Generator cooling water effluent restriction effects of Oyster Creek Generating Station closure on the Barnegat Bay fish, crab, and infaunal invertebrate community

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What was the purpose of the study?

The Oyster Creek Nuclear Power Generating Station (hereafter referred to as the "plant") in Forked River, Lacey Township, NJ, closed in September of 2018. This closure caused a 95% reduction of water flow throughout the canal system used to cool the plant. Prior to closure, cooling water was drawn from and discharged back into Barnegat Bay near Barnegat Inlet, creating a heated water effluent plume with the potential to affect the thermal ecology of cold-blooded fish and invertebrates. Closure of the plant provided an opportunity to investigate ecosystem and biotic community response to shifting temperature and flow gradients pre- and post-closure. This study looked at determining the changes associated with the closure of the plant on the fish and macroinvertebrate communities to assess whether the closure resulted in improved ecological conditions and supported the recovery of Barnegat Bay after this perceived stress.

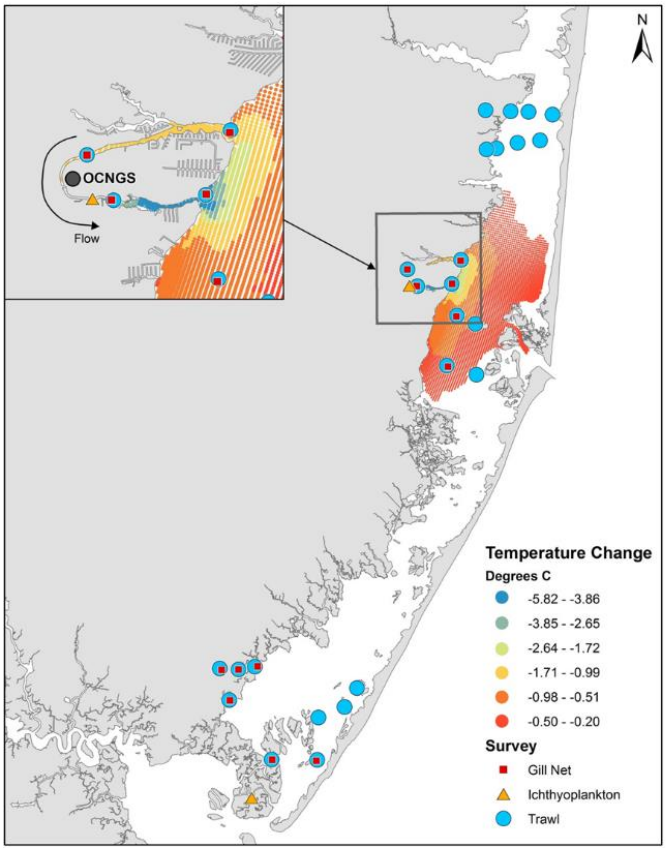

Figure 1. Location of Oyster Creek Nuclear Generating Station in Barnegat Bay, NJ. Colored gradients depict the change in water temperature cooling due to the decrease of thermal discharge.

What was the general approach to the study?

This study took place in Barnegat Bay (Figure 1) using a sampling template from two comprehensive 3-year studies of fishes and crabs (see Valenti et al. 2017 and Jivoff et al. 2017 for site templates, respectively). Samples collected in the current effort (2018-2021) were compared with previously collected samples of fish, crabs, and invertebrates from as far back as 2012 for

comparison in a Before/After Control/Impact design (for fishes and crabs) and a Before/After/Gradient design (for benthic infauna).

Four types of sampling equipment/procedures were used throughout this study, including a) sampling larval fish stages using a plankton net, b) sampling settled juvenile and small adult species using an otter trawl net, c) sampling large mobile fish using gill nets, and d) sampling crabs using traps. Ultimately, these techniques were used to determine (and compare) abundance/distribution (for fishes, crabs, and benthic infauna), assemblage change (for fishes and invertebrates), and size (for fishes) at different life stages between reference and impacted sites, before and after closure of the plant.

Overall, what did the studies show?

The primary conclusion drawn from comparing the pre- and post-closure data sets is that fish and crab communities were minimally affected by the plant and shutdown; observed shifts in size or assemblage were generally due to other sources of variation, including habitat, seasonal, interannual changes, and location among the control sites. As an example, Figure 2 shows two commonly collected species of fish in the otter trawl portion of the study where significant differences in size were measured due to the plant influence. Northern pipefish were larger in the vicinity of the plant throughout the entire study (before and after shutdown). Bay anchovies were smaller in the vicinity of the plant only before the shutdown (size increased after shutdown). While abundance appears to have shifted, the shifts identified in many species are more strongly correlated to the other environmental metrics identified above. Definitive statements regarding the health of these populations can't be made based solely on size and assemblage metrics.

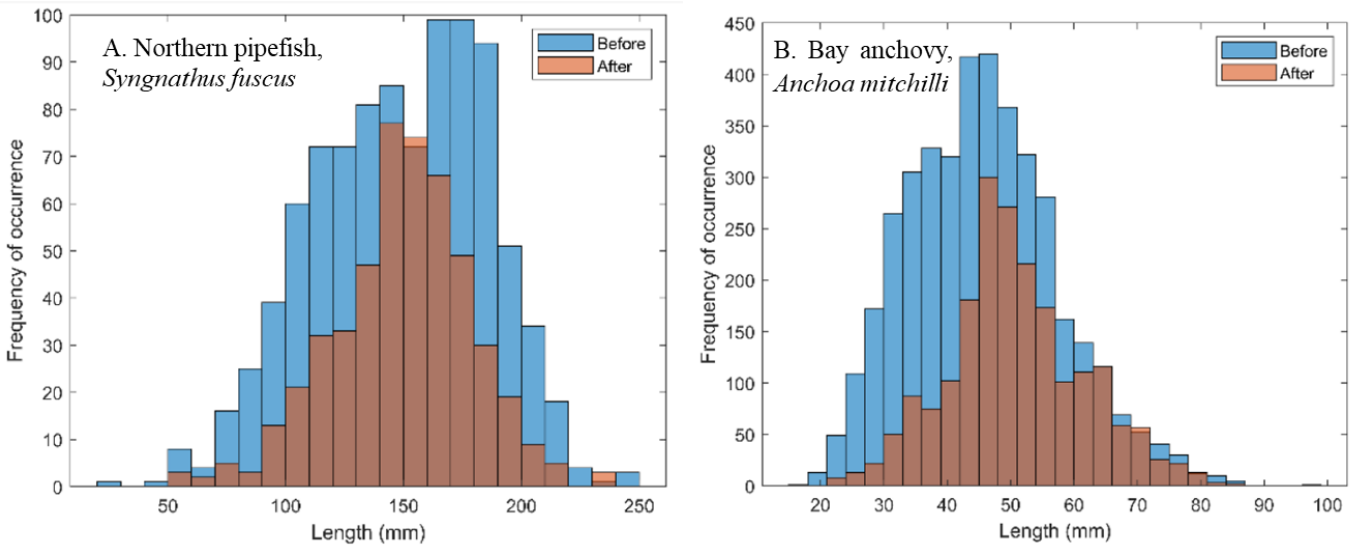

Figure 2. Length frequency distribution of A. Northern pipefish and B. Bay anchovy before and after OCNGS Shutdown.

For invertebrates, the diversity metrics were slightly elevated in the vicinity of the plant after closure but this increase in diversity tapered off as distance from the plant increased (Figure 3). The strongest correlation between biota and the heat plume associated with the plant was the greater abundance of ovigerous female crabs inside the plume during May (before closure), suggesting the elevated temperatures attracted and stimulated brood production earlier in the reproductive season. Overall, the strength of effects and the confidence in their measure was dependent on species and life stage, and for some there were no measurable effects. This is to say

that the influence of the plant on biotic metrics was generally weaker than the other measured variables in the Barnegat Bay system.

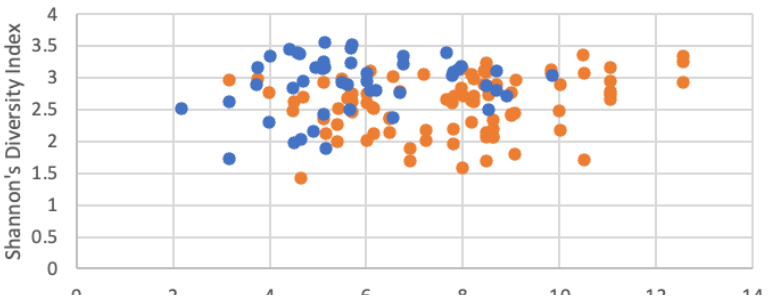

Figure 3. Shannon's diversity index for benthic macroinvertebrates relative to distance from the plant before and after closure. After closure, diversity improved near the plant, but this pattern decreases with increasing distance from the plant.

How will DEP use the data?

Fish and invertebrate species abundance and distribution data will be used to further understand seasonal and interannual population changes in Barnegat Bay. This research, along with other studies conducted concurrently to examine the ecological and biological effects of OCNGS and its closure, are the first of their kind looking at pre- vs. post-closure impacts of a nuclear power plant on a coastal/estuarine system. Local and regional shifts in temperature and water quality, due to climate change and other anthropogenic impacts, are likely to impact different species and community dynamics at a larger scale than the local influence of the OCNGS. Understanding these impacts can assist in the development of guidance to protect commercial and recreational fisheries from these impacts at a broader scale, as well as be used to inform future management decisions as populations shift due to anthropogenic impacts.

Please review the full report for more detailed information at
https://dspace.njstatelib.org/xmlui/handle/10929/113134

For additional information or questions regarding this study, please contact Daniel Millemann (dan.millemann@dep.nj.gov) in the NJDEP Division of Science and Research.

References:

Jivoff, Paul R., et al. "Population structure of adult blue crabs, Callinectes sapidus, in relation to physical characteristics in Barnegat Bay, New Jersey." Estuaries and Coasts 40 (2017): 235-250.

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