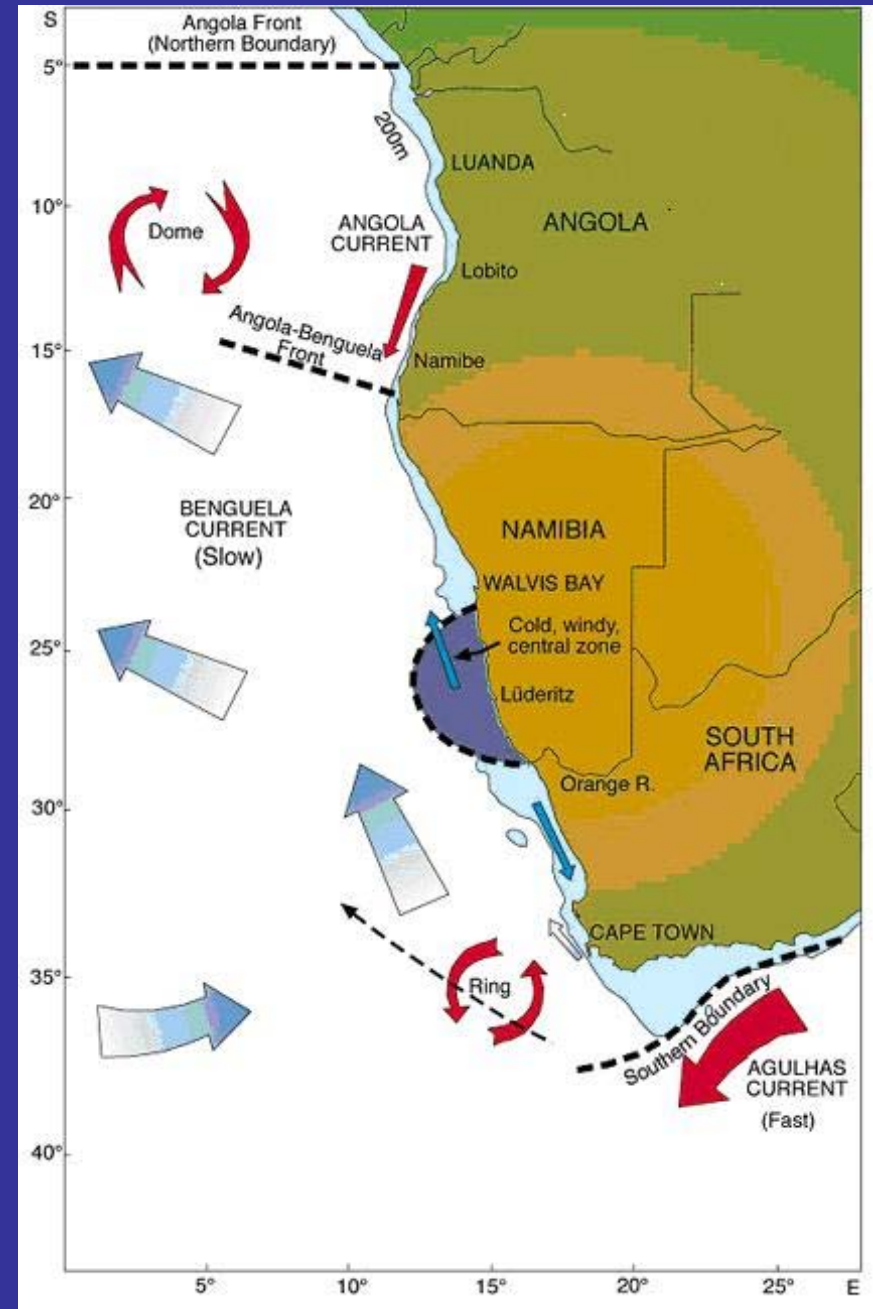
Marine activity index comparison between
the BCLME region (red) and the world average (gray)

Resource Rents from Marine Activities for the BCLME Nations
(millions of 2005 US dollars)

	Offshore Oil Production	Capture Fisheries Harvests	Offshore Diamond Mining	TOTALS
Angola	3,201	13	0	3,214
Namibia	0	200	88	288
South Africa	0	175	4	179
TOTALS	3,201	388	92	3,681

MAP of YELLOW SEA REGION
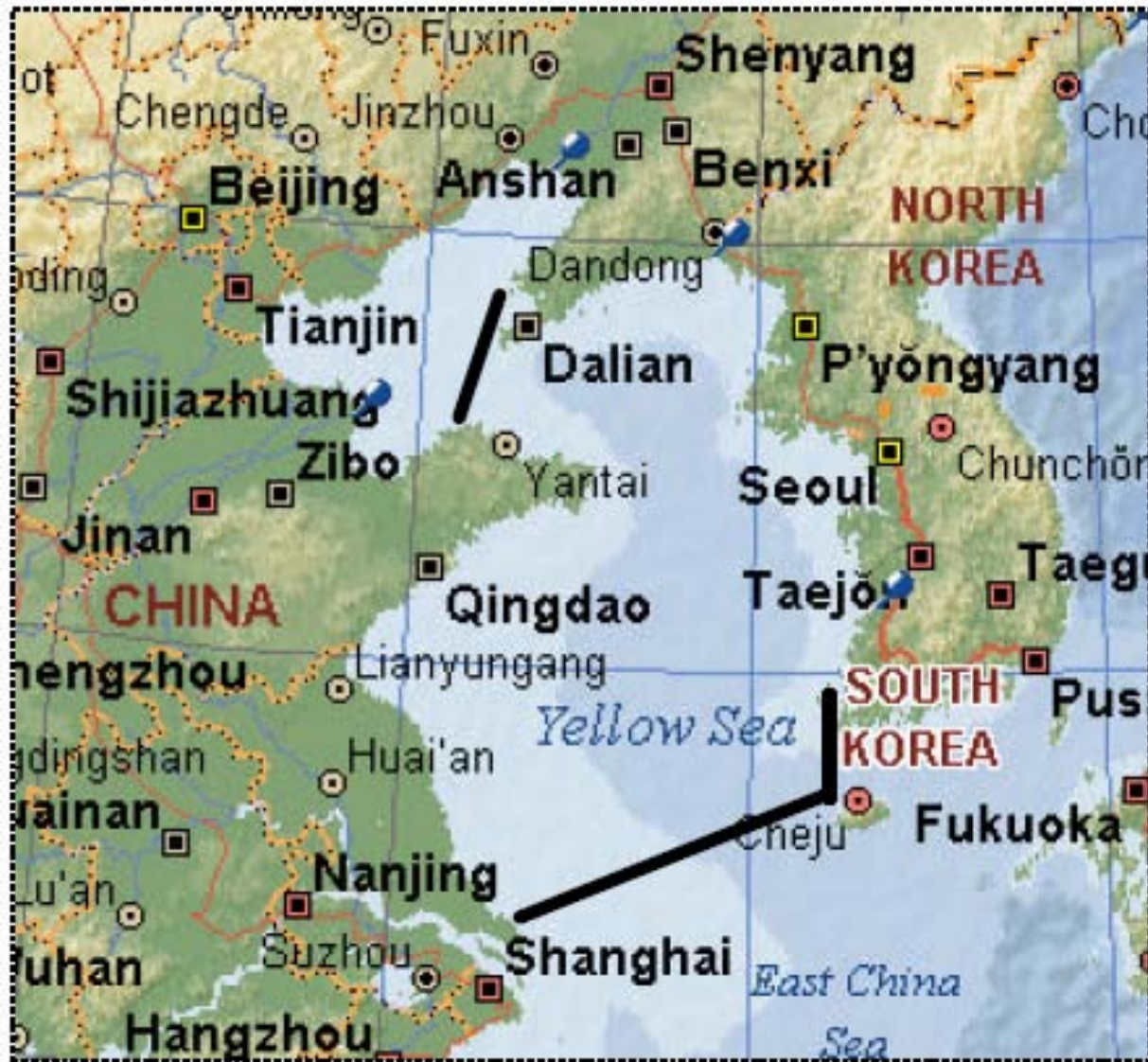
YSLME activity index values for three major marine sectors and the HDI ("socioeconomic") in comparison to the LME world average
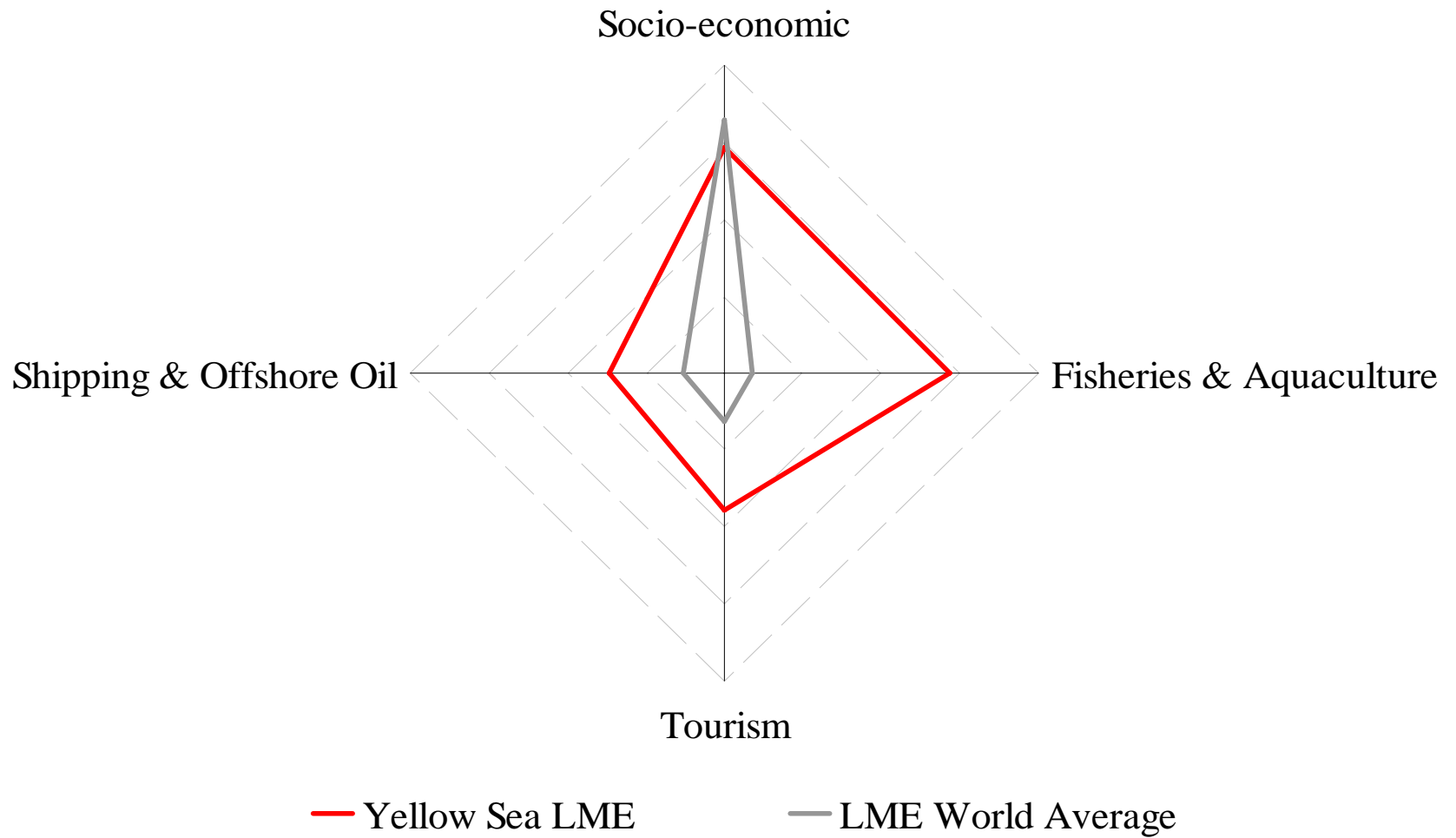
Bohai Region Marine Industry Output Value

Source: SOA (2005)

Marine Trophic Index for YSLME

Source: Sea Around Us Project (2005)

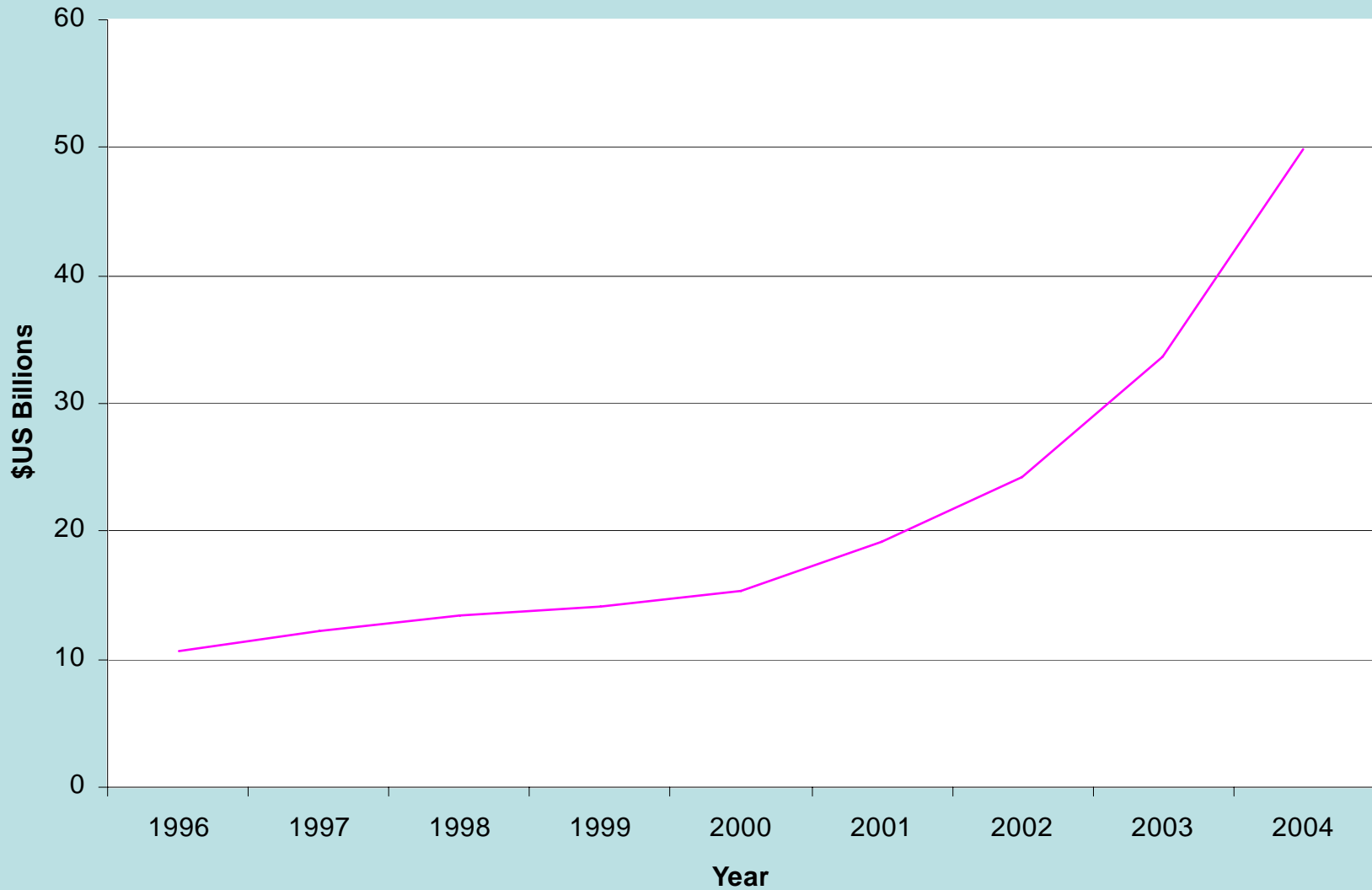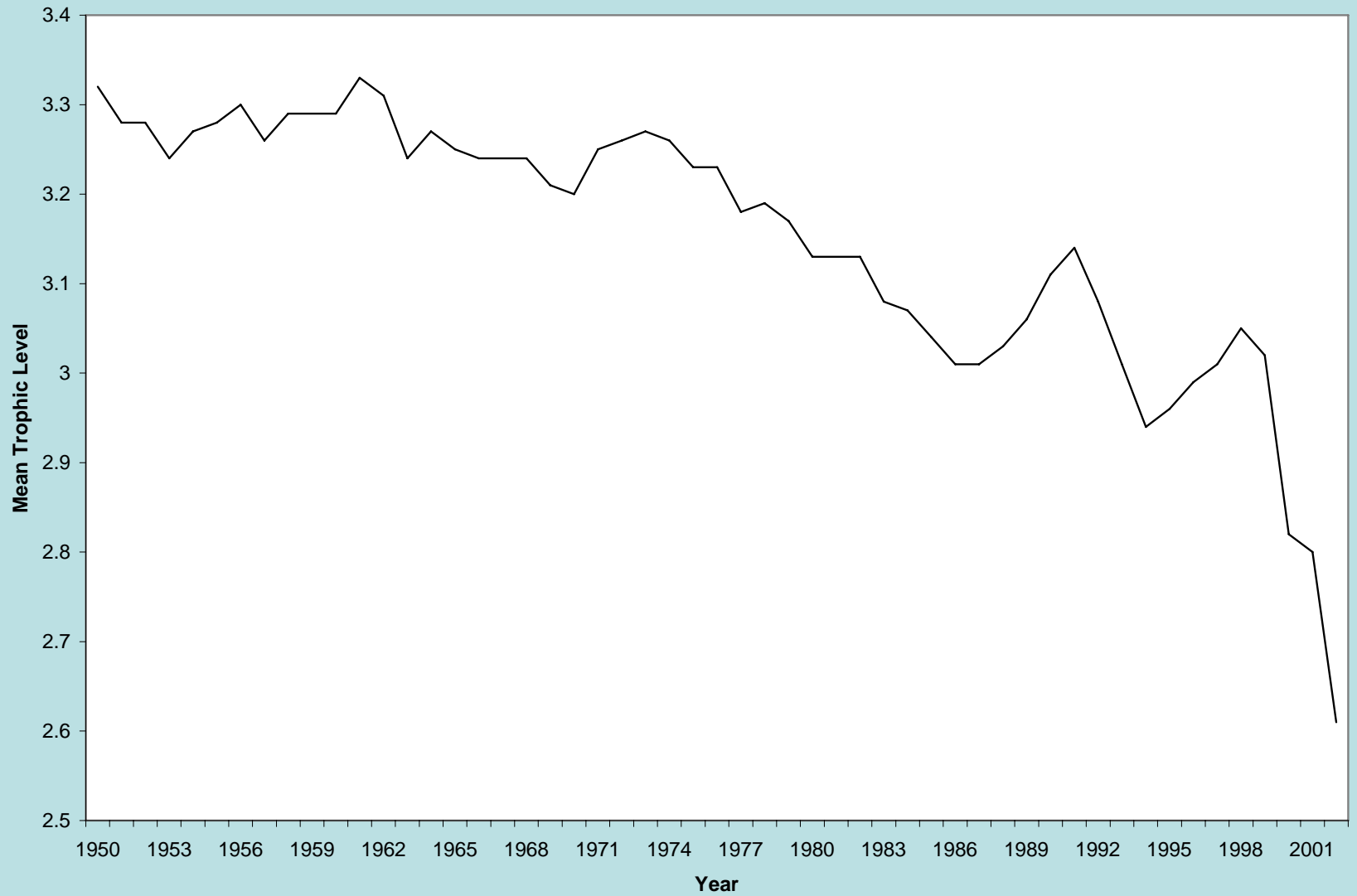## Marine Industry Output Value by Yellow Sea Coastal Areas in China, 2000 ($US millions)

Industry	Shandong	Liaoning	Tianjin	Jiangsu	Hebei	Total	Percent
Fishery and Mariculture	6,665	2,553	80	1,321	399	11,018	64.3
Port & Shipping	548	453	462	136	235	1,834	10.7
Offshore Oil & Gas	438	59	815	0	0	1,312	7.7
Shipbuilding	315	571	28	117	33	1,064	6.2
Sea Salt	691	53	58	126	97	1,025	6
Tourism[*]	255	256	232	64	71	878	5.1
Sand & Gravel	1	0	0	0	0	1	0
Total	8,912	3,945	1,675	1,764	836	17,132	100

Source: SOA (2005)

Marine Fisheries Landings and Value by Yellow Sea Coastal Cities in Korea

Year	Mokpo		Inchon		Kunsan		Seosan		Total	
	MT	$US mill	MT	$US mill	MT	$US mill	MT	$US mill	MT	$US mill
1996	47,798	223	51,000	237	--	--	10,238	19	109,036	479
1997	40,498	139	43,600	189	--	--	6,333	14	90,431	342
1998	35,940	56	38,900	89	32,391	46	2,573	4	109,804	195
1999	38,956	69	45,400	148	34,564	51	2,082	4	121,002	271
2000	33,874	71	41,258	164	58,058	49	5,601	7	138,791	292
2001	31,444	55	35,889	138	26,776	43	4,271	3	98,380	239
2002	28,981	58	39,221	160	18,276	43	16,065	16	102,543	276
2003	23,840	56	25,079	119	13,610	29	3,081	6	65,610	210

Source: KORDI (2005)

Summary

We have developed an index approach to provide an overview of the socioeconomic dimension of different large marine ecosystems (LMEs).

The study is unique in its global perspective.

The results may be used by GEF, UNEP, and UNDP to address management questions regarding sustainable development and sustainable self-financing of regional programs.