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”

Steve Bortone
Osprey Aquatic Sciences, LLC
steve.bortone@gmail.com
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)
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)
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)

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
Modules or Units of Opportunity
B. Uses
B. More Uses of Artificial Reefs
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

You are here!
Bortone’s Heretical Observation:

“Artificial Reefs play almost no role in the management of any fishery”.

(November 2009)
Kim et al. (2011) presented an application of artificial reefs toward specific life stages.

*Arctoscopus japonicus*, Japanese Sandfish
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”
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
Harvest Rotation

Year 1, 5…

Year 2, 6…

Year 3, 7…

Year 4, 8…

“Time Limited” Marine Protected Areas
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?
We also 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

![Graph showing the accuracy of sampling methods over different mob length values. The graph indicates a general trend of decreasing accuracy with increasing mob length, with the labels 'First Trial' and 'Second Trial' indicating two different data sets. The x-axis represents mob length in cm, ranging from 10 to 50, and the y-axis represents accuracy, ranging from 0.0 to 1.2. The graph includes error bars indicating variability in accuracy measurements.]
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
Distance “halo” of reef association
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).

---

**Application**

- **Module A**
- **Module B**
- **Module C**

Optimizing features in module “A” or “C” will not produce a change in the performance of the application until the performance problems in module “B” are addressed.
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
Reef Features
A. Orientation
B. Location
C. Construction

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

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...

Yes, I thought it over quite thoroughly. It's 42.
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
Do artificial reefs have utility in both individual species management & ecosystem management?
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.”
...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...
STUDIES AND REVIEWS

No. 96

PRACTICAL GUIDELINES FOR THE USE OF ARTIFICIAL REEFS IN THE MEDITERRANEAN AND THE BLACK SEA

2015

Giuseppe Scarcella
Gianna Fabi
Alessandra Spagnolo