An Overview of Methods for Estimating Absolute Abundance of Red Snapper in the Gulf of Mexico

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The Issue
The Project
The Methods

Photo by Brian Jones
The Issue

- Historical overfishing led to depletion of the Gulf of Mexico red snapper stock
- Despite decreased season lengths, the stock remains overfished
- Recreational anglers perceive a healthy stock
- This has lead to mistrust between recreational anglers and federal managers
The Project

• Congress made available funding to independently estimate red snapper abundance

• Two year project: starts in 2017, to be completed by 2019

• Well-integrated, multi-disciplinary team of investigators
The Methods

1. Habitat mapping
2. Tagging
3. Direct counts
4. Depletion methods
Habitat Mapping: Ecological Boundaries

Grouping variables
- Sediment type (% cover of sand, mud, gravel, rock)
- Artificial reefs + platforms (based on 0.2 degree cell grid of the shelf)
- Turbidity
- Dissolved Oxygen

Map indicating different ecological boundaries.
Habitat Mapping

4 Regions

- Shallow (10 - 40 m)
  - Artificial Reef
    - Large
    - Small
  - Natural Reefs
  - Uncharacterized Bottom

- Mid-depth (40 – 100 m)
  - Artificial Reef
    - Large
    - Small
  - Natural Reefs
  - Uncharacterized Bottom

- Deep (100 - 160 m)
  - Artificial Reef
    - Large
    - Small
  - Natural Reefs
  - Uncharacterized Bottom

- Shelf Slope
  - Salt domes, Seamounts, other natural features

Habitat Mapping

- Sources: bathymetry data; multi-beam and side-scan sonar imagery
- Calculate the extent of natural hard bottom substrates and unknown/unconsolidated bottom habitats
- Quantify the number of existing artificial reef structures
Tagging: Proof of Concept

- Select random reef sites for tagging
- Tag no more than five red snapper per reef
- One-third of all fish get double tagged

750 fish tagged immediately prior to season opening
Tagging: Results

3 weeks - 724 fish tagged

Photo by David Hay Jones

Legend

- Reef Permit Zone

Tagged RSN per Reef
- 0
- 1
- 2
- 3
- 4
- 5

Gulf of Mexico
New High Dollar Red Snapper Tags

New Red Snapper tags have been placed in the Gulf of Mexico. If you catch one of these fish, snip off the tag at the skin and report your tag to receive a cash reward.

Claim your reward!

1. Tell Us → RED@AUBURN.EDU or toll-free 1-855-818-9983

2. Mail Us → The Tag
   Auburn Dept. of Fisheries
   Attn. Dana Sackett
   203 Sngle Hall
   Auburn, AL 36849

- single-tagged fish $250
- double-tagged fish $500

Photo by David Hay Jones
How does the model work?

- **Alive**: Retain Tag → Stay → Not Caught → Not Reported
- **Dead**: Lost Tag → Move → Not Caught → Not Reported
- **Caught**: Stay → Caught → REPORTED
- **Not Caught**: Not Caught → Not Reported
- **Released**: PRM_{at} → Released
- **Reported**: U_{d1} → REPORTED
Tagging

• We’ve demonstrated proof of concept for this method (2016, 2017)

• Estimated *exploitation* using a conceptually straight-forward approach that engaged the recreational angling community


Estimating Population Size

- There are two general approaches to estimating population size:

1. Make a direct count of fish in a defined area (or make a count that needs to be adjusted to account for gear efficiency)

2. Note how removals (i.e. depletions) affect an index of relative abundance
   - 2a. Change-in-ratio
   - 2b. Index Removal
   - 2c. Removal Estimators
Remotely operated vehicles (ROVs) and towed camera arrays

Testing to determine the area “sampled” and gear affects (attraction, avoidance)


What about the fish you don’t see?
Depletion methods use a known removal to adjust an index of relative abundance.

Change-in-Ratio, Index-Removal, and Removal Estimators

Change-in-Ratio: calculates how a known, selective removal (e.g. legal size fish) changes the ratio of the population in two classes (legal and sublegal).

Index removal: survey-removal-survey
Change in Ratio
Index-Removal

- Index-removal looks at how an index (of relative abundance) changes due to a known removal.

- Let’s assume catch is proportional to abundance.

- Then a (camera) survey indicates an index of relative abundance of 40 fish per unit effort.

- Subsequent (VL) harvest captures 100 fish

- The following (camera) survey indicates an index of relative abundance of 20 fish per unit effort: i.e. the relative abundance declined by half.

- We can then infer that 100 animals represents half of the initial population size, i.e. the initial population size was 100/0.5, or 200.


Hoenig and Pollock (1998) provide assumptions for this method:

1. Closed population except for the removals
2. All animals have the same probability of capture, and this probability doesn’t vary between surveys
3. Sampling is with replacement, or the fraction of the population removed is negligible.

When assumptions of CIR and IR are met, IR is more precise.
• Gulf of Mexico red snapper remains overfished, yet recreational anglers perceive a healthy stock; this has lead to mistrust between recreational anglers and federal managers

• Consequently, Congress funded a multi-disciplinary team of experts to independently estimate the abundance of the stock

• Habitat-specific methods will be tested and employed

• High-reward tagging, direct counts and depletion methods