

Monitoring the Wheeler North Reef to determine its success in mitigating for losses of kelp forest habitat



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Key Elements of the SONGS Artificial Reef Mitigation Project

Goal

In-kind compensation for the loss of kelp forest habitat and associated biota caused by the operation of SONGS Units 2 & 3.

Performance Criteria

Physical and biological standards established by which the performance of the artificial reef is judged.

Evaluation

Data from independent long-term monitoring used to determine:

- (1) whether the performance standards are met*
- (2) the causes for any failures to meet the standards*
- (3) the most appropriate methods for remediation*

4 Physical Performance Standards



Pertain to the type and amount of hard substrate that must remain available to reef biota

9 Biological Performance Standards



Pertain to the abundance, diversity and ecological function of giant kelp, understory algae, invertebrates, and fish

Two different types of physical and biological performance standards will be used to judge the success of the Wheeler North Reef:

1. Fixed: Measured against a set value

(e.g., sustain 150 acres of giant kelp)

2. Comparative: Measured relative to natural reefs

(e.g., the abundance and diversity of algae and invertebrates must be similar to that of natural reefs)

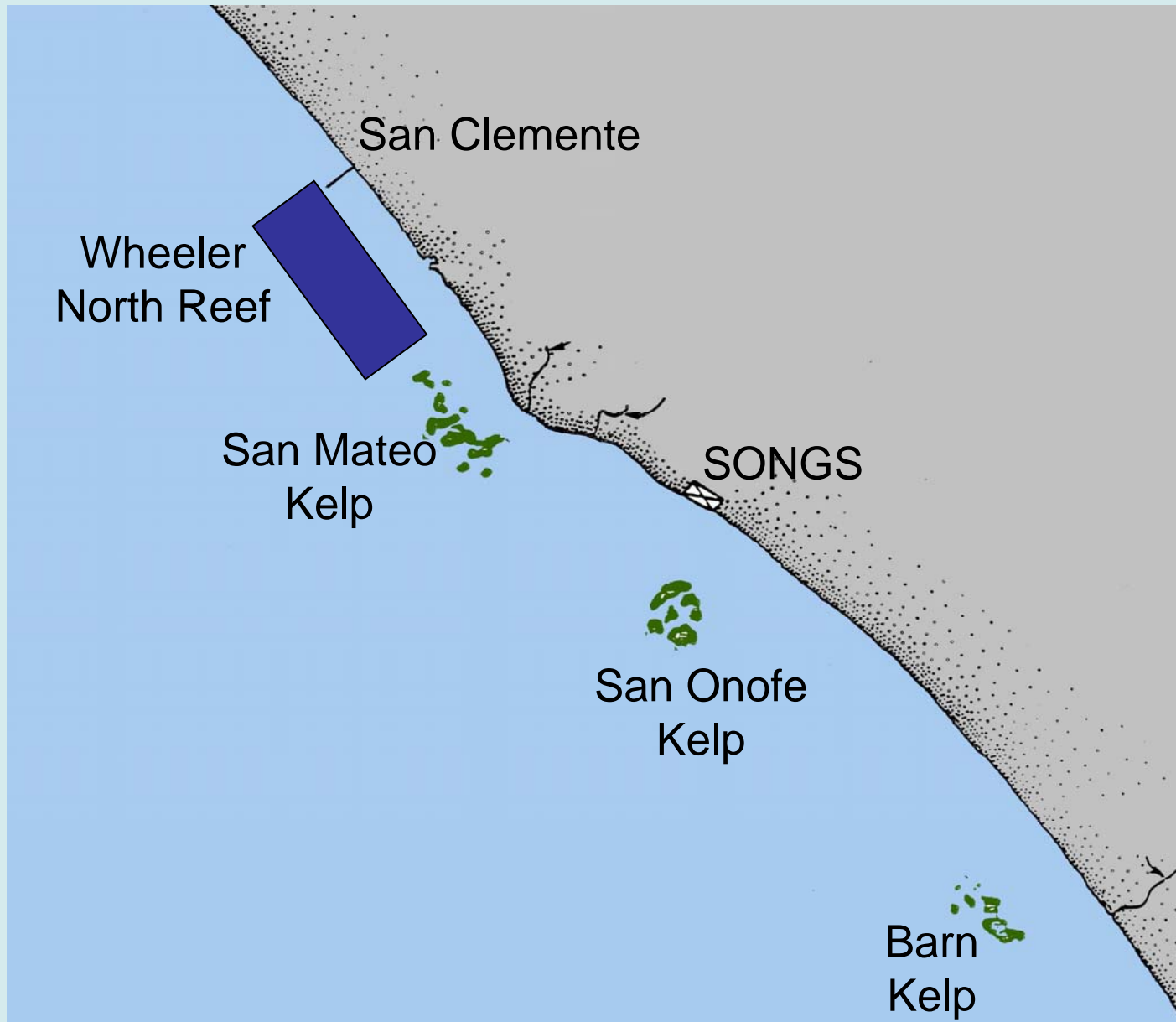
Relative standards require comparisons to natural reference reefs

RATIONALE: to be successful the Wheeler Nort Reef must provide the types and amounts of resources that occur on natural reefs in the region.

Criteria for reference reef selection:

- 1) history of sustaining giant kelp.**
- 2) depth similar to experimental reef.**
- 3) primarily low relief, preferably consisting of cobbles and boulders.**
- 4) located within the local region**

Project site and reference reefs



What counts as similar?

Problem:

No off-the-shelf method for determining similarity that was suitable for the project's needs.

Challenge:

To develop a ***scientifically defensible*** and ***cost-effective*** method capable of detecting a ***meaningful difference*** in the performance of the Wheeler North Reef relative to the reference reefs with a ***reasonable degree of certainty*** that is ***fair*** to both SCE and to the public of California.

Elements considered in developing the method for assessing similarity between Wheeler North Reef and reference reefs

1. **Effect size:** the amount of difference between the Wheeler North Reef and the reference reefs that we want to be able to detect.
2. **Type I error:** Concluding that the Wheeler North Reef and the reference reefs are different when in fact they are similar.
3. **Type II error:** Concluding that the Wheeler North reef and the reference reefs are similar when in fact they are different.
4. **Sample size:** which not only affects the cost of monitoring, but also the level of certainty in the estimated performance values for the Wheeler North Reef and reference reefs (and hence the effect size, and Type I and Type II errors).

Rules adopted for determining similarity between Wheeler North Reef and the reference reefs

- 1) Evaluate each performance standard separately as well as collectively**
- 2) Balance the risk of committing a Type I and Type II error by setting each of their probabilities at 20%**
- 3) Set effect size = 20%**
- 4) Use the values chosen for effect size, Type I and Type II errors to determine the sampling effort**

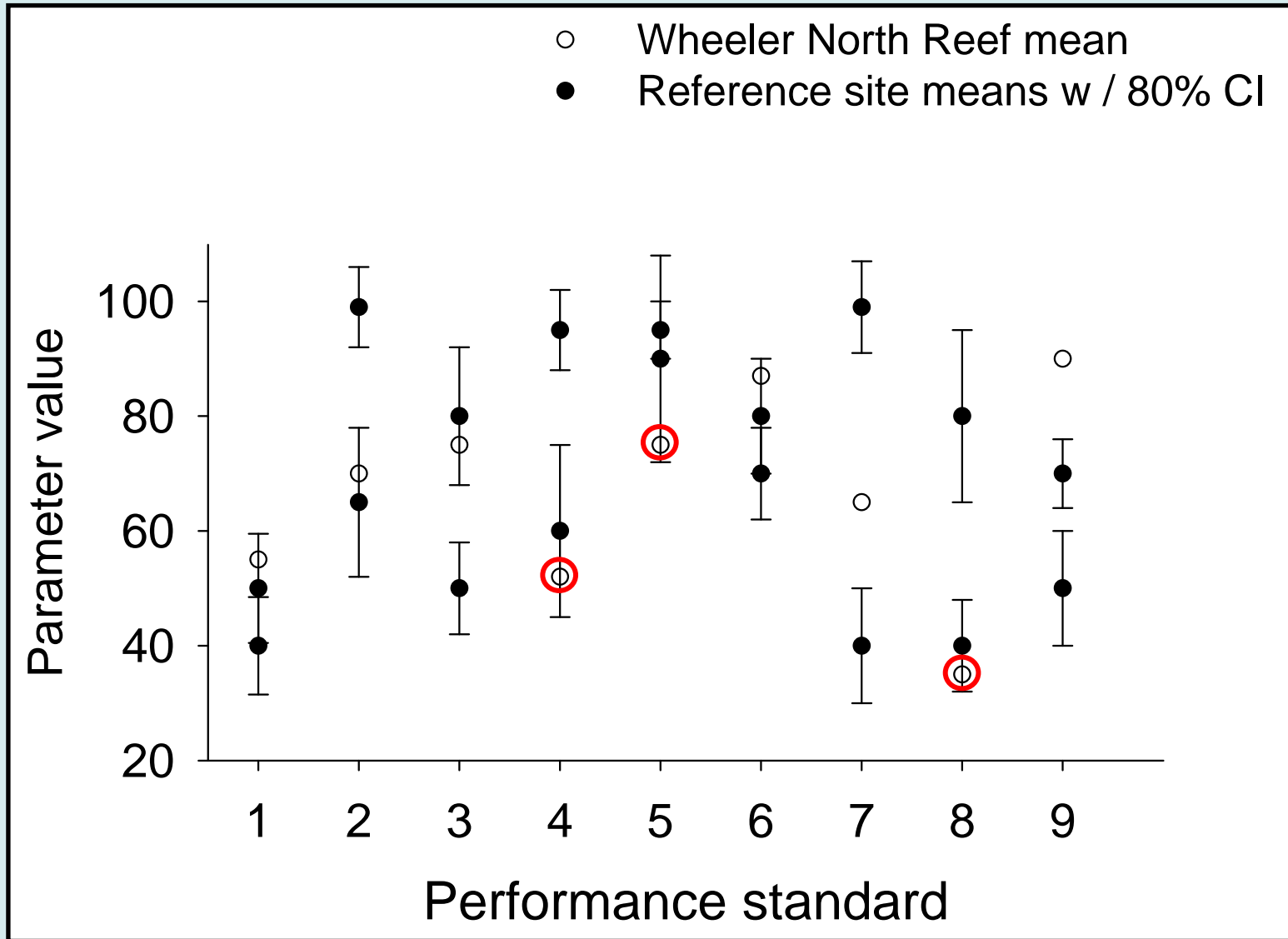
Criteria used to assess similarity between Wheeler North Reef and reference reefs

1) The values of the performance variables at Wheeler North Reef must be within the range of the 80% confidence intervals of San Mateo and Barn for all performance variables.

and

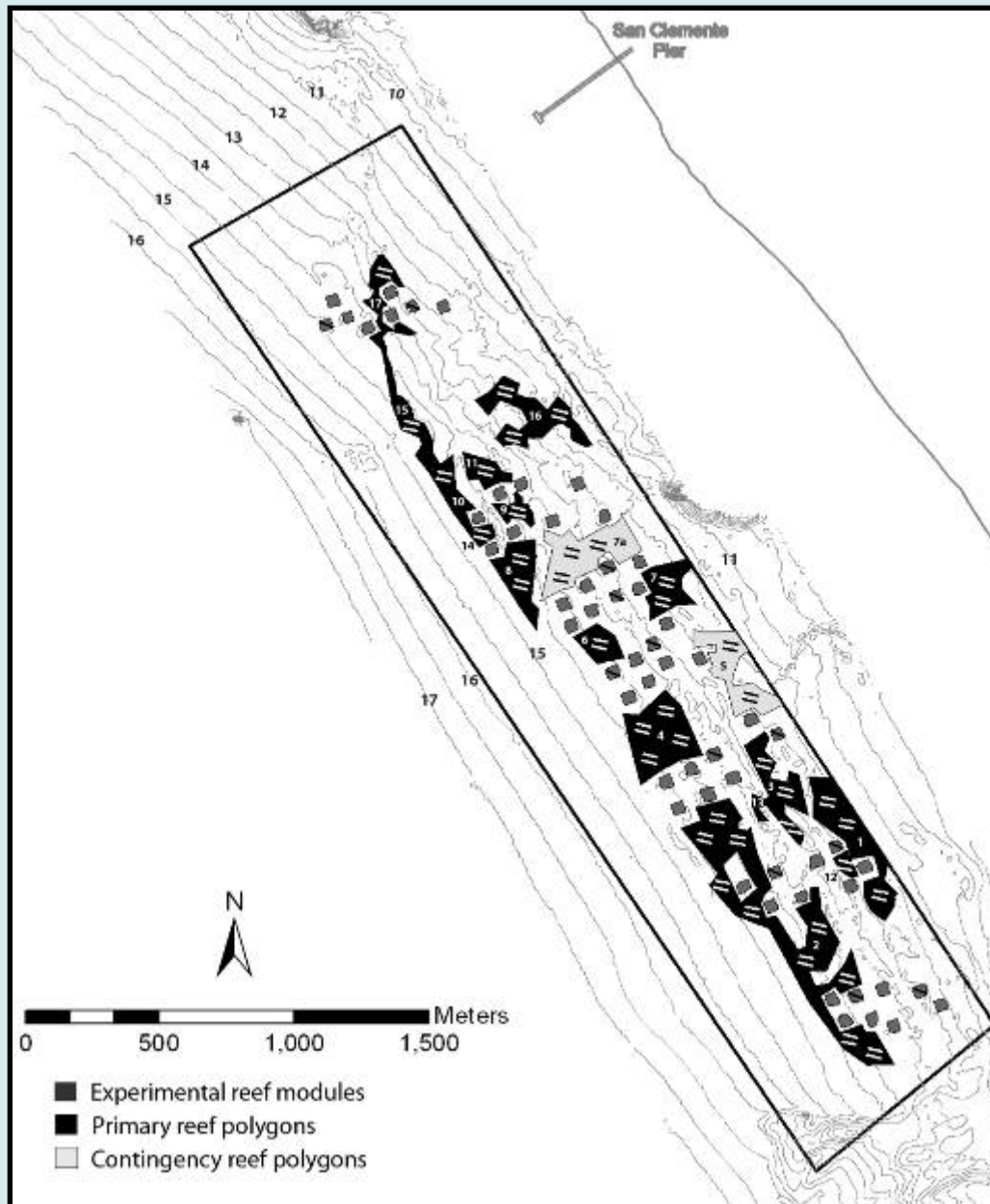
2) Wheeler North Reef must not have the lowest value more often than expected by chance alone.

Hypothetical example



Sampling Design

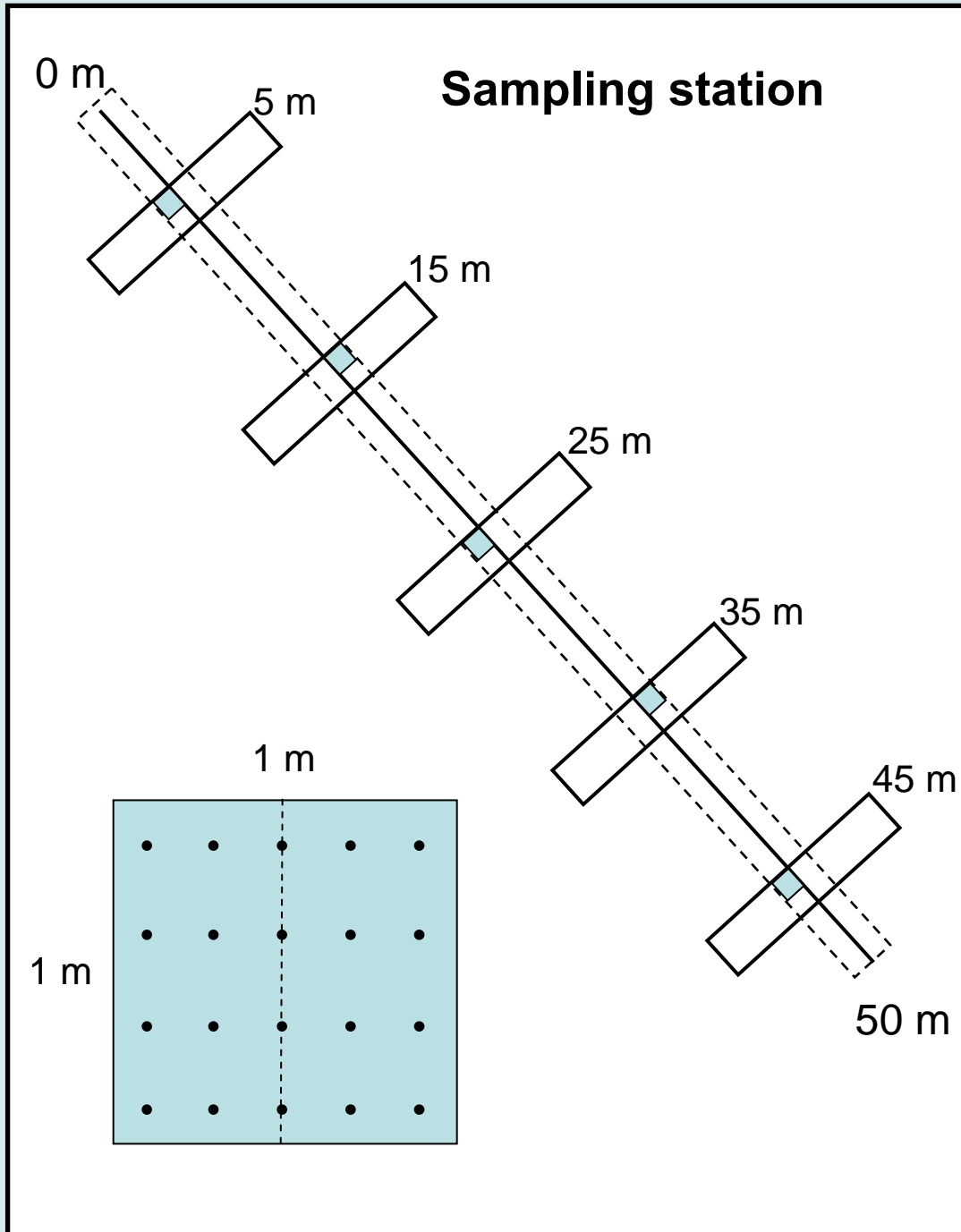
- 92 sampling stations arranged in 41 pairs
- Each station is 50m x 10m in area & defined by a differential GPS coordinate and a compass heading
- Sampling design and effort on reference reefs same as on Wheeler North Reef



Sampling Design

- Different sized sampling units used to sample different performance variables:

- 50 m x 2 m
- 10 m x 2 m
- 1 m x 1 m
- 0.5 m x 1 m



Performance Standards for Bottom Substrate

- ✓ 1. The mitigation reef shall be constructed of rock, concrete, or a combination of these materials.
- ✓ 2. The total area of the mitigation reef (including the experimental reef modules) shall be no less than 150 acres.
- ✓ 3. At least 42% but no more than 86% of the mitigation reef area shall be covered by exposed hard substrate
4. At least 90 percent of the exposed hard substrate must remain available for attachment by reef biota.

Evaluating the performance of hard substrate

- Measure percent cover of rock in the same 1m² quadrats used to verify the as-built specifications of the WNR
- Measure footprint area of WNR using multi-beam sonar
- Compare area of exposed rock to that measured immediately after reef construction to determine whether 90% or more is still available for reef biota



9 Substrate categories:

Bedrock

Large boulder (≥ 100 cm)

Medium boulder (≥ 50 cm & < 100 cm)

Small boulder (≥ 26 cm and < 50 cm)

Cobble (≥ 7 cm and ≤ 25 cm)

Pebble (≥ 2 mm and < 7 cm)

Sand (< 2 mm)

Shell hash

Mudstone

Performance Standard for Giant Kelp



The artificial reef shall sustain 150 acres of medium-to-high density giant kelp

Medium-to-high density kelp is defined as at least 4 adult plants per 100 m²

Performance Standard for Giant Kelp



Measure giant kelp density in fixed transects on Wheeler North Reef (WNR)

Determine whether $P \times 174 \geq 150$

where:

P = the proportion of transects with at least 4 plants

and

174 = Area of WNR

Performance Standards for Kelp Forest Fishes

Abundance, Diversity, Recruitment



1. The resident fish assemblage shall have a total density and number of species similar to natural reefs within the region.
2. The total density and number of species of young-of-year fish shall be similar to natural reefs within the region.
3. The standing stock of fish at the mitigation reef shall be at least 28 tons.

Performance Standards for Kelp Forest Fishes

Fish reproductive rates shall be similar to natural reefs within the region

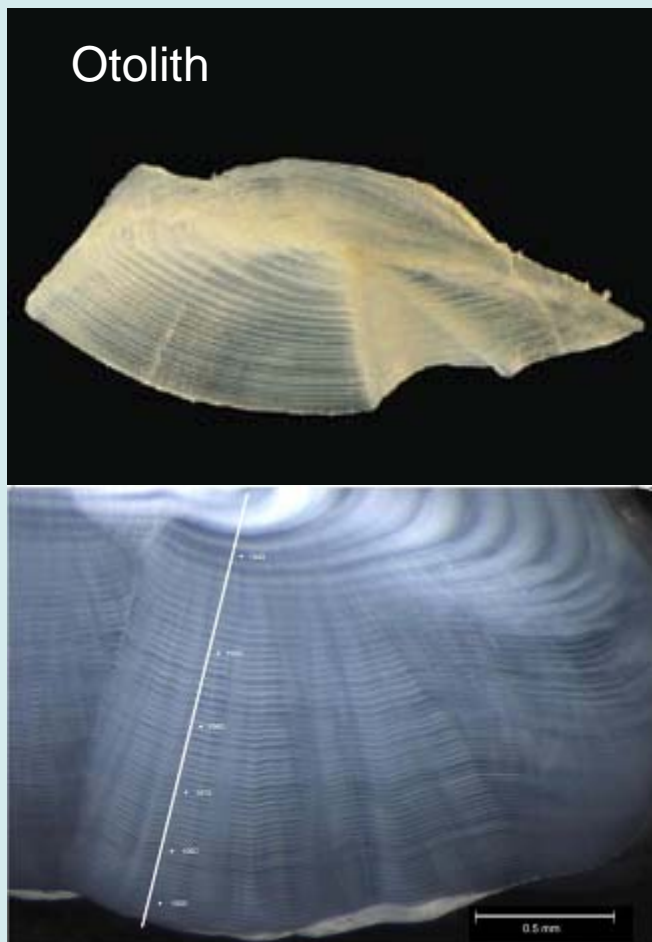


Measure annual egg or embryo production in a group of common species that represent the major feeding and reproductive guilds of fishes on southern California reefs



Performance Standards for Kelp Forest Fishes

Fish production shall be similar to natural reefs within the region



Use information collected on fish abundance, size structure, and reproductive rates combined with estimates of somatic growth obtained from ear bones (otoliths) to calculate fish production

Benthic Community Structure

The benthic community (both algae and macroinvertebrates) shall have coverage or density and number of species similar to natural reefs within the region

Understory Algae



Sessile Invertebrates



Mobile Invertebrates



Benthic Community Function

The benthic community shall provide food-chain support for fish similar to natural reefs within the region

Sheephead



Sample gut fullness in reef fishes that feed on the bottom and are collected for other purposes

Black Surfperch



Impairment of Ecological Function

The important functions of the reef shall not be impaired by undesirable or invasive benthic species (e.g., sea urchins or *Cryptoarachnidium*)



Ecological Functions of interest include:

- Benthic food-chain support
- Primary production by giant kelp



Monitoring Period

- No less than the full operating life of SONGS plus years monitored without the project attaining compliance with permit standards.
- The level of sampling can be reduced to annual site inspections after 10 years if the performance standards have been met for the preceding 3 years.
- The reef mitigation requirement will be fulfilled when the performance standards are met for a period equal to the total years of operation of SONGS Units 2 & 3, including decommissioning period to the extent that there is continuing discharge of cooling water.