Division of Science and Research

Research Project Summary

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*A Pilot Trap Survey of Artificial Reefs in New Jersey for Monitoring of Black Sea Bass, Tautog, and American Lobster**

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Abstract

The data generated from this research were used to characterize the seasonal and spatial variation in community composition and relative abundance of structure-associated species on artificial reefs along the coast of New Jersey. These results also provided the information necessary to design a statistically robust trap survey for three targeted recreational and commercial important fish species (Black Sea Bass, Tautog and American lobster). This research provides immediate utility for New Jersey fishery managers through a characterization of seasonal changes in the fish and invertebrate communities inhabiting two existing artificial reefs (Sea Girt and Little Egg Inlet Reefs) and one artificial reef site from pre-construction through construction (Manasquan Inlet Reef). In addition, data on the targeted species and other species (Scup, Jonah crab and rock crab) were generated for a comparison of fish and invertebrate abundance that utilize different artificial reef material, including metal, concrete, and sand. These data are necessary in the development of reliable and efficient trap surveys that can stand up to the rigorous peer review process associated with stock assessments.

Introduction

Three of the most important target species of commercial and recreational fisheries in New Jersey, Black Sea Bass (BSB), Tautog, and American lobster, are structure-associated species that may not be sampled effectively by existing scientific trawl surveys. This project was developed to meet the needs of the NJDEP Marine Fisheries program for these species. Information about stocks of Scup, Jonah crab, and rock crab, which are targeted by recreational or commercial fisheries, is extremely valuable as well. Because hard structure grounds are generally avoided by vessels fishing with bottom trawls, stock assessment scientists and fishery managers have long recognized the need for trap or other fixed-gear surveys to monitor populations of such structure-associated species. As a result, the reliability of current scientific bottom trawl surveys for providing an index of relative abundance for these species is uncertain. However, a concern relevant to any fixed gear survey is the ability of that survey to provide a reliable index of relative abundance. That is, if the abundance of a target species in the greater vicinity of the survey doubles, the survey catch-per-unit-effort (CPUE) should also double. This should be true regardless of the absolute level of abundance or a consistent linear relationship between the survey CPUE and actual abundance. Unfortunately, in practice, trap survey indices often show both random noise as well as some degree of non-linearity in relation to abundance. When the processes leading to noise and non-linearity are understood, the survey CPUE can be corrected for these effects. One source of both noise and non-linearity in trap surveys could be "soak time trap saturation", where only a finite number of individuals would enter or can fit inside a trap. Other sources include "priority effects", where the presence of one organism in a trap alters the subsequent catch rate either positively or negatively, depending upon the species involved.

The relative lack of natural hard bottom off the New Jersey coast has driven the development and expansion of a large artificial reef program including 15 federally permitted reef sites containing more than 4,000 patch reefs. Relative to the importance of these reefs to New Jersey's recreational fisheries and diving industry, there has been little in the way of scientific studies focused on understanding their ecology or evaluating their effectiveness at increasing productivity of target species. As development of New Jersey's artificial reef network continues, a key question is which materials provide the highest catch rates of target species. While there are many different factors including cost and durability that determine which materials are best for artificial reefs, the ultimate goal is to enhance habitat and fishing opportunities. The two most widely utilized classes of artificial reef materials are concrete, including reef balls, castings, and demolition concrete, as well as primarily metal structures, including steel-hulled ships and tanks and stainless-steel subway cars. Overall, the performance of different materials in attracting and retaining target species of commercial and recreational fisheries remained unexamined.

Methods

The project focused on three artificial reefs off New Jersey coast (Figures 1 and 2): Sea Girt Reef, Little Egg Reef, and Manasquan Inlet Reef during 2016-2018 seasons. A total of 42 traps were deployed at the Sea Girt and Little Egg Reefs, 6-12 traps at the Manasquan Inlet Reef site during different stages of reef construction. Six traps were deployed on each of three bottom types (soft, concrete structure, metal structure) at Sea Girt and Little Egg Reefs and 12 traps at preconstruction of the Manasquan Inlet Reef on soft bottom. After construction, one trap was deployed on the new metal structure and two traps were deployed on the new concrete structures. Traps on soft bottom were randomly selected from within a buffer strip 1-3 km from the artificial reef. Two to four additional traps were deployed at each site to provide data for spatial autocorrelation. Traps were deployed for three survey periods: spring survey in March-April, summer survey in June-August, and fall Survey in October-November. A winter survey was rejected due to logistical difficulties, severe weather conditions, and BSB migration offshore to deeper water in the winter. The spring and fall surveys were timed to capture the arrival and departure of BSB. Traps were deployed, sampled and retrieved for a duration of four weeks each season. To assess trapping effectiveness, soak time and priority effects experiments were conducted at Sea Girt Reef and Little Egg Inlet Reef respectively, as was shell disease monitoring and the Before-After Control-Impact (BACI) study on Manasquan Inlet Reef.

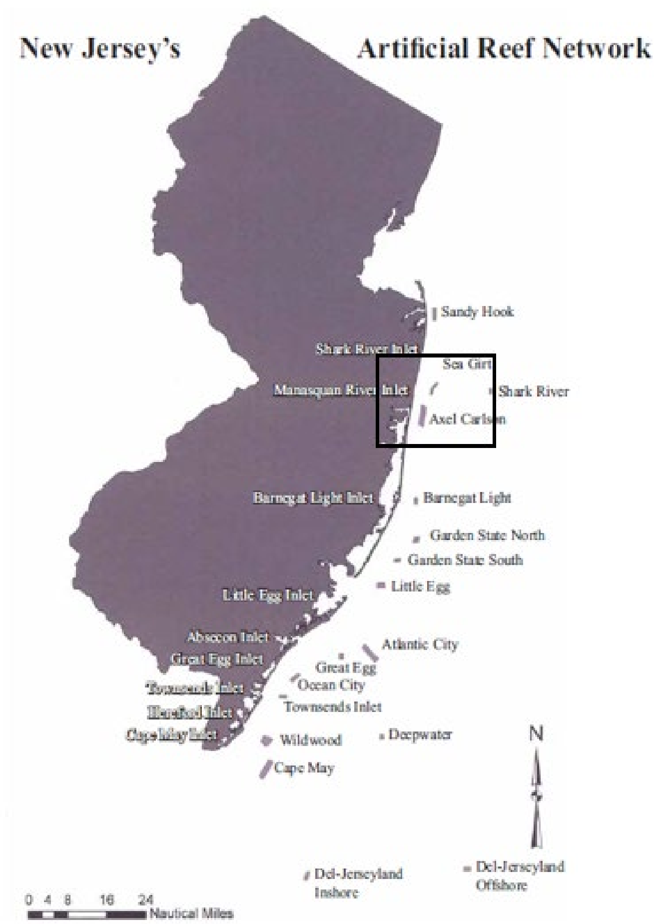

Figure 1. Location of reefs off the New Jersey Coast. See Figure 2 for detail of the area near Manasquan River Inlet.

Results

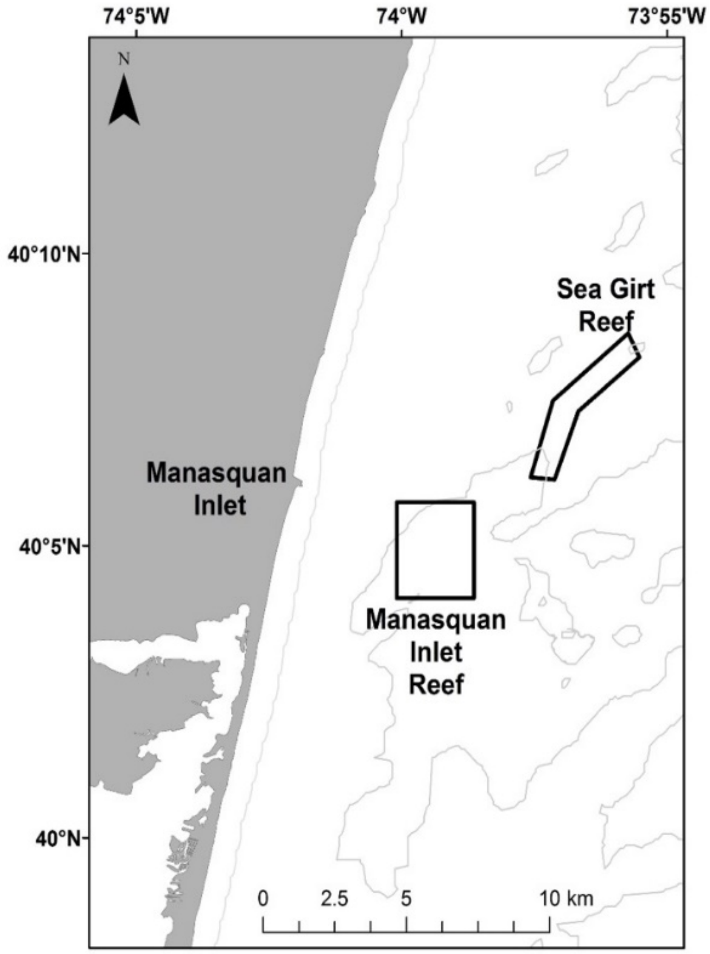

Figure 2. Location of the Manasquan Inlet Reef and Sea Girt Reef

The following are results from the data collected during seasonal monitoring and experiments on Little Egg Inlet Reef, Sea Girt Reef, and Manasquan Inlet Reef from 2016-2018.

Seasonal Monitoring: Tautog, BSB, and American lobster catches varied spatially (Figure 3). Overall, BSB catch was significantly higher on Sea Girt Reef than on either Little Egg Inlet Reef or Manasquan Inlet Reef. Tautog catch was highest on Sea Girt Reef, intermediate on Little Egg Inlet Reef, and lowest on Manasquan Inlet Reef. American lobster catch was highest on Manasquan Inlet Reef, intermediate on Little Egg Inlet Reef, and lowest on Sea Girt Reef. Separating mean catch per unit effort (CPUE) by year saw similar general seasonal trends each year, with some interannual variation. BSB CPUE peaked in the summer and was relatively low in both spring and fall across both reefs and all three years. Lobster CPUE was lowest in the spring and high in the summer for both reefs across all three years; however, it varied in the fall. Tautog CPUE showed the greatest amount of inter-reef and inter-annual variation. At Sea Girt Reef, Tautog CPUE was lowest in the spring but similar in the summer and fall, except in 2018 when fall Tautog CPUE was higher than summer. At Little Egg Inlet Reef, Tautog CPUE in 2016 and 2017 was low in both spring and summer and peaked in the fall, but in 2018, Tautog CPUE there was low in both spring and fall and peaked in the summer.

The catch of BSB, Tautog, and American lobster also varied temporally (Figure 2). BSB catch was highest in the summer season on all three reefs. On Little Egg Inlet Reef and Manasquan Inlet Reef, catch of BSB was intermediate in the fall and lowest in the spring. In contrast, on Sea Girt Reef, BSB catch was intermediate in the spring and lowest in the fall. Tautog catch was highest in the fall season on all three reefs. On Little Egg Inlet Reef and Manasquan Inlet Reef, there was no significant difference in the catch of Tautog between spring and summer. On Sea Girt Reef, tautog catch was significantly higher in the summer than in the spring. Lobster catch was lowest in the spring on both Little Egg Inlet Reef and Sea Girt Reef and there was no significant difference in lobster catch between summer and fall on either Little Egg Inlet Reef or Sea Girt Reef. On Manasquan Inlet Reef, lobster catch was highest in the summer and there was no difference between spring and fall catch rates.

The catch of BSB, Tautog, and lobster varied by different substrate types: metal, concrete, and sand. BSB catch rates showed no consistent pattern between the three reefs. BSB catch was highest on concrete at Little Egg Inlet Reef, sand at Sea Girt Reef, and metal at Manasquan Inlet Reef. BSB catch was lowest on sand at both Little Egg Inlet Reef and Manasquan Inlet Reef and lowest on metal on Sea Girt Reef. With the exception of Manasquan Inlet Reef, there was no difference in mean Tautog CPUE between metal and sand structures. Tautog CPUE was consistently higher on structure (metal or concrete) sites than on sand sites at all three reefs. There was no consistency in which structure type (metal vs. concrete) had the highest Tautog catch. Tautog catch was highest on metal structure at Little Egg Inlet Reef, highest on concrete at Manasquan Inlet Reef, and on Sea Girt Reef there was no significant difference between Tautog catch on metal and concrete sites.

There was no consistent pattern in the catch of lobster from different substrates across reefs. Lobster catch was lowest on sand sites on Little Egg Inlet Reef, equivalent across all substrate types on Sea Girt Reef and highest on sand sites on Manasquan Inlet Reef. There was no significant difference between lobster catch on metal or concrete sites on any of the reefs.

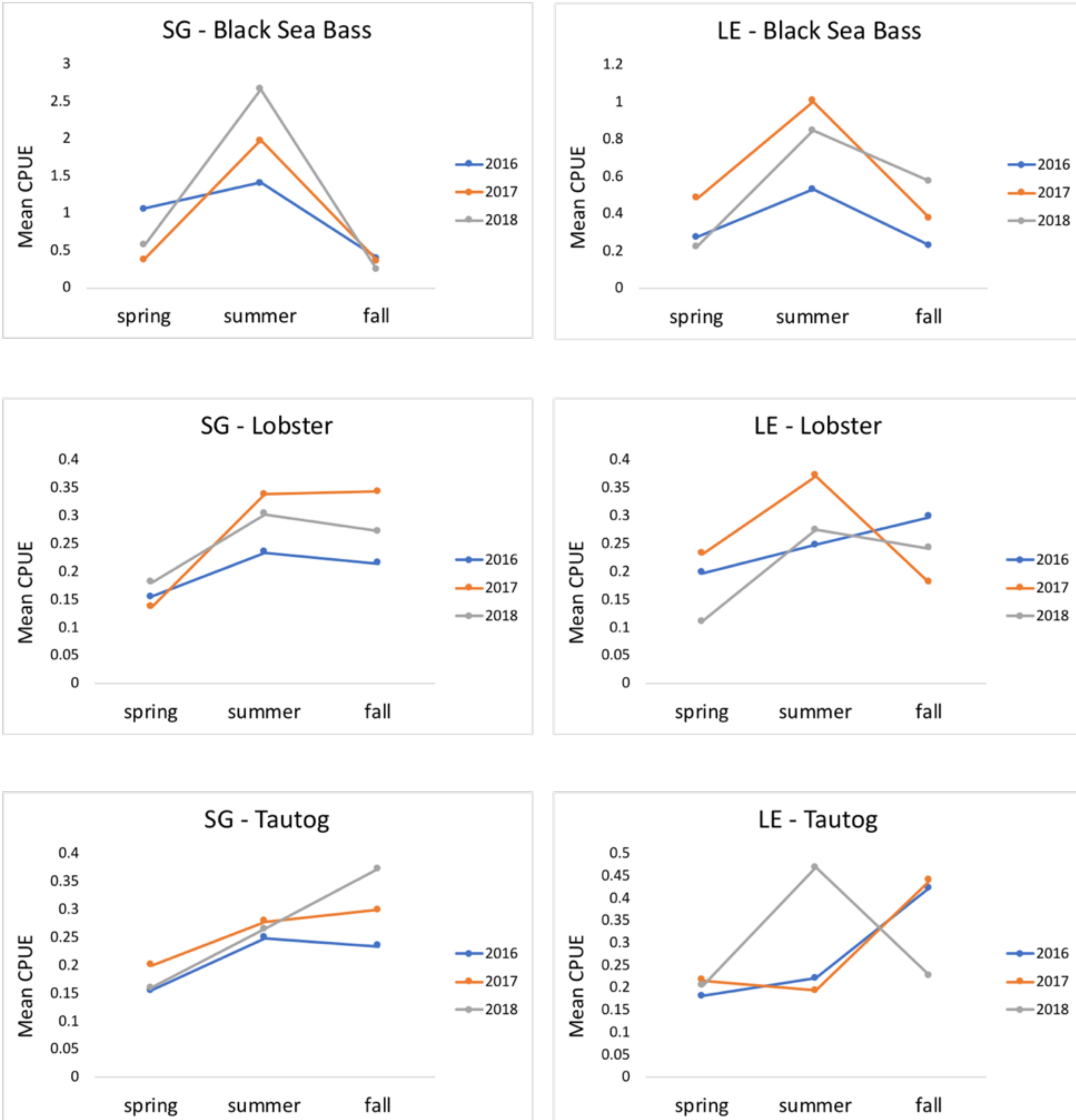

Figure 3. Seasonal variations in mean catch per unit effort for Black Sea Bass, American lobster, and Tautog at the Sea Girt (SG) and Little Egg Inlet (LE) reefs.

Discussion

Priority Effects Experiment on the Little Egg Inlet Reef: Trap CPUE data exhibited evidence of priority effects; the presence of some species in the trap influenced the catch of other species. Lobster seeded traps caught significantly more lobsters and significantly fewer Jonah crabs than either control or Tautog seeded traps. Both seeded treatments caught fewer BSB than the control traps. Tautog catches were very low in all treatments and no significant differences between treatments were detected. The lobster seeded traps were divided into traps seeded with male and female lobsters. Regardless of the sex of the seed lobster, traps seeded with lobsters caught more lobster than the control traps. Traps seeded with male lobster caught significantly fewer Jonah crabs; however, Jonah crab catch in traps seeded with female lobsters was not significantly different from control traps. Neither BSB nor Tautog showed a significant difference in CPUE between male lobster seeded, female lobster seeded, and control traps.

Soak Time Experiment on Sea Girt Reef (June 2016): Traps were deployed for 1 day (n=17), 2 days (n=18), 3 days (n=12), 5 days (n=18), or 7 days (n=17). The mean number of BSB in the catch increased from 1 day to 5 days soak time, with a reduction in catch for 7 days soak times. Based on these results, a 5-day soak time appears optimal for BSB. The catches of Tautog (n=15) and lobster (n=14) were both very low during the soak time experiment. For Tautog, catches were highest for 5 days and 7 days soak times, with no evidence of a trap saturation point. No lobsters were caught for 1 day or 2 days soak times but catch increased in time with 7 days having the highest catches. No saturation point was observed.

Shell Disease Monitoring: The prevalence of shell disease varied spatially, temporally, and between lobster, Jonah and rock crab. Overall, Jonah crabs had the highest level of shell disease prevalence (68.5%), while rock crabs had the lowest level (10.4%). No temporal or spatial trend in shell disease prevalence was observed. Shell disease prevalence increased with size for both males and females of all three species. Female Jonah crabs had a lower prevalence of shell disease than males. There was no significant difference in prevalence of shell disease between sexes in American lobsters or in rock crab.

BACI Study on Manasquan Inlet Reef: Construction of the Manasquan Inlet Reef revealed a significant increase in BSB CPUE. Comparing catch before and after the construction of the Manasquan Inlet Reef, the control traps (Sea Girt Reef) had a significant increase in mean CPUE of 0.52 BSB per trap per day and the treatment traps (Manasquan Inlet Reef) had a significant increase in mean CPUE of 1.59 BSB per trap per day. Therefore, the net increase in mean BSB CPUE attributed to the deployment of reef materials was 1.07 BSB per trap, per day. In contrast, lobster CPUE decreased. The control traps had a significant increase in mean lobster CPUE of 0.05. The treatment traps had a significant decrease in mean CPUE of 0.23. Therefore, the net decrease in mean lobster CPUE was 0.28 lobster per trap per day. There was no significant difference in the mean size of BSB caught before and after reef construction. It is important to note that the traps used in these surveys are size selective, and will catch fish large enough to not fit through the trap mesh, but small enough to enter the trap funnel; therefore, a change in the abundance of very small or very large fish would not be detected in the trap survey data.

Conclusions

Seasonal Monitoring (2016-2018): The trap survey seasonal monitoring captured spatial and temporal variation in abundance and community composition, providing useful supplementary information to trawl surveys specifically about the population dynamics within reef areas. Catch rate, both within and between species, varied by reef, season, and substrate, indicating that broad geographic and temporal sampling is necessary for a complete understanding of population dynamics on and around artificial reefs.

Priority Effects Experiment on the Little Egg Inlet Reef (2016): The priority effects experiment demonstrated the influence of the relationship between trap CPUE and true abundance. Trap CPUE may not be linearly related to abundance. Therefore, priority effects are a potential source of bias in trap survey data that could result in hyper-stability or hyper-depletion of the survey index and should be taken into consideration when interpreting survey data. Additional information is needed to identify priority effects in the general seasonal monitoring dataset. An overdispersion assessment of CPUE (i.e., schooling behavior; shared habitat associations, etc.) and more continuous information is needed to connect survey data to hyper-stability or hyper-depletion. A better understanding of this factor would enhance the application of this study to other regions and improve the interpretation of trap survey data on a larger geographic scale. This is an important step toward the development of statistically robust trap surveys that can be used to monitor spatial and temporal trends in marine community composition and inform fishery management.

Soak Time Experiment on Sea Girt Reef (2016): The soak time experiment demonstrated the relationship between trap CPUE and true abundance. The shape of this relationship varies between species, and the saturation point (reached at approximately 5 days) was observed for BSB. Additional experimentation (longer soak times) may improve our understanding of this relationship, which is important for improving trap survey data.

Shell Disease Monitoring (2016-2018): The results of the shell disease monitoring support existing literature that shell disease prevalence increases with size caused by the reduced frequency of molting as size increases. In contrast, these results do not support the existing hypothesis that, after sexual maturity, females will have higher prevalence of shell disease than males due to the lack of molting when they are egg-bearing. Shell disease increases mortality, decreases reproduction, and presents a serious threat to the profitable crustacean fisheries of the Northwest Atlantic. This survey expanded the understanding of shell disease in American lobster and Jonah crabs and provided some of the first shell disease monitoring for rock crabs. Continued monitoring is needed to better understand and predict shell disease prevalence and severity.

BACI Study on Manasquan Inlet Reef (2017-2018): From the current data, it is unclear what impact Manasquan Inlet Reef construction has had on the marine community (slight increase in BSB mean CPUE, slight decrease in mean lobster CPUE, no detectable impact on diversity). The existing data spans seventeen months after initial reef construction; changes in diversity and abundance of the reef community may occur on longer time scales. In addition, the future deployment of additional materials in the reef area will provide increased sample size for structure sites. Continuing to survey Manasquan Inlet Reef in the future will provide a more complete understanding of the impacts of reef construction on the marine community.

* This RPS is summarized from the PI report. Jensen, O.P and D. Zemeckis. 2020. A Pilot Trap Survey of Artificial Reefs in New Jersey for Monitoring of Black Sea Bass, Tautog, and Lobster. Performance Period: January 1, 2016 through April 1, 2019. Submitted to the New Jersey Department of Environmental Protection, Trenton, NJ.

RESEARCH PROJECT SUMMARY

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