Hypoxia Coordination Workshop

Incorporating Hypoxia Into The Fishery Management Process: To Be or Not To Be?

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But First…

Fisheries Conservation and Management Act of 1976

Why ? – During the 1960's and 70's:

1. Fisheries were declining (or at least not increasing)
2. Foreign fleets were operating within 3 miles of the U.S. coast
3. It was during the Cold War!

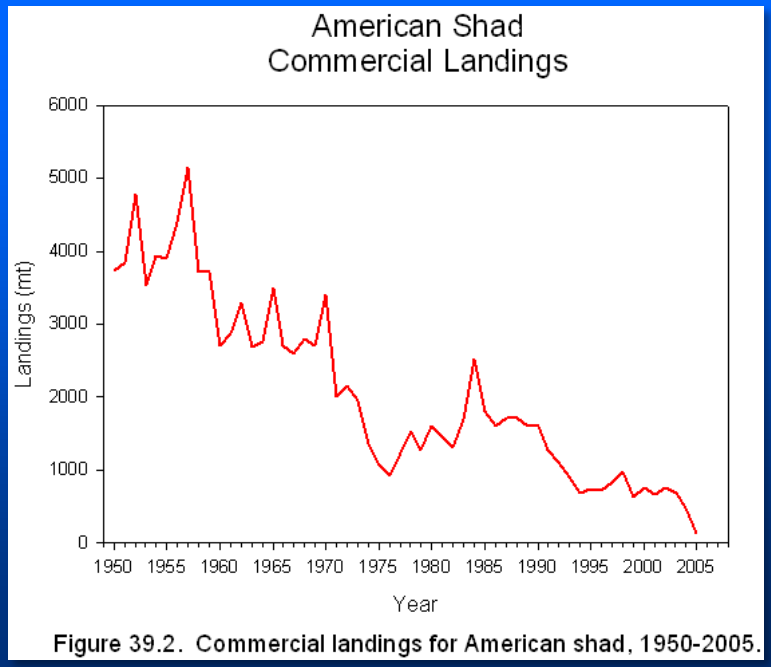
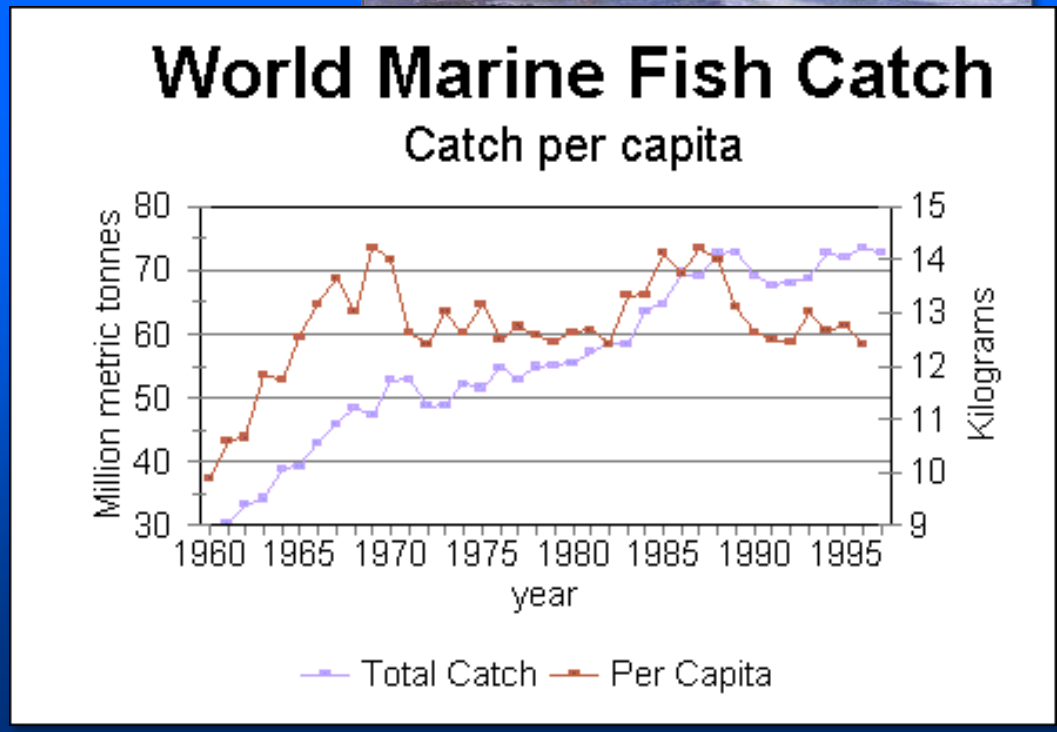


Figure 39.2. Commercial landings for American shad, 1950-2005.



Fisheries Conservation and Management Act of 1976 (later – the Magnuson-Stevens Act – MSA)

Established comprehensive federal management:

1. Loan programs to increase U.S. fishing capacity.
2. Created eight federal fishery management councils
3. Established a Fishery Conservation Zone to 200 miles (later called the Exclusive Economic Zone – EEZ)
4. Established National Standards


New England
Fishery Management Council
WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NE
KS
OK
TX
MN
IA
MO
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LA
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AL
OH
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GA
FL
SC
NC
VA
PA
NY
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MD
DE
NJ
CT
RI
MA
NH
ME
AK
HI
PACIFIC FISHERY MANAGEMENT COUNCIL
MID-ATLANTIC FISHERY MANAGEMENT COUNCIL
BUILDING SUSTAINABLE FISHERIES
South Atlantic Fishery Management Council
GULF OF MEXICO
Fishery Management Council
WESTERN PACIFIC REGIONAL
FISHERY MANAGEMENT COUNCIL
CFMC


WA
OR
CA
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NY
ME
VT
NH
MA
RI
CT
NJ
DE
MD
DC
AK
HI
New England
Fishery Management Council
Protecting Our Fishery
Great Lakes Fishery Commission
SCIENCE • SEA LAMPREY CONTROL • PARTNERSHIPS
MID-ATLANTIC FISHERY MANAGEMENT COUNCIL
BUILDING SUSTAINABLE FISHERIES
PACIFIC FISHERY MANAGEMENT COUNCIL
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GULF OF MEXICO
Fishery Management Council
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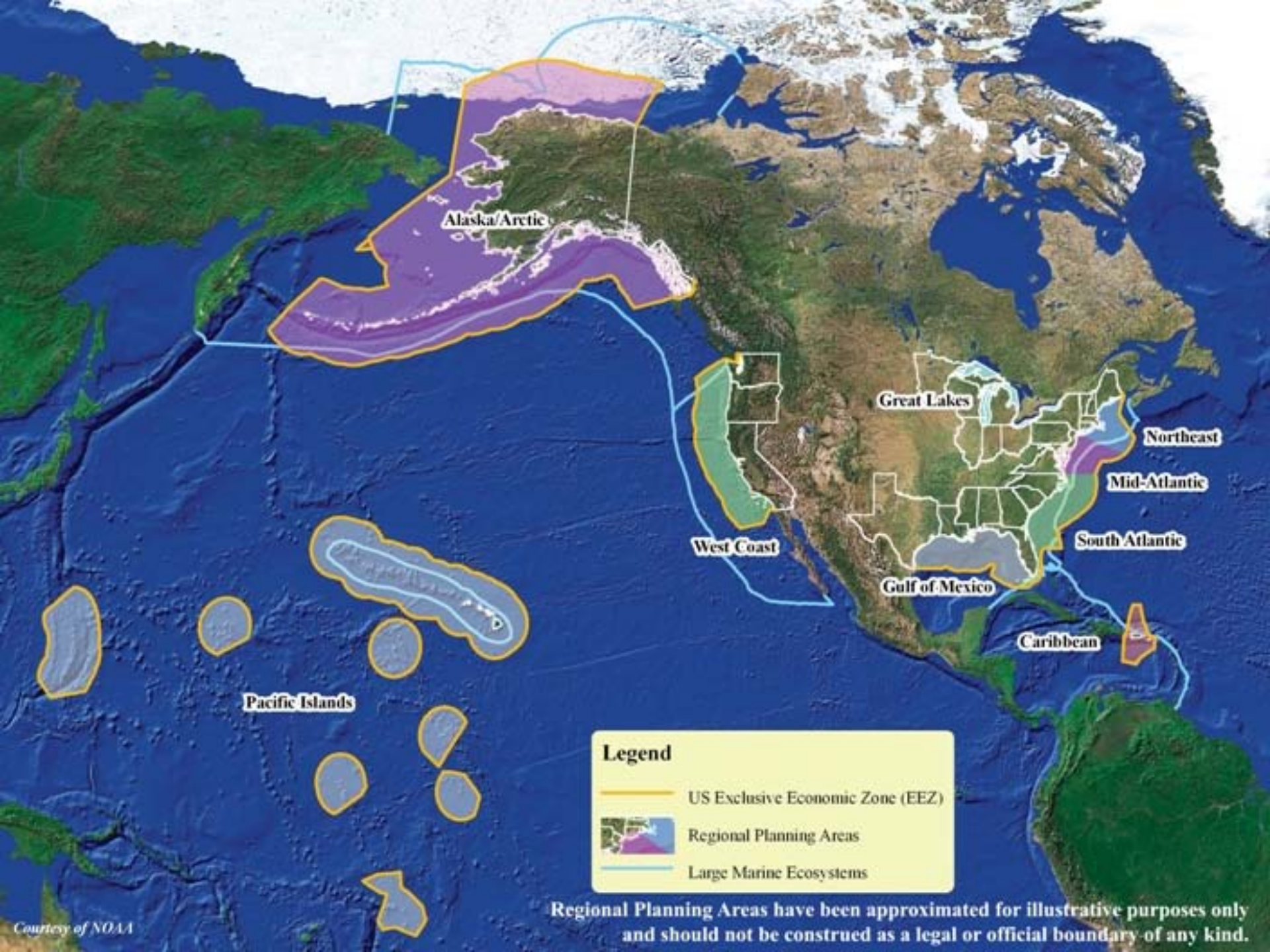
FISHERY MANAGEMENT COUNCIL
CFMC


Alaska/Arctic
Great Lakes
Northeast
Mid-Atlantic
South Atlantic
West Coast
Gulf of Mexico
Caribbean
Pacific Islands
Legend
US Exclusive Economic Zone (EEZ)
Regional Planning Areas
Large Marine Ecosystems
Regional Planning Areas have been approximated for illustrative purposes only
and should not be construed as a legal or official boundary of any kind.
Courtesy of NOAA

Established National Standards

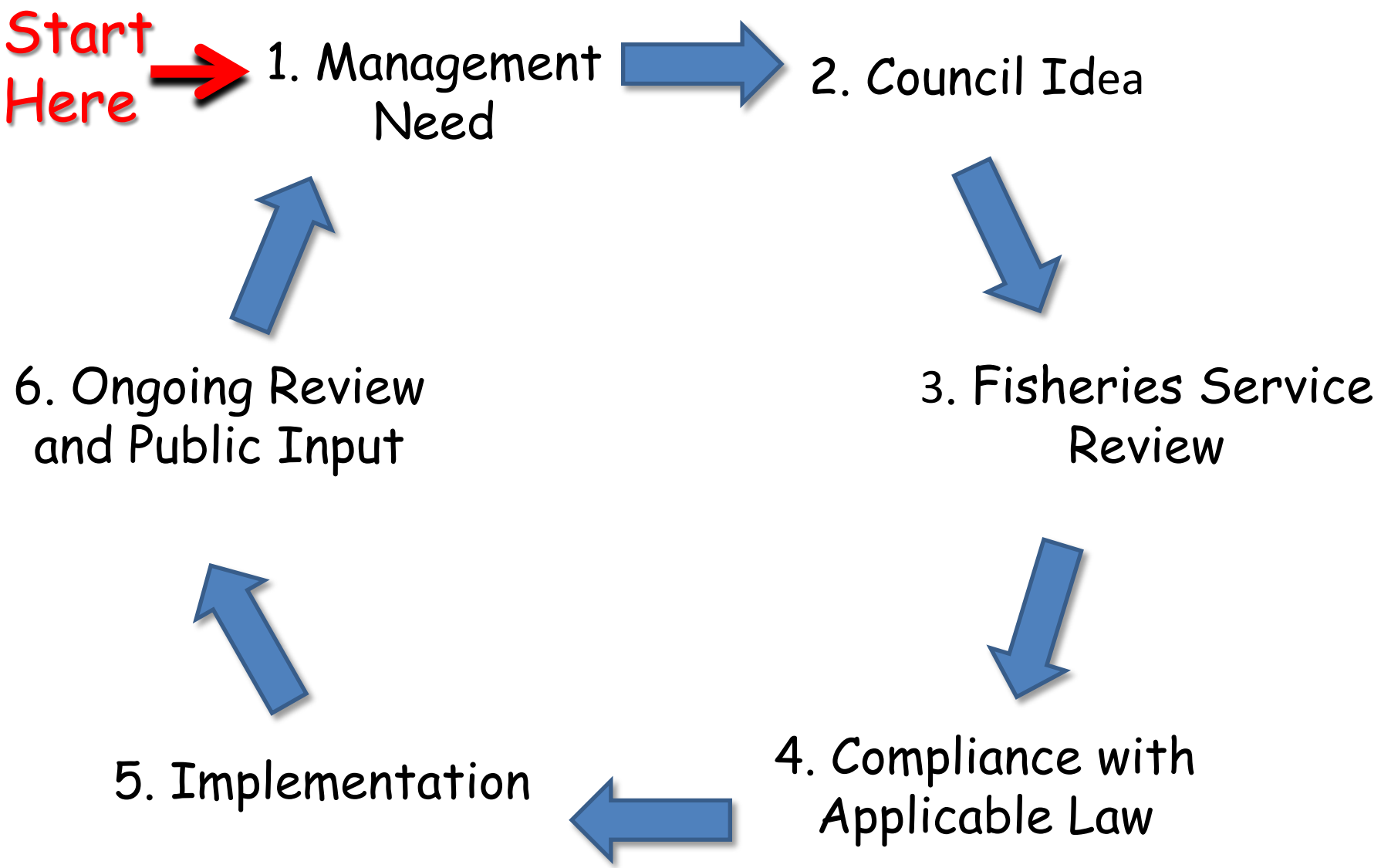
1. **Achieve Optimum Yield (OY) & prevent overfishing**
2. **Use the best scientific information available**
3. Manage stocks as a unit
4. Allocations are fair and equitable, promote conservation, & prevent excessive shares
5. Consider efficiency & not have economic allocation as sole purpose
6. Allow for variation & contingencies
7. Minimize costs & avoid duplication
8. **Consider fishing communities & minimize adverse impacts***
9. Minimize bycatch & bycatch mortality*
10. Promote safety of human life at sea*

* Added in 1996 reauthorization

…and there are Fishery Management Plans

The Councils use Fishery Management Plans (FMPs) and amendments to address problems identified in a particular fishery – usually by suggesting an Accountability Measure (i.e., size limit, bag limit, closed season etc.) to attain a specified catch level

Fisheries Management – The Big Picture

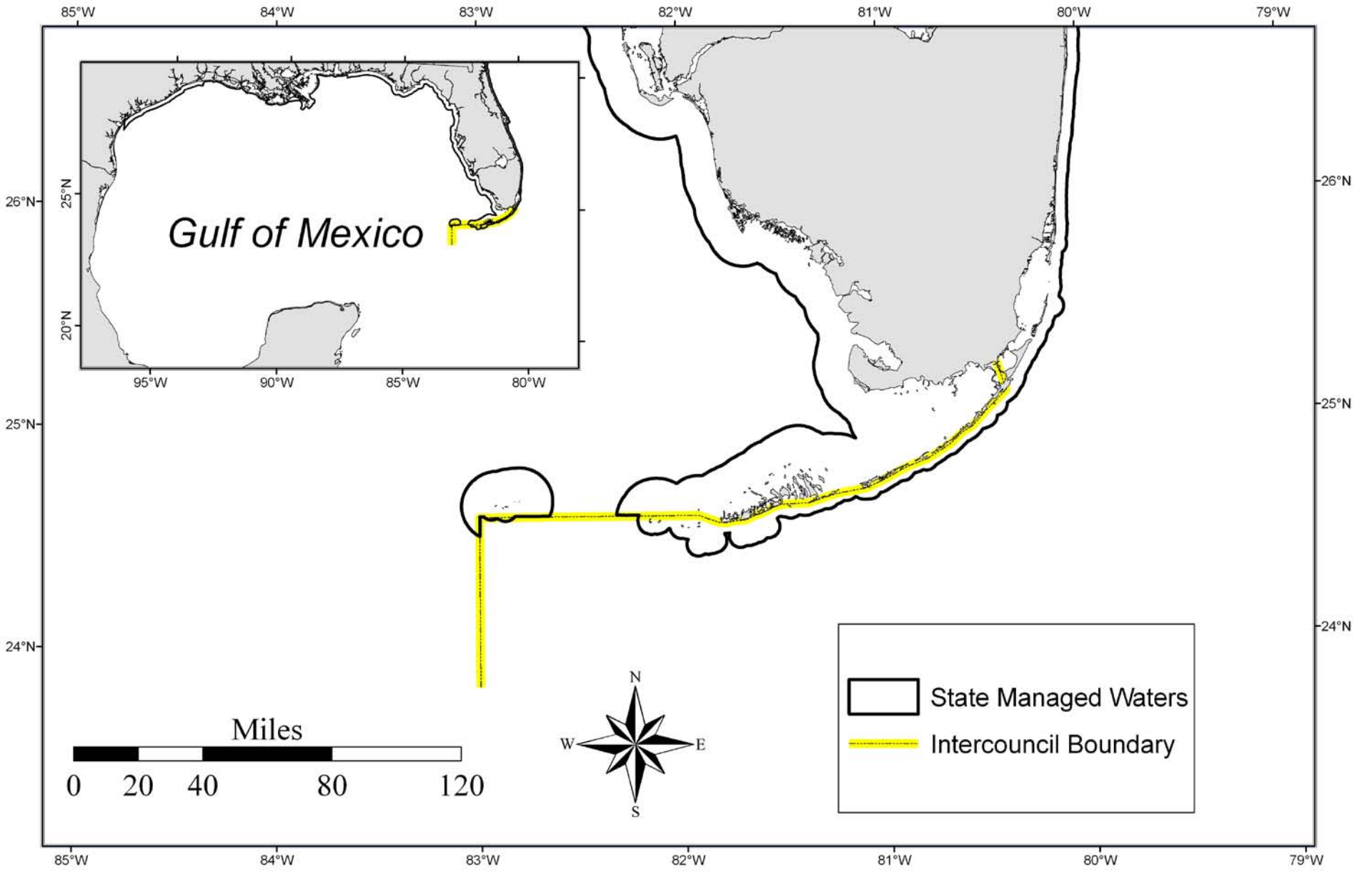


Gulf of Mexico Fishery Management Council

Council Process Overview

In the Gulf of Mexico, there is a 3-mile inshore limit to federal jurisdiction off Louisiana, Mississippi, and Alabama and a 9-mile limit off Texas and Florida

It's Complicated !



Gulf Council membership…

17 voting members:

Governor appointments from states	=	11
State resource managers from each state	=	5
Fisheries Service Regional Administrator	=	1
		17

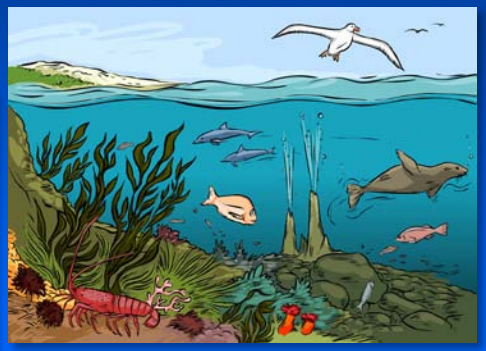
Non-voting members:

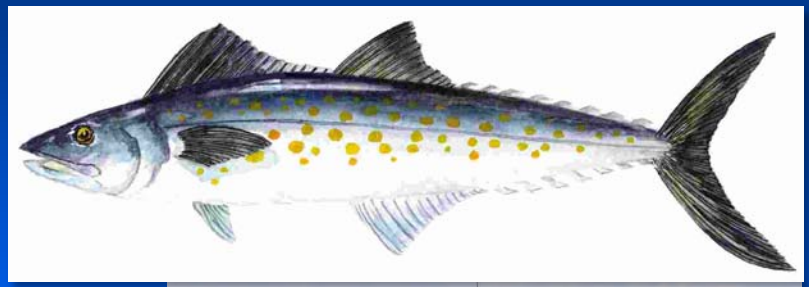
Gulf States Marine Fisheries Commission
U.S. Coast Guard
U.S. Fish and Wildlife Service
U.S. Office of Foreign Affairs

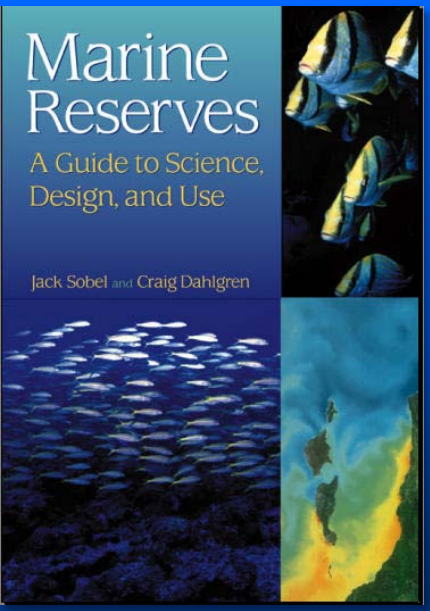
Potential Gulf Council Products

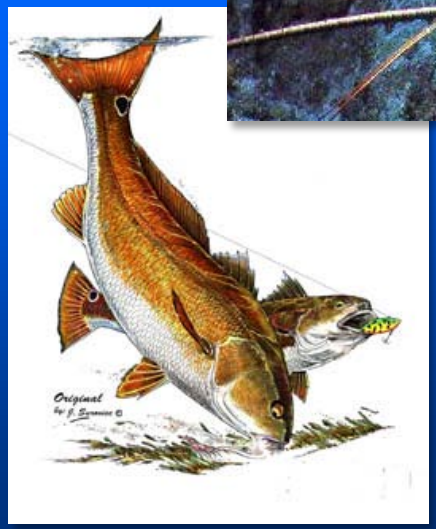
- Fishery Management Plan (FMP)
- FMP or Regulatory Amendment
- Interim Rule for depleted stocks
- Emergency Rule (two 180-day periods)
- Accountability Measures
  - In-season :
    - Size limits, bag limits, season closures
  - Post-season:
    - Adjust the quota

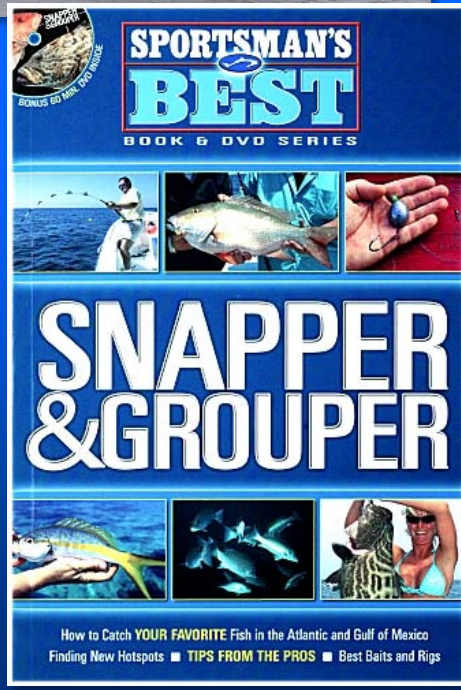
Scientific & Statistical Committee with special committees



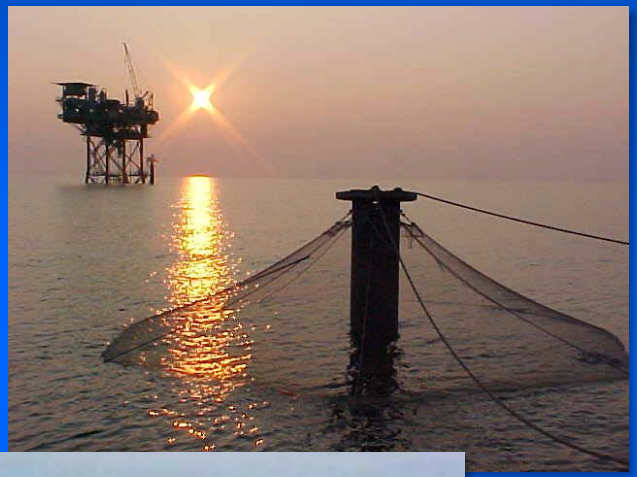


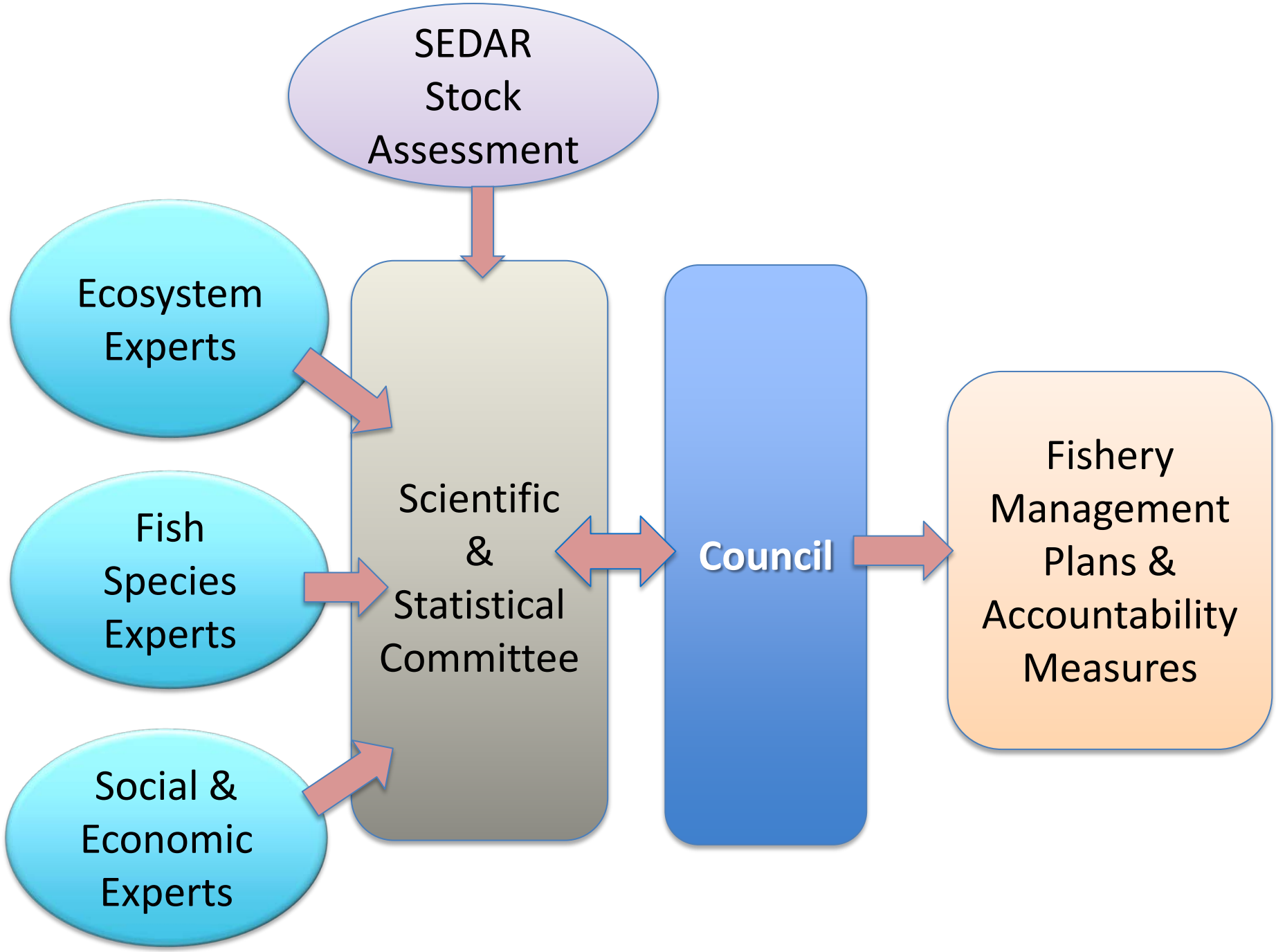






Advisory Panels: include most of the Scientific & Statistical Committees plus…




SEDAR
Stock
Assessment
Ecosystem
Experts
Fish
Species
Experts
Social &
Economic
Experts
Scientific
&
Statistical
Committee
Council
Fishery
Management
Plans &
Accountability
Measures

SEDAR
Southeast Data Analysis and Review

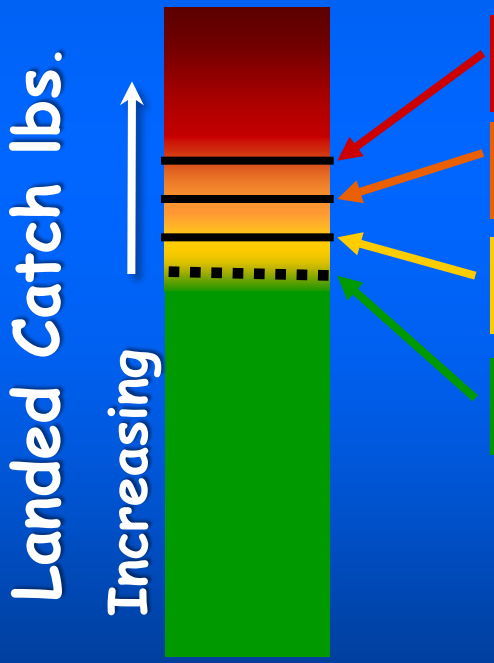
Involves:

- Fisheries scientists from the Southeast Fisheries Science Center in Miami
- Scientific & Statistical Committee members
- Council staff and Council members
- Other experts as appropriate

Magnuson-Stevens Reauthorization Act of 2006

Greater movement toward precautionary management:

1. Councils must set annual catch limits (2011)
2. Greater responsibilities for SSCs: estimate OFL & ABC
3. Tightens rebuilding timelines



Overfishing Limit (OFL)

Acceptable Biological Catch (ABC)

Annual Catch Limit (ACL)

Annual Catch Target (ACT)

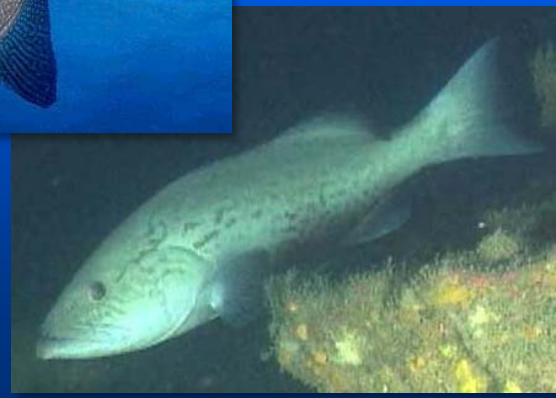
$$OFL \geq ABC \geq ACL \geq ACT$$

Stocks the Gulf Council Manages

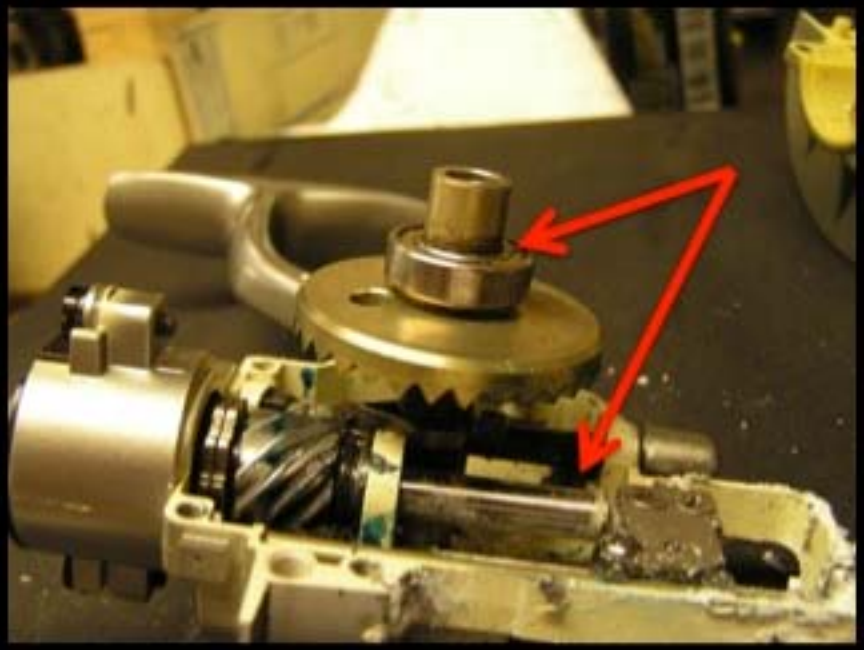
69 Species in all

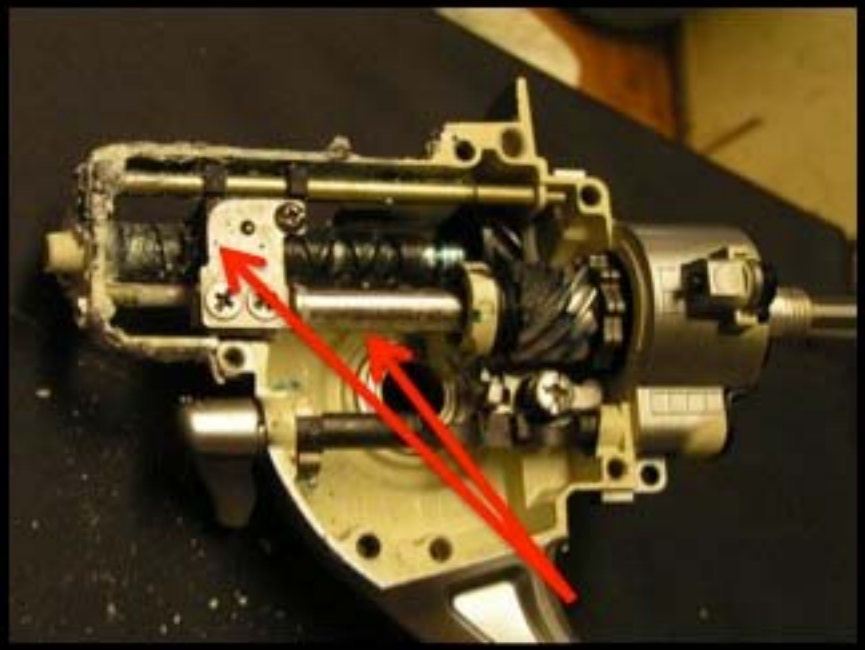
Coastal Migratory Pelagics – Cobia, Mackerels, Sharks
Reef Fish – Red, Vermilion, & Yellowtail Snapper
Deep-water Groupers - Warsaw, Snowy, Misty
Shallow-water Groupers – Gag, Black, Scamp, Yellowmouth
Other Reef Fish – Triggerfish, Amberjack

Species	Overfishing	Overfished
Red Snapper		X
Greater Amberjack	X	X
Gray Triggerfish	X	X
Gag	X	X



Changing gears!

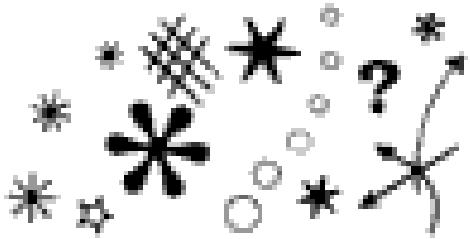




HYPOXIA

Dead Zone

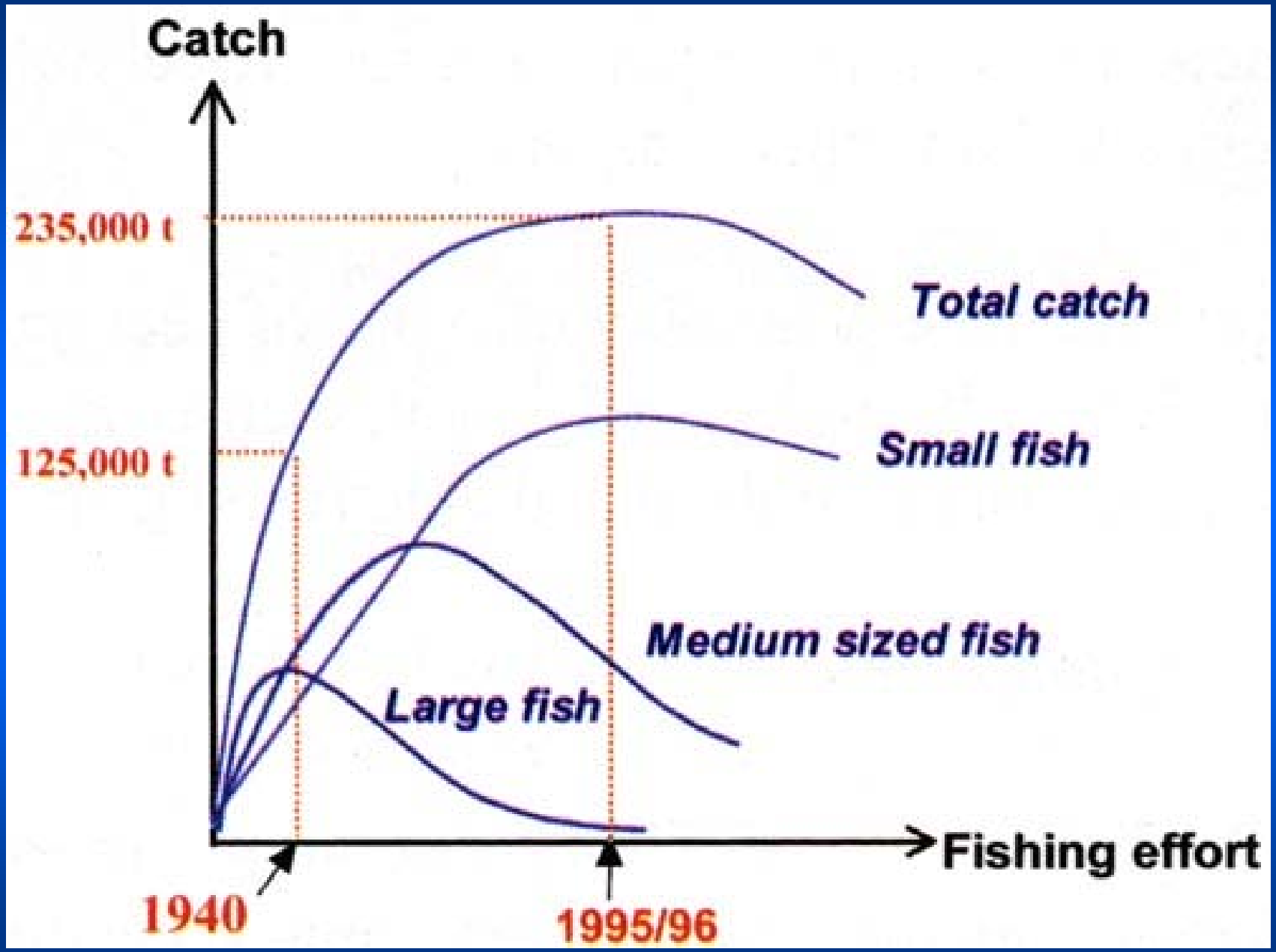
LACK OF OXYGEN!

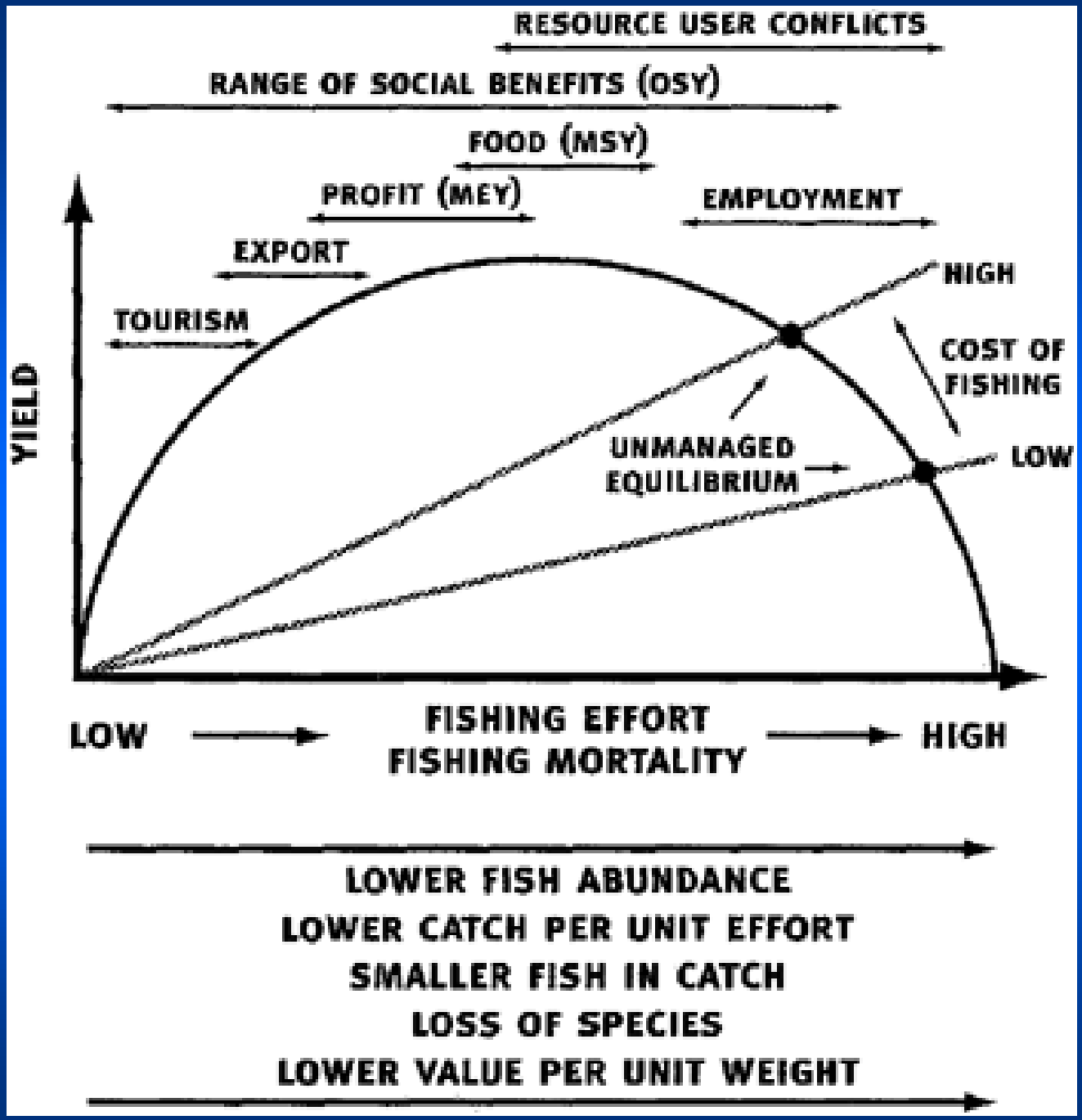


Can cause the same effect as a couple of Martinis

OVERCONFIDENCE...InCoOrDiNaTiOn

USE OXYGEN OVER 12,000 FEET


Catch
235,000 t
125,000 t
Total catch
Small fish
Medium sized fish
Large fish
Fishing effort
1940
1995/96


RESOURCE USER CONFLICTS
RANGE OF SOCIAL BENEFITS (OSY)
FOOD (MSY)
PROFIT (MEY)
EMPLOYMENT
EXPORT
TOURISM
YIELD
HIGH
COST OF FISHING
UNMANAGED EQUILIBRIUM
LOW
LOW
FISHING EFFORT
FISHING MORTALITY
HIGH
LOWER FISH ABUNDANCE
LOWER CATCH PER UNIT EFFORT
SMALLER FISH IN CATCH
LOSS OF SPECIES
LOWER VALUE PER UNIT WEIGHT

Beverton & Holt equations for stock assessments

$$F = \frac{\frac{n_1}{t}\log_e\left(\frac{n_1}{n_2}\right)}{N_o\left(1 - \frac{n_2}{n_1}\right)}$$

$$M = \frac{1}{t}\left[\log_e \frac{n_1}{n_2}\right]\left[1 - \frac{n_1}{N_o\left(1 - \frac{n_2}{n_1}\right)}\right]$$

$$\frac{Y'}{R} = EU^m\left[1 - \left(\frac{3U}{1+m}\right) + \left(\frac{3U^2}{1+2m}\right) - \left(\frac{U^3}{1+3m}\right)\right] \quad (8)$$

where $U = 1 - \left(\frac{L_c}{L\infty}\right)$; $m = \frac{1-E}{\frac{M}{K}} = \frac{K}{Z}$; and L_c = length

$$N^c_{y+1,0,g} = \lambda^c R_0^T \frac{4hB^c_y}{B^c_0(1-h) + B^c_y(5h-1)} e^{\varepsilon_y - \sigma_T^2/2} \times e^{\eta^c_y - \sigma_C^2/2}$$

EcoSim/EcoPath – biomass components

CMPs
cobia
king mack. (2 stanzas)
Span. mack. (2 stanzas)
dolphinfish/wahoo/tunnies/jacks

HMPs
LC sharks
SC sharks
billfish & tuna

Seabirds

Dolphins

sardine/herring complex

sm. oce. pel.
(flyingfish, ballyhoo)

Reef Fish

red snapper (2 stanzas)
vermilion snapper
other snapper
tilefish
yellowedge (3 stanzas)

other DWG
gag grp. (3 stanzas)
red grp. (3 stanzas)
black grp. (3 stanzas)
goliath grp.

other SWG
triggerfish/hogfish
amberjacks
black sea bass

reef carn.
(grunt, porgy, wrasse, perch)

reef omn.
(angelfish, surgeonfish, chub)

lg. coas. carn.
(drum, sheepshead, catfish)

sm. coas. carn.
(mojarra, eels, searobbin, lizardfish)

rays/skates

Mullets

Coastal piscivores
(tarpon, snook, seatrout)

coas. omin.
(pinfish)

anchovies/ silversides

Benthic Invertebrates

shrimp
lobsters
large crabs
octopods
stomatopods
echino./g-pods

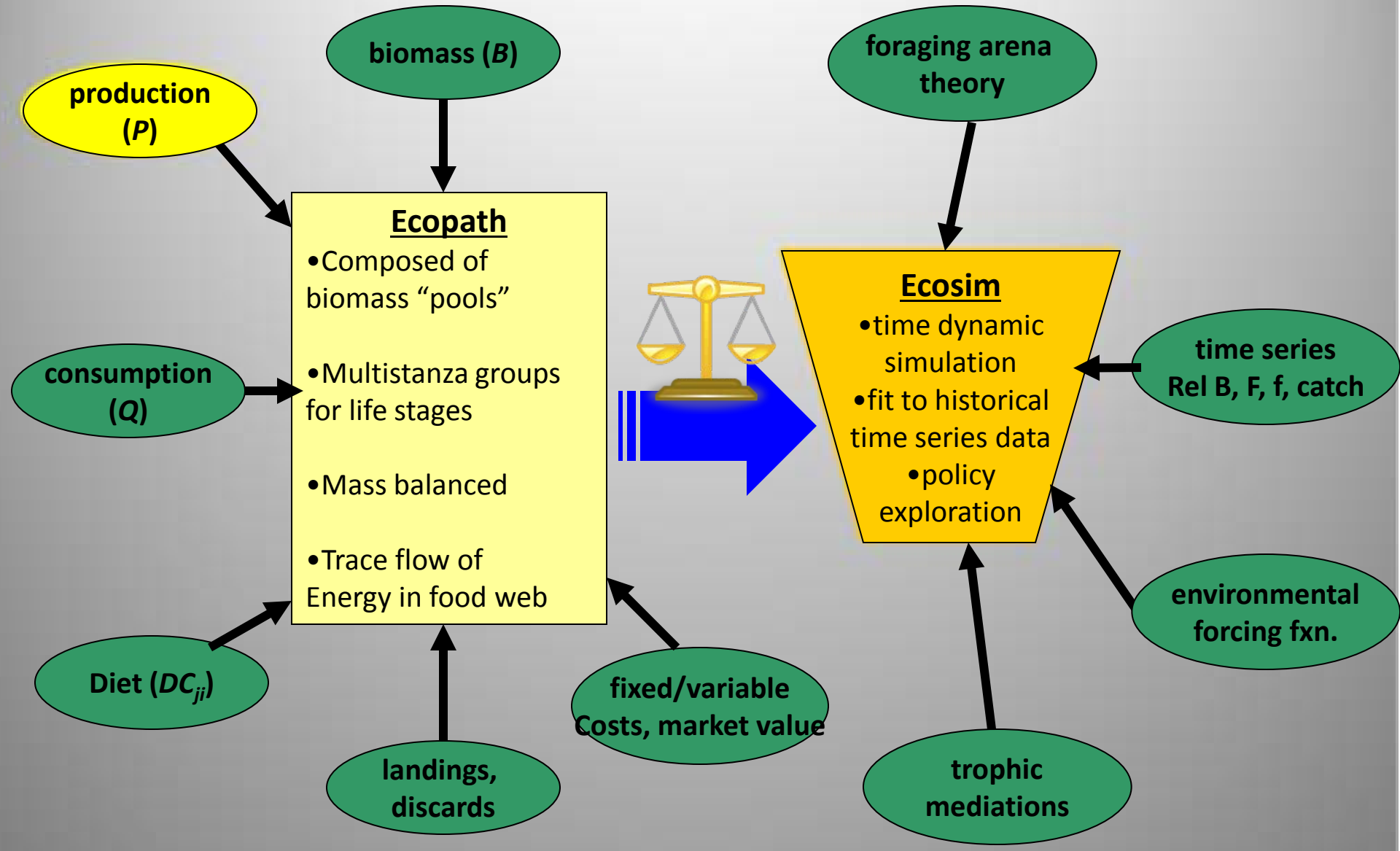
bivalves
ses. epibenthos
small infauna
sm. mob. epifauna
meiofauna
microbes

Zooplankton
sm. copepods
mesozooplankton
carn. zooplankton
ichthyoplankton
carn. jellyfish

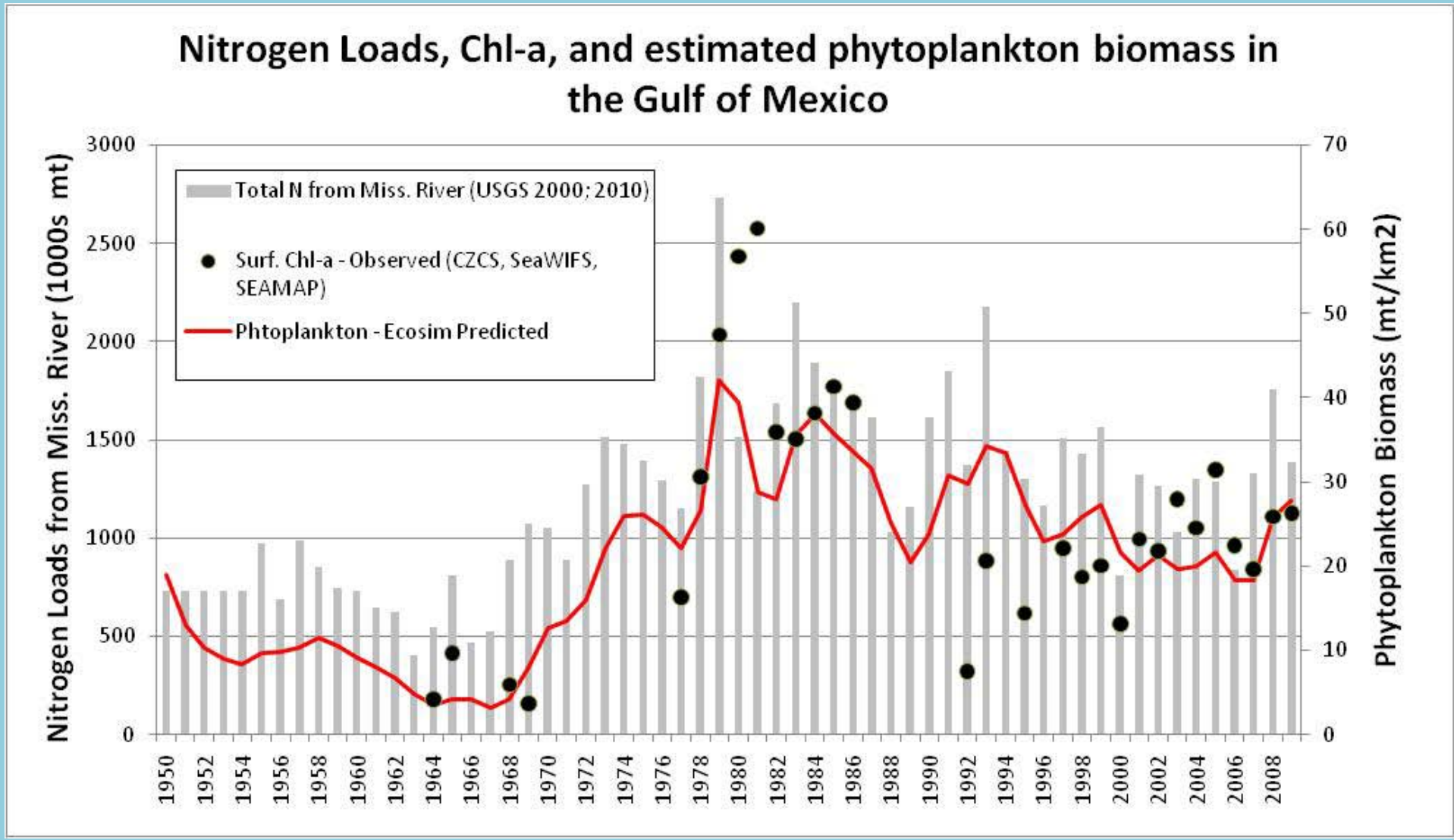
PPs
ben. micro algae
macroalgae
phytoplankton
seagrass

Detritus
water column
sediment
dead discards

Ecopath with Ecosim



Primary Production on the West Florida Shelf

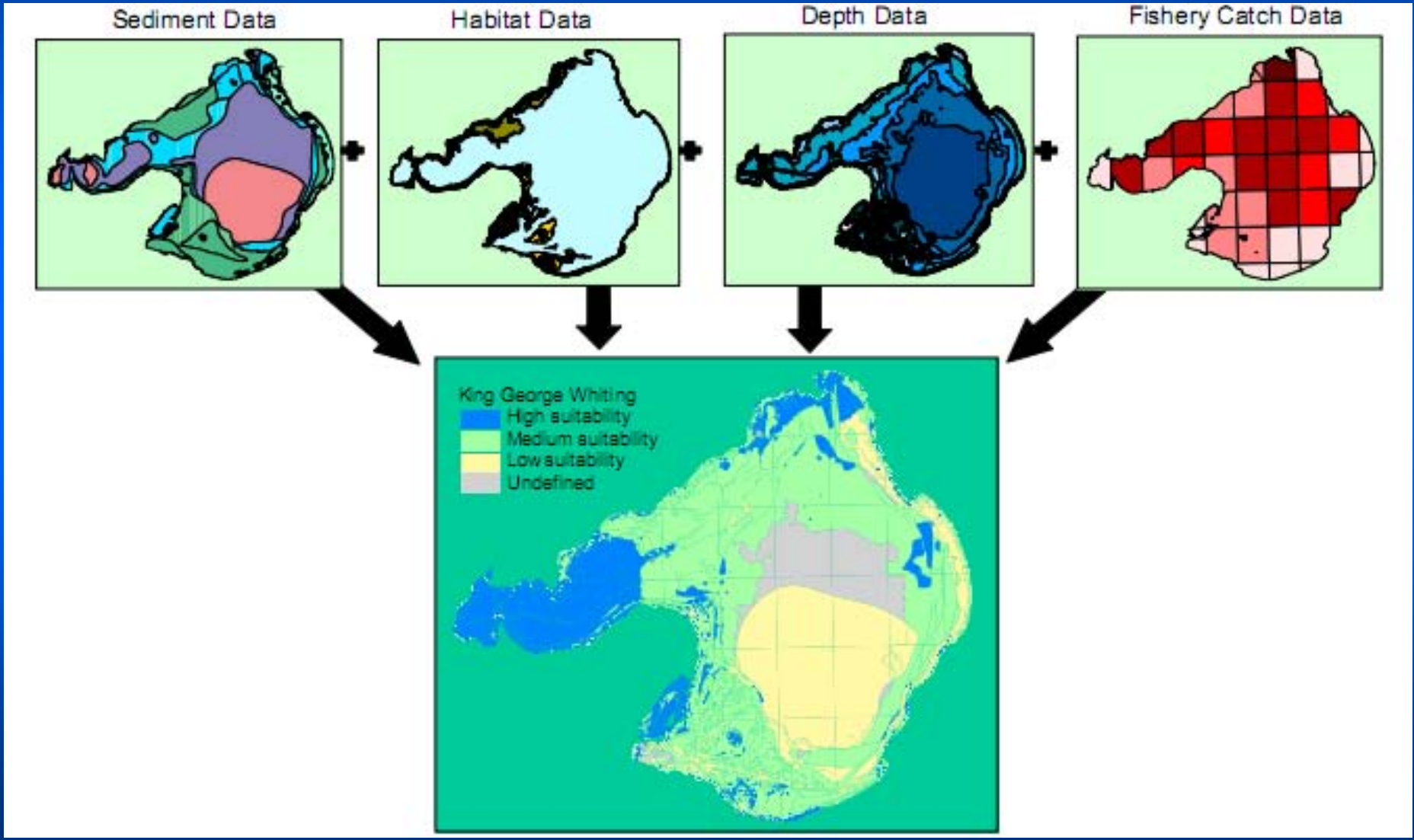


Chlorophyll Plumes on West Florida Shelf (Gilbes et al. 1996) – *"Green River Phenomenon":*

$$
\begin{aligned}
&\log_e C_{yt} - \log_e C_{bt} \\
&\quad = (\log_e q_{ym,g} - \log_e q_{bm,g}) + \alpha(\log_e K_{yt} - \log_e K_{bt}) \\
&\qquad + \beta(\log_e \mathrm{Len}_{yt} - \log_e \mathrm{Len}_{bt}) + (\log_e z_{y0} - \log_e z_{b0}) \\
&\qquad + m_f \left(\sum_{i=0}^{t-1} \frac{H_{yi}}{w_i} - \sum_{i=0}^{t-1} \frac{H_{bi}}{w_i} \right) \\
&\qquad + \sum_{i=\tau-t+1}^{t} a_{1i}(\mathrm{OI}_{yi} - \mathrm{OI}_{bi}) \\
&\qquad + \sum_{i=\tau-t+1}^{t} a_{2i}(\mathrm{TI}_{yi} - \mathrm{TI}_{bi}) \\
&\qquad + \sum_{i=\tau-t+1}^{t} a_{3i}(\mathrm{SI}_{yi} - \mathrm{SI}_{bi}) + b_1(\log_e O_{yt} - \log_e O_{bt}) \\
&\qquad + b_2(\log_e T_{yt} - \log_e T_{bt}) + b_3(\log_e S_{yt} - \log_e S_{bt}) \\
&\qquad + (\varepsilon_{yt} - \varepsilon_{bt}). \qquad (14)
\end{aligned}
$$

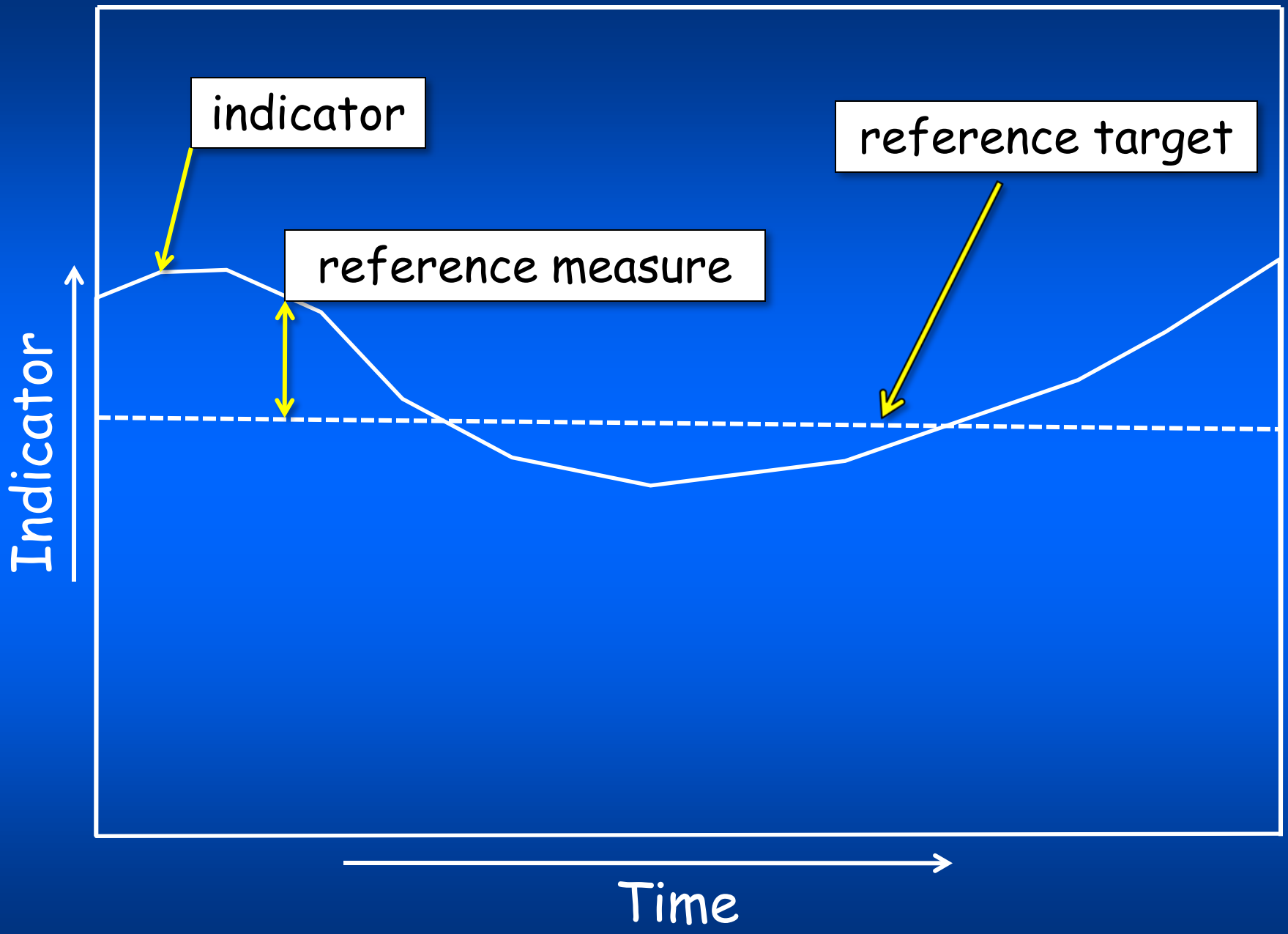
Huang, L, M.D. Smith, & J.K. Craig. 2010. Quantifying the economic effects of hypoxia on a fishery for brown shrimp *Farfantepenaeus aztecus*. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 2:232-248.

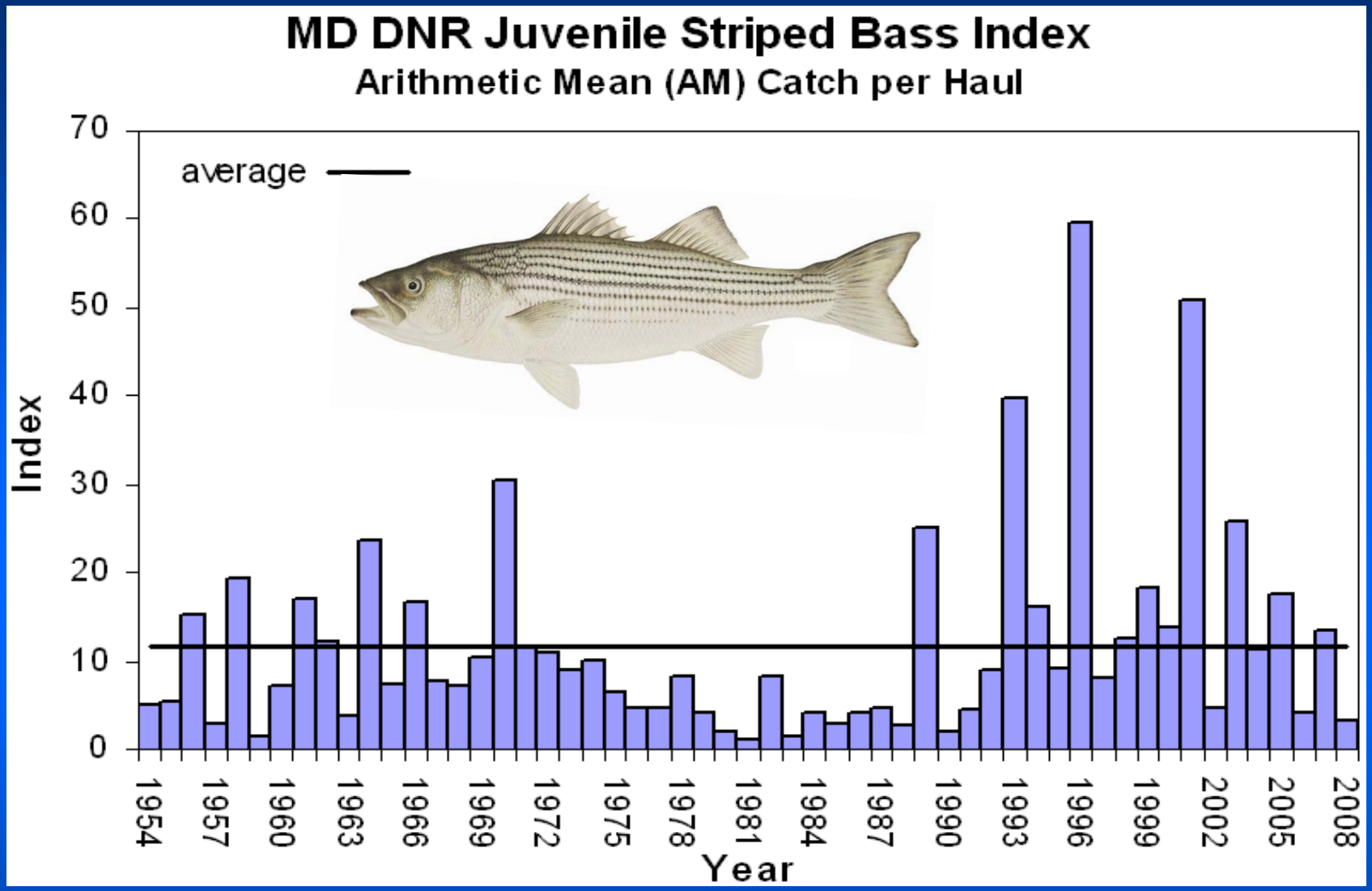
Coastal & Marine Spatial Planning



Ecosystem-Based Management Indicators

- Impetus: limited resources to fully assess exploited species and ecosystems
- Desire for ecosystem-based approaches to fisheries management (EBM)
- Indicators:
  - Reflect processes
  - Serve as signals of something more basic or complicated (NRC 2000).
- Long history of use in sciences


indicator
reference target
reference measure
Indicator
Time



Juvenile index: Annually since 1954; 22 fixed stations; Jul. (I), Aug. (II), & Sep. (III). Replicate seine hauls (30.5-m x 1.24-m bagless beach seine, 6.4-mm mesh).

Tautog Spawning Stock Biomass

Source: ASMFC 2011 Tautog Stock Assessment Update

SSB

SSB target

SSB threshold

Addendum I

Addendum III

FMP

Addendum II

Addenda IV & V

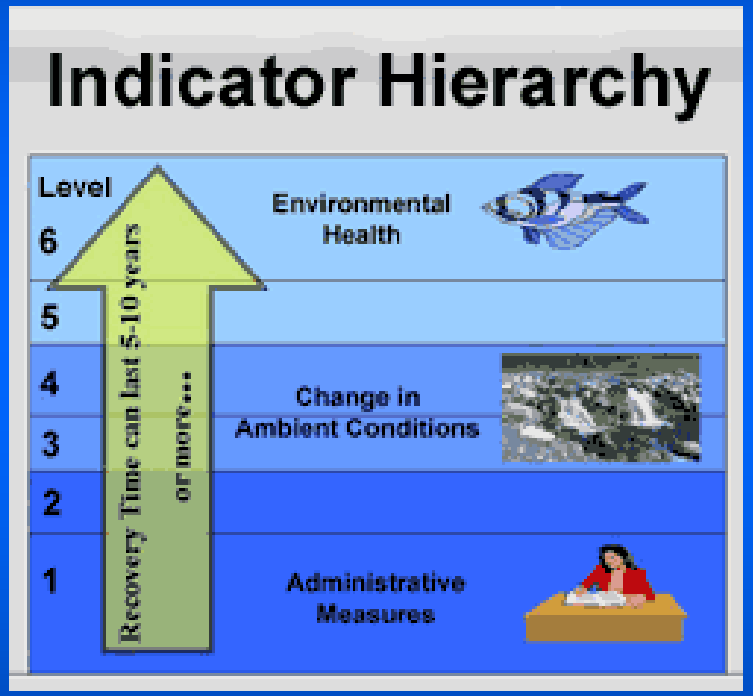
Biomass (millions of pounds)

0 10 20 30 40 50 60 70 80 90

1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009

Indicator selection for Ecosystem-Based Management for the GOM

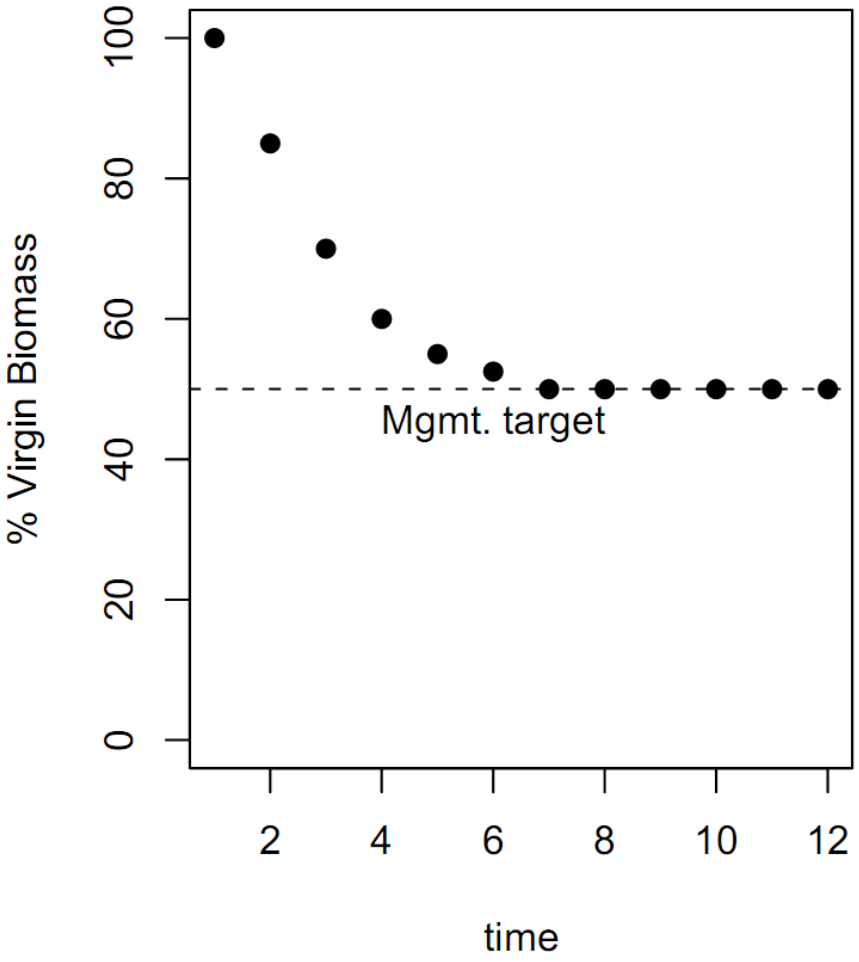
- Are indicators appropriate or adequate for GOM?
  - Data availability
  - Management Goals
  - Focus on status or trend
    - Trend detection:
      - Indicators over time
      - Appropriate analytical technique to balance Type I & II errors



What is a trend?

1. General: general tendency or direction (eyeball)
2. Statistical: $Indicator_{ij} = x_i + y_j + x^*y_{ij} + \varepsilon_{ij}; p < 0.05$
3. Useful:
   - Integrates long and short term properties of series
   - Low error probability (Type I & II)
   - Scientifically grounded
   - Simple and flexible enough to apply to variety of metrics
   - Incorporates uncertainty
   - Assumptions can be evaluated via simulation or data
   - Easy to communicate results to wide audience

What is a trend?



Alternative Methodology

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ECOLOGICAL INDICATORS 9 (2009) 732–739

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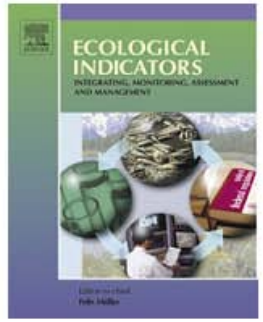
journal homepage: www.elsevier.com/locate/ecolind



Intersection–union tests for characterising recent changes in smoothed indicator time series

Verena M. Trenkel *, *Marie-Joëlle Rochet*

Alternative methodology cont.

Table 1 – Test results for recent trends and chang
Southern North Sea fish ($\alpha = 0.05$) using linear reg
***p*-Values for χ^2-test for GAM model fit to entire ti**
decreasing (⇘), increasing (⇗) or stable. Change
derivatives (↘); positive derivatives (↗).

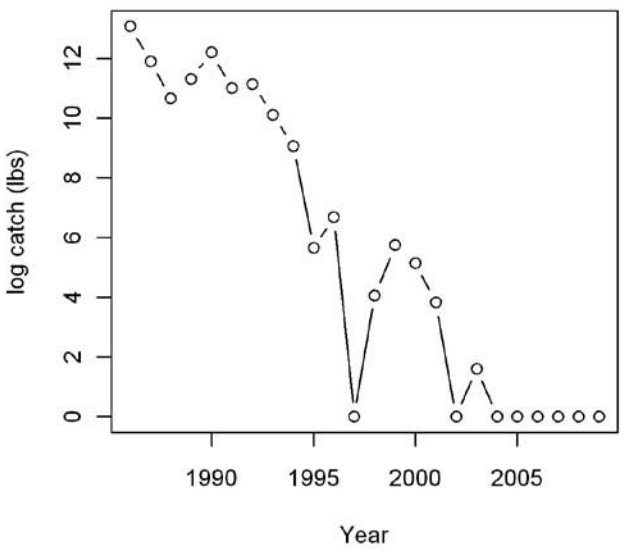
	1984-2006	2004-2006			
Scientific name	χ^2 p-value	LR p-value	LR	MK	IU
Agonus cataphractus	0.001	0.06	⇔	⇔	⇗
Arnoglossus laterna	0.051	0.51	⇔	⇔	
Buglossidium luteum	0.039	0.64	⇔	⇔	⇗
Callionymus lyra	<0.001	0.92	⇔	⇔	⇔↘
Chelidonichthys gurnardus	0.001	0.07	⇔	⇔	⇔
Clupea harengus	<0.001	0.42	⇔	⇔	⇘
Echiichthys vipera	0.052	0.40	⇔	⇔	
Enchelyopus cimbrius	0.002	0.19	⇔	⇔	⇗
Engraulis encrasicolus	<0.001	0.31	⇔	⇔	⇗
Ammodytidae	<0.001	0.96	⇔	⇔	⇘

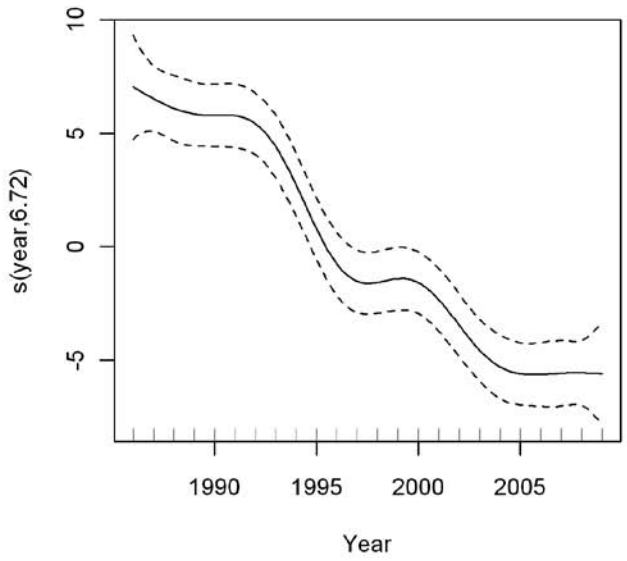
- Long and short term properties
- Low probability or error (Type I & II)
- Scientifically grounded
- Flexible
- Incorporates uncertainty
- Assumptions can be evaluated
- Easy to communicate results?

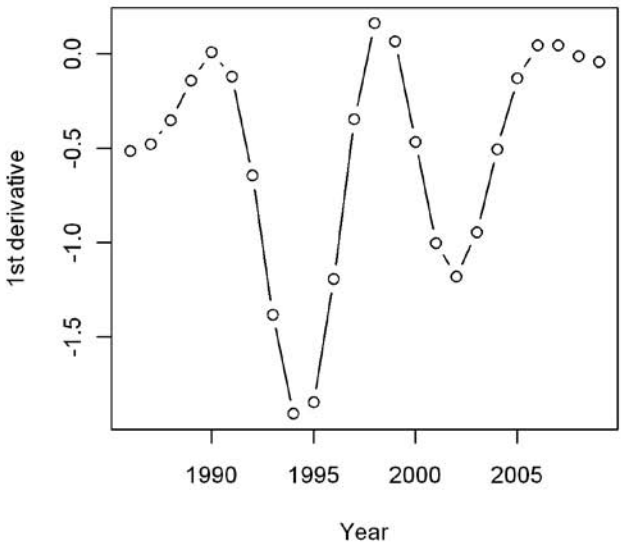
Examples

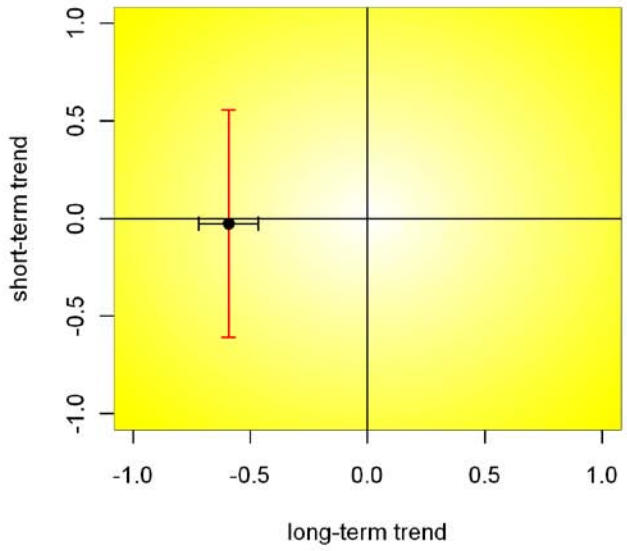
- Data: Annual Catch Limit data set used to inform harvest levels for data-poor GOM managed species
  - Landings
    - lbs whole weight
    - Recreational
    - For-hire
    - Commercial
    - 1986 – 2009
  - Based on methodology of Trenkel and Rochet 2009

Nassau Grouper

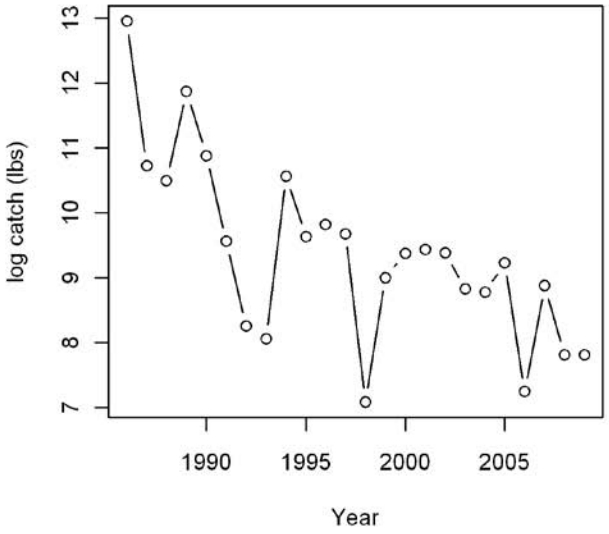


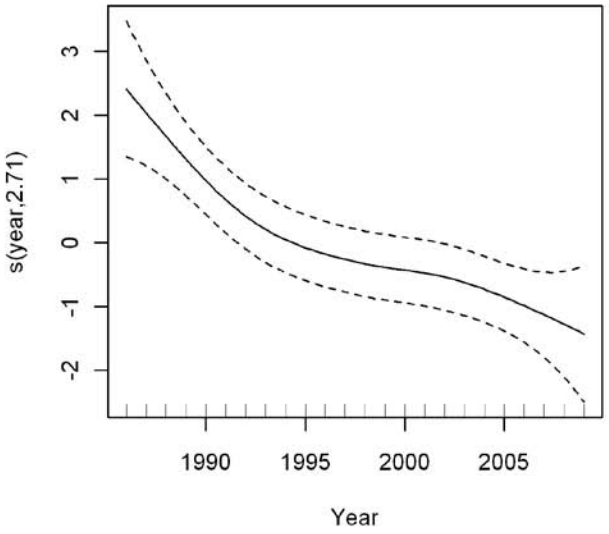


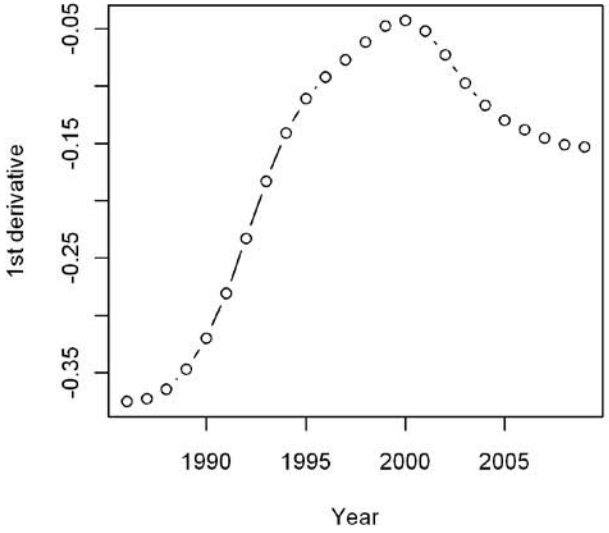


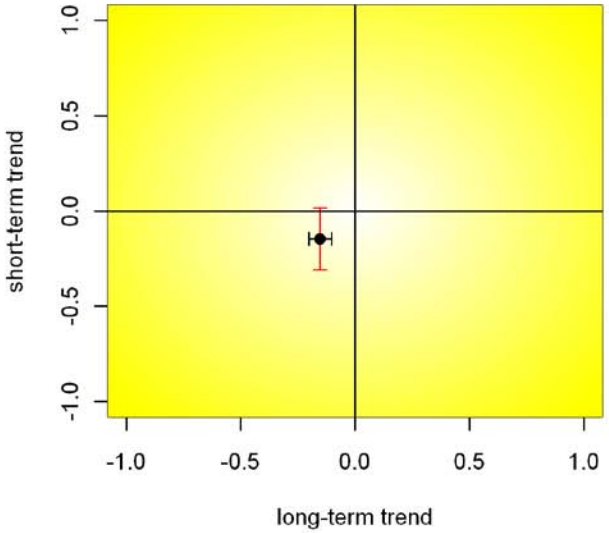


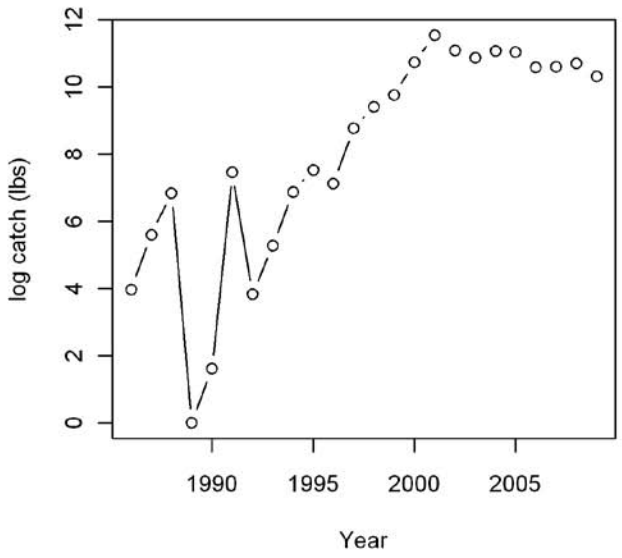
Yellowfin Grouper

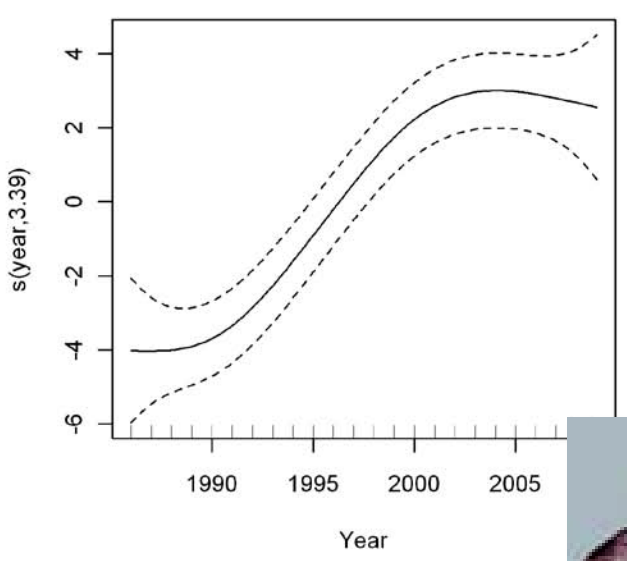




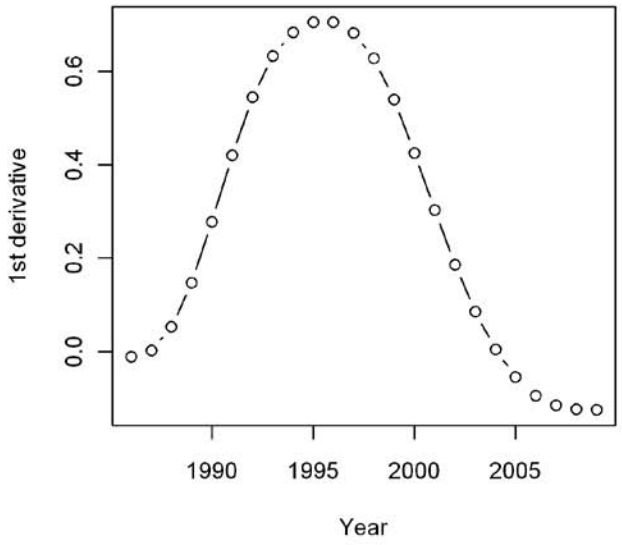


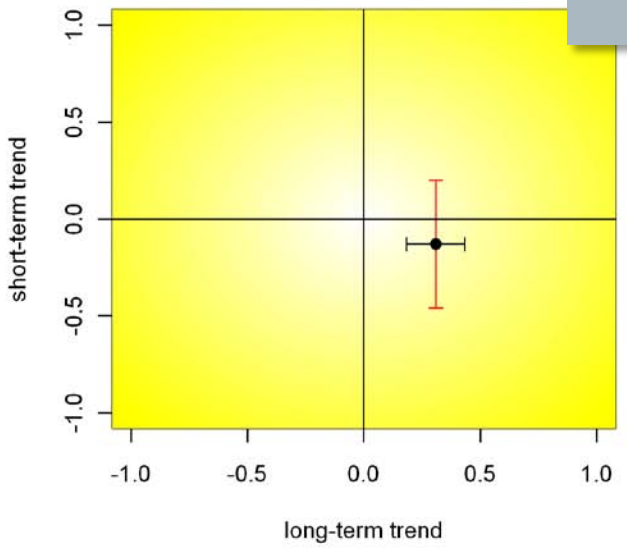



log catch (lbs)
0
2
4
6
8
10
12
1990
1995
2000
2005
Year

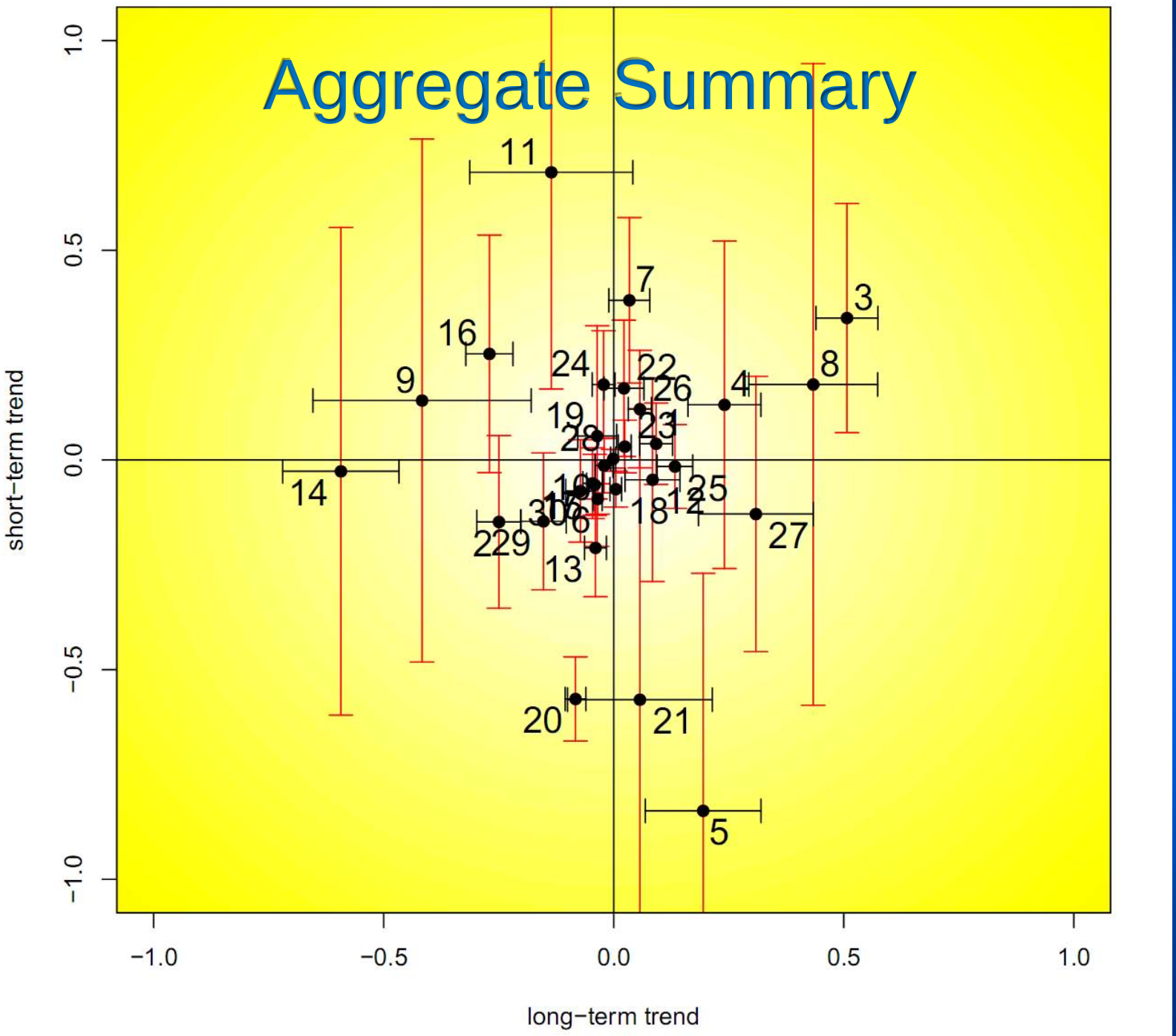

s(year,3.39)
-6
-4
-2
0
2
4
1990
1995
2000
2005
Year

Wenchman


1st derivative
0.0
0.2
0.4
0.6
1990
1995
2000
2005
Year


short-term trend
-1.0
-0.5
0.0
0.5
1.0
-1.0
-0.5
0.0
0.5
1.0
long-term trend

Aggregate Summary



"Are we there yet?"


2B OR NOT 2B?
Wm. Shakespeare
Apt. 2B
ye Olde Posty
Apt 2A
Lynch