Artificial Reefs in Fisheries Management: Has the Time Come?

The time has come the Walrus said “to speak of many things. Of shoes, and ships, and sealing wax. Of cabbages and kings. And why the sea is boiling hot, and whether pigs have wings”

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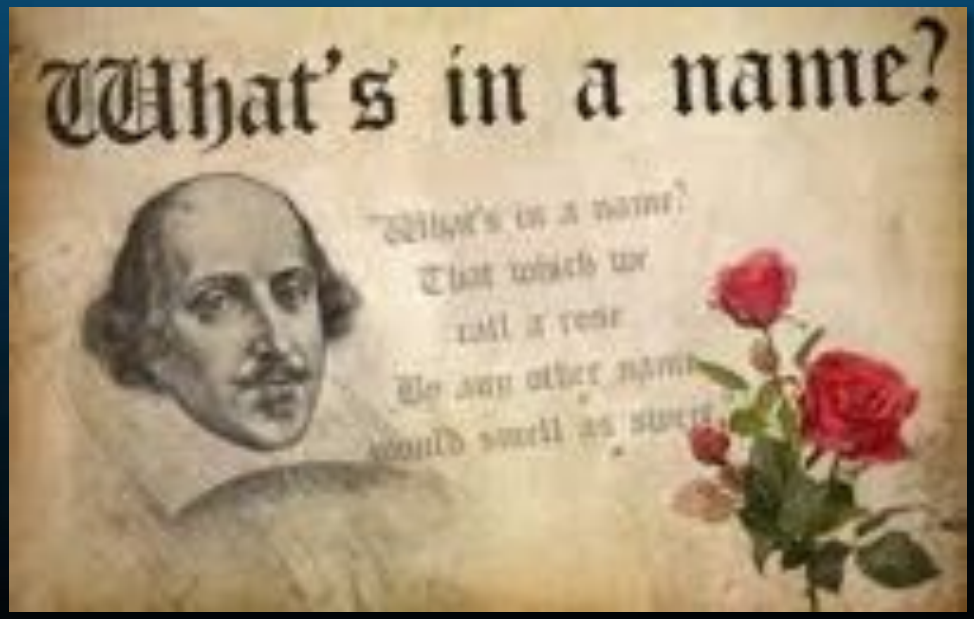
Outline

A. What is an artificial reef?
B. Uses of artificial reefs
C. What is Fisheries Management?
D. Current use of artificial reefs in Fisheries Management
E. Potential uses of artificial reefs in Fisheries Management
F. Obstacles for using artificial reefs in Fisheries Management
G. Overcoming obstacles for using artificial reefs in Fisheries Management

A. What is an artificial reef?

Artificial Reef - one or more objects of natural or human origin deployed on the seafloor to influence physical, biological, and/or socioeconomic processes related to living aquatic resources.

(modified from Seaman & Jensen, 2000)



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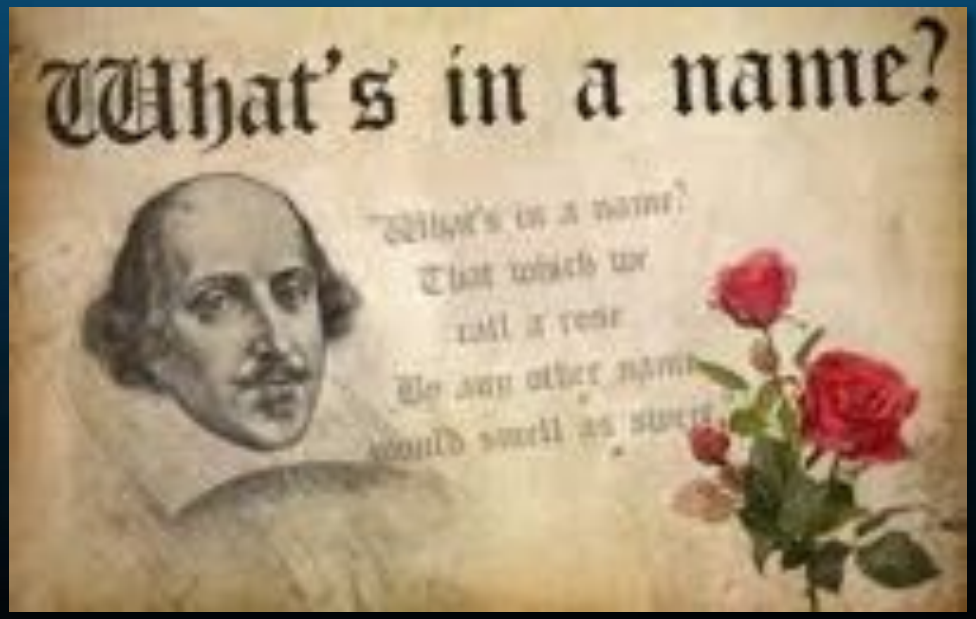

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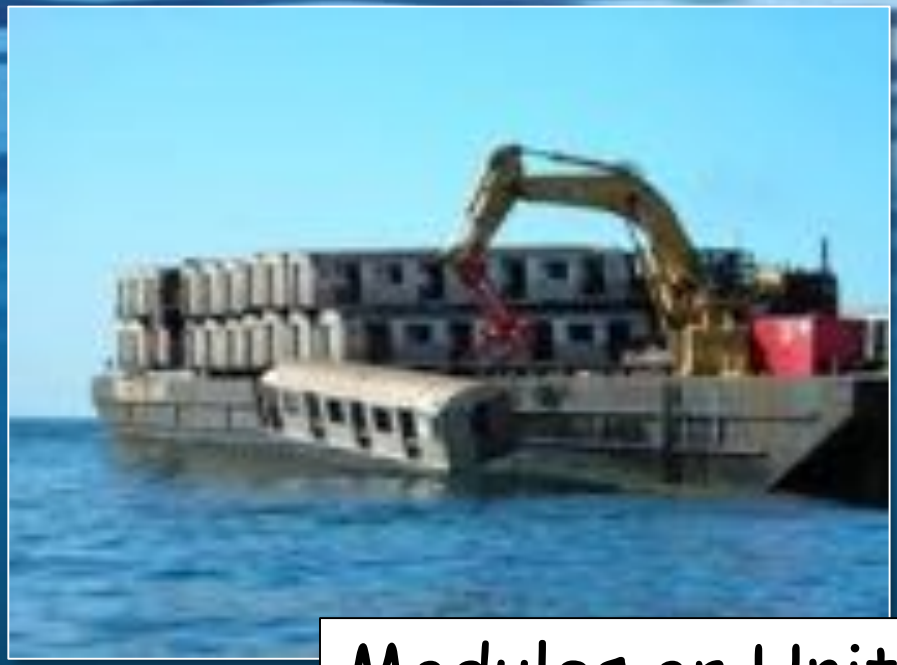
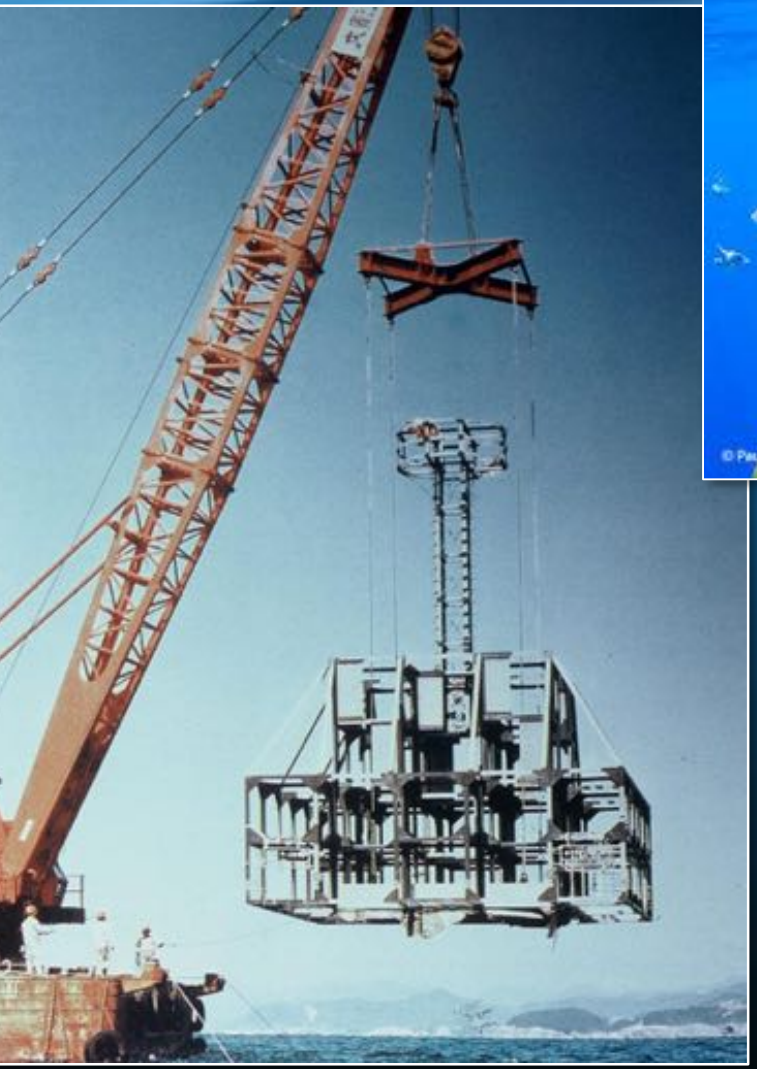
Artificial Reef - one or more **objects** of natural or human origin **deployed** on the seafloor **to influence** physical, biological, and/or socioeconomic processes related to living **aquatic resources**.

CliffsNotes version

Types



Modules or Units of Opportunity

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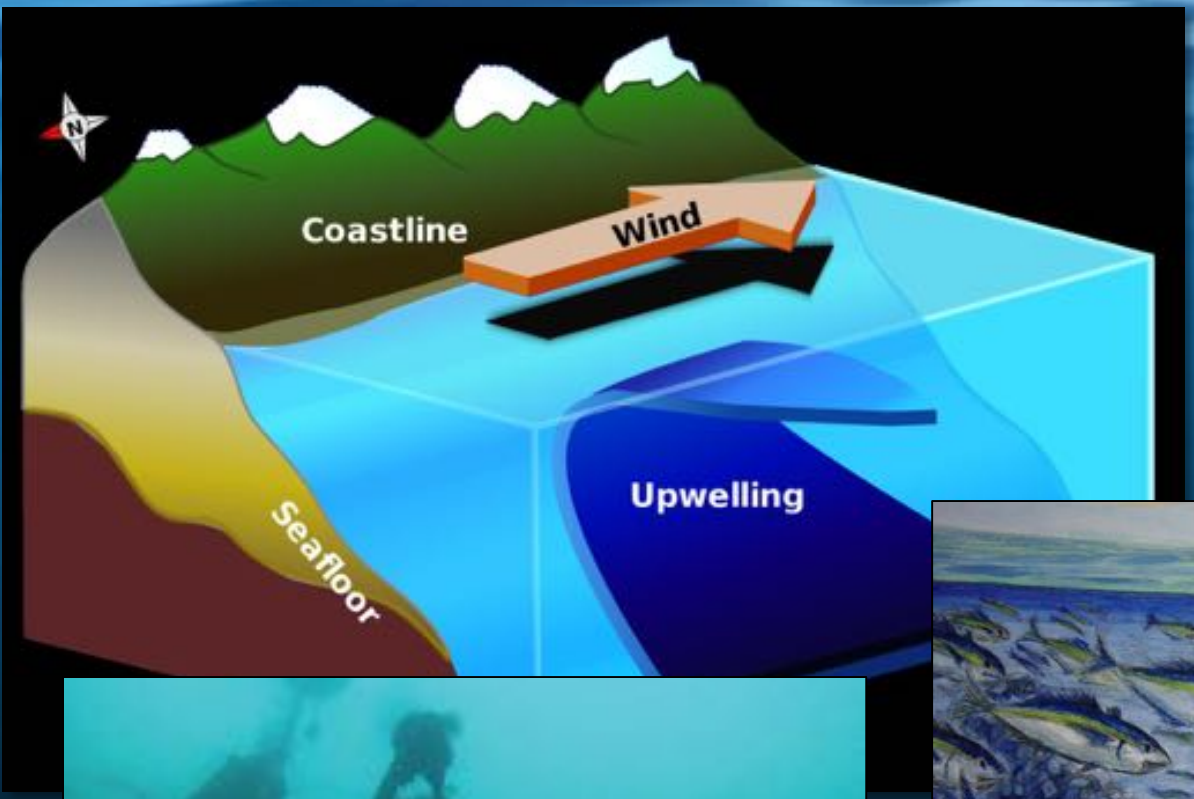
B. Uses

B. More Uses of Artificial Reefs




FLORIDA
Panama City Beach


CANADA
Seattle
Portland
Boise
Minneapolis
Milwaukee
Detroit
Buffalo
Boston
Cape Cod
UNITED STATES
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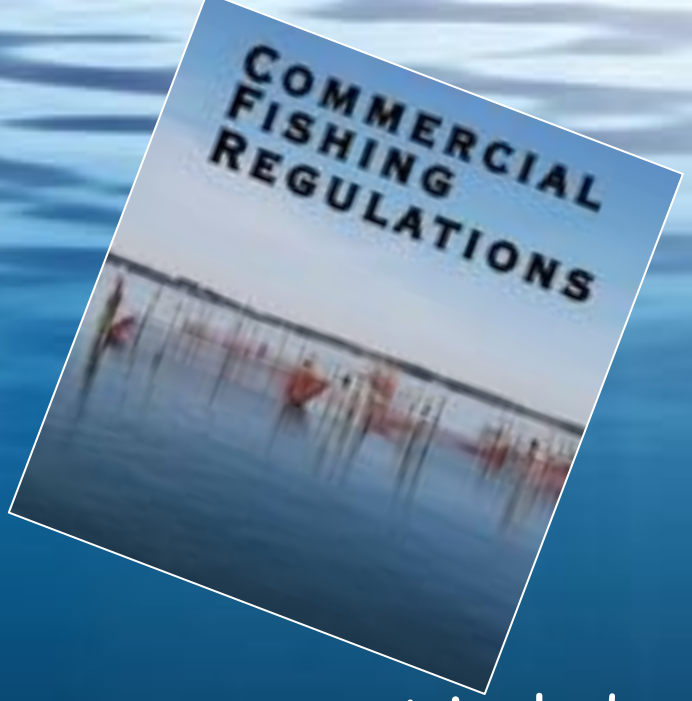
New York
Salt Lake City
Omaha
Philadelphia
Atlantic City
Napa
Denver
Reno
Colorado Spr
Kansas City
Cincinnati
Baltimore
San Francisco
Aspen
Wichita
Oakland
Branson
Washington DC
Santa Barbara
Las Vegas
Taos
Santa Fe
Memphis
Nashville
Sedona
Albuquerque
Los Angeles
G.Canyon
Jackson
Atlanta
San Diego
Phoenix
Dallas
Tucson
Panama City
El Paso
Austin
Houston
Tallahassee
San Antonio
Tampa
Fort Myers
Orlando
Corpus Christi
Naples
Fort Lauderdale
Miami
Key West
MEXICO
Bahamas
Cuba

C. What is Fisheries Management?

A Fishery Manager's Guidebook (FAO)
by Cochrane and Garcia 2009

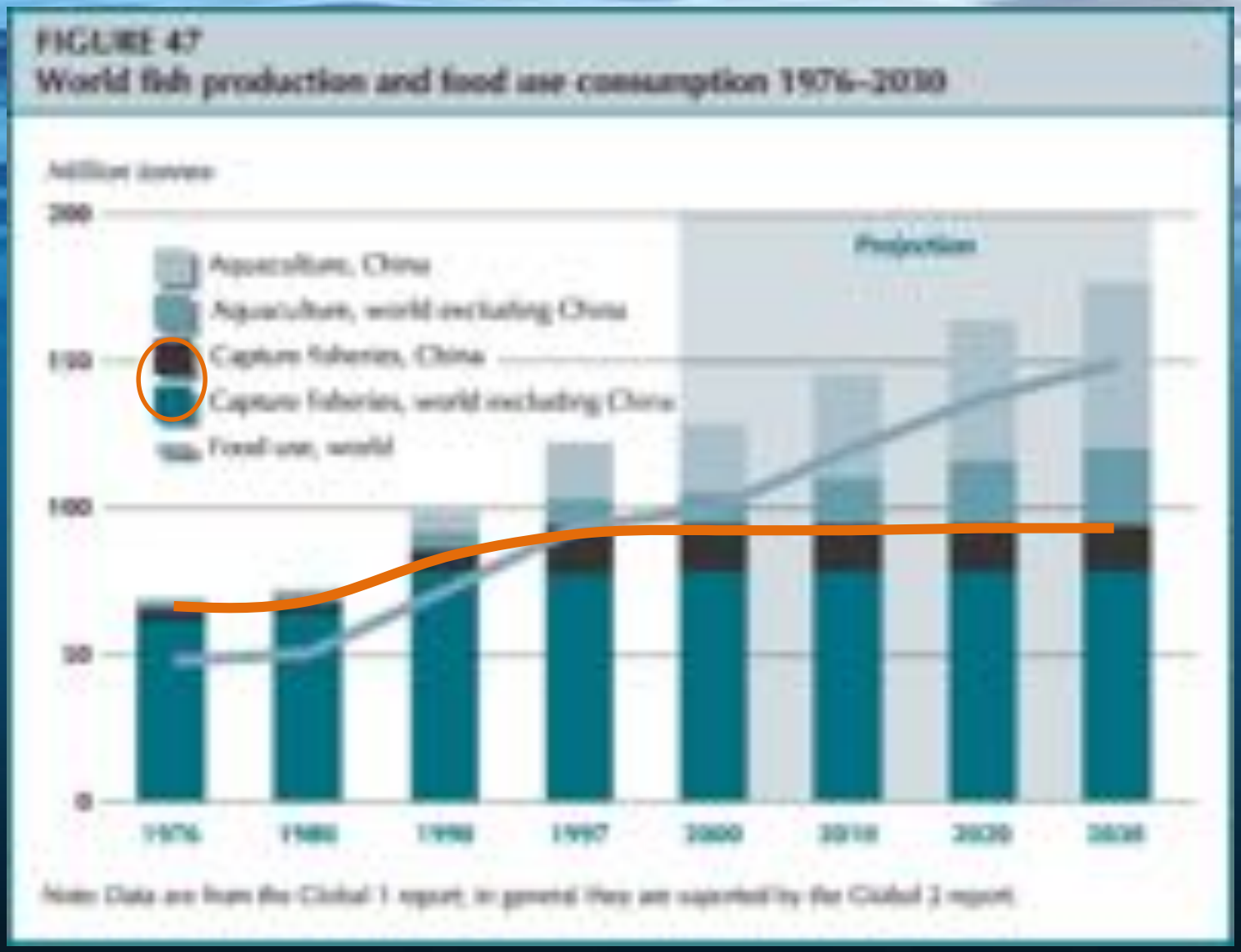
"The integrated process of information gathering, analysis, planning, consultation, decision- making, allocation of resources and formulation and implementation, …to ensure the continued productivity of the resources and the accomplishment of other fisheries objectives."

"The manipulation of human interactions with living aquatic resources in a manner that allows humans to gain some sustainable benefit from these resources." Nelson (1993).



Fishery management includes manipulating human behavior (controlling harvest with regulations), to control aquatic habitats (e.g., pollution abatement, artificial reefs), & resources themselves such as introductions (Ross, 1997).

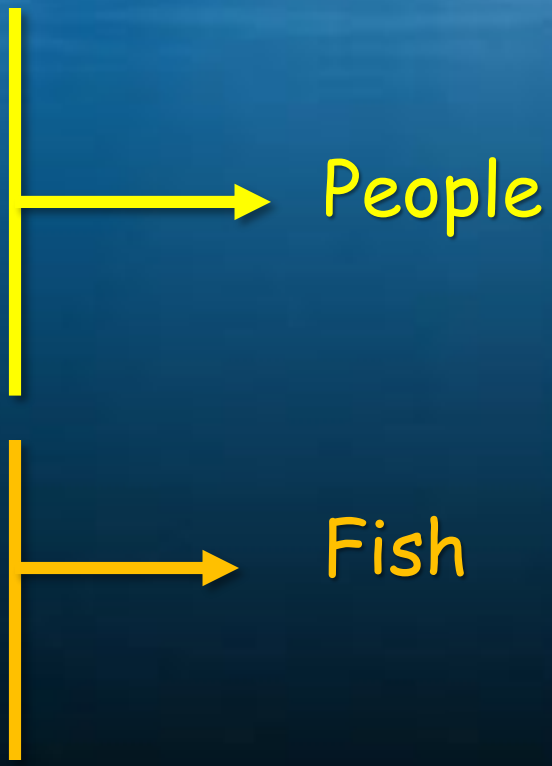
Fishery management involves active manipulation based on quantitative choices: how many, what size, how large an area, how many fishers allowed, how much fishing effort, how much harvest, etc. (Walters and Martell, 2004).



Ultimately, fishery management is concerned with applying controls on the current fishery so that the future fishery will be better (Gulland, 1983).

Management Options that Apply to People or Fish

- Size Limits
- Catch Quotas
- Seasons
- Gear Restrictions
- Area Restrictions
- Stocking
  - Breeding/GMO
- Fish Removal
- Habitat Enhancement

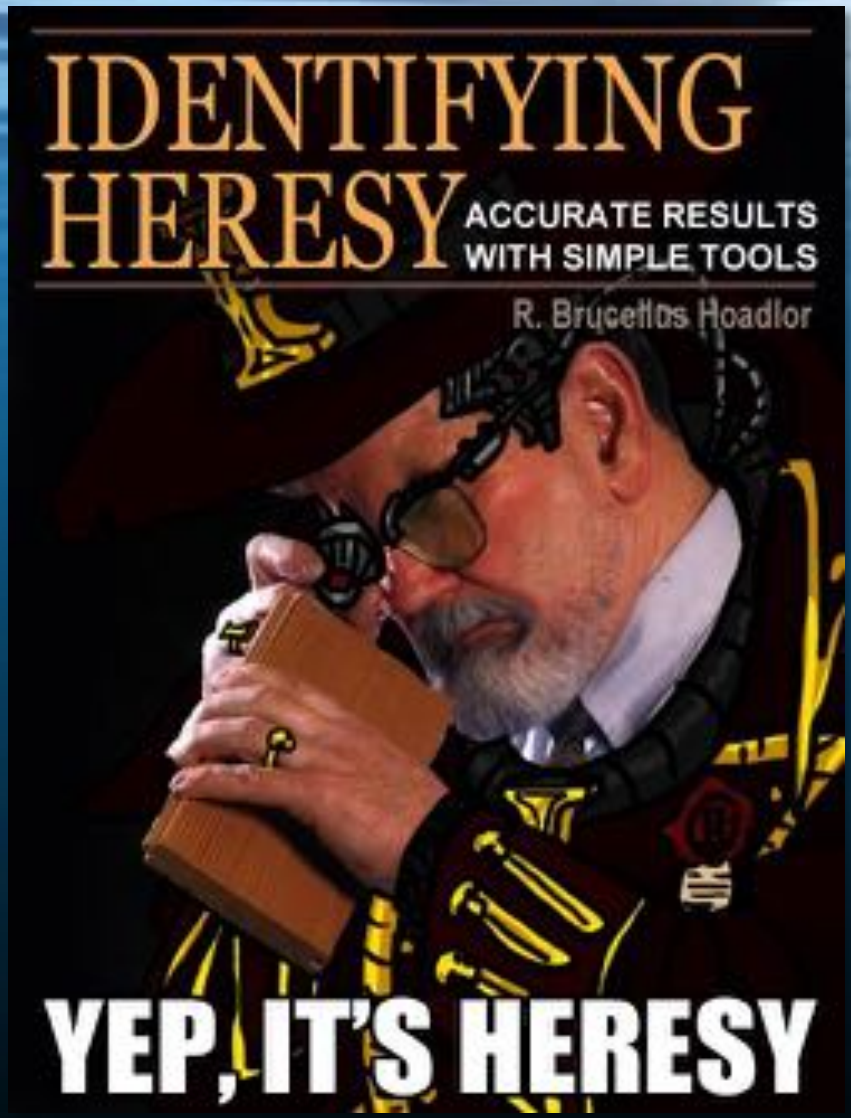


after Jeff Gunderson

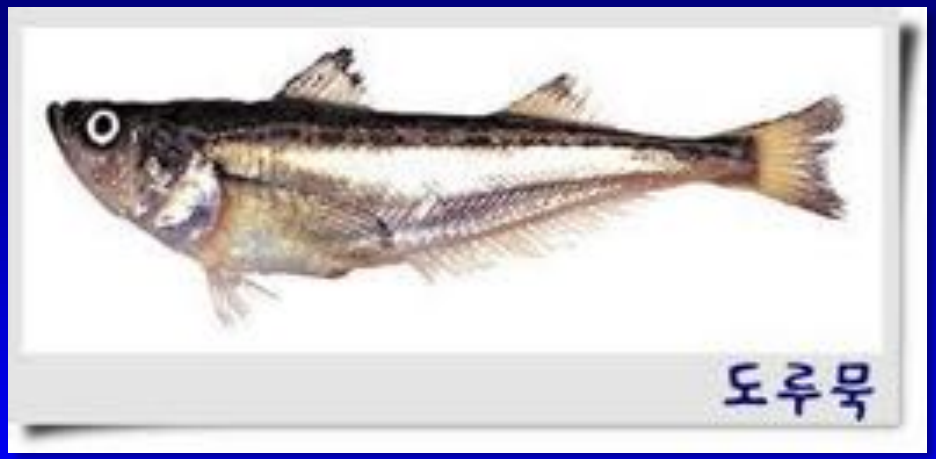
D. Current use of artificial reefs in Fisheries Management

Bortone's Heretical Observation:

"Artificial Reefs play almost no role in the management of any fishery".
(November 2009)



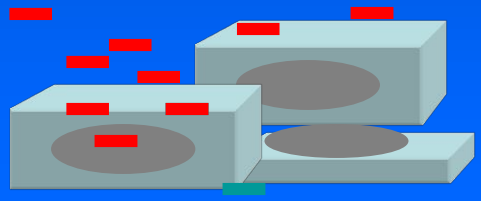
Arctoscopus japonicus,
Japanese Sandfish

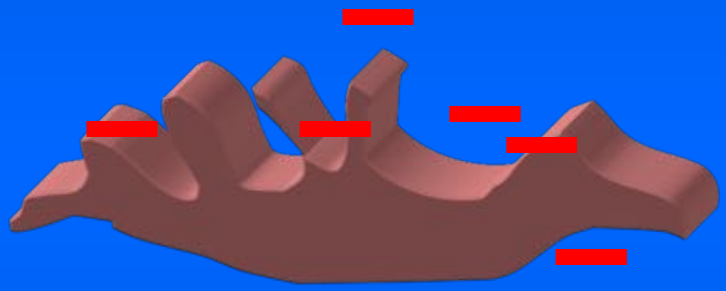


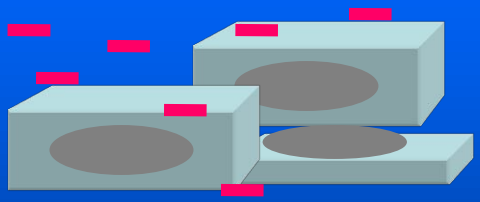
Kim et al. (2011) presented an application of artificial reefs toward specific life stages.

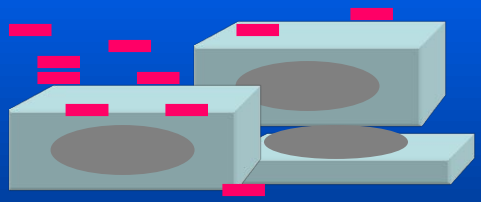
E. Potential uses of artificial reefs in Fisheries Management

Increase habitat if species are habitat limited

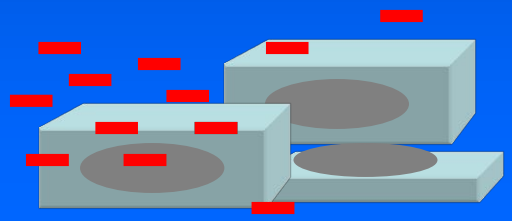


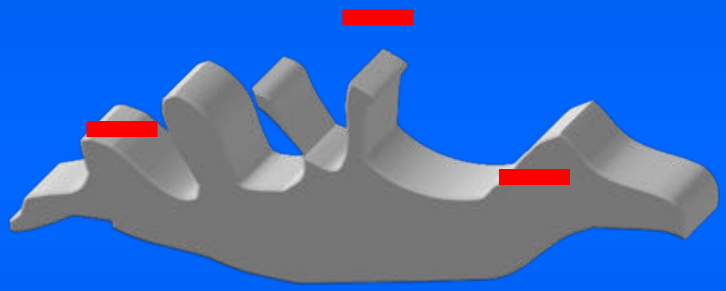


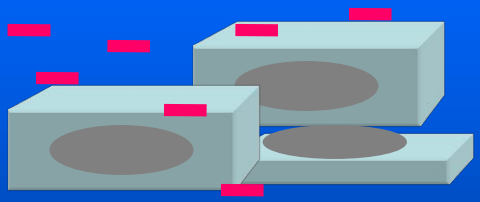


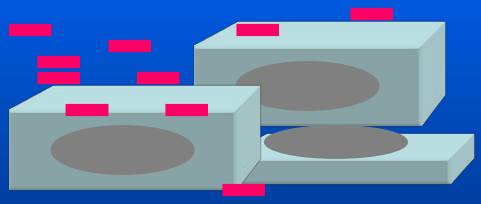


Mitigation for stressed habitat

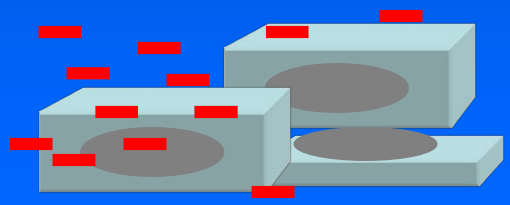


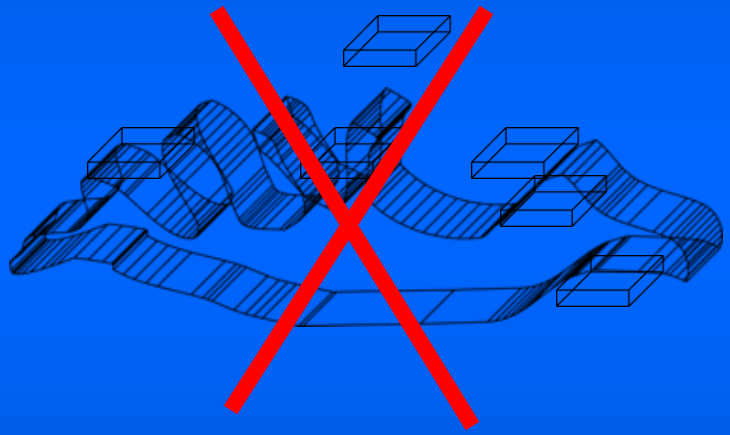


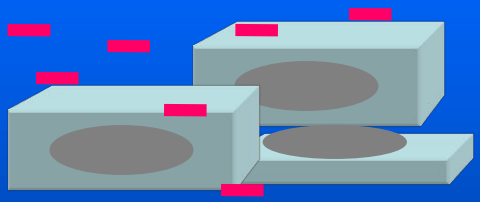


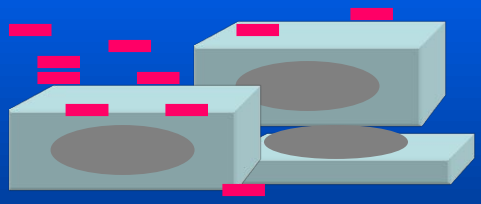


…mitigation for destroyed habitat

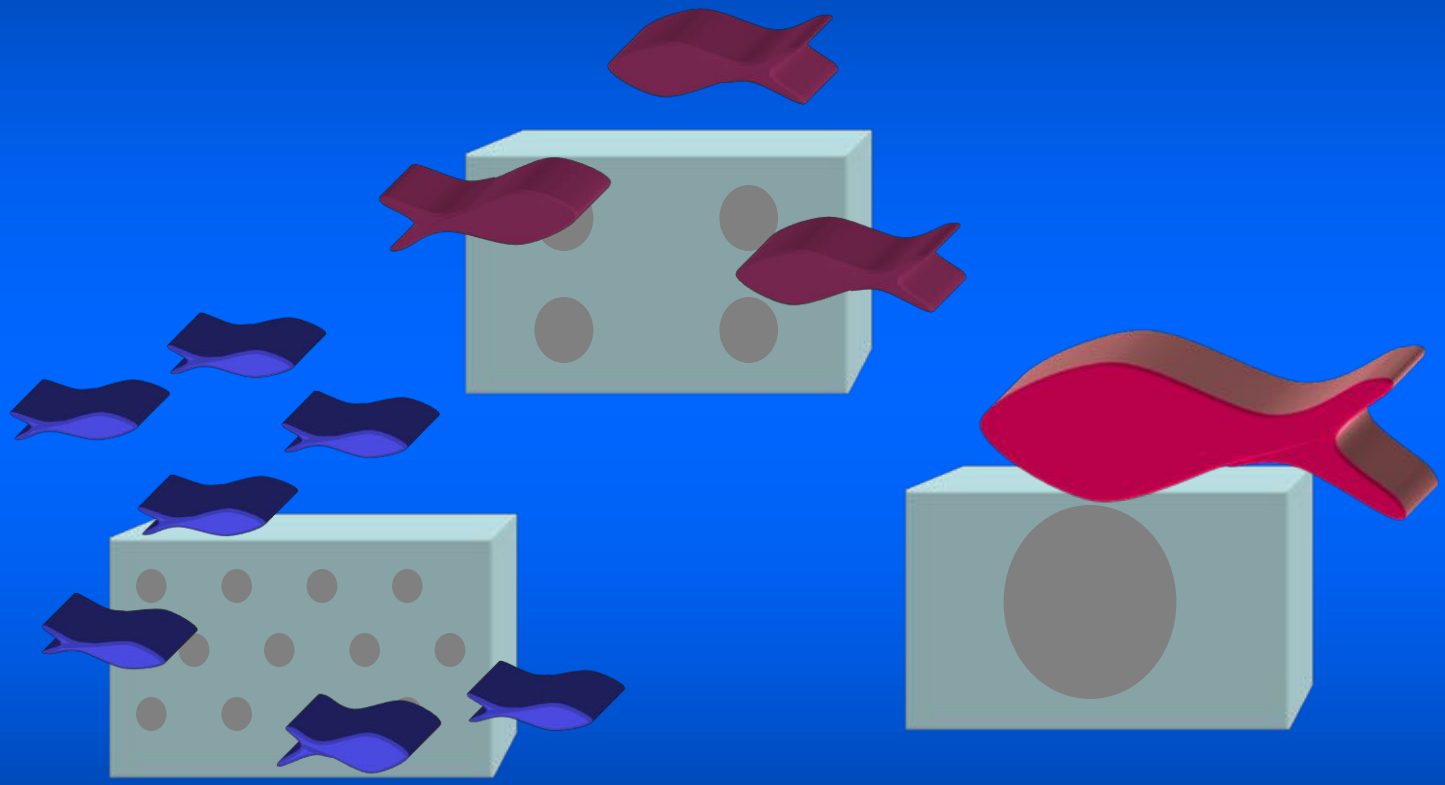




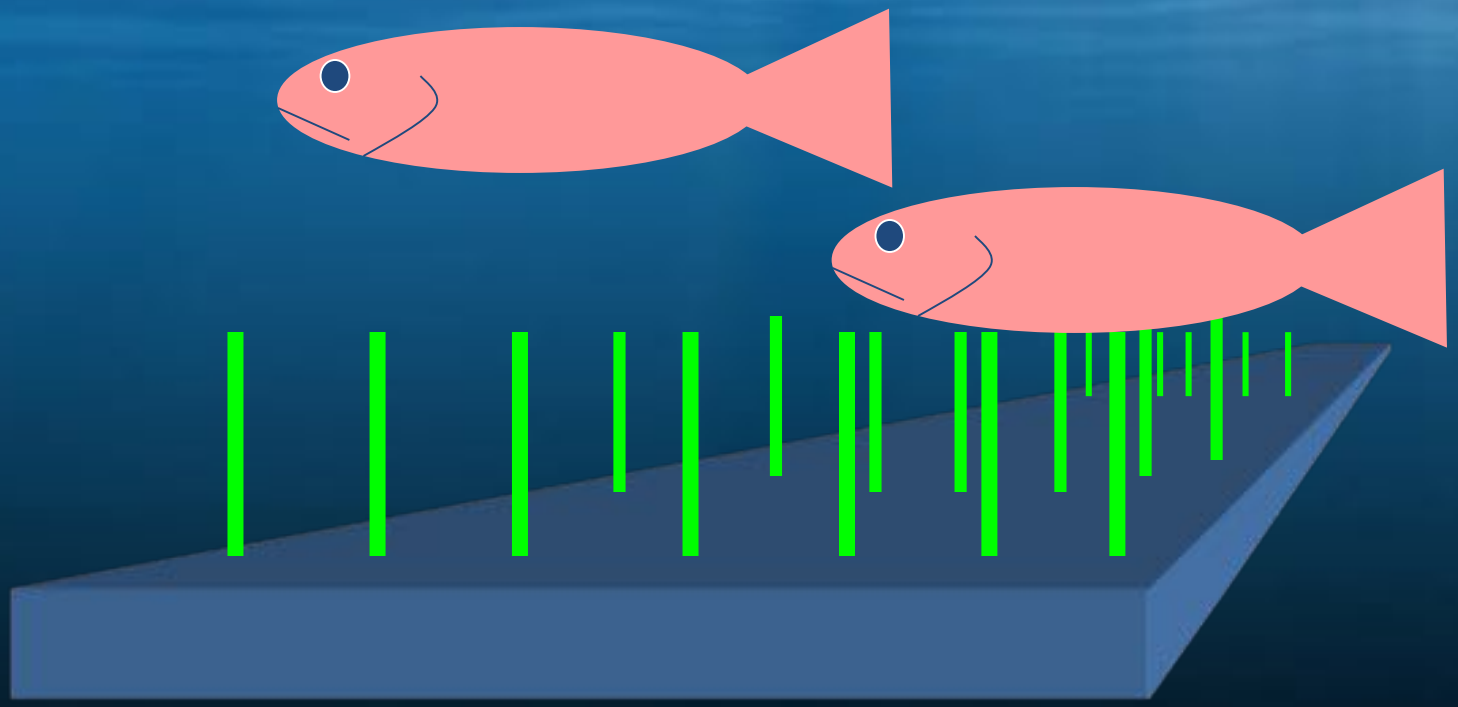


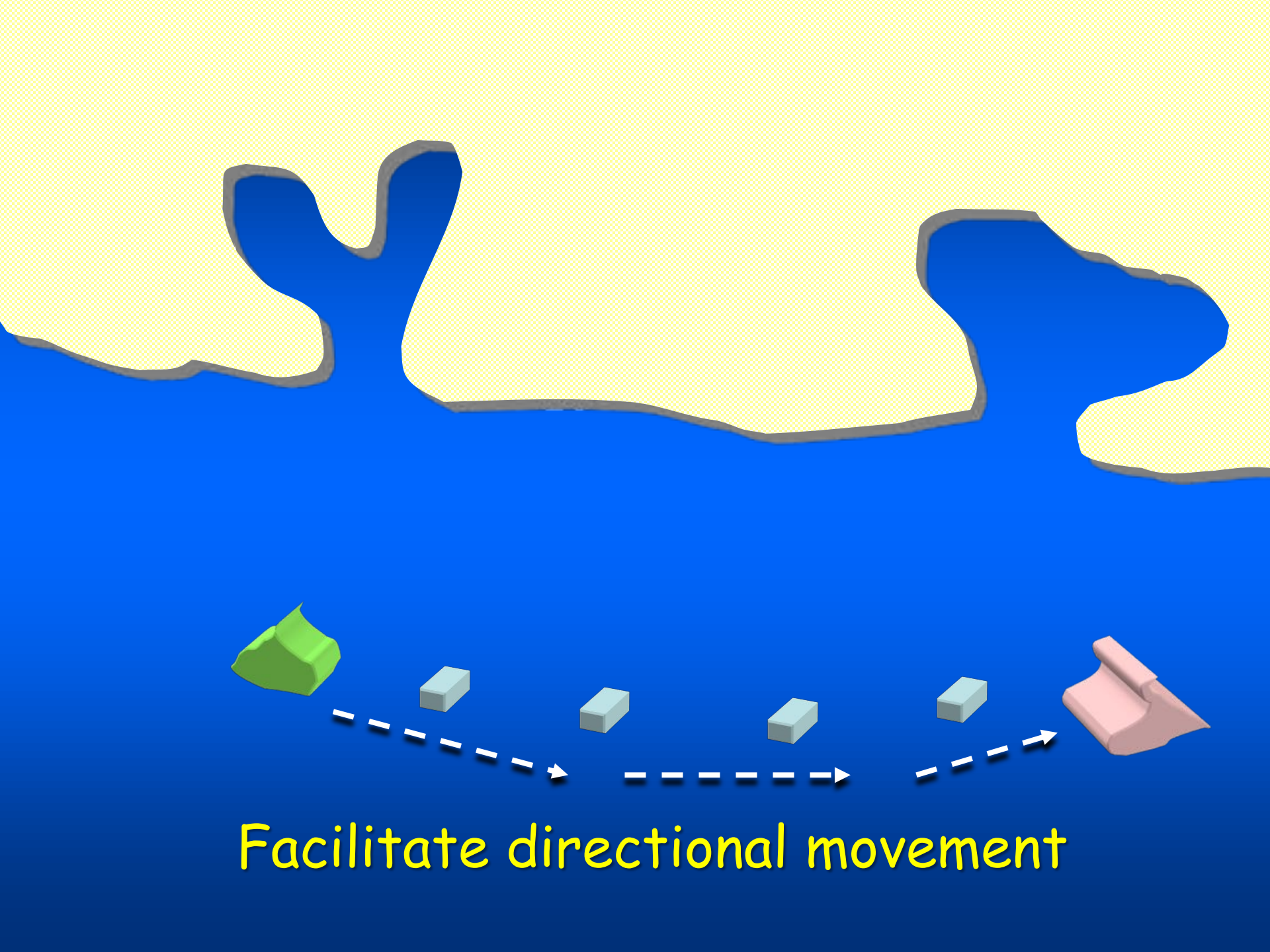


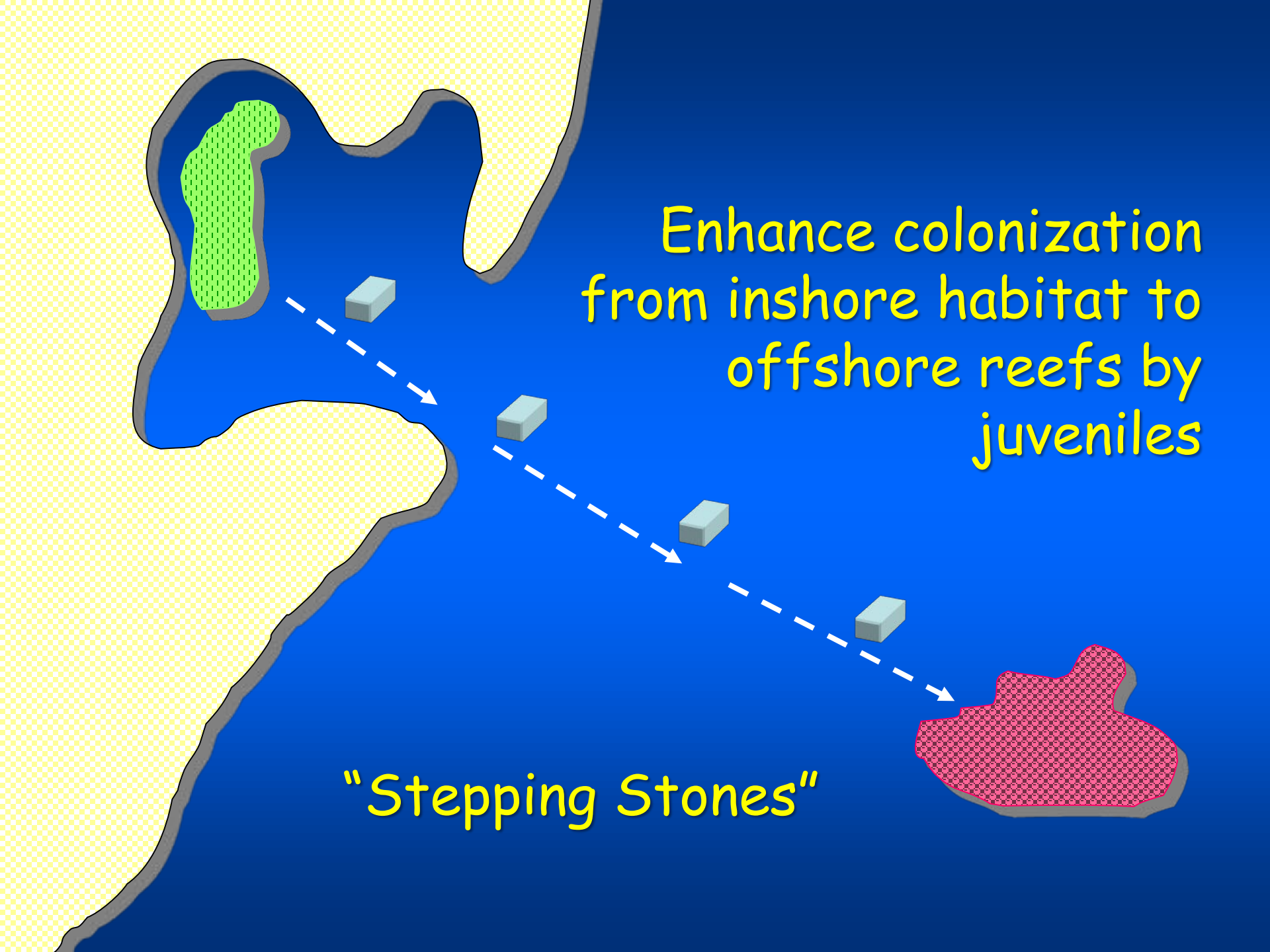
Enhance life stage survival for species at a specific life stage



Spawning substrate




Facilitate directional movement

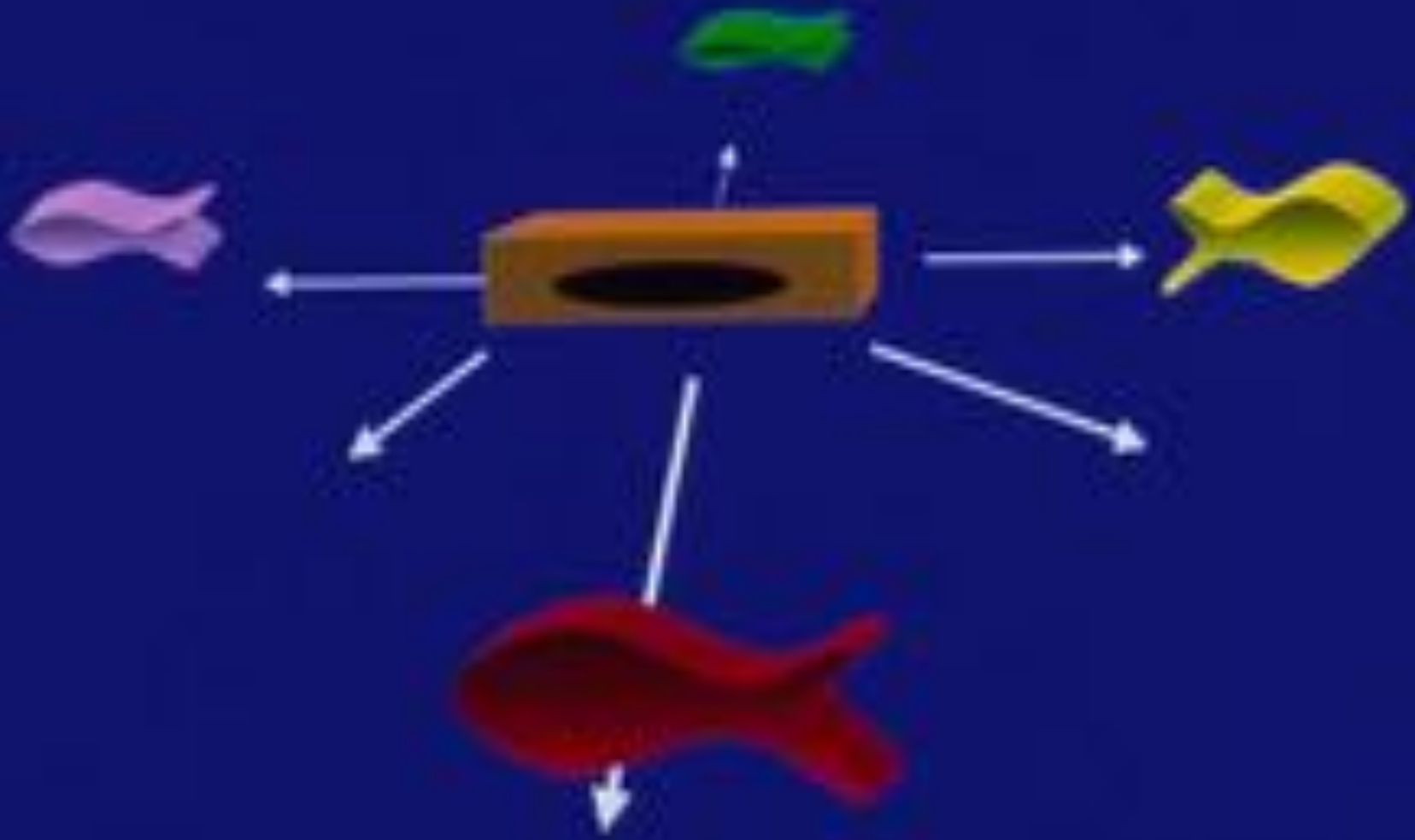

Enhance colonization from inshore habitat to offshore reefs by juveniles
"Stepping Stones"

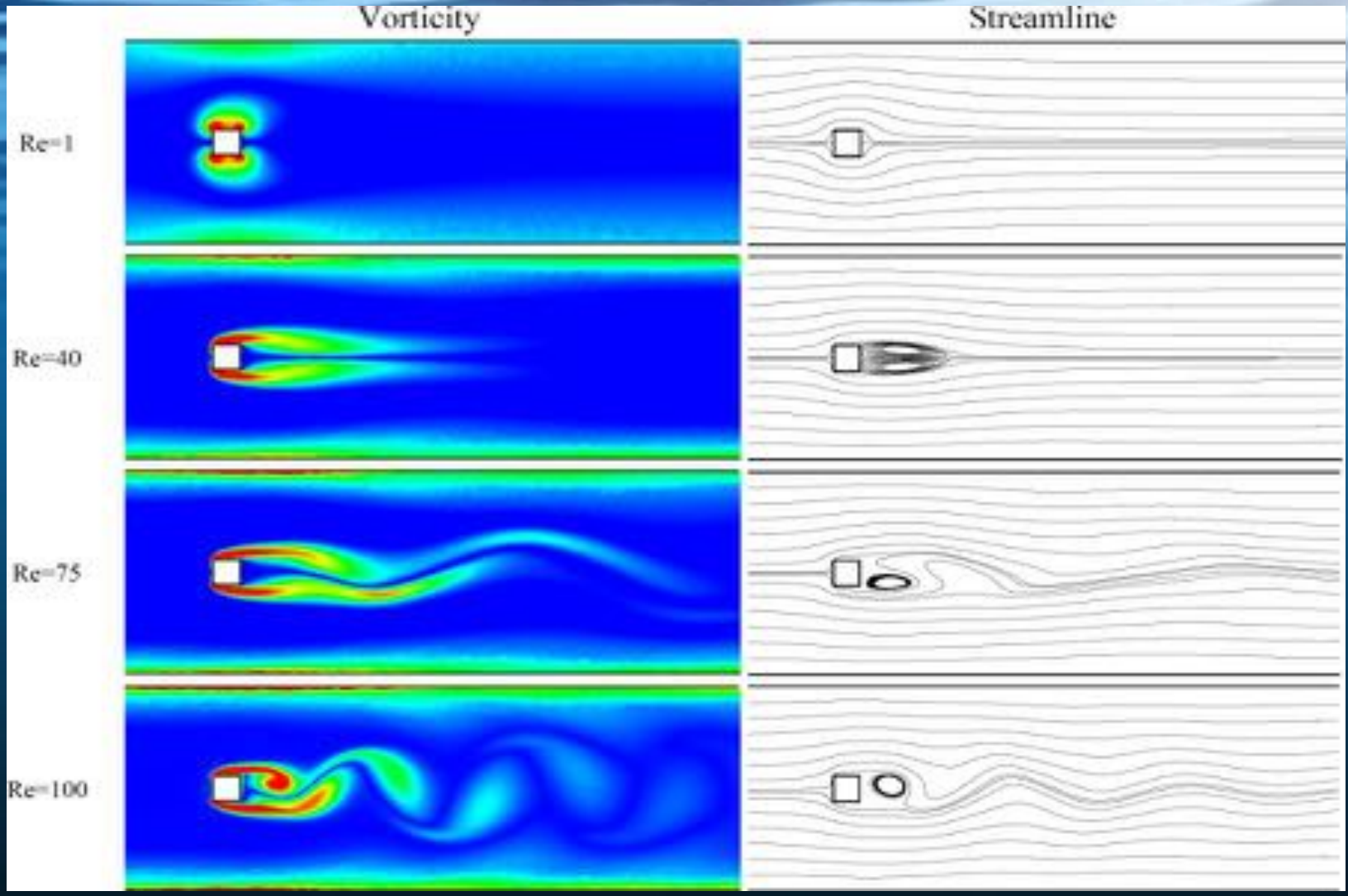
X km

3X km

Reduce fishing pressure on natural habitat

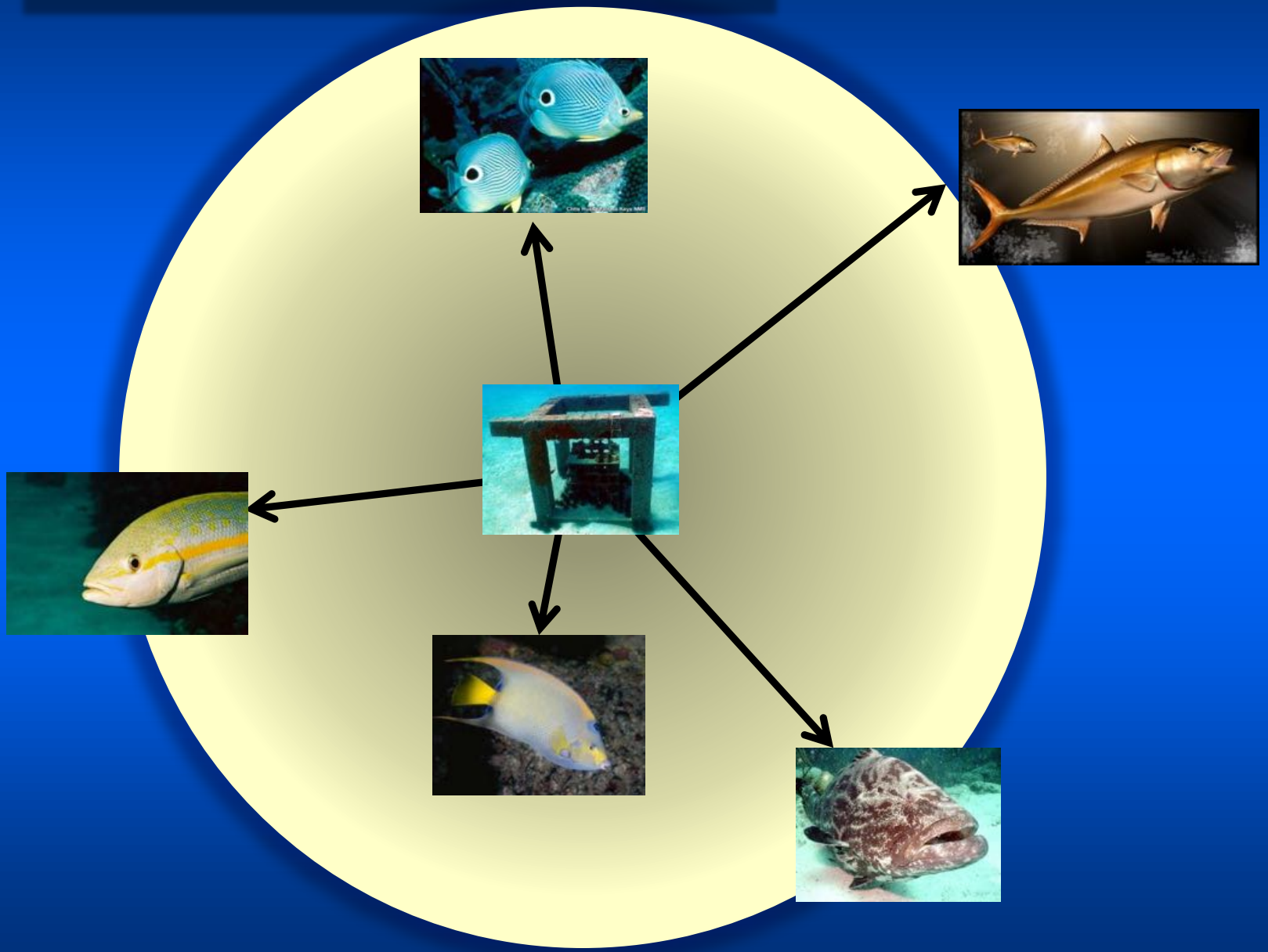
…facilitate orientation…



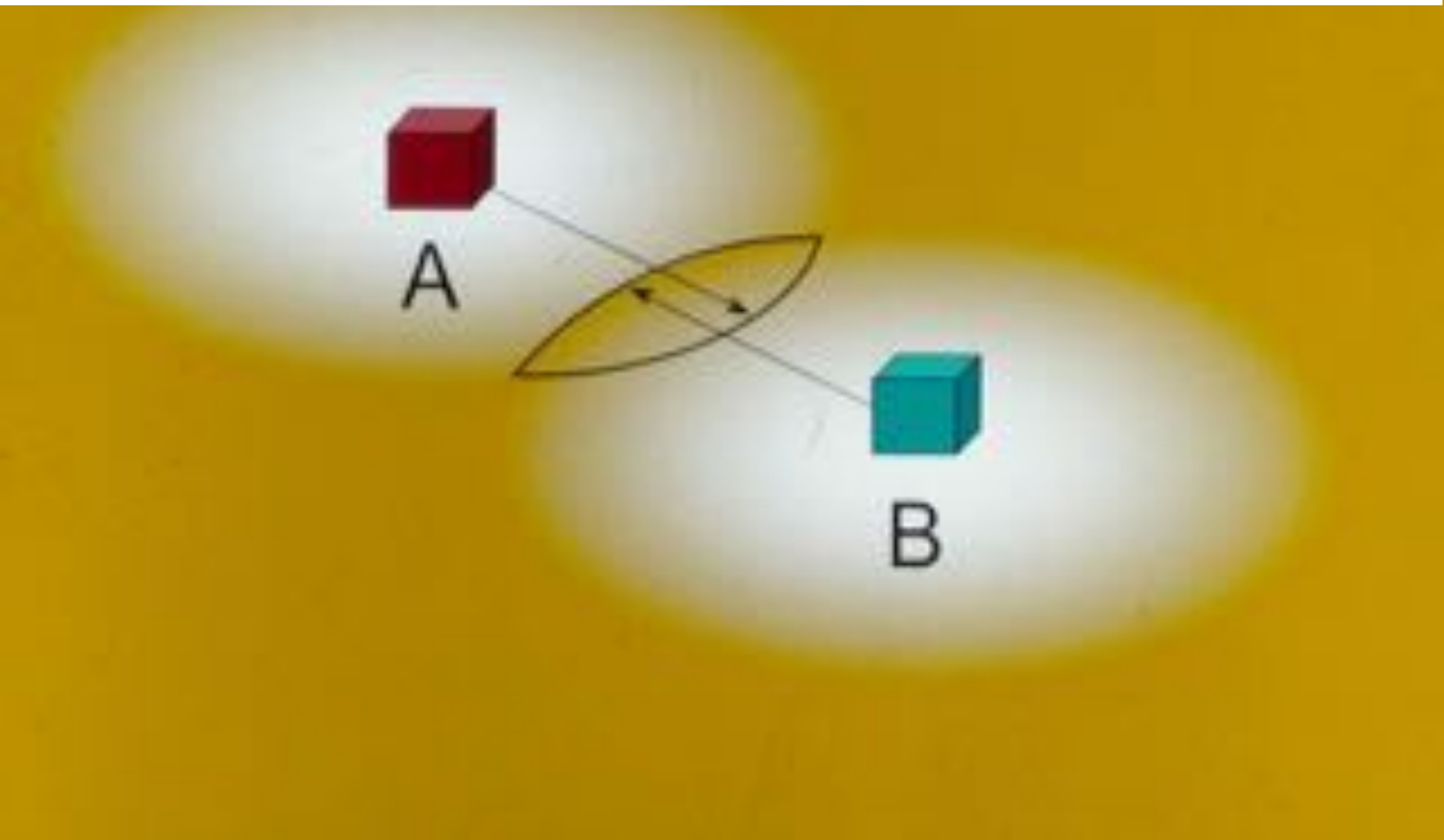


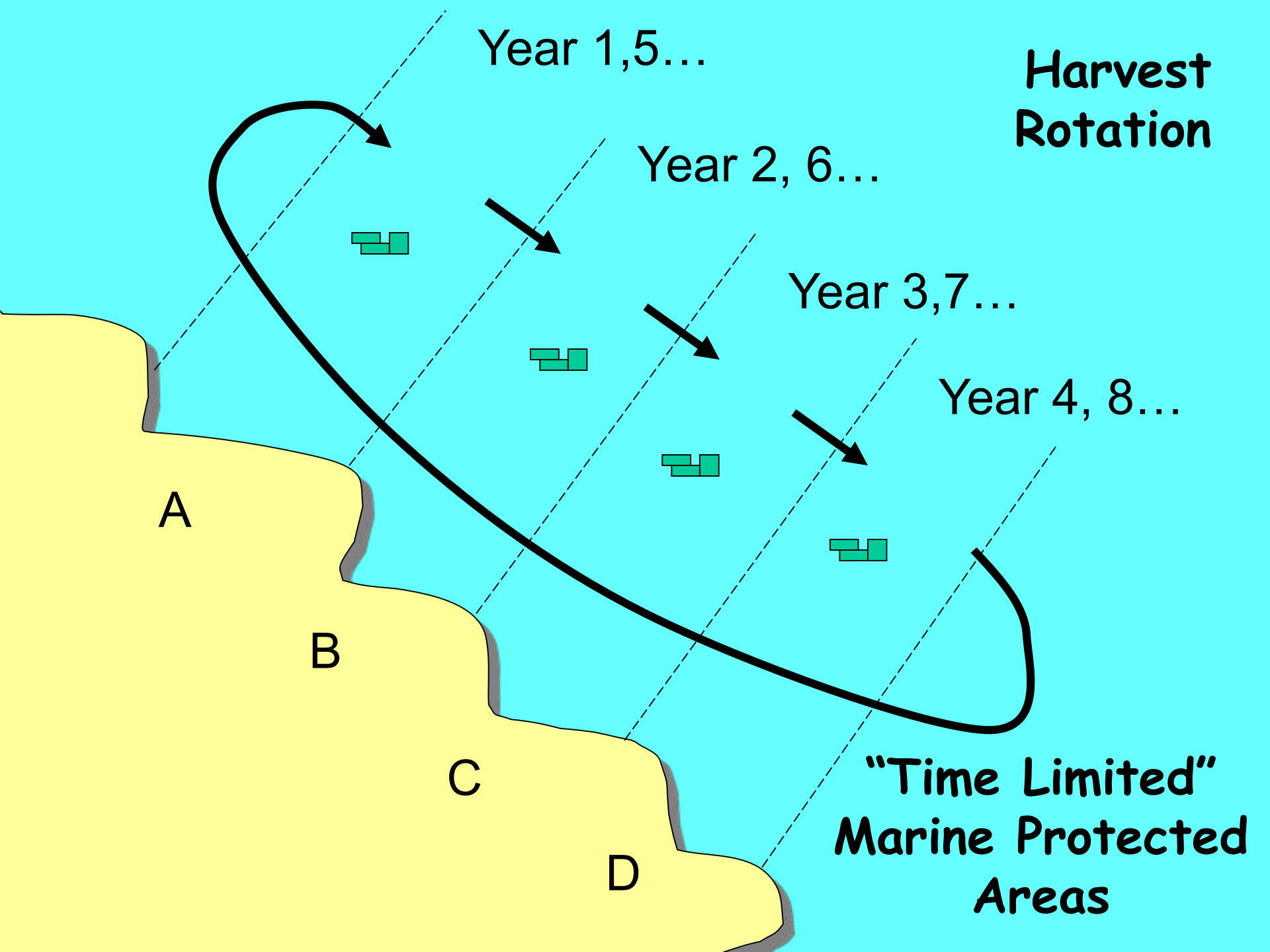
Eddies & Wakes to enhance attraction and retention

…optimize foraging…



Forage range and overlap may lead to competition & a reduction in amount of available forage

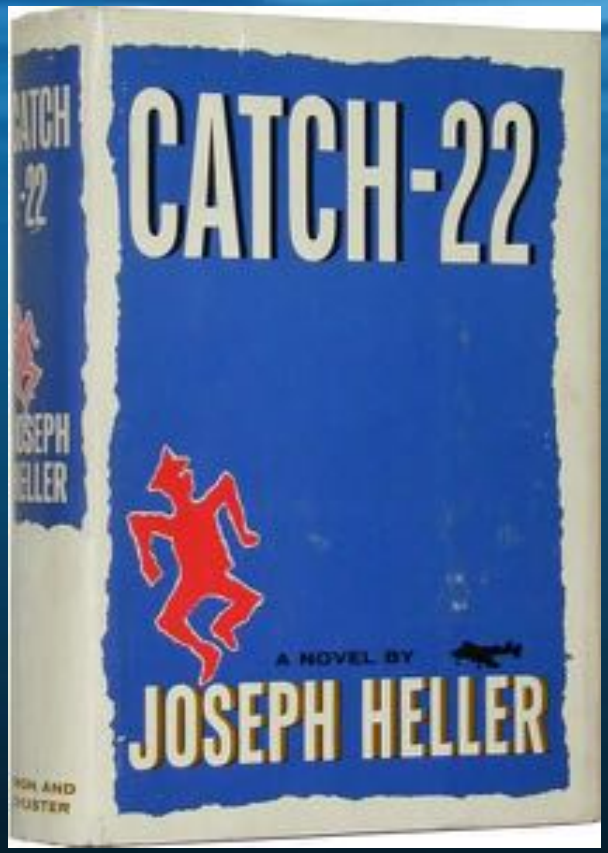



Year 1,5…
Year 2, 6…
Year 3,7…
Year 4, 8…
Harvest Rotation
A
B
C
D
"Time Limited" Marine Protected Areas

F. Obstacles for using artificial reefs in Fisheries Management

…we have issues…

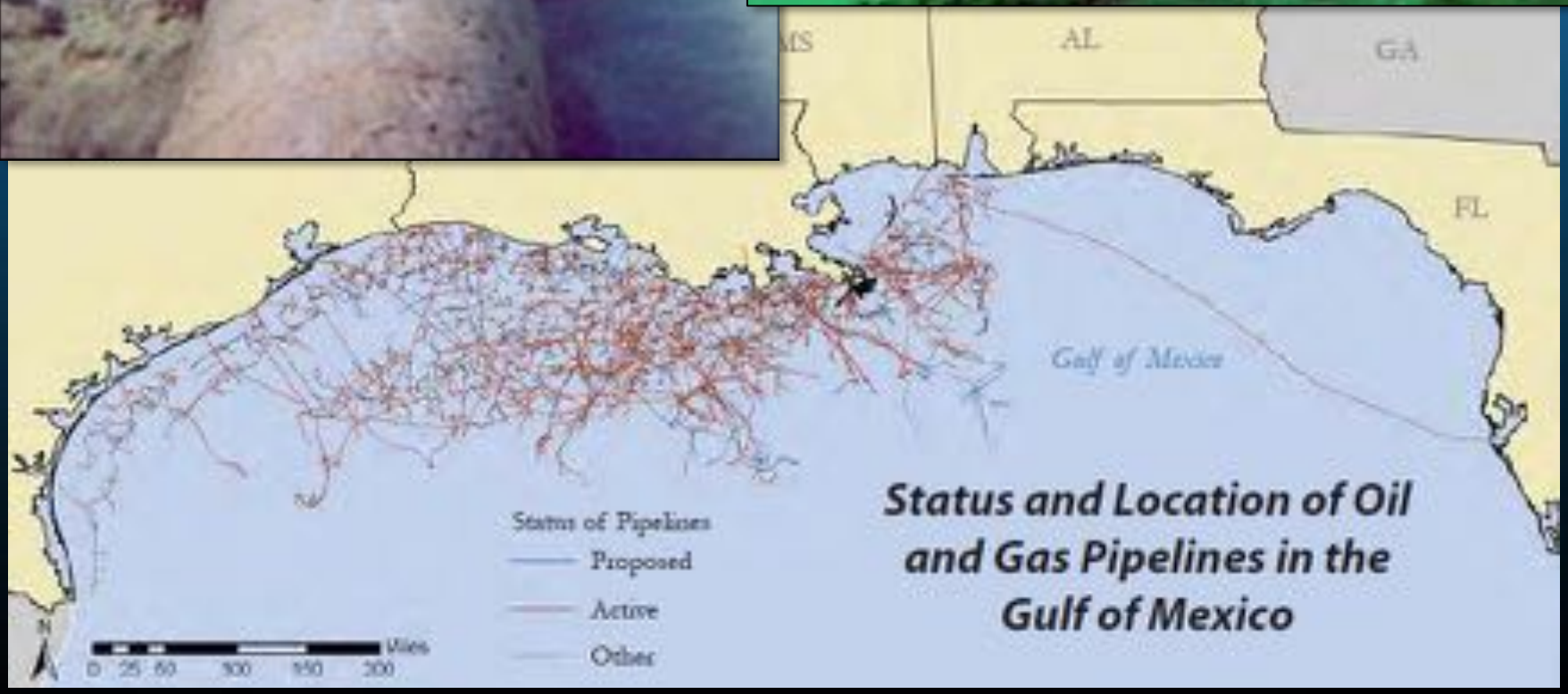
The Conundrum …



How can we evaluate artificial reefs in fisheries management…

…if there are no artificial reefs used in fisheries management?


How much artificial reef material is out there?

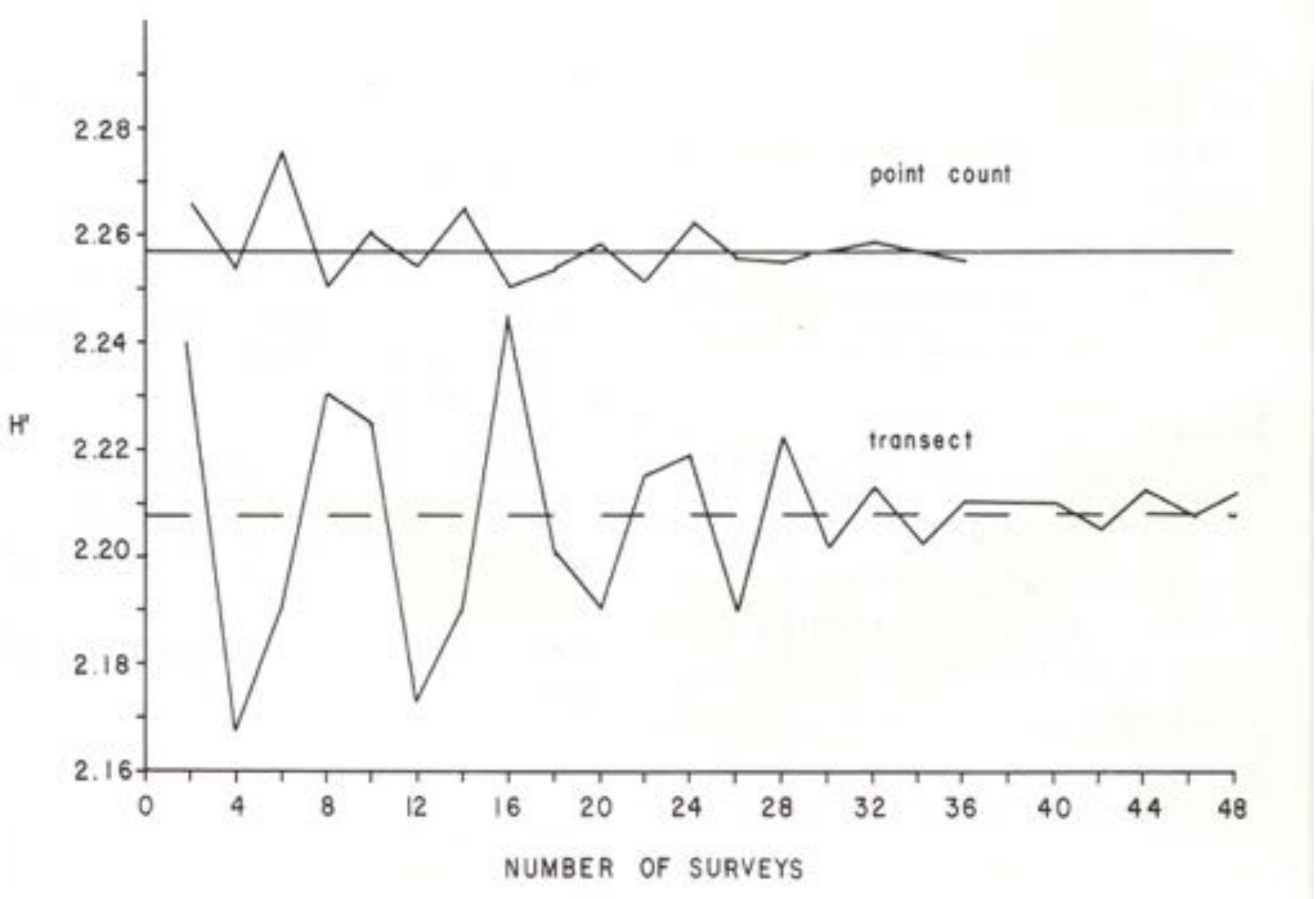

AL
GA
FL
Gulf of Mexico
Status of Pipelines
Proposed
Active
Other
Miles
0 25 50 100 150 200
Status and Location of Oil and Gas Pipelines in the Gulf of Mexico

We also have have data issues

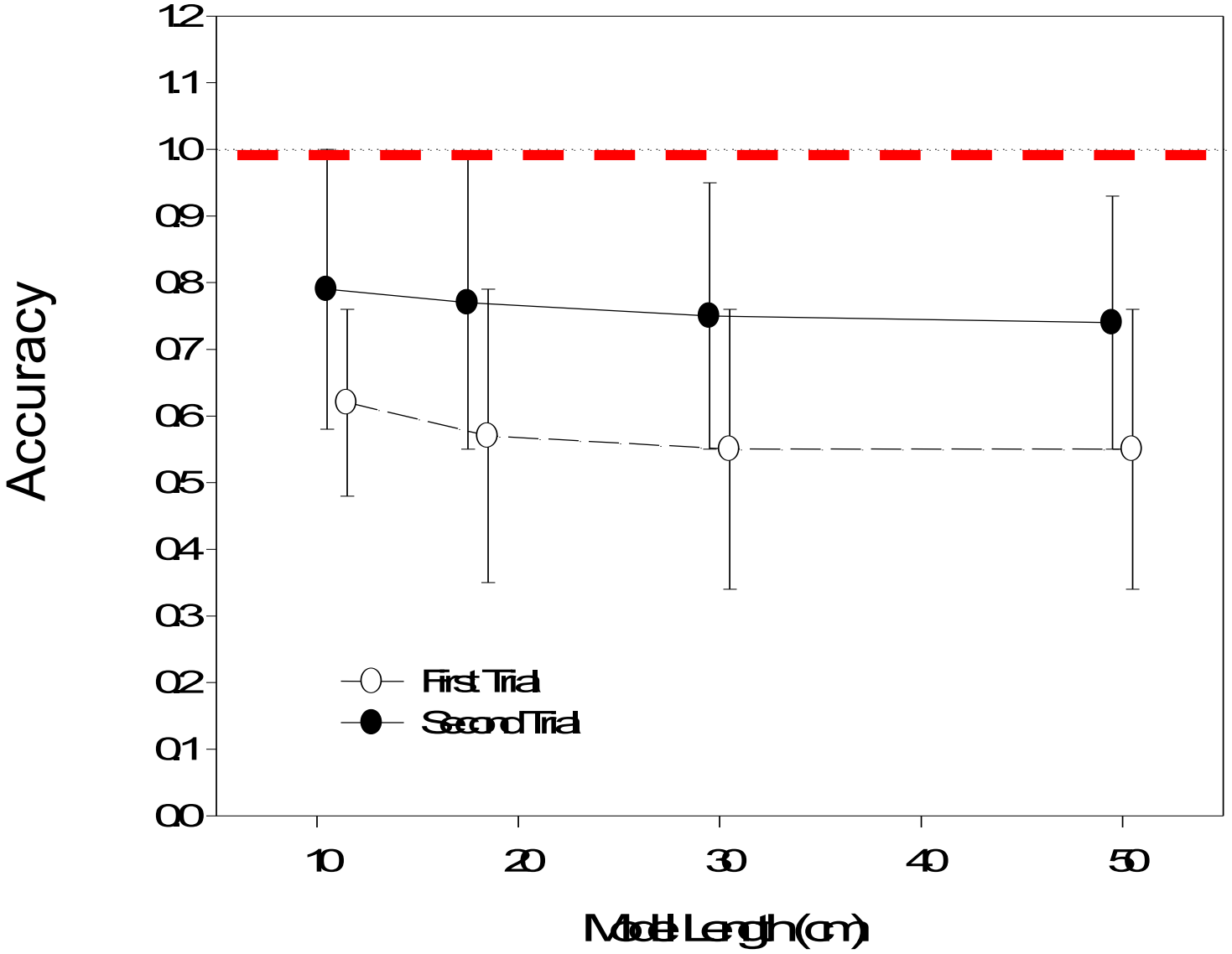
Differences in:

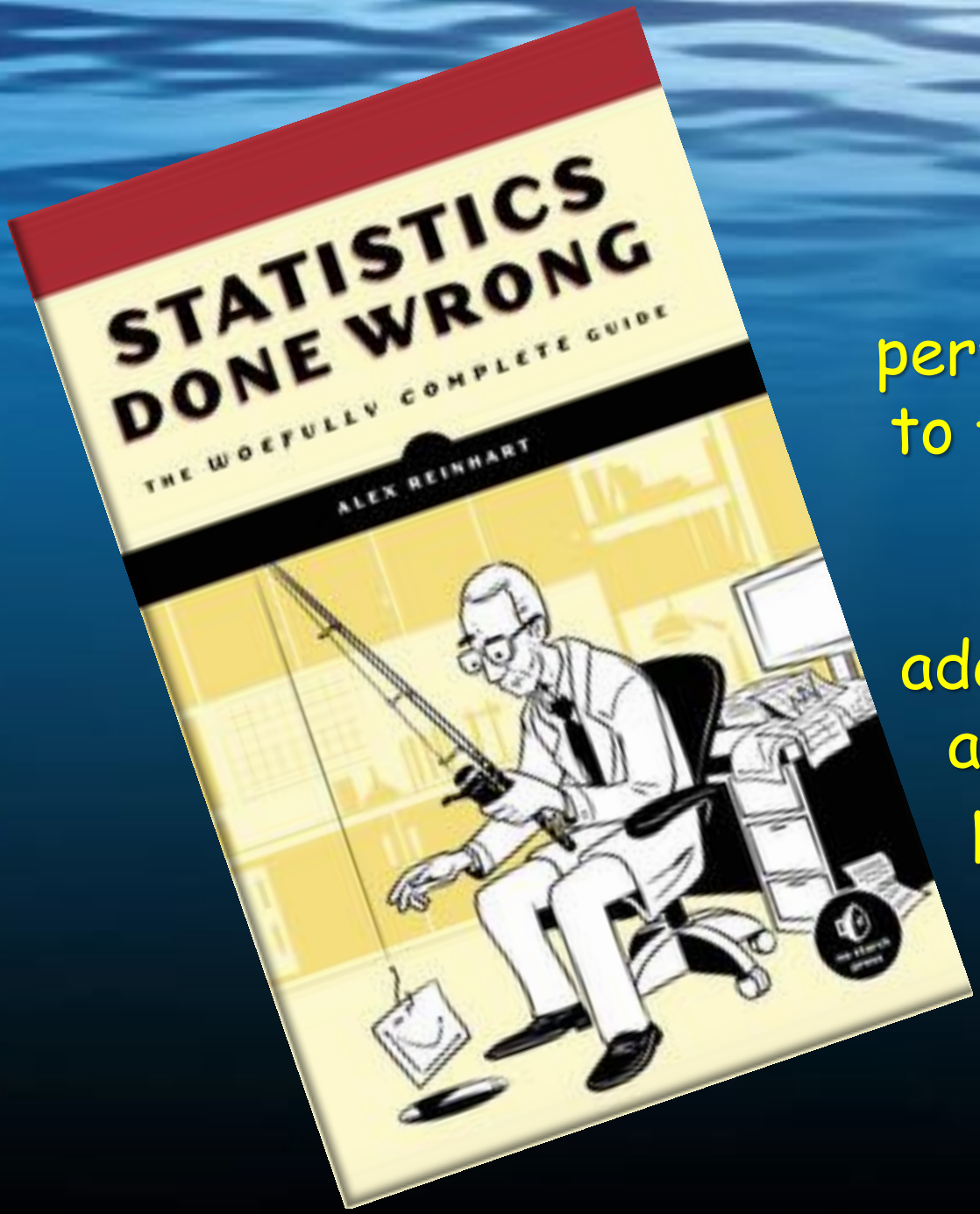
- Assessing performance
- Reporting metrics
- Recording methods
  - (video, counts, side-scan)

High variance (low precision) among samples

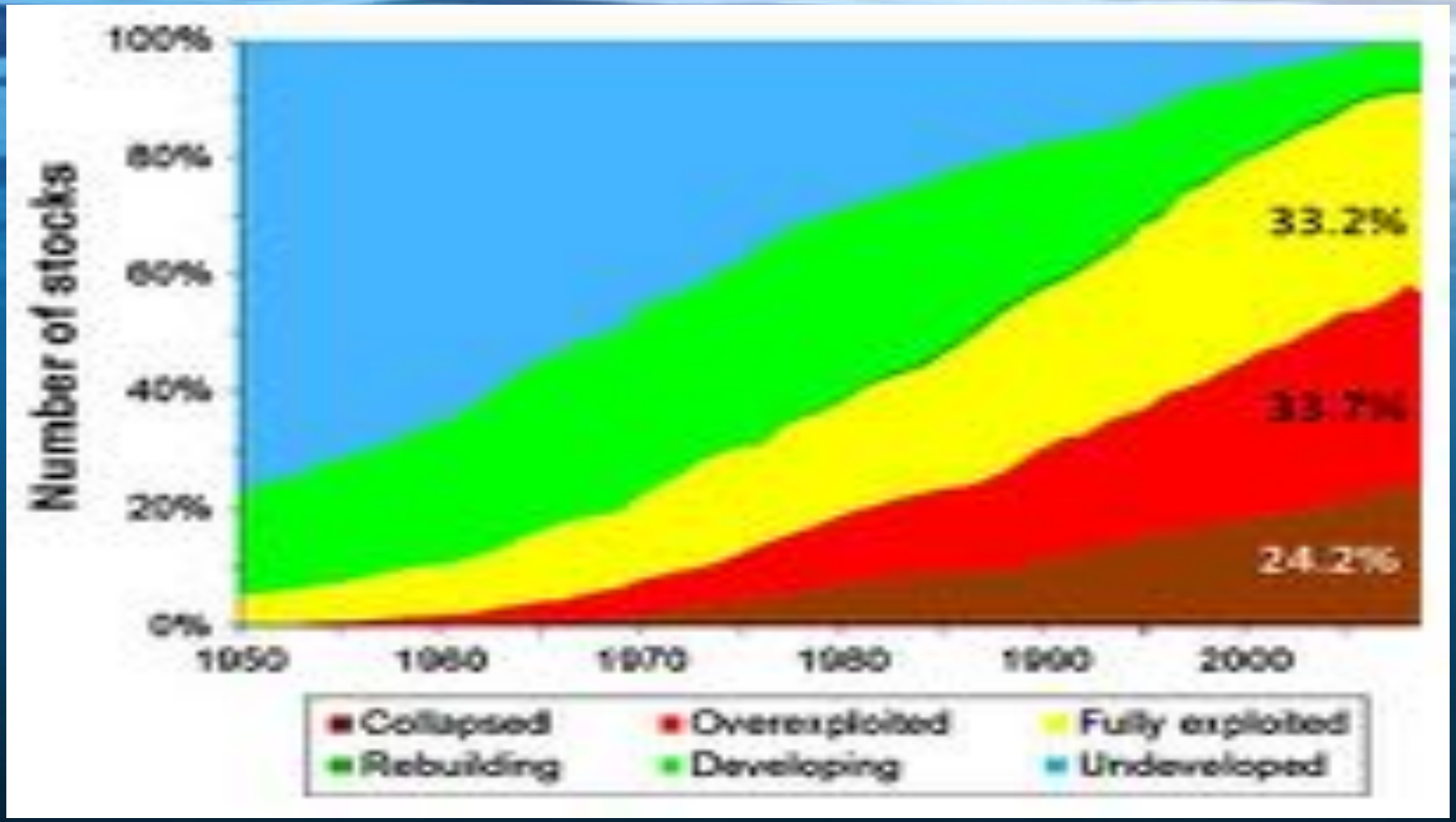


Low accuracy of sampling methods





Few generalities regarding reef performance relative to fisheries. Studies inherently suffer from a lack of adequate replication and the effects of pseudoreplication.



Issues with understanding the role that artificial reefs play in improving the sustainability of fisheries

Have we been wasting our time?

Attraction

Production

C

C

C

B

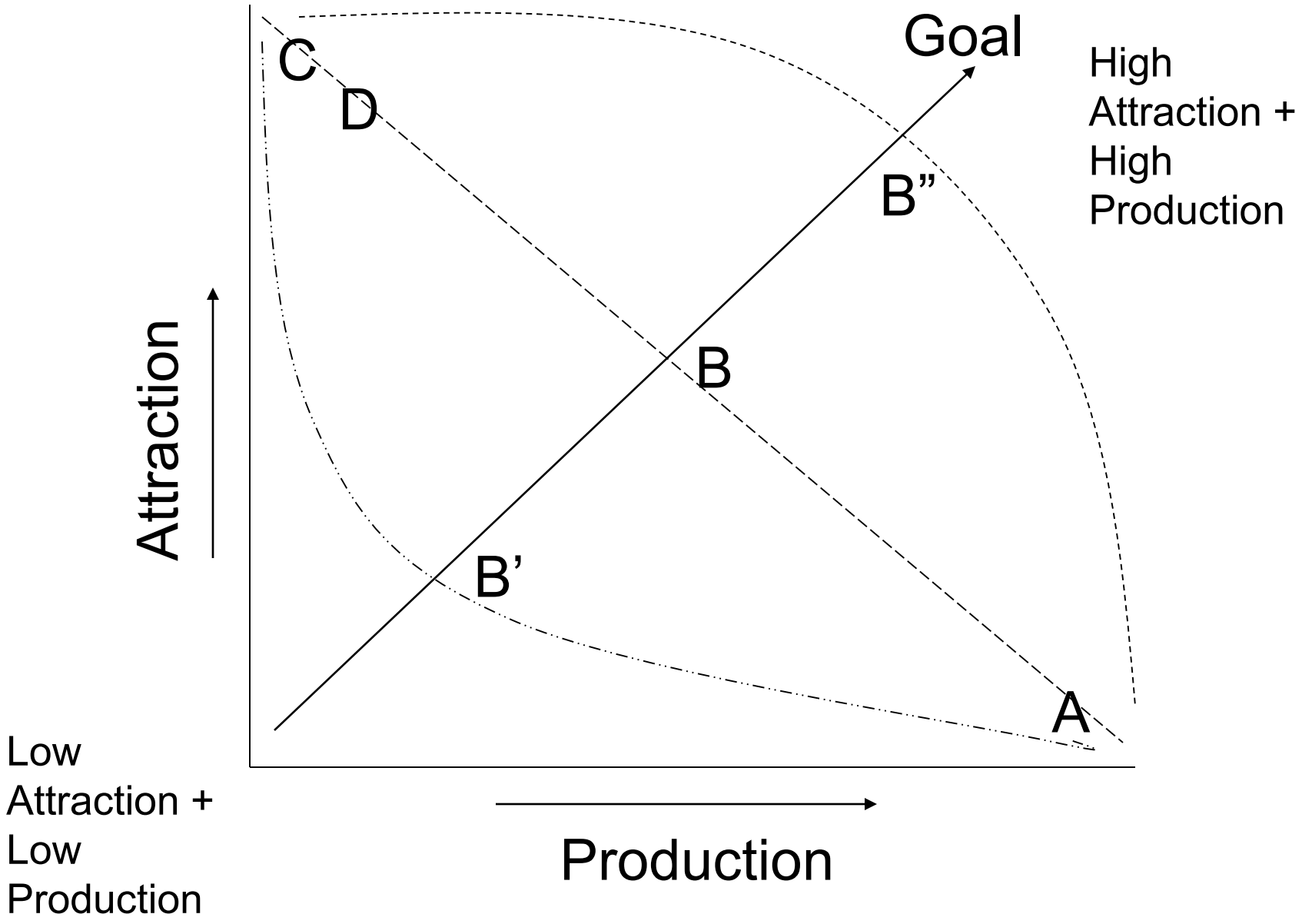
B

B

A A

D D D

Distance "halo" of reef association



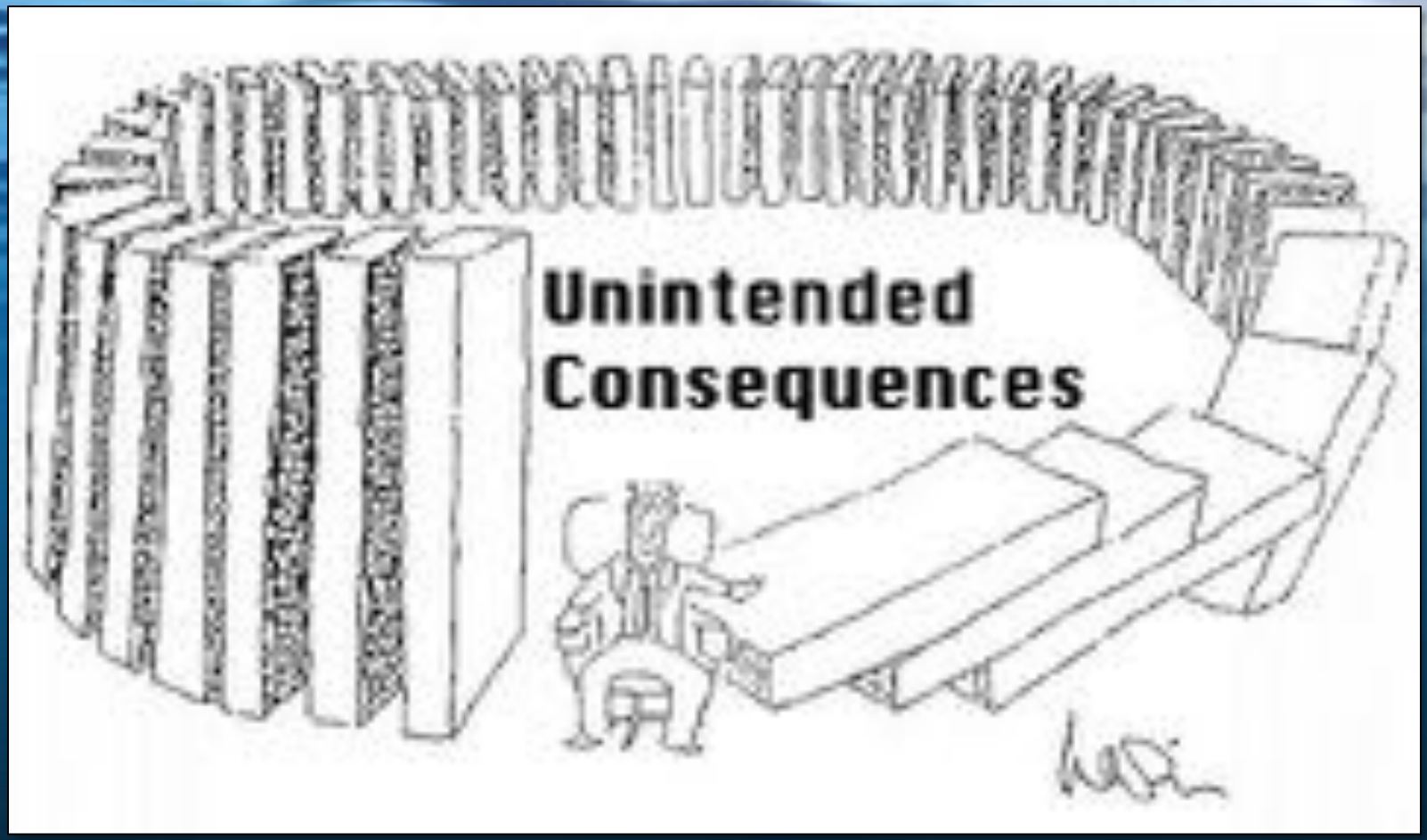
Bortone, 2008

Additional problems…

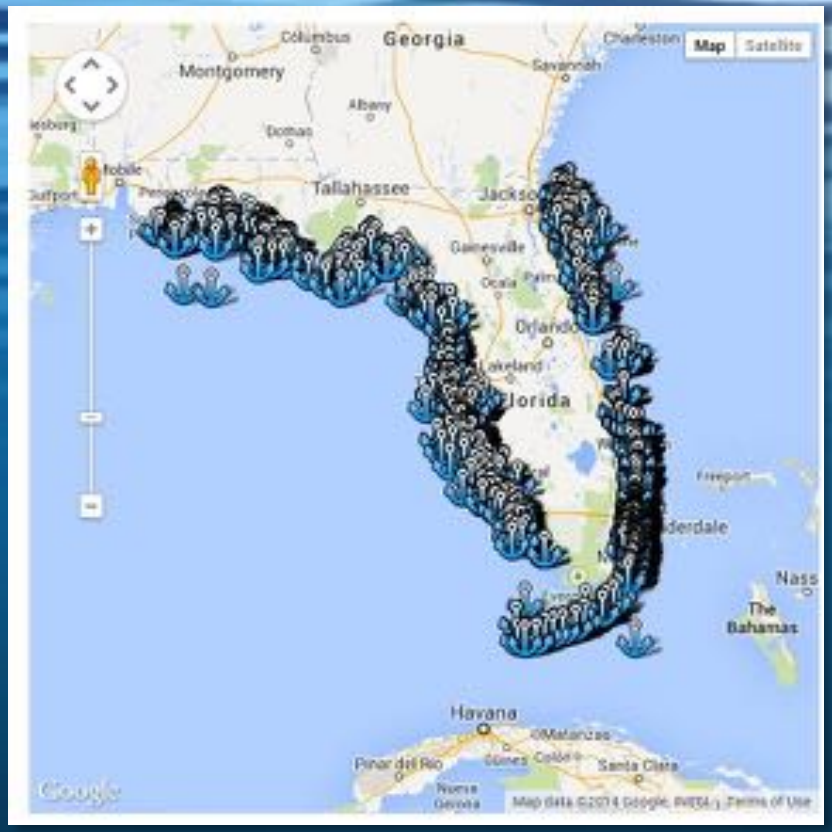
Many of our studies to date:

1. Are neither tested nor testable
2. Produce too much variance
3. Have too many factors, levels & treatments to resolve the hypotheses

4. **Do not give fishery managers the information they need to justify using artificial reefs in their management plans**



Unknown collateral effects artificial reefs may have on target populations & communities (i.e., fishing, fishery, and non-target species)

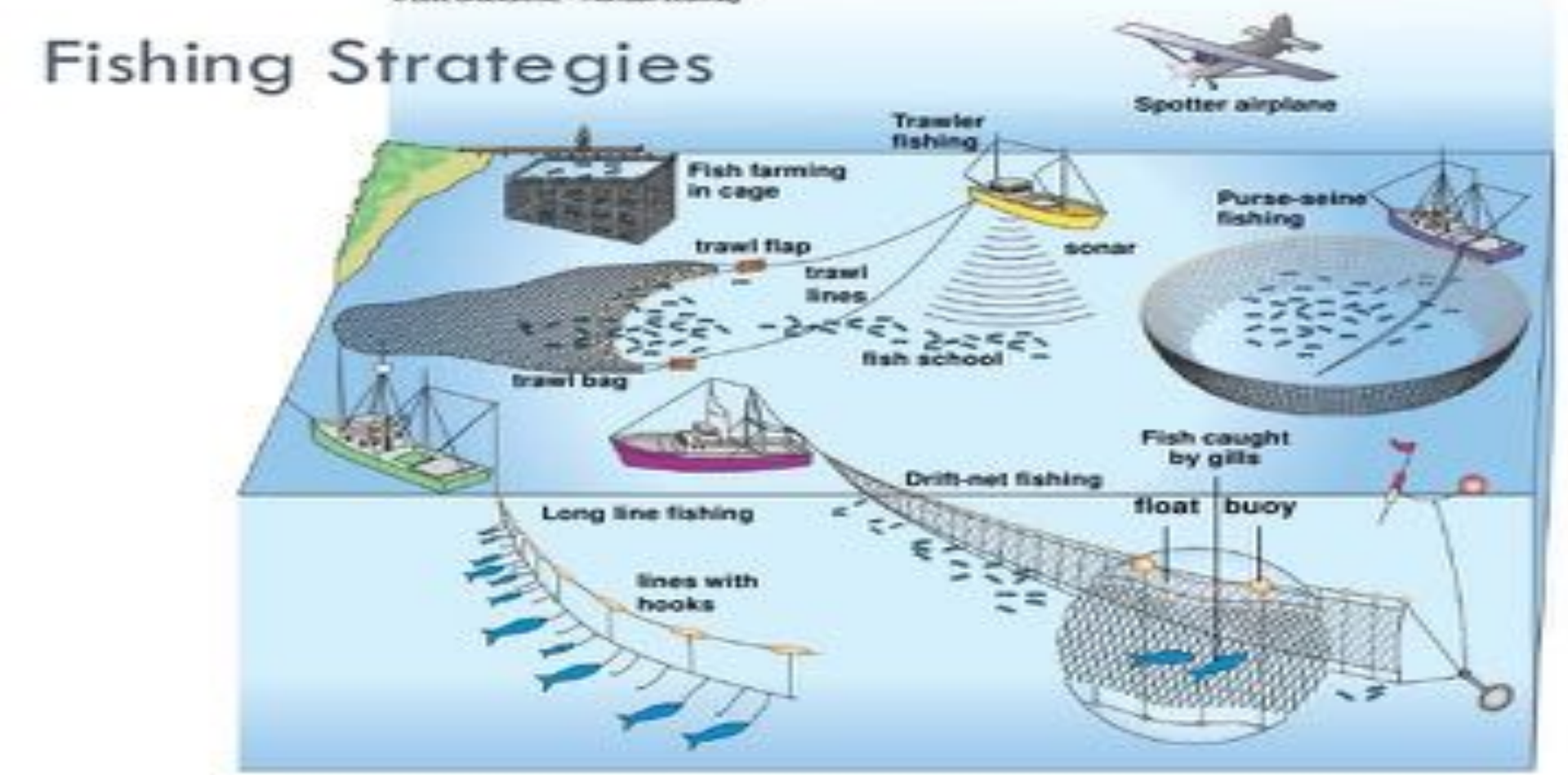


Lots of reefs deployed around the world. So far only a small percent of shelf has been affected, probably less than 0.001% of the continental shelf.

So there are problems, but what to do?

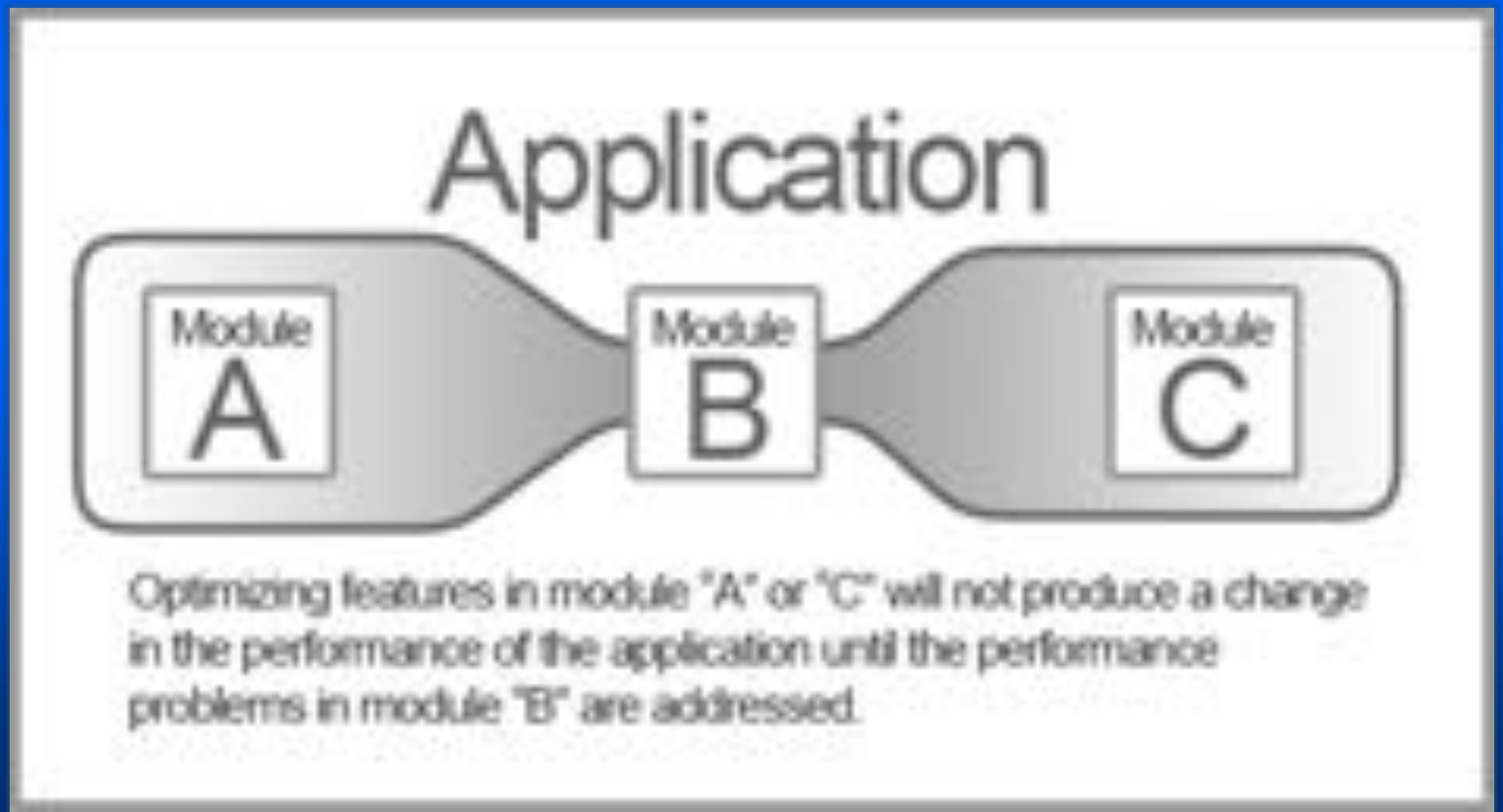
"After careful analysis, I've decided to give up, hit the liquor store and get snockered. Who's with me?"

G. Overcoming obstacles for using artificial reefs in Fisheries Management



The solution must allow reliable predictability just as we require of other fisheries management options.

Management plans are often based on the premise that limits to a fishery may be the result of bottlenecks (e.g., interference at a particular phase of a species' life history)



If the specific life history feature can be identified, artificial reefs can be designed to lessen the influence of bottlenecks…

…thus allowing the fishery to expand – even beyond its current carrying capacity.

Solution – a strategic approach, directed toward overcoming the barriers that prevent artificial reef applications in Fisheries Management

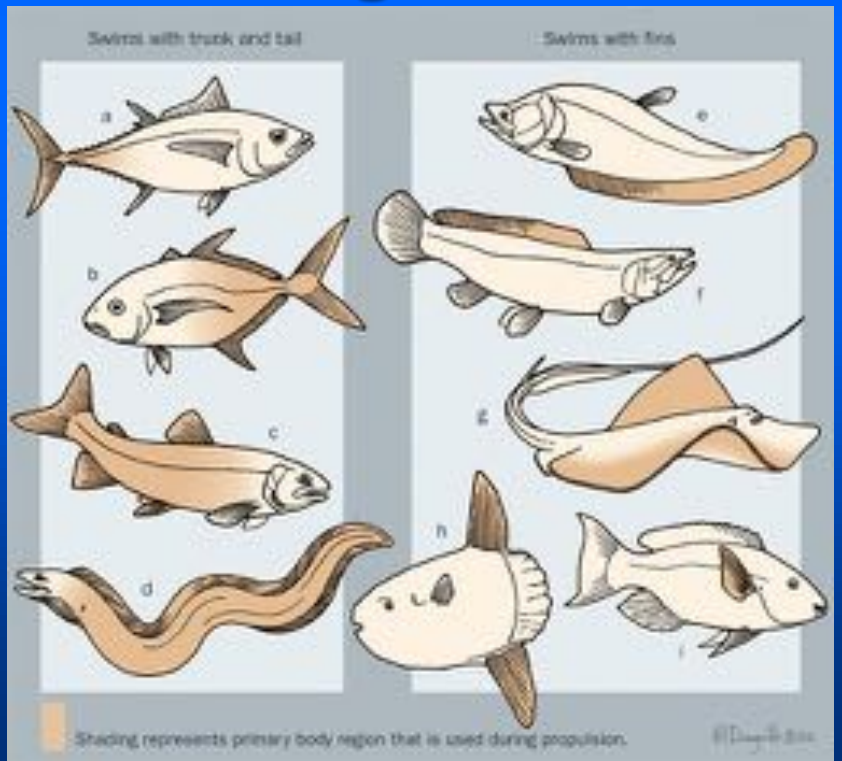
In the course of human history, there are only a few species that are actually used in agriculture (e.g., 5400 mammals, about 20 normally farmed)

Why?

Because only a few species are amenable to management.

Guns, Germs, and Steel by Jared Diamond

Perhaps we should be directing our efforts towards the management of only a few selected species instead of the entire assemblage.



Ok – but how do we select which species?

In fisheries management, artificial reefs should be directed toward fish species that:

1. Disperse to find the reef
2. Will stay on the reef once there
3. Can benefit from the reef scenario through:
   a) Enhanced fitness
   b) Faster growth
   c) Larger populations
4. Are pre-adapted to reef conditions

B-Type Fish Features

1. Half r- (opportunistic), half K- (equilibrium) selected species
2. Disperse at early life stage (at least prior to becoming a recruit)
3. Niche specific
4. Need intervention

Reef Features

A. Orientation

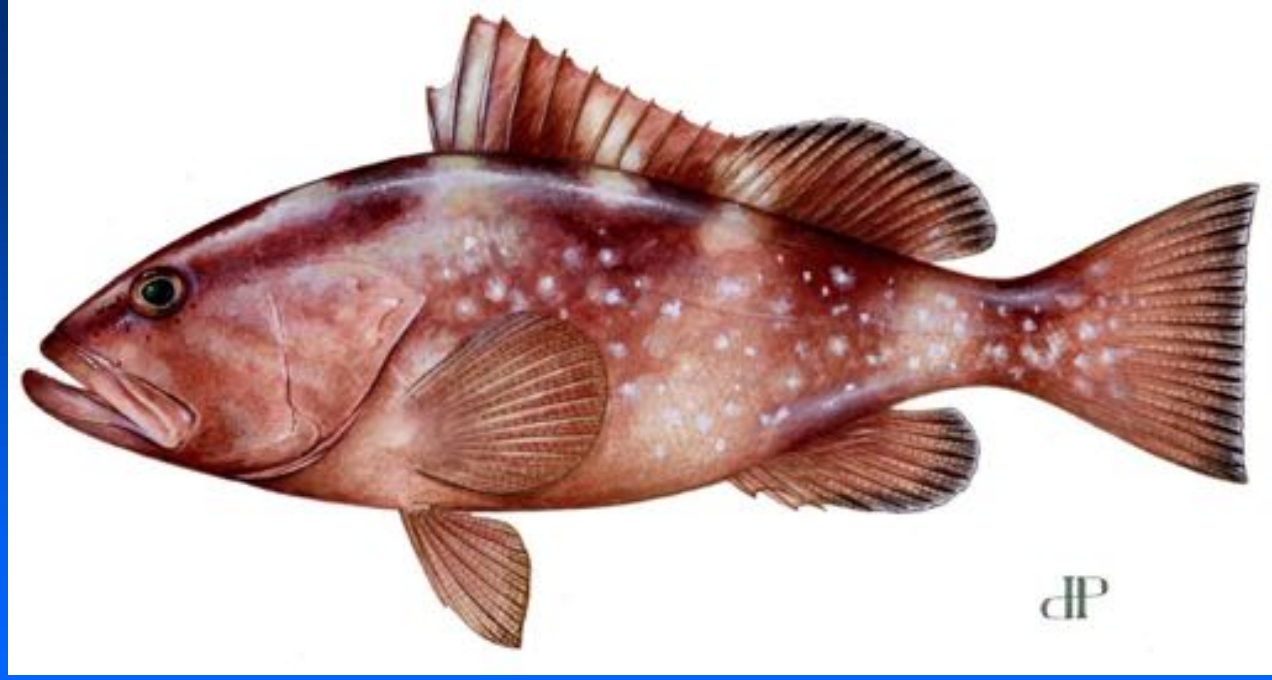
B. Location

C. Construction

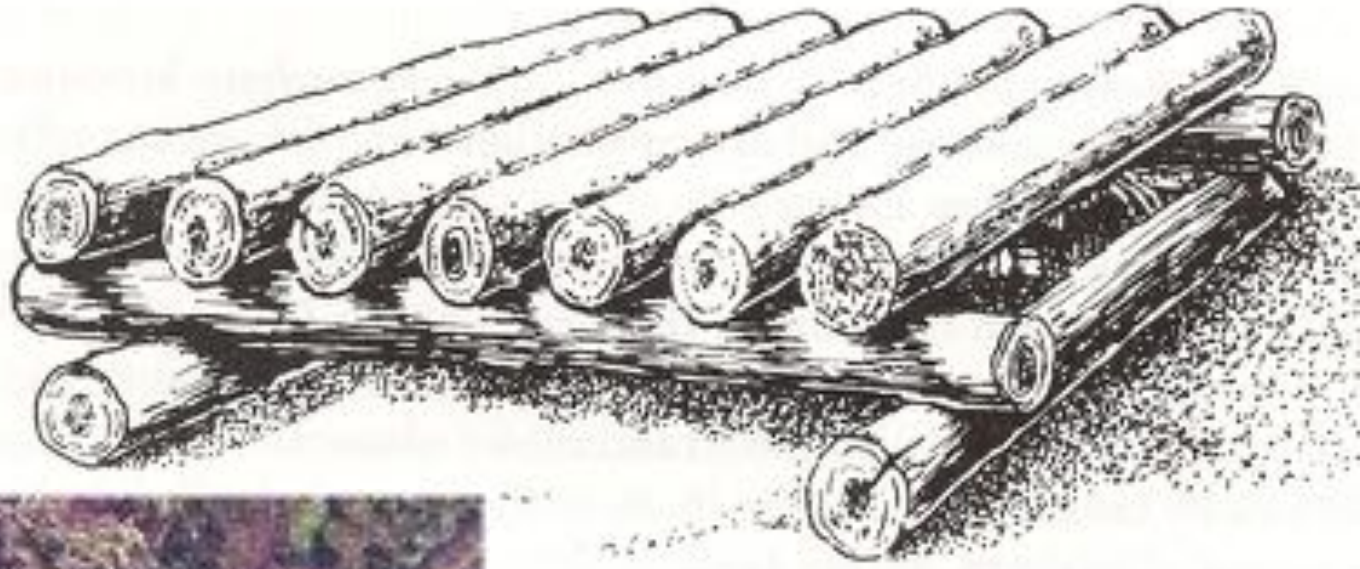
Thanks, Jim!

Artificial Reefs should be constructed, located, and oriented to enhance life history attributes that align with artificial reef attributes

Adult specific habitat (e.g., Chris Koepfer's Red Grouper Reef)



'Casitas' to increase survivorship in juvenile spiny lobster



Hatchery-reared Red Snapper released onto artificial reefs

If the answer to life, the universe and everything (including artificial reefs) is 42...

…then what are the questions?

Managers need to communicate to the artificial reef researchers the questions they need to have answered.

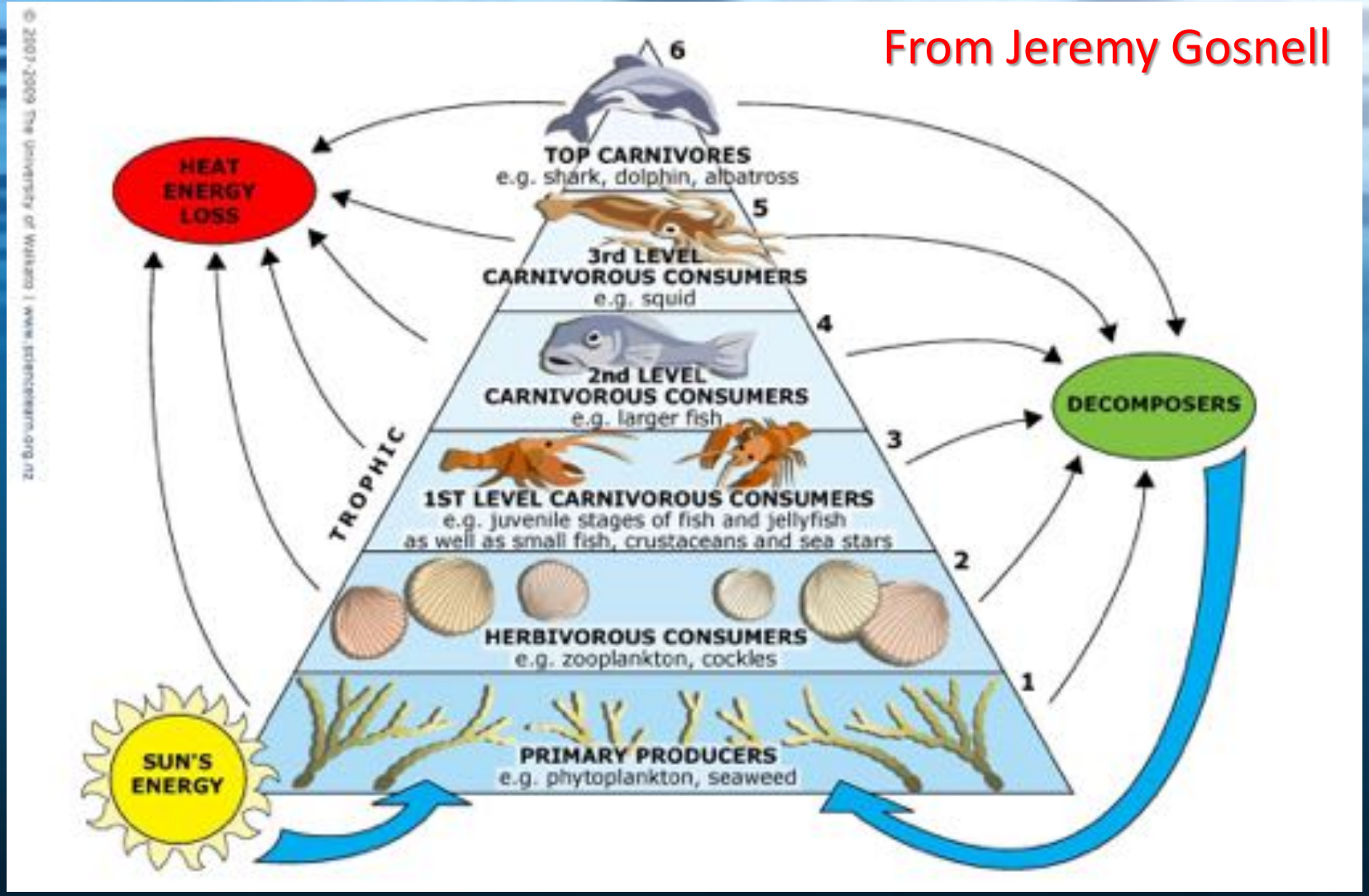
…then what are the questions?

Managers need to communicate to the artificial reef researchers the questions they need to have answered.

"So tell me what you want, what you really, really want"

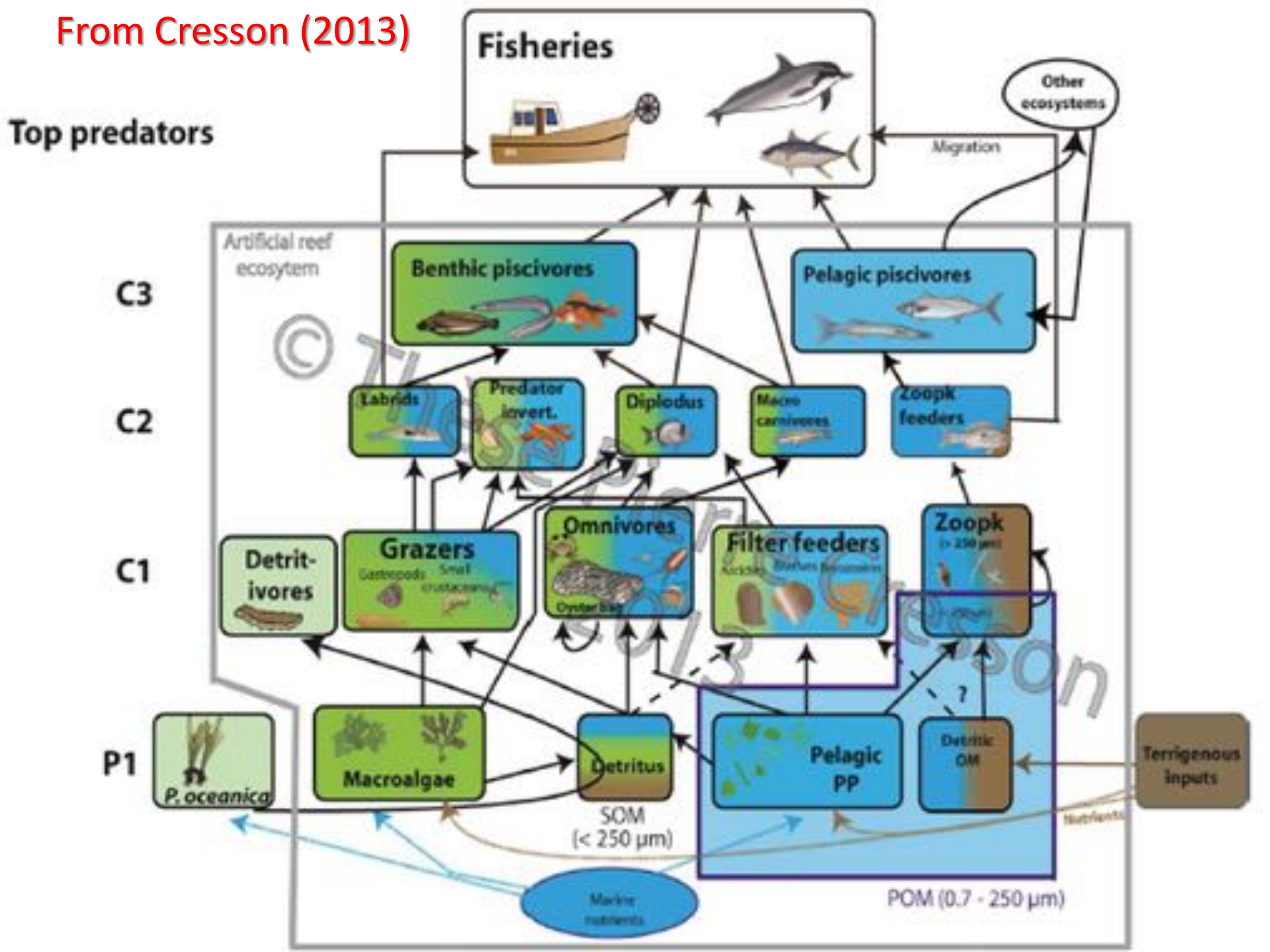
Spice Girls, 1996

From Jeremy Gosnell



Do artificial reefs have utility in both individual species management & ecosystem management?

From Cresson (2013)



Can standardized (control) reefs help in Fishery Independent Monitoring to allow comparisons with other study results?

How about overcoming our obstacles with a NASA-like approach?

National Fish Habitat Action Plan –

Its Mission:

"…to protect, restore and enhance the nation's fish and aquatic communities through partnerships that foster fish habitat conservation and improve the quality of life for the American people."

NATIONAL FISH HABITAT PARTNERSHIP

(or something like it)

…can help address resolve some of these issues so artificial reefs can be used to predictably improve habitat-associated problems in fisheries.

Pressing Needs:

1. Cooperation/Organization
2. Nationwide database
3. Estimate of the footprint and impacts of artificial reefs
4. Energy budget
5. Meaningful management objectives

"We have nothing to fear, but fear itself"…and a lack of cooperation and coordination and funding, and…

Food and Agriculture Organization of the United Nations

General Fisheries Commission for the Mediterranean
Commission générale des pêches pour la Méditerranée

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10TH ARAH

The 10th International Conference on Artifical Reefs and Related Aquatic Habitats

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