Large Fish Distributions among Pier Habitats on the Hudson River Using Dual Frequency Identification Sonar

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BACKGROUND

- Shading under piers potentially affects fish habitat.
- Shading may provide refuge from visually foraging predators, or predators may ambush from shade (Duffy-Anderson and Able 2001).
- Piers negatively affect the growth of some caged juvenile fish, despite ample prey and senses used for foraging (Metzger *et al.* 2001, Duffy-Anderson and Able, 1999, Duffy-Anderson and Able, 2001).
- Larger fish and top predators could not be caged in previous studies, thus information on impacts to these fish is lacking.
- For this work, we examined distribution of large fish (> 240 mm, mainly striped bass, also including Atlantic menhaden, weakfish, and bluefish) under piers, at edges, in open water, and among un-shaded pile fields.
- This study is necessary for gauging pier effect during construction permitting and mitigation.
- We tested H_0: Large fish are randomly distributed among edge, under pier, pile field, and open water habitats.

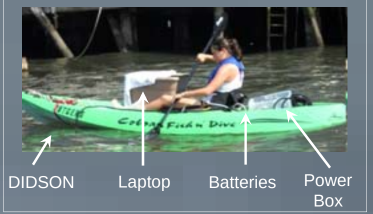

Figure 1. The DIDSON is mounted under the bow of a kayak, which can fit under piers in shallow areas and around pilings. A laptop between the kayaker's knees allows realtime viewing and control.

Dual Frequency Identification Sonar (DIDSON)

- DIDSON uses sound waves to produce echograms.
- Echograms show the subject's depth, size, and approximate shape, using two frequencies (1.8 and 1.1 MHz) at a range of 1 to 30 meters.
- Low light conditions, poor water clarity, and structural challenges make visual systems and nets impractical sampling methods.
- DIDSON computer software was used to record fish length, height, depth, location within the transect, amount of debris, and other details.

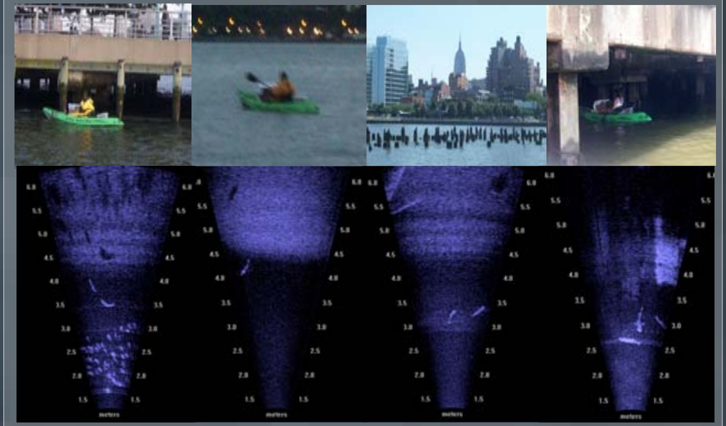

Figure 3a. Small fish follow their larger predators along the edge of a pier.

Figure 3b. Larger fish swimming in the water column in open water.

Figure 3c. Two larger fish swimming amidst a pilefield, with clear debris along the bottom.

Figure 3d. A few striped bass swim away from their school under the pier.

Figure 2. The study site was eight piers along the western shoreline of Manhattan on the lower Hudson River estuary.

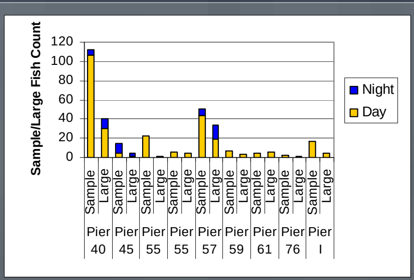

Figure 4. We sampled 235 transects (214 day, 21 night) among 8 piers between September and October 2007, June and October 2008, and June 2009. DIDSON recorded 98 sightings of large fish (70 day, 28 night). Each transect was about 5 minutes long.

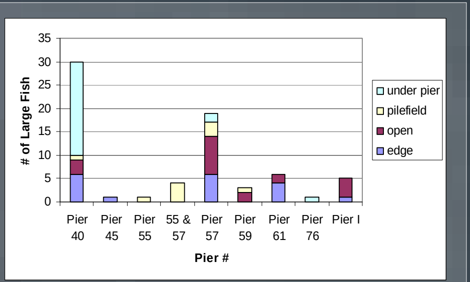

Figure 5. Stacked graph showing the number of large fish found at each habitat, at each pier.

Results

- There was no significant difference in large fish distribution between any of the four habitats (pairwise ANOVA single factor tests, Bonferroni corrected alpha=0.0083) (Table 1).
- Large fish distributions at each habitat during the day were compared to the same location at night, but there was no significant difference (P-values > alpha 0.05) (Table 2).
- The mean number of large fish per sample for four habitats at one pier during the day were compared to the mean number of fish observed at the same pier at night, but there was no significant difference (Figure 6, Table 2).

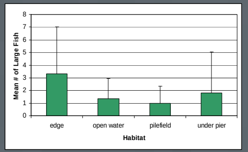

Figure 6. Mean number of large fish at each defined habitat amongst all piers studied was not significantly different.

Habitat Comparison	P-value
Edge/Open	0.3077
Edge/Pilefield	0.2162
Edge/Under	0.6637
Open/Pilefield	0.5139
Open/Under	0.7012
Pilefield/Under	0.5377
edge/open/pilefield/under	0.6662

Table 1. Results of ANOVA single factor test with 95% confidence interval, comparing large fish distributions between habitats, P > 0.0083.

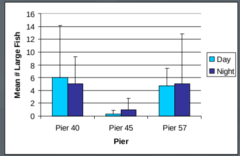

Figure 7. Mean number of large fish during the day and night at piers 40, 45, and 57 during two 24 hour periods were not significantly different.

Day vs. Night Comparison	P-value
Edge	0.1213
Open water	0.4950
Pilefield	0.4226
Under pier	0.8789

Table 2. Results of ANOVA single factor test with 95% confidence interval comparing each habitat during the day versus at night, P > 0.05.

Conclusions

- We could not reject the null hypothesis.
- Day versus night comparisons suggest that shading does not significantly affect large fish distribution along the pier edge. Light data is in the process of being collected at the pier habitats to get more exact information on distribution of fish at various light levels.
- As experience and groundtruthing with DIDSON improves, it will be easier to discern predators from similarly sized forage fish. Our observed effect could break down at the species level. The results for large fish from this study can be compared to previous studies of schools of small fish, and then refined to better define predators, together mapping distribution specific to trophic levels in pier habitats.

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