Fish standing stock is the one performance standard that the artificial reef has never been met.
This standard includes the biomass of all fish species on the reef.
Estimating the standing stock of the biggest species on the reef, the giant sea bass, has been a challenge.
We are planning to investigate new ways to estimate the standing stock of giant sea bass.
This talk outlines the challenges we’ve faced and methods we intend to try to address these challenges.
Historically, giant sea bass were common on reefs in Southern California. But overfishing, both recreational and commercial, had drastically reduced the abundance of this species by the 1970’s. For example, this species was so rare that none were seen during the impacts-assessment phase of the SONGS project in the 1980’s. After partial protection from commercial take and complete protection from recreational fishing in 1982, as well as the 1994 ban on nearshore gillnets, this species has begun to rebound locally. Giant sea bass are now commonly seen on Wheeler North Reef, as well as the reference reefs San Mateo Kelp and Barn Kelp.
The data used to assess the fish standing stock performance standard come from diver transects (50 x 2 x 1.5 m) on which the species, number, and estimated size of each fish is recorded. The weight of each fish is estimated from its length; and an average biomass density for WNR is estimated from all 92 transects on the reef. This biomass density is then extrapolated across the entire 175 acres of the reef.

GSB are just one of the many species of fish seen, but getting robust estimates of their biomass density could be important because they are so much bigger than all the other reef fish, with record-size fish reaching 600 pounds, and individuals seen on WNR often approximately 100-200 pounds. Thus, this species could represent a relatively large fraction of the total standing stock.

Using diver transects to estimate GSB standing stock is challenging because...

- These big fish live at very low densities, so encountering one on any given transect is very unlikely.
- They have big home ranges, and so they likely move all over the reef, and from it to other reefs.
- They aggregate, so if you miss the aggregation you may see none, or it you encounter an aggregation, you will overestimate their abundance.
- They are attracted to divers, which will cause you to overestimate their abundance and standing stock.
Results of this problem:

- if a single GSB is seen on one (out of 92) transects, this extrapolates to an estimate of 51 GSB on the entire reef
- this number is implausible (Chabot et al. 2015, House et al. 2016)

- For example, if a single GSB is seen on 1 out of the 92 transects on WNR, when extrapolated up to the entire reef, this produces an estimate of 51 GSB on WNR
- This number is implausible...
  - There are few really reliable estimates of GSB density, but at Catalina Island, House et al. estimated a total population at the island of 25-50.
  - Based on genetic diversity and rough estimates of effective population size, Chabot et al. estimated a total of about 5000 GSB in the entire Southern California Bight, which works out to about 7 on a reef the size of WNR, not 50!
Shown here are the fish standing stock estimates (in tons) for each year of the mitigation monitoring, and a 4-yr running average; for all fish (red) and all fish except GSB (white).

Whether GSB are seen on the diver transects can have a fairly large impact on the estimate of total fish standing stock as you can see in 2014 and 2016.

In those years, estimated GSB standing stock can make up to about 5 tons, or up to about 25% of the total standing stock.

In the other 6 years, no GSB were seen on transects, so their estimated standing stock is 0.

Yet, we know GSB were on the reef because we saw them off of the transects, so their standing stock was underestimated in those years.
This table shows the number of GSB seen on all 92 transects on WNR in each year; and the estimated number of GSB on the entire reef, as well as their estimated standing stock.

The main point is that in any given year, our estimates of the number and standing stock of GSB are not very good, given that we are certain that GSB were present every year, and there is no way that more than 100 were present on the reef in some years.

<table>
<thead>
<tr>
<th>Year</th>
<th># GSB on transects</th>
<th>Estimated # of GSB on WNR</th>
<th>Estimated GSB standing stock (tons)</th>
</tr>
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<tbody>
<tr>
<td>2009</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2010</td>
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<td>0</td>
</tr>
<tr>
<td>2016</td>
<td>2</td>
<td>102</td>
<td>4.9</td>
</tr>
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</table>
How can we obtain better estimates of GSB density and standing stock?

- methods must circumvent rarity and behavioral response of GSB to divers
  - repeated observations of known individuals
    - traditional mark-recapture? (expensive and time consuming)
    - Individual recognition via spot patterns?

- The preceding slide raises the question of how to obtain better estimates of GSB standing stock.
- Methods that circumvent the attraction of GSB to divers and their overall rarity are needed.
- A general approach would be to obtain repeated observations of known individuals.
- This is the basis of mark-recapture methods, which can be used to estimate total population size.
- But traditional mark-recapture with tagging and recapture would be time consuming and expensive.
- An alternative that is promising and much less expensive is repeated observations of known individuals, based on their unique spot patterns.
Spot-pattern recognition allows individual fish to be recognized when spot patterns are unique – essentially, each individual’s pattern is its unique tag.

- This approach has been used with many different animals, including fishes.
- The best known application to fish is with whale sharks, shown here.
- The software program I3S is commonly used to match photos of the same individual.
Spot-pattern recognition of GSB

- Preliminary work in the labs of Drs. Milton Love and Larry Allen indicates that individual fish can be distinguished by spot patterns, which don’t change over time.

- Preliminary work in the labs of Drs. Milton Love (UCSB) and Larry Allen (CSUN) indicates that spot-pattern recognition can identify and distinguish individual GSB.

- Importantly, the work in Dr. Love’s lab indicates that spot patterns do not change over time, as the fish grows (though GSB can change the intensity of their spots within seconds).
Plan for obtaining a better estimate of number & standing stock of Giant Sea Bass on WNR

- use spot recognition with video images of GSB
  - all divers doing routine monitoring will be outfitted with GoPros to obtain images when any GSB is sighted
  - also a limited number of additional dives targeted at videoing GSB
  - determine number of unique individuals seen on WNR using spot recognition software
  - relatively inexpensive

- This summer, we plan to trial spot-pattern recognition to estimate the number of unique GSB on WNR to help obtain a better estimate of standing stock of this species.
- During routine dives for other monitoring work, divers will be outfitted with GoPro video cameras to opportunistically capture footage of any GSB encountered.
- Also, a limited number of dives will be done targeted at videoing GSB.
- This video work, when combined with spot-pattern recognition software, will allow us to determine how many unique individual GSB are seen on WNR.
- Overall, this extra research will be relatively inexpensive because the time-demanding field work will mostly be piggy-backed on other required monitoring.
• We will also video any GSB seen while doing other monitoring work at the two reference sites, San Mateo Kelp and Barn Kelp.
  • This information will allow us to explore movement by GSB among reefs.
• We will also use stereo-video, which will provide very accurate estimates of the length of any GSB seen, which will help improve estimated weight, and thus our estimate of standing stock.
The findings from the work I’ve outlined will give us...

- insight into the actual standing stock of GSB on WNR
- insight into movement among reefs
- insight whether it is worthwhile to focus on GSB in future monitoring (e.g., if GSB standing stock is actually very low, it might not be worth the time and money to get good estimates of their density and size)
A potential complication:

- Giant Sea Bass do not always show their spots
References


