Moss Landing Power Plant Thermal Outfall Studies

Choy, S.J., A.P. DeVogelaere, S.I. Lonhart
Monterey Bay National Marine Sanctuary, 299 Foam Street, Monterey, California 93940

Introduction: The Moss Landing Power Plant (MLPP) began operation in 1950. The natural gas-fired power plant generates 2,560 megawatts of electricity, enough to provide power for 2.5 million homes. Cooling operations are vital to the safe functioning of the power plant (one of California's largest), and requires large quantities of ocean water for thermal regulation. Sea water is taken in through intake structures located in Moss Landing Harbor, routed through the MLPP, and finally discharged into Monterey Bay via two outflow pipes extending 200m offshore. Discharge into the Monterey Bay is estimated to be 4.56 billion liters (120 millions gallons) per day. As a consequence of cooling operations, water exiting the outflow pipes are generally warmer than ambient ocean water, resulting in what is known as thermal outfall.

This poster presents an overview of research projects initiated to understand the impacts of the MLPP thermal outfall on local marine fauna, and the broader environmental implications of the thermal discharge. It is possible that because the thermal outfall is located at the head of the Monterey Canyon (see bathymetry in Figure 3), and at the mouth of the Elkhorn Slough, thermal impacts are minimal.

Figure 1: Satellite imagery of the Moss Landing Harbor. (Image: Google Earth)

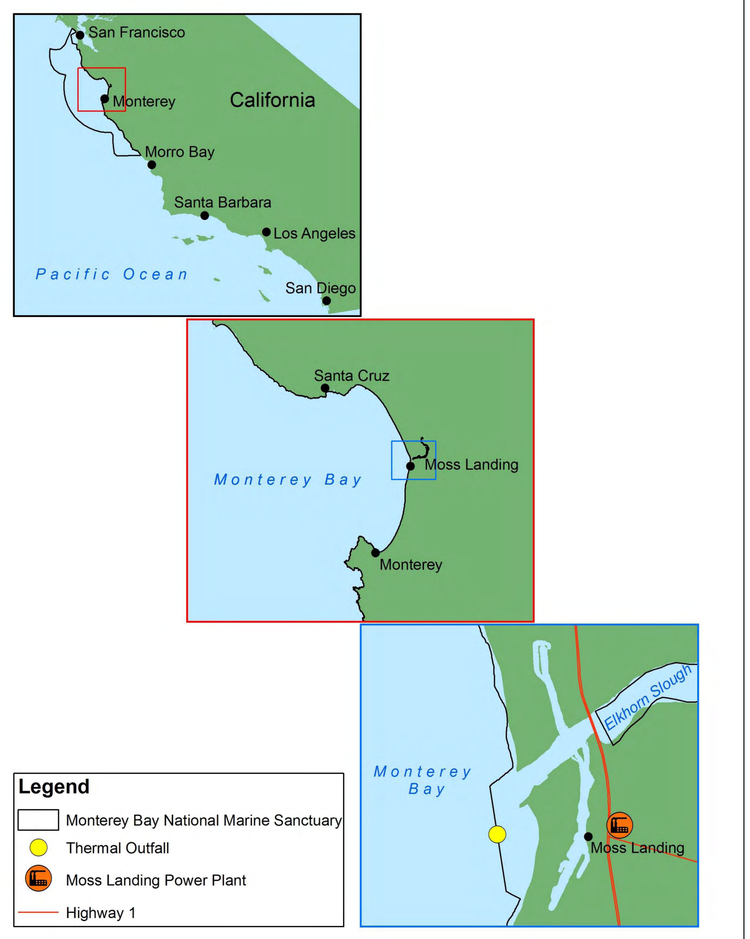


Figure 2. Location of the Moss Landing Power Plant and thermal outfall.

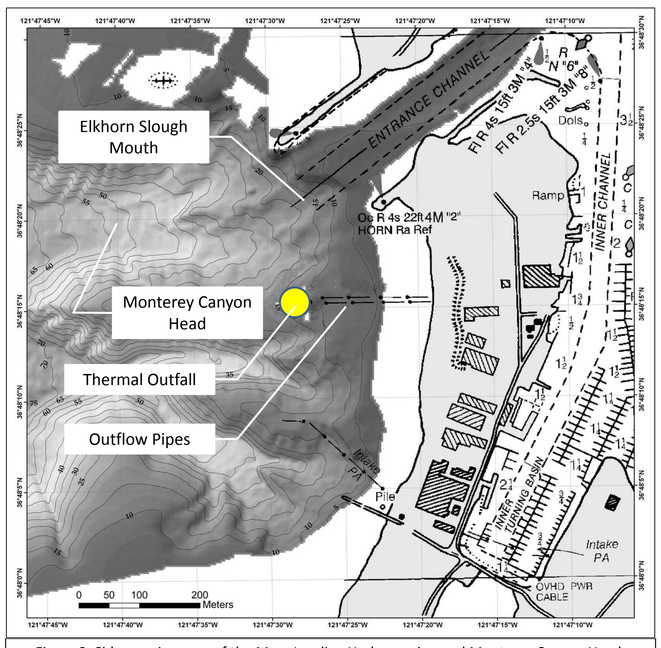


Figure 3: Sidescan imagery of the Moss Landing Harbor region and Monterey Canyon Head. (Image: Eric Niven, Center for Habitat Studies, MLML; Published in Ferry-Graham et al., 2009)

Figure 4: Aerial view (looking south) of Moss Landing Harbor. (Photo: Jeffrey Paduan, Naval Postgraduate School)

Ecological Effects of the Moss Landing Thermal Discharge (Oliver et al., 2006)

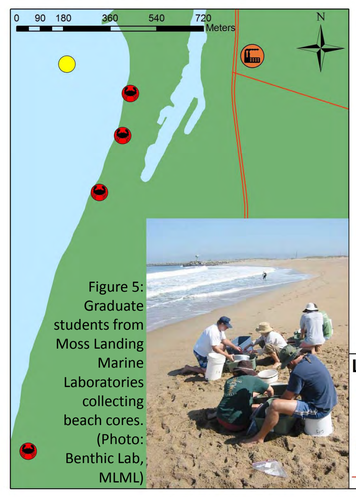


Figure 5: Graduate students from Moss Landing Marine Laboratories collecting beach cores. (Photo: Benthic Lab, MLML)

The goal of this study was to assess potential impacts of the thermal outfall at an ecosystem scale. In order to address this issue, researchers sampled phytoplankton and bacteria, benthic invertebrates, fish, and sea birds at 4 sites in the Moss Landing area. Results of the study show that:

1) Phytoplankton production will be inhibited and bacteria production will be enhanced due to entrainment.

2) No significant impacts of the thermal outfall on benthic invertebrates (intertidal or shallow-subtidal) were detected.

3) Bat rays were observed congregating around the site of the thermal outfall, which may be a result of thermoregulatory behavior.

4) Certain species of sea birds and marine mammals appeared to be more actively utilizing the thermal outfall site for foraging relative to non-outfall sites, however no negative impacts were observed.

Fish Surveys at the Moss Landing Power Plant Outfall (Ferry-Graham et al., 2009)

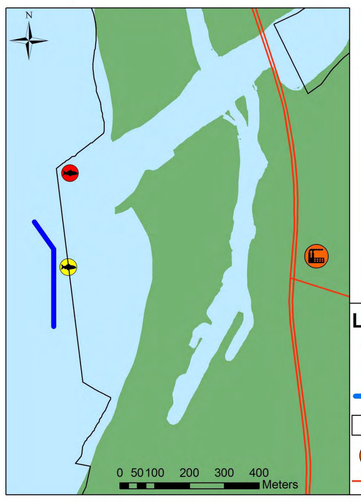


Figure 6: Bat rays (*Myliobatis californica)* have been observed congregating near the MLPP thermal outfall pipes. (Photo: NMFS)

The purpose of this study was to characterize the assemblages of fishes near the thermal outfall site of the Moss Landing Power Plant using top-side visual assessments, mid-water trawl surveys, and SCUBA transects. Visual surveys revealed a number of bat rays (Figure 7), mid-water trawls brought up almost exclusively jellyfish, and SCUBA surveys revealed a few fish and several invertebrate species generally associated with benthic habitats. No direct deleterious impacts from the thermal outfall itself were noted.

A comparison of discharge plumes from Elkhorn Slough and the Moss Landing Power Plant (Fischer, 2006)

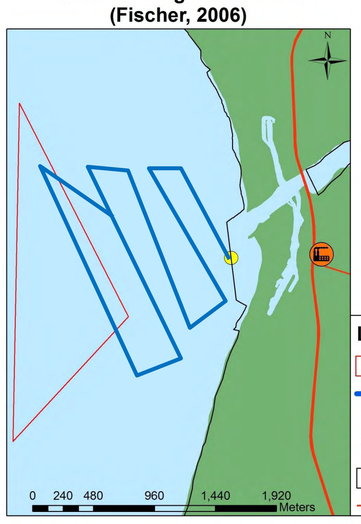


Figure 7: Aerial view (looking north east) of Moss Landing Harbor. Note the clearly visible thermal outfall from the MLPP. (Photo: Wikipedia)

This project sought to compare the natural thermal outfall produced by the Elkhorn Slough to the anthropogenic thermal outfall produced by the Moss Landing Power Plant. Data were collected both remotely and onsite using a variety of technologies, ranging from weather buoys to infrared imaging. Results indicate that while the temperature gradient produced by the MLPP is larger, the overall thermal contribution from the Elkhorn Slough is greater. Thermal imagery shows no distinction between the thermal outfalls during high tide suggesting that some mixing occurs, but imagery taken during low tide clearly shows the Elkhorn Slough thermal outfall. (Figure 8).

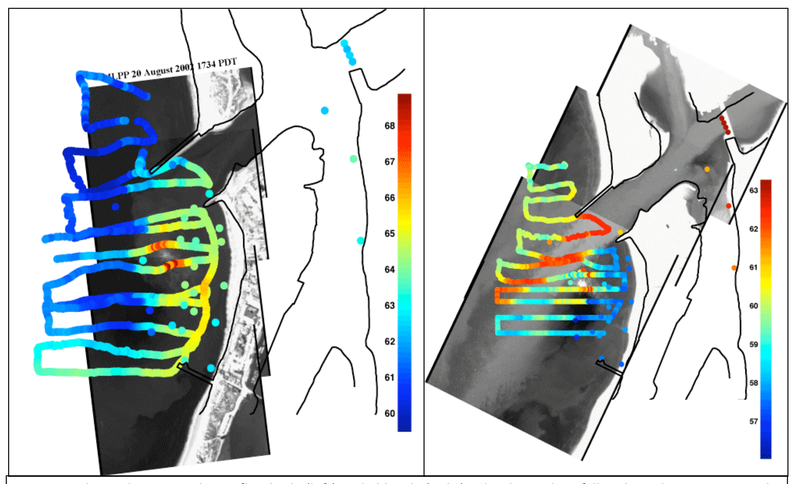


Figure 8: Thermal imagery during flood tide (left) and ebb tide (right). The thermal outfall in the right pane is a result of shallow water in the Elkhorn Slough that is warmed by the Sun. (Image: Jeffrey Paduan, Naval Postgraduate School)

Analysis of mussels collected near the Moss Landing Power Plant thermal outfall (Ichikawa et al., 2009)

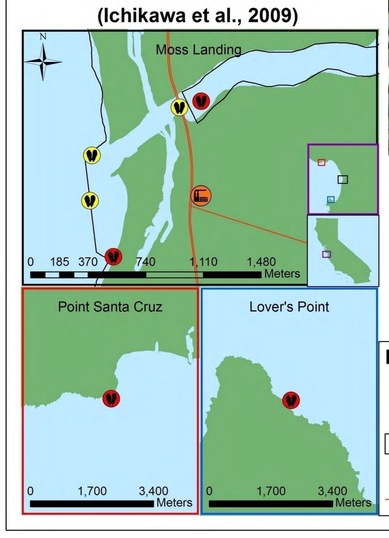
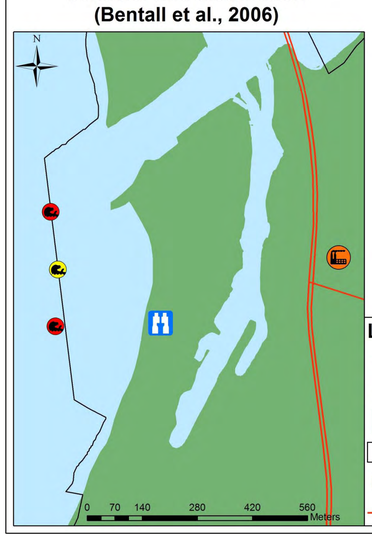


Figure 9: California mussels (*Mytilus californianus*). (Photo: Steve Lonhart)

As a part of NOAA's Mussel Watch program, mussel sampling sites were established in Monterey Bay. In 2006, sampling sites were added in Moss Landing to compare samples from original Mussel Watch sites to samples collected near the MLPP thermal outfall. An initial analysis of the results show that only concentrations of Cadmium (Cd) were found to be higher at the thermal outfall sites compared to the 20 year averages of the initial Mussel Watch sampling sites. Other contaminants were not found to be concentrated at the outfall.

The effect of the MLPP thermal discharge plume on sea otter behavior and distribution (Bentall et al., 2006)



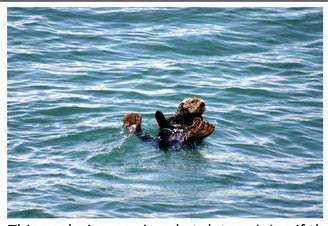


Figure 10: Sea otter (*Enhydra lutris nereis*). (Photo: Josh Pederson)

This analysis was aimed at determining if the presence of the MLPP thermal outfall alters the behavior of sea otters. These potential changes in behavior were documented using visual observations through spotting scopes (Figures 10 & 11). Initial analysis of the results show that sea otters do not appear to be preferentially using the outfall area as opposed to non-outfall areas, however, a visual inspection of the raw data suggests that otters utilizing the outfall area are feeding on prey associated more with hard-bottom substrate than otters in non-outfall areas, which are feeding more on prey commonly found in soft-bottom habitat.

Figure 11: View from MBARI observation deck where researchers made notes of sea otter behavior. (Photo: Steve Lonhart)

References

Bentall, G., T. Tinker. 2006. "The Effect of Moss Landing Power Plant Thermal Discharge Plume on Sea Otter Behavior and Distribution." A report submitted to the Monterey Bay National Marine Sanctuary Sanctuary Integrated Monitoring Network (SIMoN) and Monterey Bay Sanctuary Foundation.
Fischer, A. 2006. "A comparison of discharge plumes from Elkhorn Slough and the Moss Landing Power Plant." A report submitted to the Monterey Bay National Marine Sanctuary Sanctuary Integrated Monitoring Network (SIMoN) and Monterey Bay Sanctuary Foundation.
Oliver, J., N. Welschmeyer, J. Harvey. 2006. "Ecological Effects of the Moss Landing Thermal Discharge." A report submitted to the Monterey Bay National Marine Sanctuary Sanctuary Integrated Monitoring Network (SIMoN) and Monterey Bay Sanctuary Foundation.
Ferry-Graham, L., G. Cailliet, B. Perlman. 2009. "Fish Surveys at the Moss Landing Power Plant Outfall." A report submitted to the Monterey Bay National Marine Sanctuary Sanctuary Integrated Monitoring Network (SIMoN) and Monterey Bay Sanctuary Foundation.
Ichikawa, G., J. Negrey, S.I. Lonhart, S.J. Choy. 2009. "Analysis of mussels collected near the Moss Landing Power Plant thermal outfall." Unpublished data.