A Method For Managing Freshwater Inflows To Estuaries

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The Integrated Management Imperative

- Following the collapse on inshore fisheries in New England in the 1860s, a National Commission concluded that effective management requires linking planning and decision making for
  - Water quality
  - Land use, and
  - Fisheries

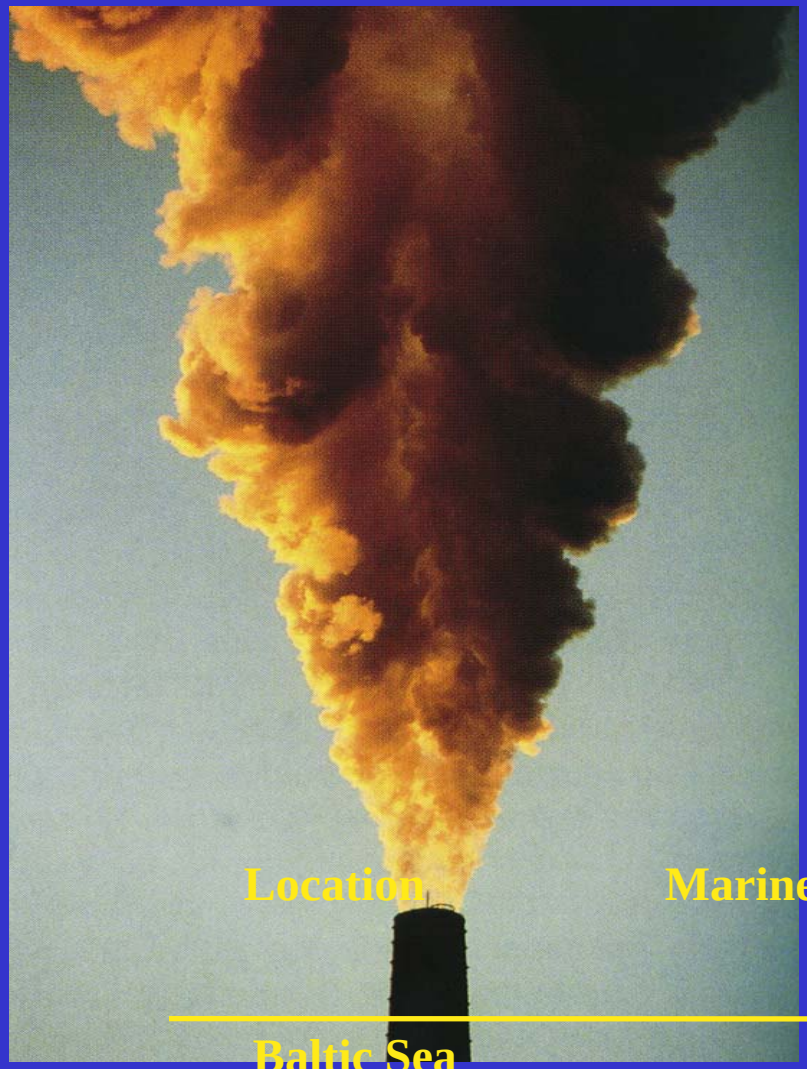
Ecosystem Based Management

- Today the same insight requires linking integrated water resources (IWRM), integrated coastal (ICM) and large marine ecosystem (LME) management
- Our effort has addressed the small to medium sized systems in developing nations where
  - Change is accelerating
  - Funding and data are scarce
  - Technical capabilities are limited
  - Governance capacity is often low

Three Key Variables

The impacts of freshwater inflows are determined by changes in

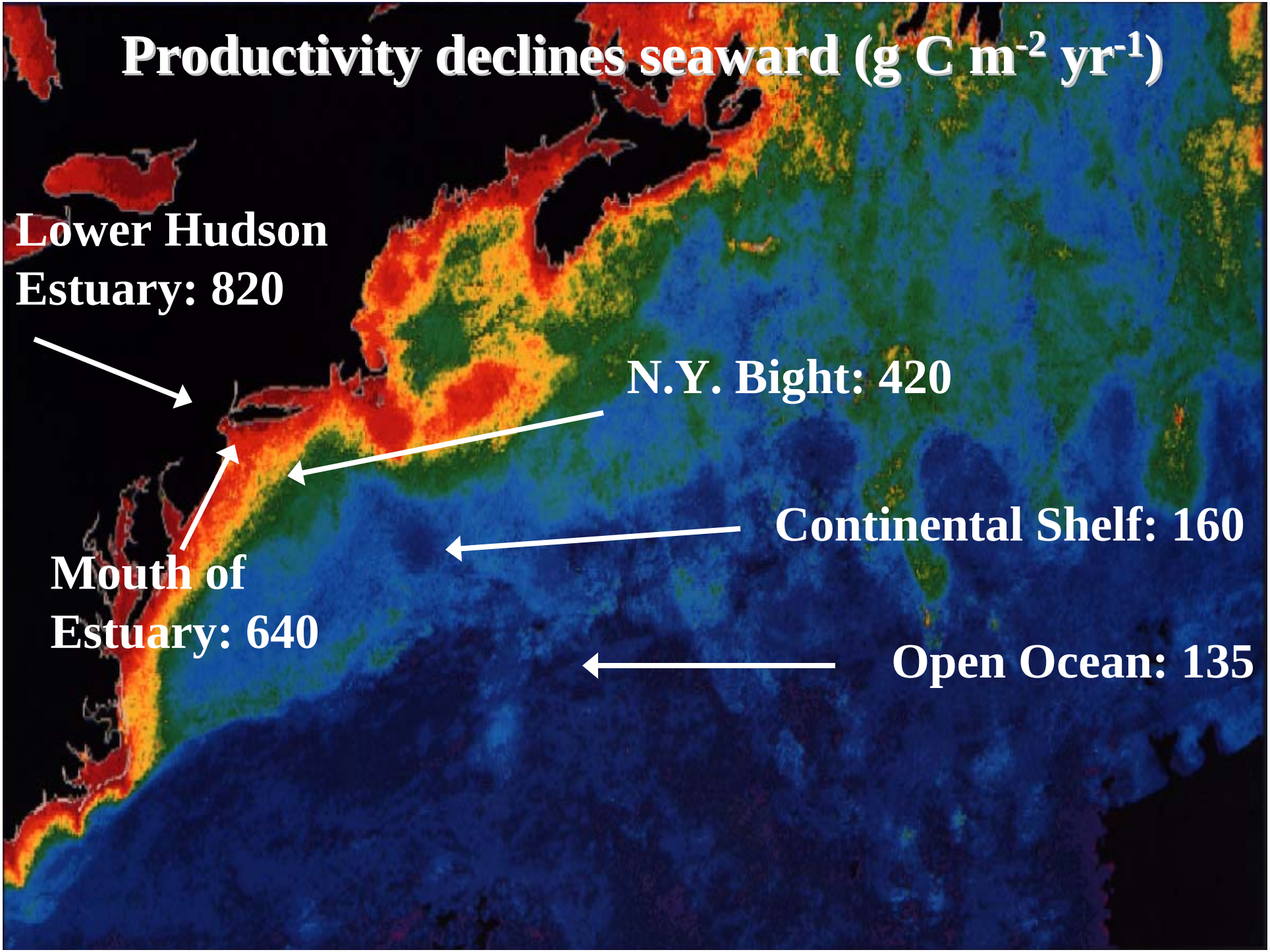
- Volume
- Pulsing, and
- Quantity



Why are estuaries so productive?

The Inverse Smokestack effect

Location	Marine Surface Area (km^2)	Watershed Area (km^2)	Ratio (land/water)
Baltic Sea	422×10^3	17×10^5	4
Narragansett Bay	$.4 \times 10^3$	4613	11
Nile	19×10^3	30×10^5	154
San Francisco Bay	1.2×10^3	121924	104

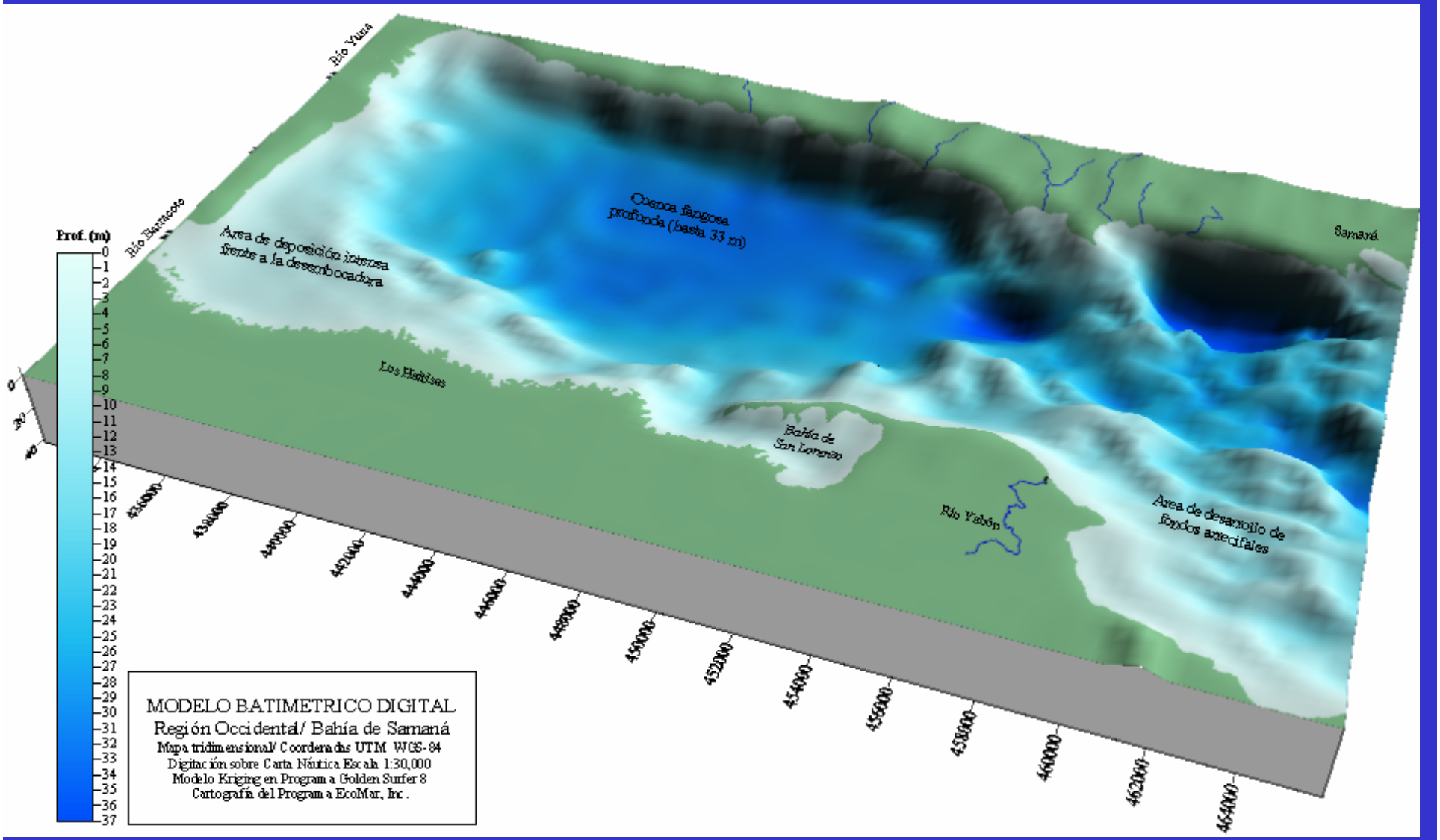

Productivity declines seaward (g C m-2 yr-1)
Lower Hudson Estuary: 820
N.Y. Bight: 420
Continental Shelf: 160
Mouth of Estuary: 640
Open Ocean: 135

Yield of Animals from Different Kinds of Ecosystems:

	Yield of fresh weight kg ha^{-1} yr^{-1}
Estuaries	100-500
Ocean Upwelling	~250
Seas	30-60
Prime Fishing Grounds	~162
Coral Reefs	5-50
Lakes	1-10
Non-Agricultural Terrestrial Systems	0.5-50

Reduced F.W. Inflows Transform the Ecology of an Estuary

- Reduces the size and alters the features of the nursery area
- Reduces the habitat zones down estuary
- Changes primary and secondary productivity and the food web


Río Yuna
Río Barracote
Cuenca fangosa profunda (hasta 33 m)
Area de deposición intensa frente a la desembocadura
Samaná
Los Haitises
Bahía de San Lorenzo
Río Yabón
Area de desarrollo de fondos arrecifales
Prof. (m)
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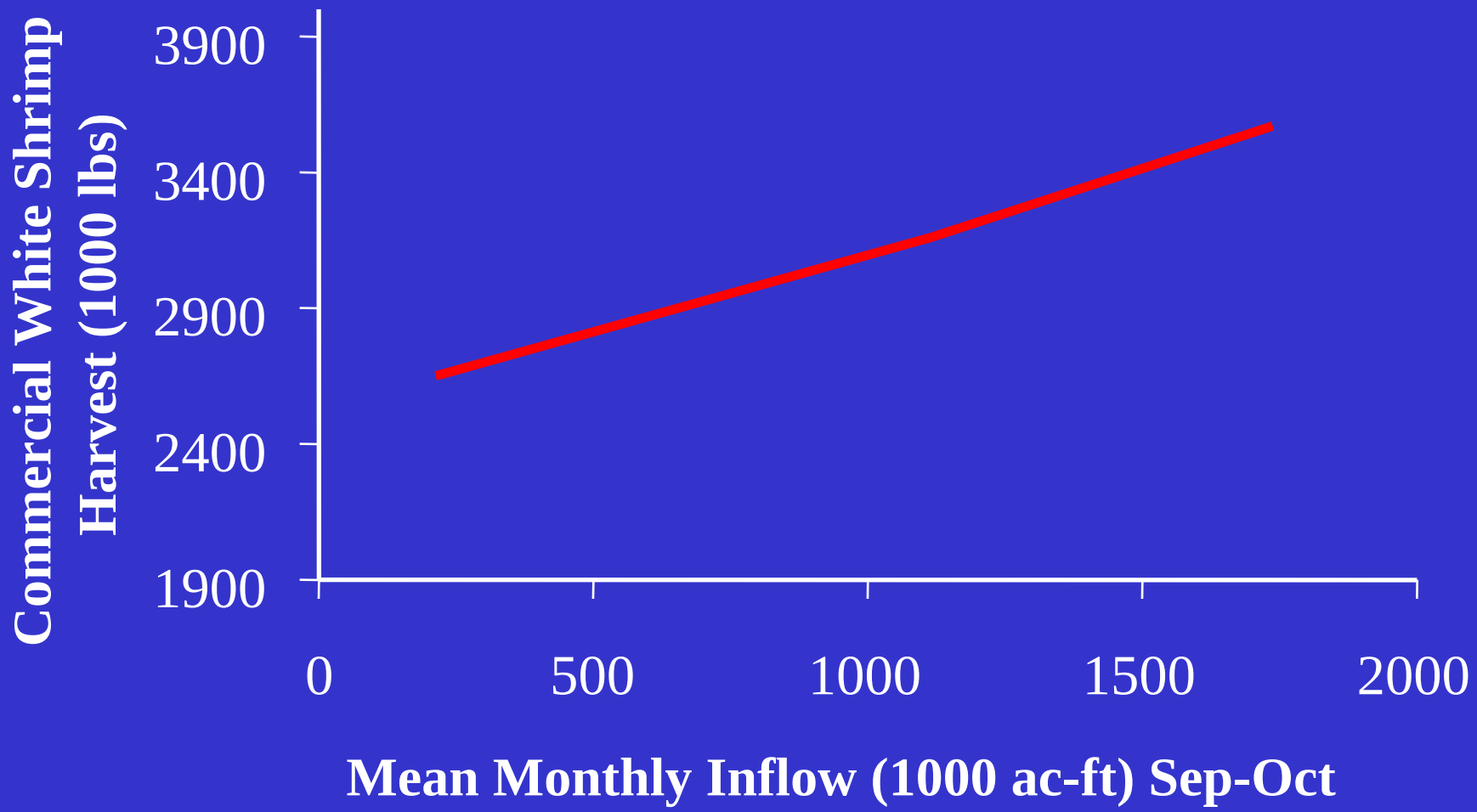
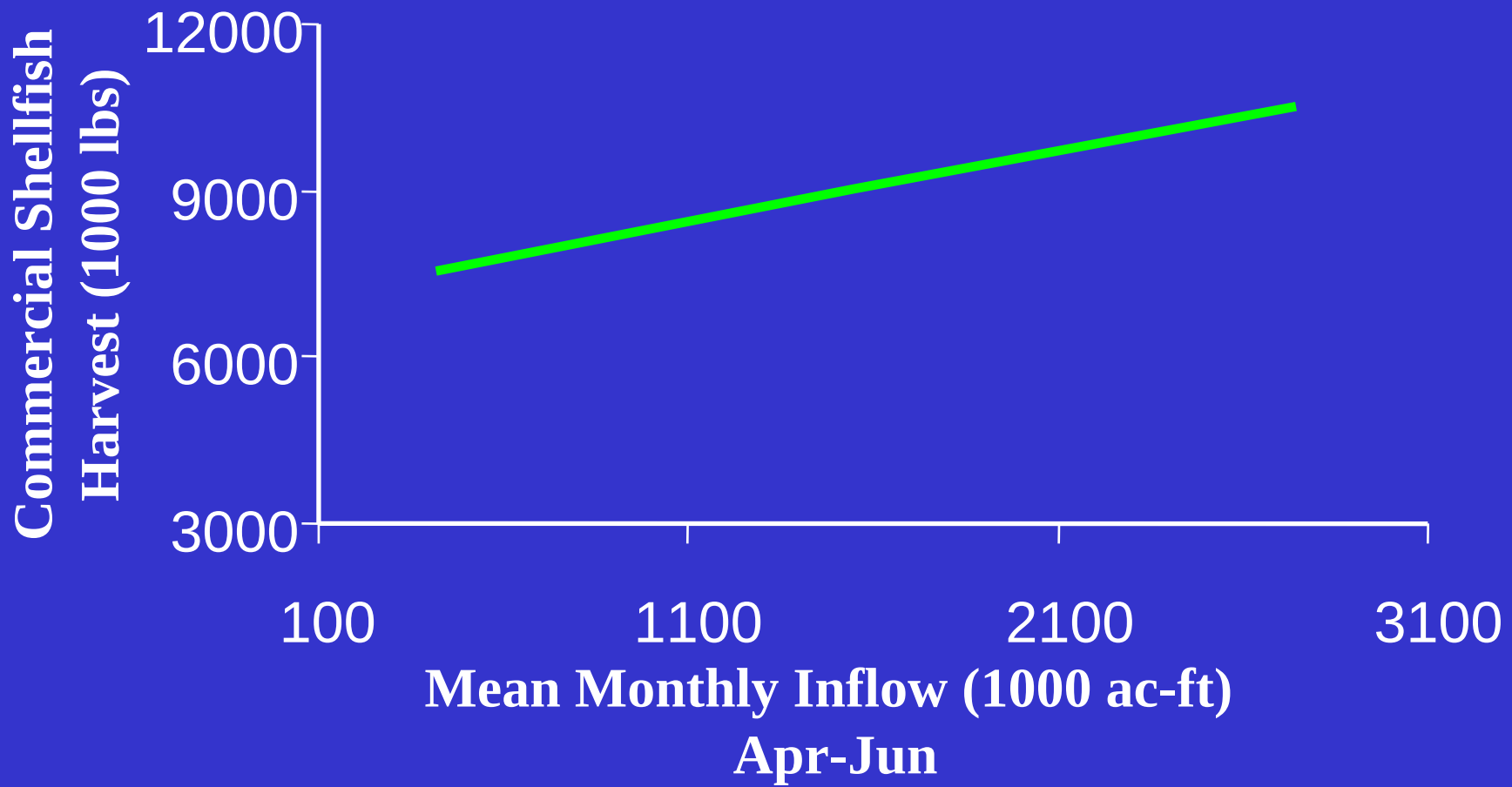
MODELO BATIMETRICO DIGITAL
Región Occidental/ Bahía de Samaná
Mapa tridimensional/ Coordenadas UTM WGS-84
Digitación sobre Carta Náutica Escala 1:30,000
Modelo Kriging en Programa Golden Surfer 8
Cartografía del Programa EcoMar, Inc.

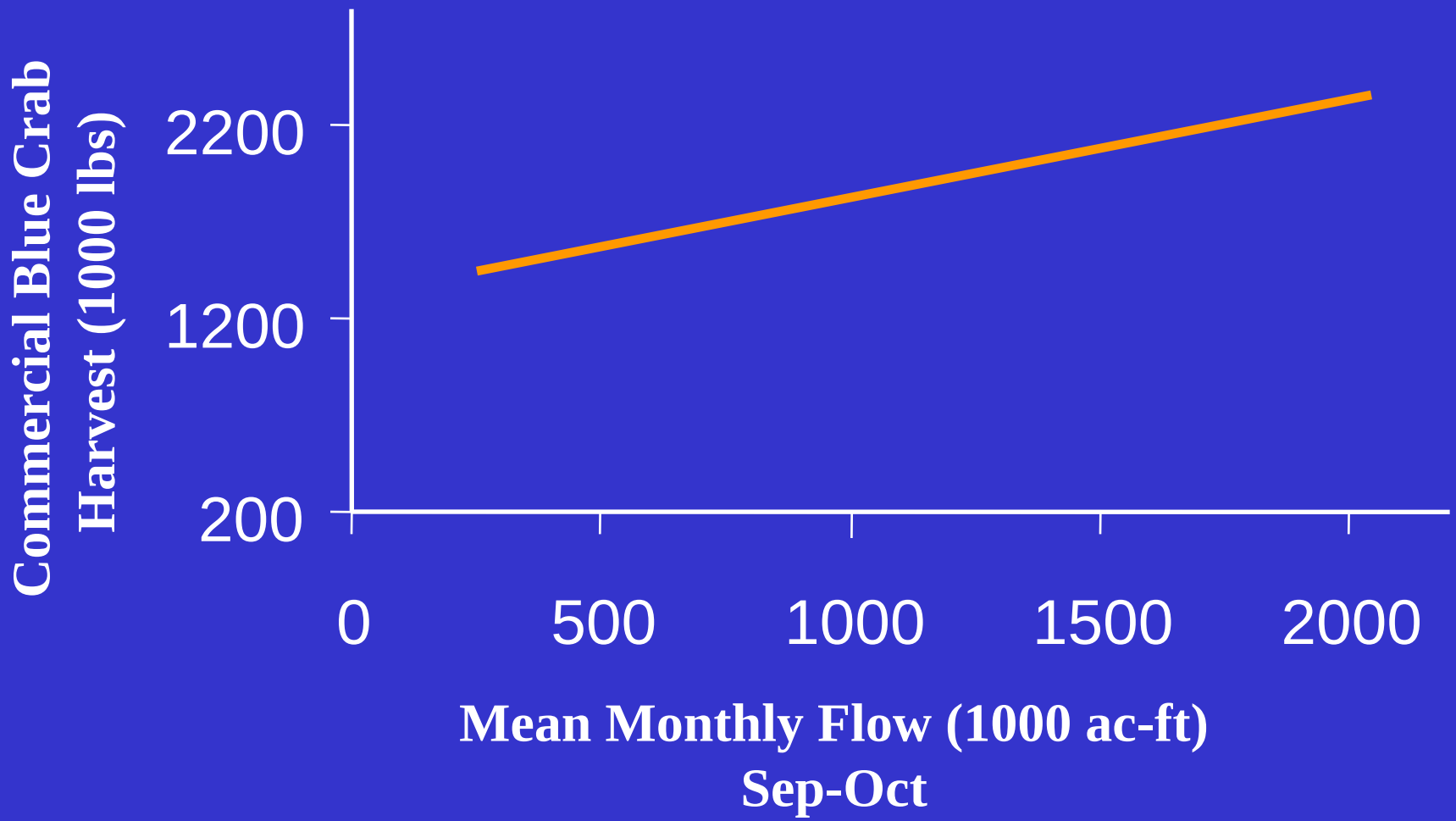
Offshore Commercial White Shrimp Harvest - Texas



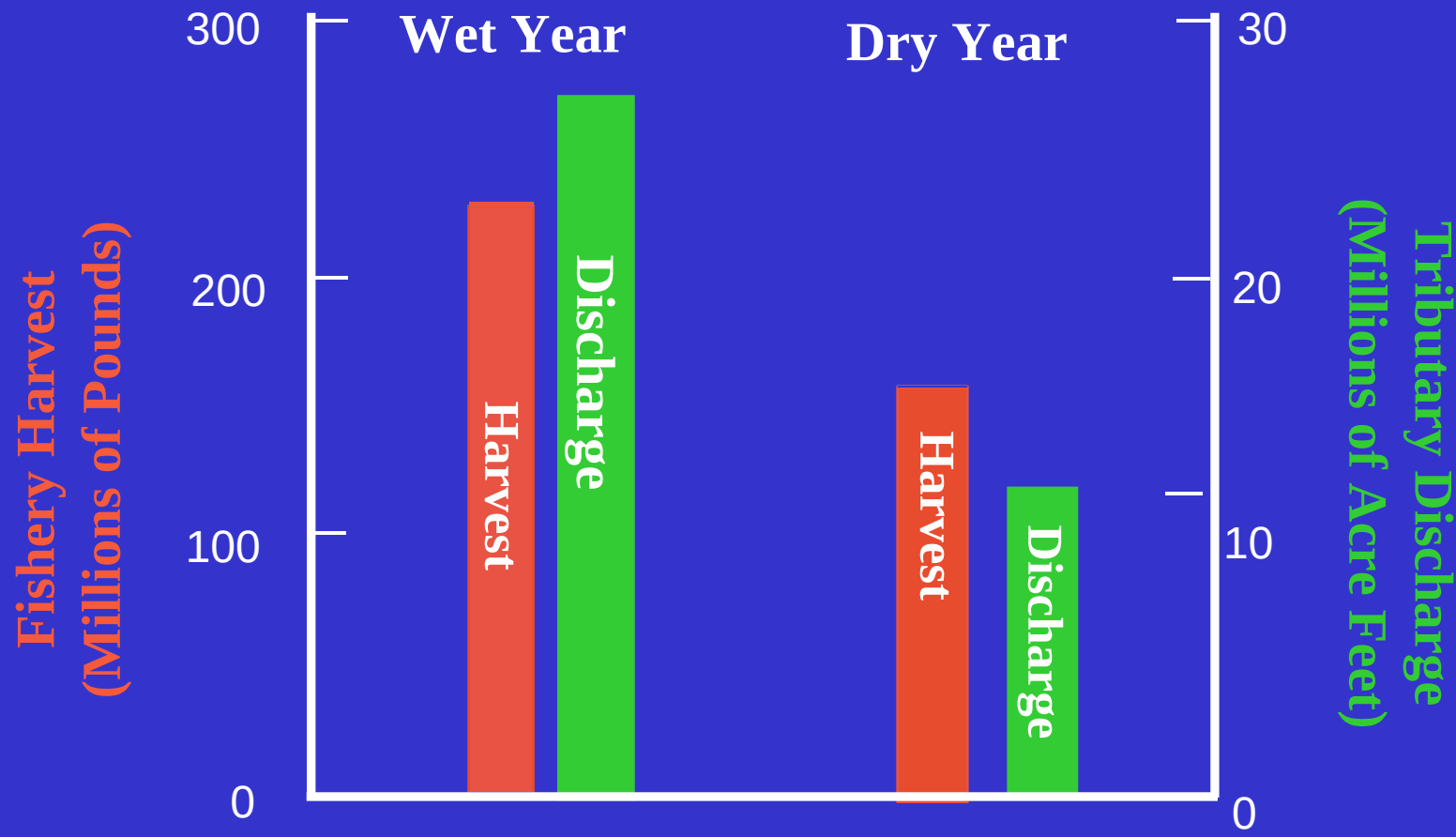
Inshore Commercial Shellfish Harvest - Texas Bay



Inshore Commercial Blue Crab Harvest - Texas Bay



Texas Basins Projects



Commercial Harvest of estuary dependent fishery resources from Texas waters during wet and dry years (1956-62).

Chapman 1972

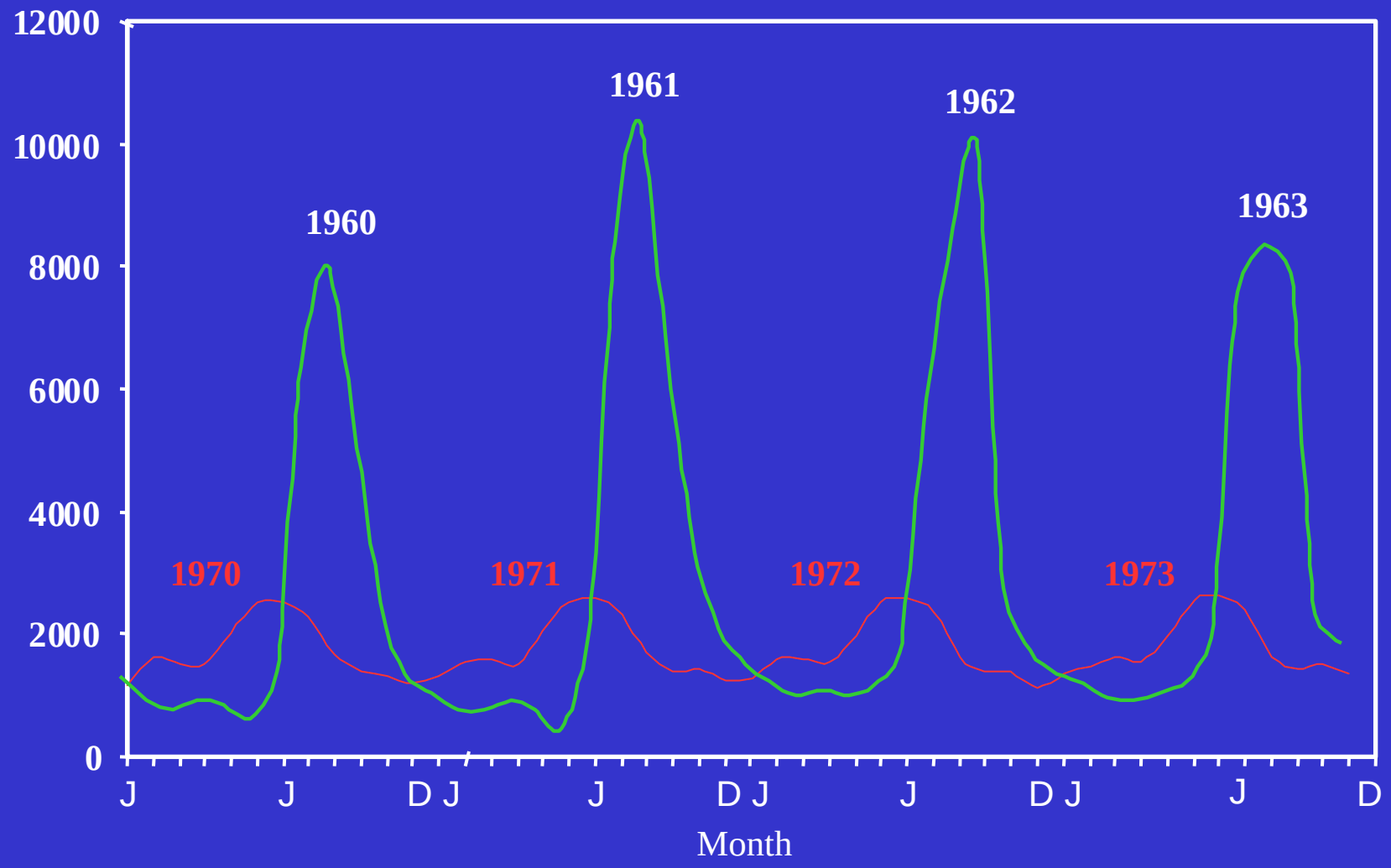
The Nile River

- The Nile River, before the construction of the Aswan High Dam, provided large quantities of nitrogen, phosphorus and silica to the Mediterranean which supported a productive fishery.

Nixon 2003

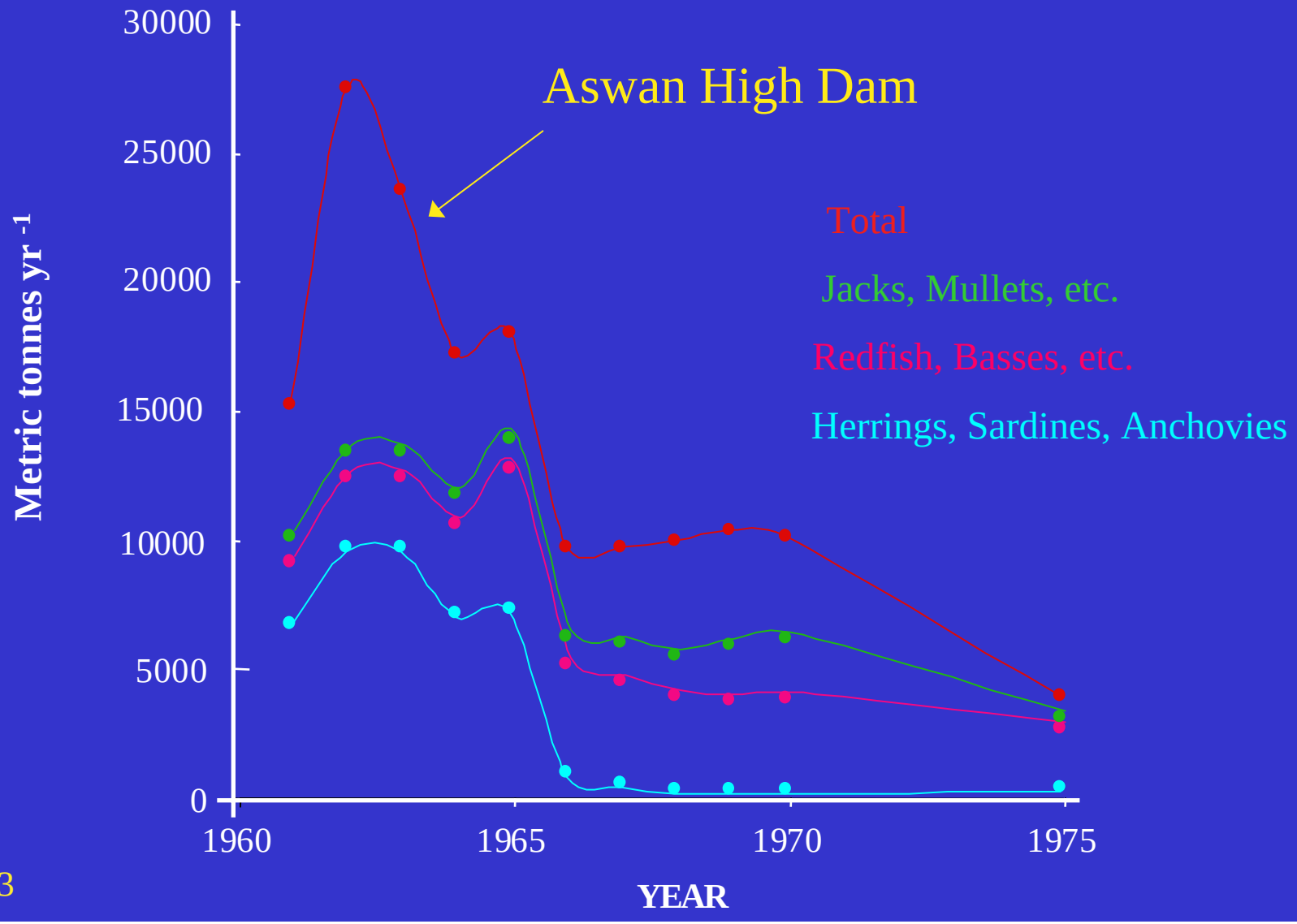
- In 1965 the Aswan High Dam was constructed and the Nile River flow was reduced by 90%. With this reduction came a collapse of the fisheries

Nile River flow before and after the Aswan High Dam



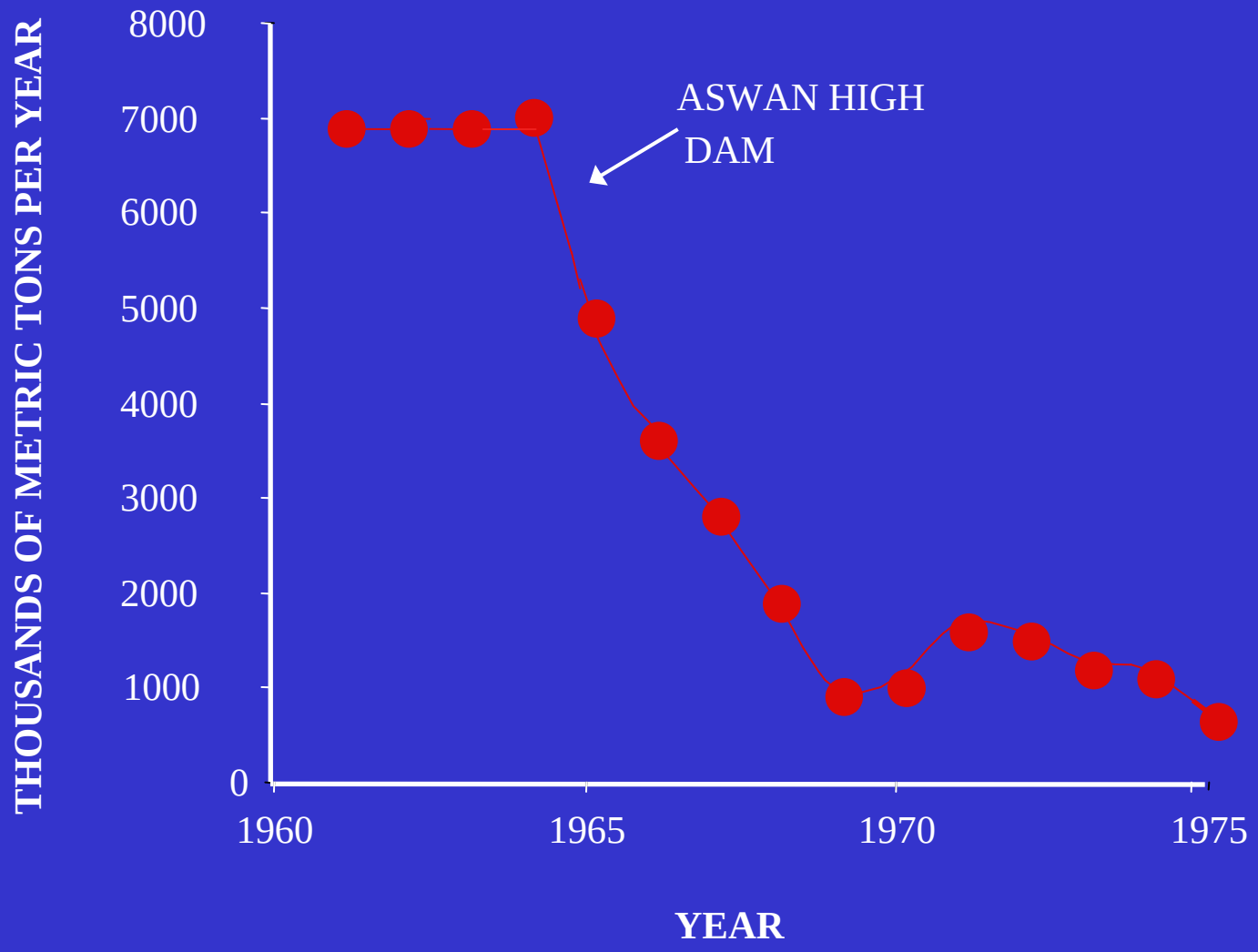
Nixon 2003

Decline in Landings from Egypt's Mediterranean Fisheries Coast



Nixon 2003

Decline in Egypt Shrimp Landings:



Nixon 2003

Reduced F.W. Inflows will also:

- Change vertical mixing: this may encourage stratification, low oxygen episodes at the bottom and mass mortalities

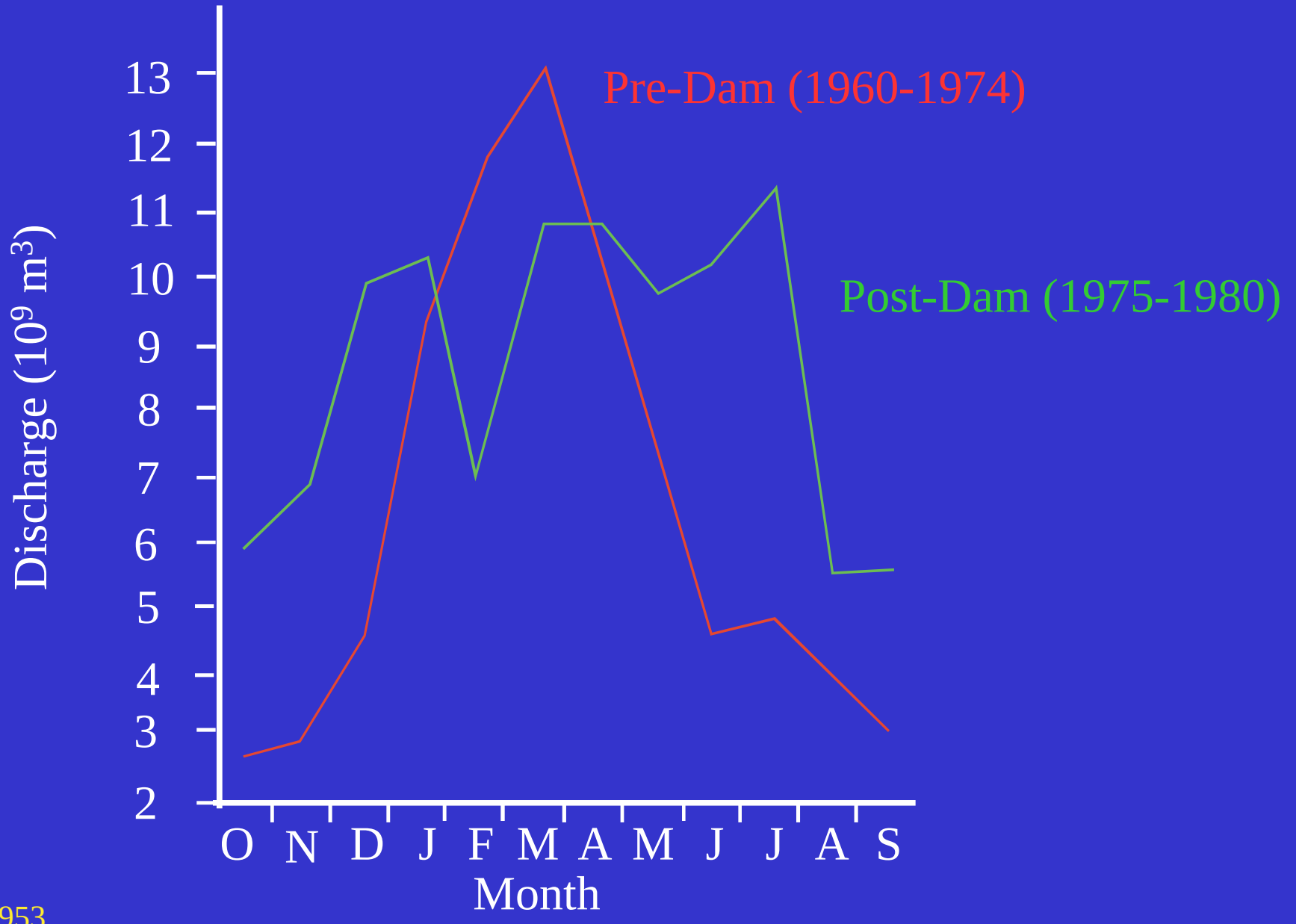
- Change the pathways and fates of pollutants

And will alter patterns of sedimentation and accretion

- With potentially major impacts on shoreline erosion and
- the condition of wetlands.
- These impacts will be amplified by rising sea level

“Estuaries and the organisms and communities they support have each evolved over long periods of time to particular regimes of fresh water inflow. The timing of the inflow is probably as important as the total quantity of freshwater added.” Scott Nixon

Average monthly outflow of the Zambezi River, Africa

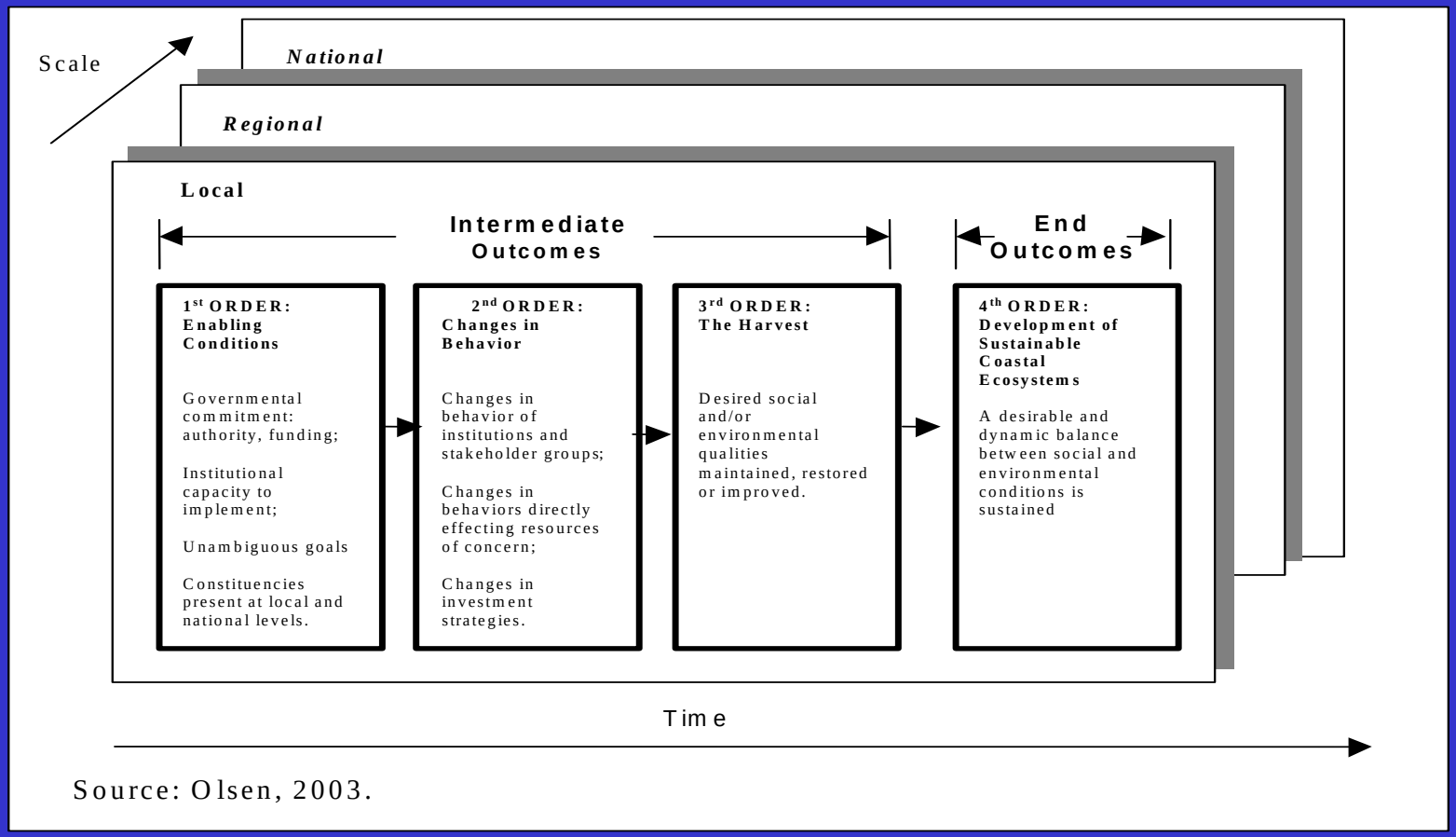


Zetler 1953

Major Challenges When Addressing Freshwater Inflows

- Little or no tradition of collaboration between
  - the institutions responsible for freshwater/watersheds and coasts/fisheries
  - Freshwater/terrestrial scientists and coastal/marine scientists
  - Up end and down end stakeholders
- Differences in rules and attitudes governing private resources (land/water) and public resources (tidal waters/shorelands/seafood)

The Outcomes of Ecosystem Management



Source: Olsen, 2003.

Focus of the Guide: A Process for Assembling the Enabling Conditions

- Informed and supportive *constituencies* at the necessary scales
- *Capacity* to practice adaptive ecosystem governance in the responsible institutions
- *Commitment* from government and key stakeholders to sustain the necessary authority and funding and enforce accountability
- Unambiguous *goals* on issues that matter to the people of the place

Step 1: Identification of Issues and Constituencies

- Integrate and build upon what is already known
- Build awareness for past governance, or its absence, and its consequences
- Identify past and anticipated changes to FWIs
- Identify valued ecosystem components (VECs) as focal points for a future strategy
- Socialize an initial analysis as “Profile 1”

Step 2: Select goals, actions and an implementing strategy

- Conduct research and consultations to fill priority gaps
- Build and debate credible future scenarios
- Experiment and monitor
  - Celebrate victories, acknowledge defeats
- Set implementation objectives as behavior change targets in institutions and user groups
- Distribute and socialize Profile 2

Hydrography results

Step 3: Negotiate governmental commitment

- Negotiate commitments to clear goals
- Negotiate the necessary mandate, authorities, funding and institutional structure
- Identify and empower the leaders at different levels and for key groups
- Celebrate!

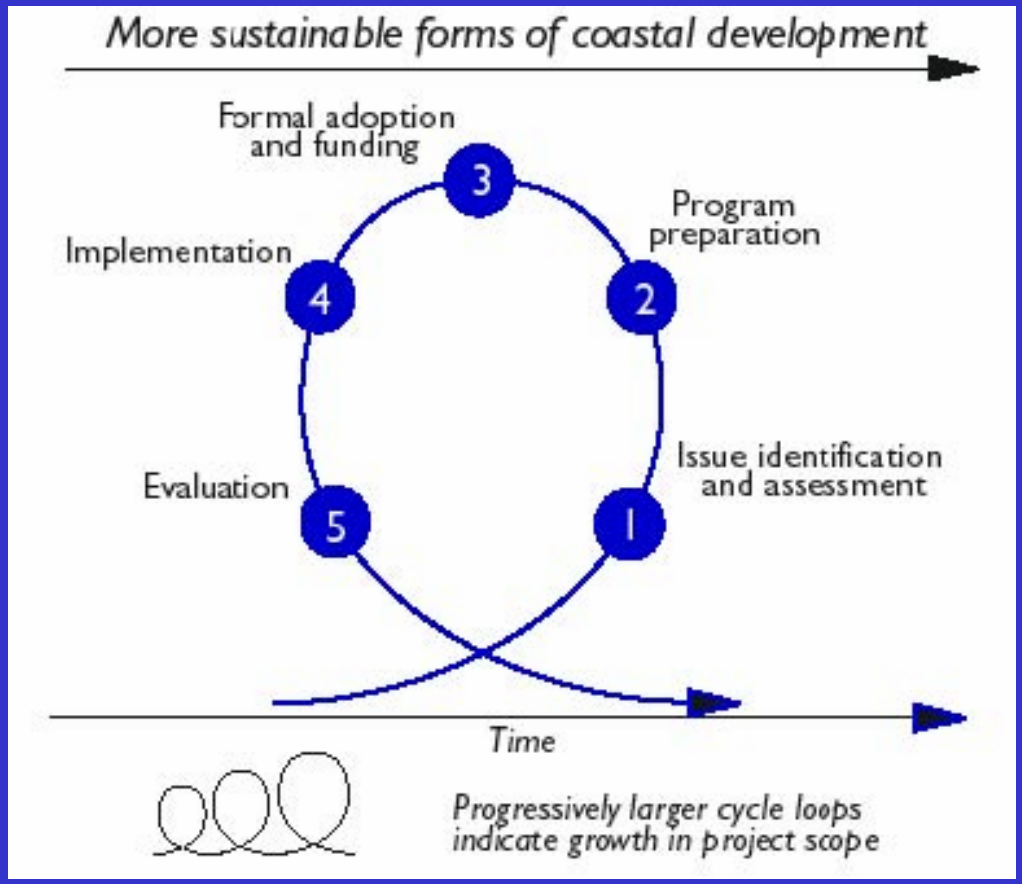
Step 4: Adaptive Implementation of a Plan of Actions

- Focus on changes in behavior in target
  - Institutions
  - User groups
  - Patterns if investment
- Monitor selected environmental and societal variables
- Disseminate results and learnings as they apply to the goals
- Practice adaptive management

Step 5: Evaluate and Learn

- Frequent self assessments
- Periodic external peer reviews
  - On performance
  - On outcomes
- Assess the continuing trajectory of change, adjust scenarios
- Set additional goals for the next generation of ecosystem governance

Management as Process



Bahia Samana and the Yuna Watershed

- In 30 months got part way to Profile 2
- There is much at stake
- There is an appreciation for the need and the benefits of an integrated approach among stakeholder and institutions
- There is potentially abundant international funding

The Method Elucidates What Should Happen Next

- Create a Steering Committee and full time coordinator
- Fill gaps on major issues
- Deliver a targeted outreach program
- Negotiate environmental and social goals
- Initiate long-term monitoring
- Experiment with tangible actions focused on behavior change

In Summary

- The world's estuaries are a keystone to abundance and diversity in the world's fish populations
- Freshwater inflows control the functioning and productivity of estuaries
- Estuaries are central to the artisinal fisheries that produce half the annual world harvest and comprise 96% of the fishers
- The majority of good and services provided by estuaries are generated in small to medium estuaries where change is most rapid and management is weakest.