

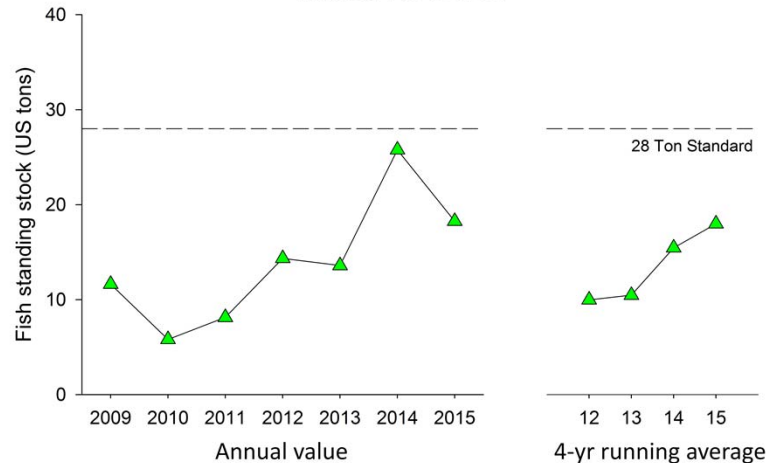
The need and potential options for expanding the Wheeler North Reef



**SONGS Mitigation Monitoring Project
Marine Science Institute, University of California Santa Barbara**

Performance Standard: Fish Standing Stock

The standing stock of fish at the mitigation reef shall be at least 28 tons



Wheeler North Reef has consistently failed to support a fish standing stock of 28 tons

- The performance standard for fish standing stock requires the Wheeler North Reef to sustain 28 tons of reef fish
- This value is based on the estimated reduction in the standing stock of fish in the San Onofre kelp forest that was attributed to SONGS' operations in the impact assessment studies overseen by the Marine Review Committee
- The Wheeler North Reef has never met this performance standard during the seven years of its existence

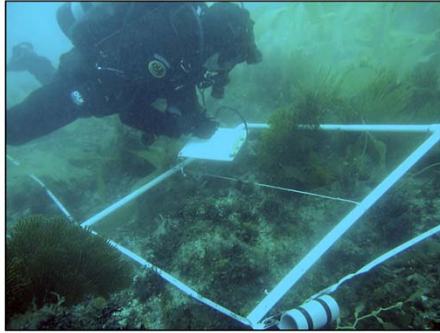
SONGS Coastal Development Permit



Requires independent studies be done to:

1. Determine why the performance standards are not being met

SONGS Independent Studies



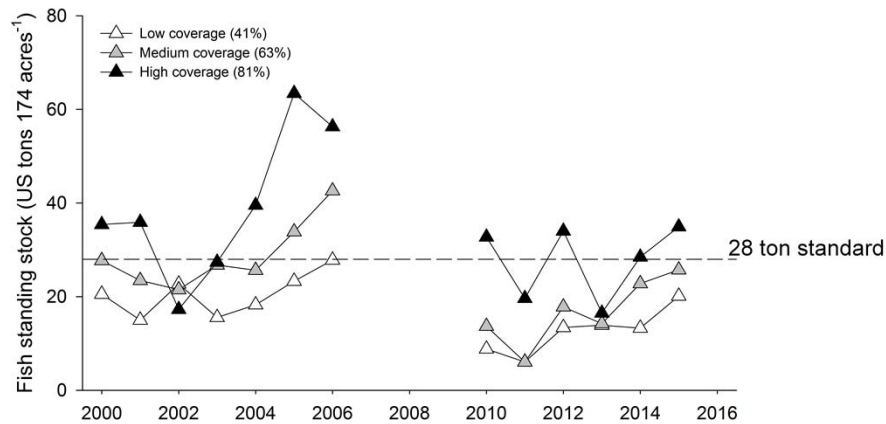
Monitoring data were used to:

1. Investigate the reason(s) for Wheeler North Reef's failure to meet the performance standard for fish standing stock
2. Develop potential solutions for ensuring that this standard is met in the future

As per the SONGS coastal development permit we used monitoring data to:

1. Investigate the reason(s) why the Wheeler North Reef has consistently failed to meet the performance standard for fish standing stock
2. Develop potential solutions for ensuring that this performance standard is met in the future

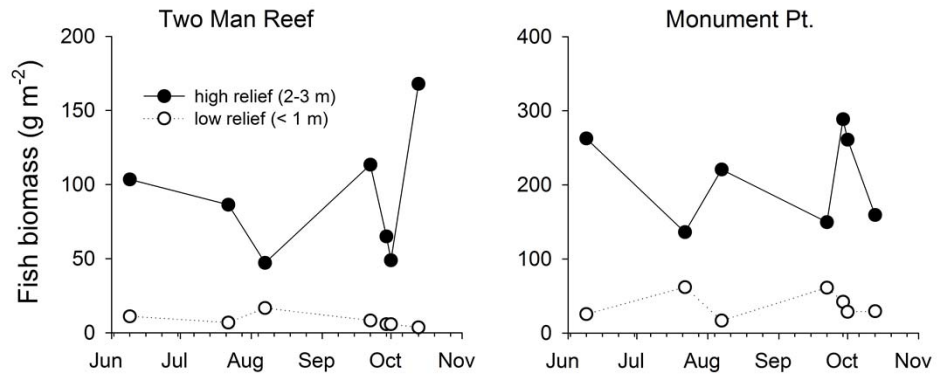
Results of Independent Studies



Reefs with higher rock coverage support larger fish standing stocks

- We used data from the 21 rock modules of the Phase 1 Reef to examine the effects of rock coverage on fish biomass
- The Phase 1 Reef was constructed in the summer of 1999 and was designed to test three bottom coverages that averaged 41%, 63% and 81%
- Data on fish biomass have been collected annually in summer at 21 modules with low, medium and high coverage of quarry rock boulders
- Plotted here are annual mean values of fish standing stock for the low, medium and high coverage rock modules since 2000
- The values have been scaled to 174 acres, which is the current size of the Wheeler North Reef
- These results show the reefs with higher rock coverage support larger fish standing stocks

Results of Independent Studies

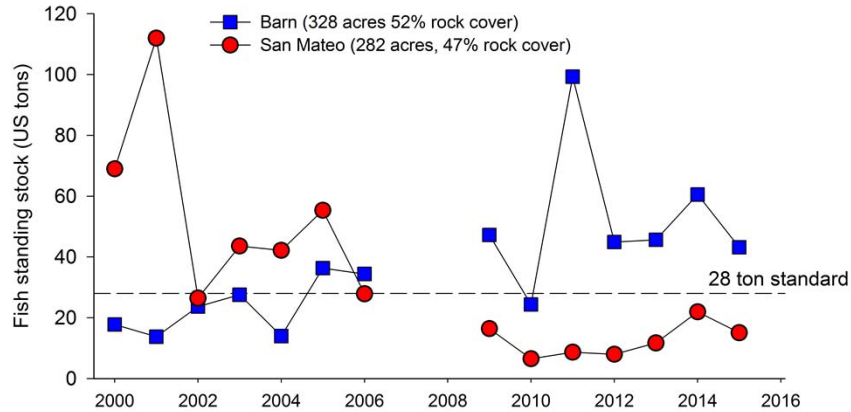


Fish biomass in areas of high relief was on average 5-10 times greater than that in adjacent areas of low relief

Reefs with higher relief support larger fish standing stocks

- Because high relief was not considered in the initial design of Wheeler North Reef there are no time series data for quantifying the effects of high relief on fish standing stock
- To address this lack of information we collected data during summer 2014 in areas of high relief (2-3 m tall) and in adjacent areas of low relief (< 1 m tall) at two natural reefs in the vicinity of Wheeler North Reef (Two Man Reef in the San Mateo Kelp bed and Monument Point, just north of Dana Point)
- These data show that fish biomass in areas of high relief (2-3 m tall) was on average 5-10 times greater than that in adjacent areas of low relief (< 1 m tall)

Results of Independent Studies

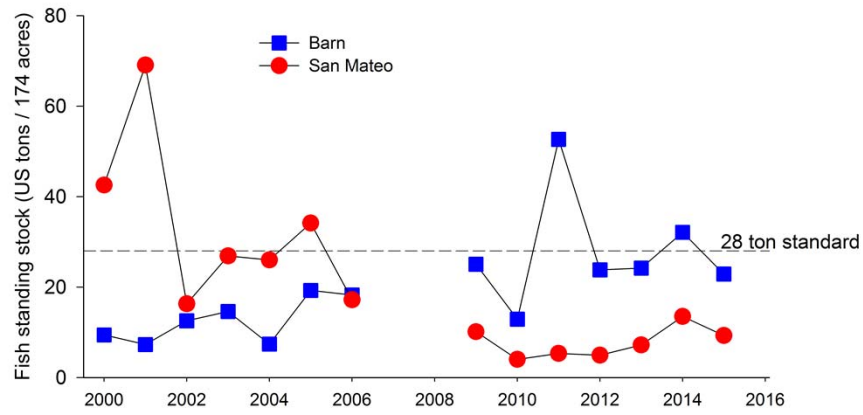


Nearby low relief natural reefs commonly support a fish standing stock of 28 tons

- Plotted here are annual values for fish standing stock for San Mateo and Barn since 2000
- Barn is 328 acres in area whereas San Mateo is 282 acres
- Both reefs are generally low relief (< 1 m tall) and their rock coverages of 52% and 47% are very similar to that of Wheeler North Reef (48% rock cover)
- These data show that Barn supported a fish standing stock of at least 28 tons in 8 of 14 years whereas San Mateo supported at least 28 tons of fish in 5 of 14 years
- However, as noted above Barn and San Mateo are much larger than Wheeler North Reef
- Therefore a pertinent question to answer is "How likely is it that Barn and San Mateo would sustain a fish standing stock of 28 tons if they were the same size as Wheeler North Reef?"

Results of Independent Studies

Fish standing stock at Barn and San Mateo scaled to 174 acres



Barn and San Mateo would not routinely support a fish standing stock of at least 28 tons if they were 174 acres

When data on fish biomass at Barn and San Mateo are scaled to 174 acres we find that Barn and San Mateo would not routinely support a fish standing stock of 28 tons

Conclusions from Independent Studies



The present configuration of Wheeler North Reef (*174 acres of low relief reef with 48% rock coverage*) is not sufficient to consistently meet the performance standard for fish standing stock

SONGS Coastal Development Permit



Requires independent studies be done to:

1. Determine why the performance standards are not being met
2. Develop recommendations for appropriate remedial measures

In addition to requiring independent studies to determine why the performance standards are not being met, the SONGS coastal development permit also requires independent studies be done to develop recommendations for appropriate remedial measures

SONGS Independent Studies



Monitoring data were used to determine:

1. How much additional acreage of different reef designs is needed for the Wheeler North Reef to consistently support a fish standing stock of at least 28 tons?

Approach for estimating area of additional reef for different reef designs

Combine the expected future standing stock of the existing 174 acre Wheeler North Reef with the expected future standing stock of fish supported by new acreage of various reef designs

- Data collected from the Phase 1 Reef from 2000 - 2015 were used to predict how many tons of fish will be supported by the existing 174 acre Wheeler North Reef in the future (e.g., 95% confidence = **13.5 US tons**)
- The same data were used to predict the number of additional acres needed to sustain 28 tons in the future
- The calculations for additional acres were done for:
 - ✓ low relief (< 1 m tall) reef designs with low (41%) , medium (63%) and high (81%) rock coverage
 - ✓ high relief (2.5 m tall) reef design with 100% rock cover

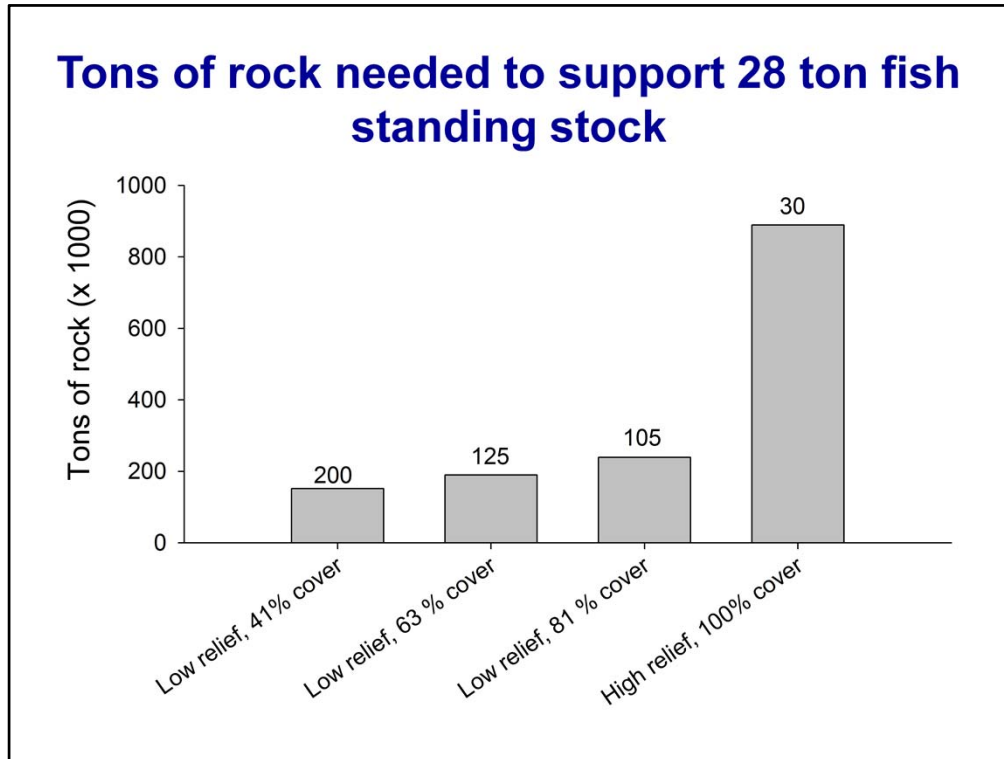
- To estimate the area of additional reef needed for Wheeler North Reef to sustain a fish standing stock of 28 tons we:
 1. Combined the expected future fish standing stock of the existing 174 acre Wheeler North Reef with the expected future standing stock of fish supported by additional new acreage of reef
 2. We did this for different reef designs for the additional new acreage
- Data from the rock modules of the Phase 1 Reef collected from 2000 – 2015 is the longest time series available and it covers a relatively wide range in environmental conditions
 1. We first used these data to predict the number of tons of fish that will be supported by the existing 174 acre Wheeler North Reef in the future with a 95% probability. This turned out to be 13.5 US tons
 2. We then used these data to predict the number of additional acres needed to sustain a fish standing stock of 28 tons in the future
- We chose a 95% as the level of confidence in our predictions because we wanted a high assurance in our estimates of the amount of new additional acres needed
- Increasing the confidence above 95% would result in more additional acres needed to sustain 28 tons of fish while decreasing the confidence below 95% would result in fewer additional acres needed

Estimated area of additional reef for remediation

Reef Design	Additional acres needed*
Low relief (< 1 m), low rock cover (41%)	200
Low relief (< 1 m), medium rock cover (63%)	125
Low relief (< 1 m), high rock cover (81%)	105
High relief (2.5 m, 100% rock cover)	30

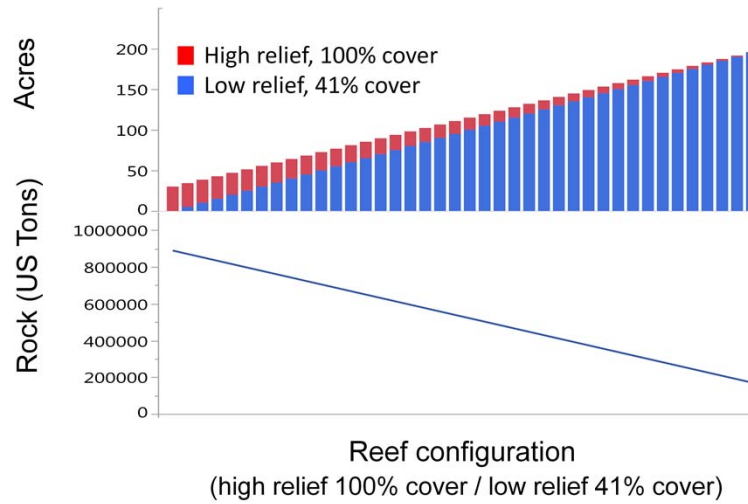
****Number of additional acres needed for Wheeler North Reef to sustain a fish standing stock of at least 28 tons with 95 % confidence***

- Shown here is a summary table with estimates of the number of additional acres of various reef designs that are needed for Wheeler North Reef to sustain a fish standing stock of at least 28 tons
- As you can see the amount of addition acreage varies greatly depending on its rock coverage and vertical relief
- If new additional acres were designed like the existing Wheeler North Reef (i.e., low relief with low rock coverage), then 200 additional acres would be needed, which would more than double its current size
- It would take approximately half of this area (i.e., 105 acres) if the additional acres were low relief with high rock coverage
- By contrast, if the additional acreage consisted of reef that averaged 2.5 m tall and was 100% rock, then only 30 additional acres would be needed



- This plot shows the tonnage of rock needed to construct 4 different reef designs, which when added to the existing Wheeler North Reef are expected to support a fish standing stock of 28 tons with 95% level of confidence
- The numbers above each bar are the number of acres of additional reef needed for each reef design
- A remediation reef designed with low relief and 41% cover rock requires the least amount of rock that is ~ 80% of that of a low relief 63% cover rock and ~ 63% of that of a low relief 81% cover rock
- By contrast, a high relief reef with 100% cover of rock requires nearly 6 times more rock to support the same fish standing stock than a low relief 41% cover reef even though it encompasses < 1/6 the area (i.e., 30 acres for high relief 100% cover vs. 200 acres of low relief 41% cover)

Combinations of low and high relief reef predicted to support 28 ton fish standing stock



- The top graph shows the amount of acres of different proportions of high and low relief remediation reef needed for the Wheeler North Reef to support a fish standing stock of at least 28 tons
- The bottom graph shows that the tonnage of rock for a remediation reef consisting of a mixture of low and high relief would decrease proportionally with the proportion of low relief reef

Ongoing activities and future plans

- Independent monitoring will continue in 2016 as required by the SONGS coastal development permit
- The CCC staff have developed options for remediation and are in discussions with SCE to finalize a plan that ensures the Wheeler North Reef is large enough to consistently meet the performance standard for fish standing stock

