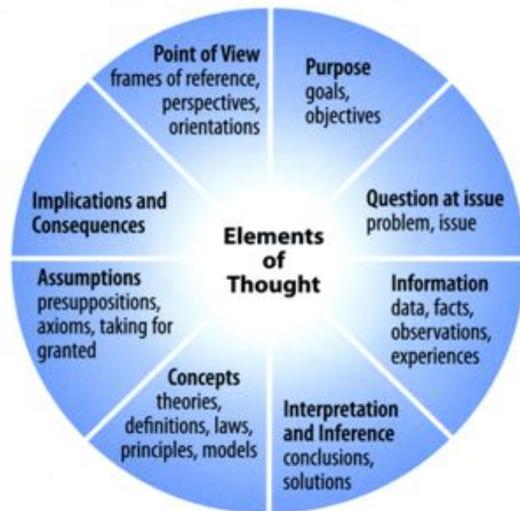


# Ecological Functioning of Artificial Reefs with Fisheries Management Implications



# Beyond Attraction-Production: Philosophical Basis of a Protracted Debate

## Critical Thinking



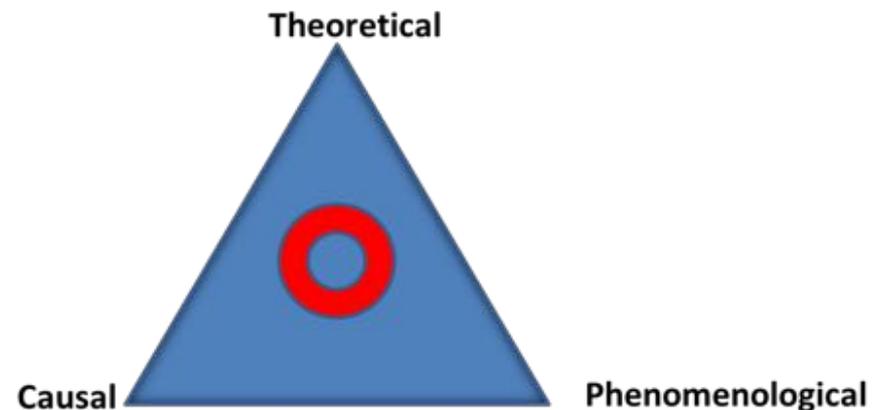
Used With Sensitivity to Universal Intellectual Standards

Clarity → Accuracy → Depth → Breadth → Significance  
Precision  
Relevance

Excerpted from "The Thinker's Guide to Critical Thinking: Concepts and Tools", page 5.

*Foundation for Critical Thinking*  
[www.criticalthinking.org](http://www.criticalthinking.org)

## Conceptual Space of Ecology



Adapted from Cooper, G.J. 2003. *The Science of the Struggle for Existence: On the Foundations of Ecology*. Cambridge University Press. 319 pp.

# Application of Habitat Selection Theory

- Ideal Free Distribution, **IFD** (Fretwell & Lucas 1970, Fretwell 1972)
- Density-Dependent Habitat Selection, **DDHS** (Rosenzweig 1981, 1985)
- Ontogenetic Habitat Shifts,  **$\mu/g$**  (Werner & Gilliam 1984)
- Spatial Scaling in Ecology (Wiens 1989)
- Basin Model of Dynamic Geography (MacCall 1990)
- Foraging Arena Theory (Walters & Juanes 1993, Walters & Korman 1999)
- Life History Bottlenecks (Caddy 2007, 2011, 2013)

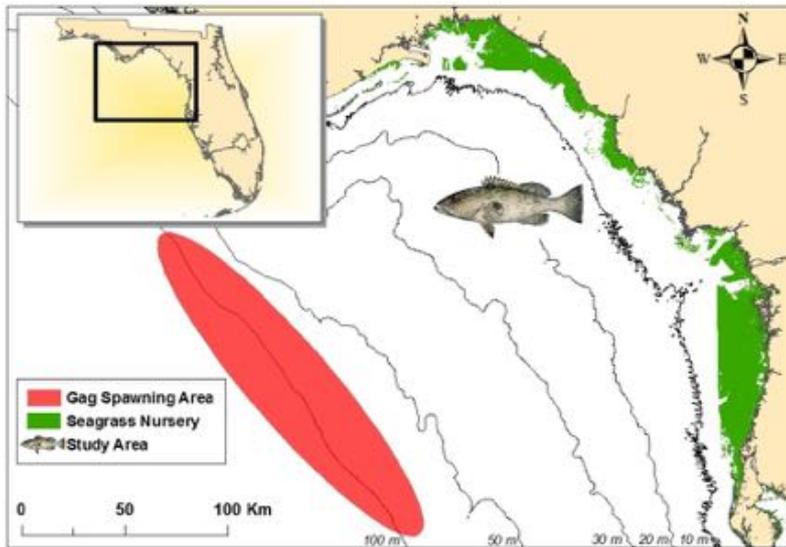
**Habitat selection affects growth, survival and reproduction.**



**Gag, *Mycteroperca microlepis***

# Gag as a Model System:

Spatially Structured Life History  
Density Dependent Habitat Selection  
Intrinsic Habitat Quality  
Fishing Effects  
Hypothesized Bottleneck



Lindberg et al. 2006. *Ecol. Appl.* 16:731-746

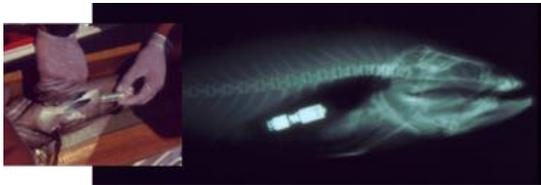
Kiel. 2004. M.S. thesis, UF

Larsen. 2005. M.S. thesis, UF

Biesinger et al. 2011. *Ecol. Modeling* 222:1448-1455

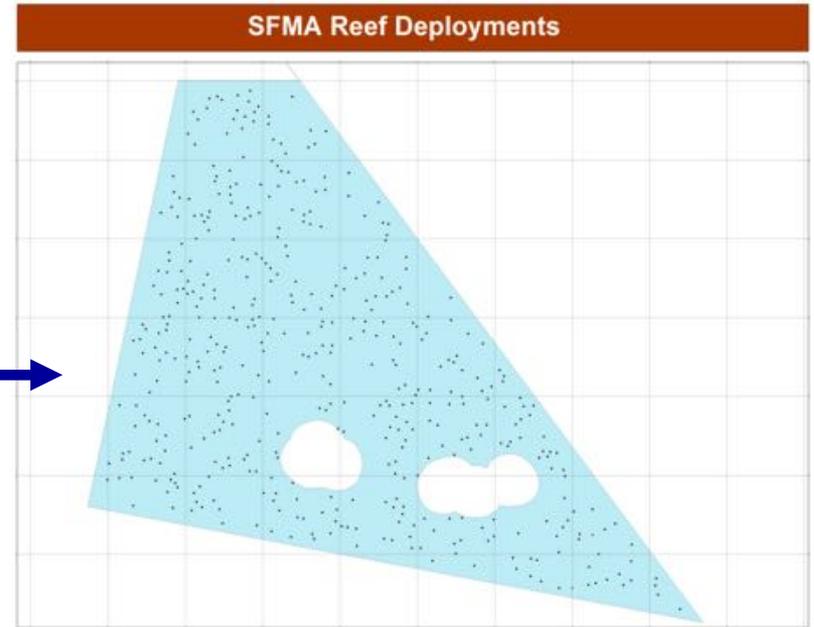
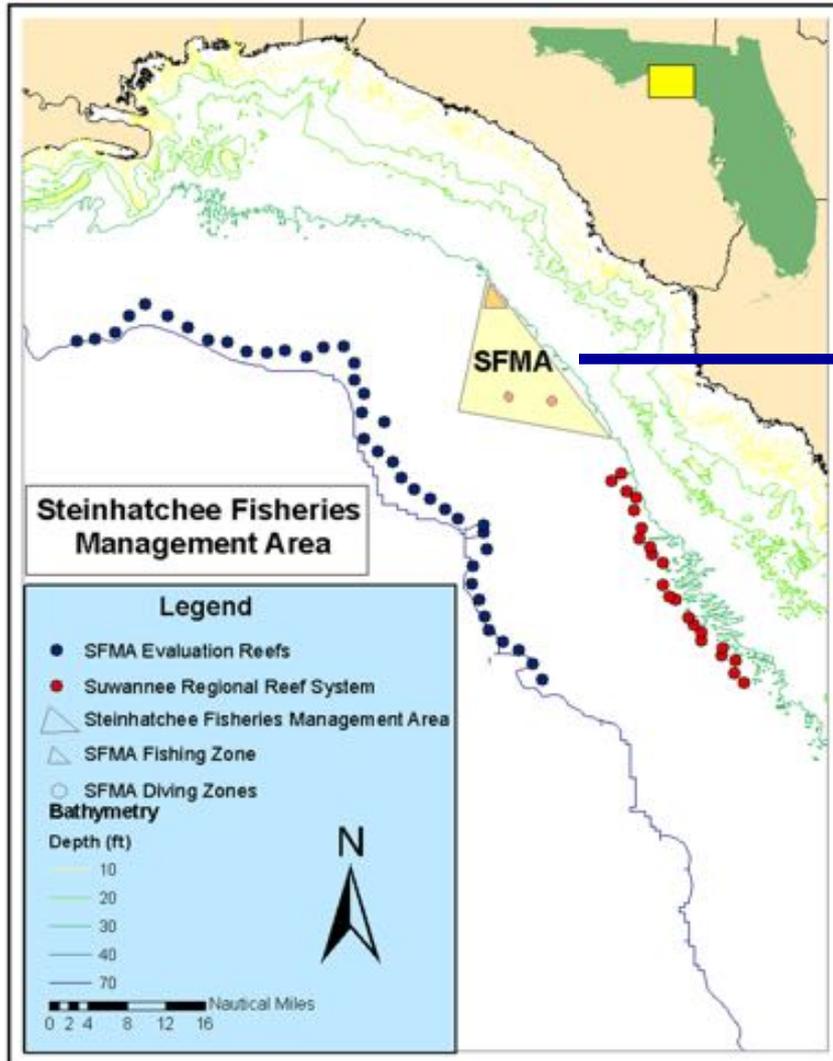
Biesinger et al. 2013. *JEMBE* 443:1-11

Biesinger et al. *submitted*. *Mar. Biol.*



Video credit: L. Kellogg ca. 2000

# Steinhatchee Fisheries Management Area

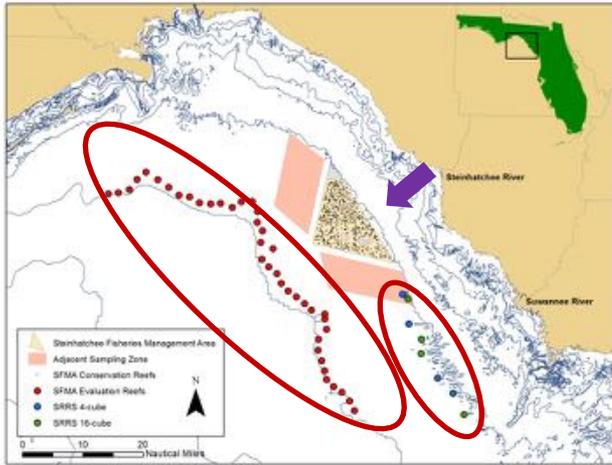


**500 Standardized 4-cube patch reefs**

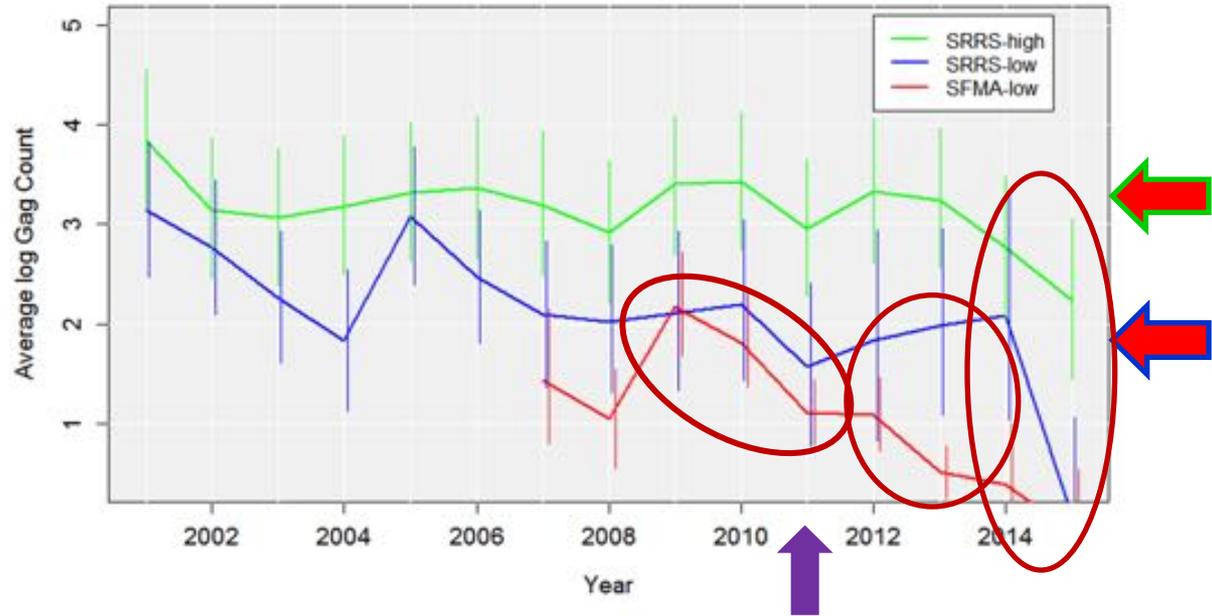


Photo Credits: Keith Mille (FWC)

# Testing Expectations from MacCall's Basin Model



Mean (log) Gag Counts and 95% Credible Intervals by Year for Three Artificial Reef Types  
SRRS-high, SRRS-low and SFMA-low



**4-Cube Reefs**  
**"Lower Quality"**  
*(from perspective of the fish)*



**16-Cube Reefs**  
**"Higher Quality"**  
*(from perspective of the fish)*

n = 24 or 40 per reef type

# Implications for artificial reefs in fisheries management?



1. Indices of abundance are a function of intrinsic habitat quality
2. Hyperstability in CPUE is to be expected
3. Spatial equilibria “all other things equal”
4. Spatial “perturbations” matter!
  - Red tides (or hypoxic zones or oil spills)
  - Changes in habitat availability
5. Spatially explicit modeling needed; socio-ecological and management strategy evaluation (MSE)



Jon Dodrill, FWC (retired)



Gag, *Mycteroperca microlepis*

## Current Collaborators

Mary Christman, Tommy Bohrmann, Deb Murie, Daryl Parkyn, Doug Marcinek  
Kai Lorenzen, Ed Camp, Rob Ahrens, Jynessa Dutka-Gianelli

## Sponsors



**NOAA FISHERIES SERVICE**  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

