HOW ROCKY INTERTIDAL MONITORING IN THE MONTEREY BAY NATIONAL MARINE SANCTUARY INFORMS NATURAL RESOURCE DAMAGE ASSESSMENTS: A CASE STUDY OF THE COSCO BUSAN OIL SPILL

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INTRODUCTION

A persistent problem in assessing impacts to biological communities resulting from oil spills is the general scarcity of baseline data that can be used to address natural temporal and spatial variation in measured parameters. The Cosco Busan oil spill provides a case study for this issue. It occurred on November 7, 2007 and spilled approximately 58,000 gallons of bunker fuel into the San Francisco Bay (Fig. 1), oiling approximately 200 miles of coastline (Inset, Fig. 3).

Figure 1. Photo showing damage sustained to Cosco Busan when the ship collided with the Bay Bridge.

Figure 2. The area between the baseline, impact and recovery lines quantifies the injury.

Immediately following the spill, the National Oceanic and Atmospheric Administration (NOAA) began the process of Natural Resource Damage Assessment (NRDA). Injury graphs (Fig. 2) are used by the NRDA to assess damage due to an oil spill. Baseline data play a vital role in determining possible injury, by providing a pre-spill characterization of the communities, and aiding in differentiation between natural fluctuations and impact from the oil spill.

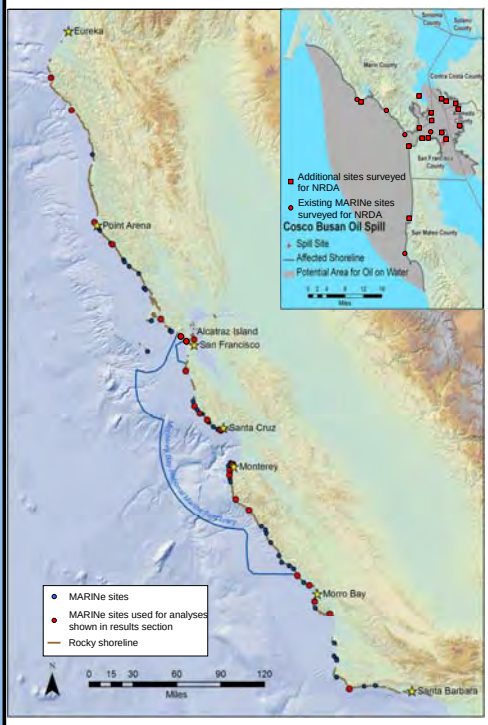

Figure 3. Dots on the main map are the 72 MARINe monitoring sites between Eureka and Santa Barbara. Map inset shows the area impacted by Cosco Busan spill and sites surveyed for NRDA.

In the 1980's, a long term rocky intertidal monitoring program (now called the Multi-Agency Rocky Intertidal Network or MARINe) was established to create a baseline dataset that could be used in the event of an oil spill. The largest program of its kind, MARINe monitors over 130 sites along the west coast of North America and parts of the east coast, including sites within the Monterey Bay National Marine Sanctuary (MBNMS) (Fig. 3). Core Monitoring (targets algal and sessile invertebrate assemblages as well as species of special interest) and biodiversity sampling provide information about how assemblages and communities change over time.

Bays are highly vulnerable to oil spills due to high tanker and barge traffic, yet rocky intertidal monitoring is largely absent. Alcatraz was one of the only established monitoring sites in San Francisco Bay at the time of the spill. MARINe data from Alcatraz and other monitoring sites were useful in assessing the affects of the Cosco Busan oil spill on the rocky intertidal communities within the San Francisco Bay.

APPROACHES

1. **Assessment across locations (spatial)**
   - Do communities at locations vary as a function of
     - Oiling, powerwashing, or substrate
   - Effects at level of individual (*Fucus* size structure)

2. **Assessment within locations (temporal)**
   - Do communities vary between pre-spill and post-spill periods at Alcatraz
     - Alcatraz was the only MARINe site oiled (heavily) in the bay

RESULTS

1. Spatial Assessment

- This approach provided inconclusive and statistically insignificant results.

2. Temporal Assessment (included sites within the MBNMS)

Changes at Alcatraz point to a disturbance in 2007 and seem to indicate that it was an oil spill (Fig. 4,5).

- Long lived species like *Fucus* decreased in the post-spill period (Fig. 4,5,6).
- Opportunistic species like *Ulva* and *Porphyra* increased (Fig. 4,5,6).
- Oil / tar sheen exhibit the opposite pattern of rock and barnacle cover (Fig. 4).

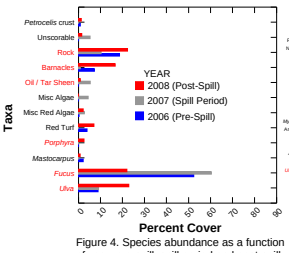

Figure 4. Species abundance as a function of year; pre-spill, spill period and post-spill. This is data from Core monitoring photo plots at Alcatraz. Key indicator species are in red.

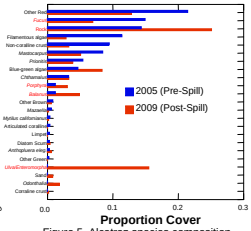

Figure 5. Alcatraz species composition from 2005 (pre-spill) and 2009 (post-spill) Coastal Biodiversity Surveys. Key indicator species are in red.

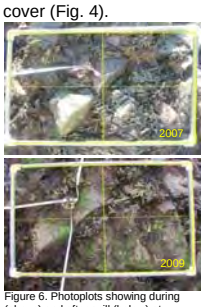

Figure 6. Photoplots showing during (above) and after spill (below) at Alcatraz.

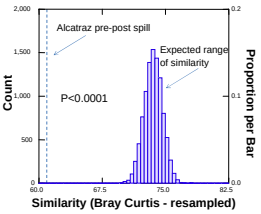

Figure 7. Mean similarities among 27 sites sampled twice between 2000 and 2009 compared to the similarity at Alcatraz.

Species composition from biodiversity surveys at Alcatraz was compared to 27 sites within the same biogeographic region but outside the influence of the spill (Fig. 7).

- Similarity of species composition for Alcatraz between pre-spill and post-spill periods falls outside of the expected distribution.
- Variation seen is more than would be expected by natural variation alone, indicating an anthropogenic disturbance.

To test the idea that these changes might be due to a natural change in the community, Alcatraz was compared to five reference sites outside the influence of the spill (Fig. 8).

- Predictions of how different species would respond to an effect of oiling were made.
- In all cases the data supported these predictions.

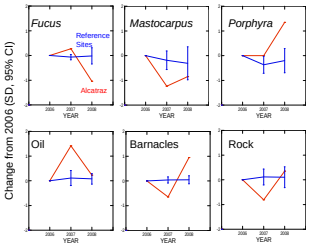

Figure 8. Change in the standard deviation of species abundance relative to 2006 at Alcatraz (red) compared to 5 reference sites (blue). Based on Core monitoring photo plots. 2006 is pre-spill, 2007 is during spill, and 2008 is post spill.

CONCLUSIONS

1. Estimates and predictions must rely on existing data sets.
2. Flexible approaches to analyses are often needed for sufficient power to detect natural variability and to make strong conclusions concerning impact or potential for recovery.
3. "Highly Vulnerable Areas" that have high tanker and barge traffic need to be included in long term monitoring programs.

RECOMMENDATIONS FOR FUTURE WORK

1. Long term rocky intertidal monitoring programs need to be established in bays, such as San Francisco and Puget Sound.
2. Post spill, continued monitoring is needed to see if there is a lag effect.
3. Monitoring invasive species after a spill may be important since they could outcompete native species.

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