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 per effect during construction permitting and mitigation.

We tested H: Large fish are randomly distributed among edge, under pier, pile field, and open water habitats.

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 5).

<table>
<thead>
<tr>
<th>Habitat Comparison</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edge/Pilefield</td>
<td>0.967</td>
</tr>
<tr>
<td>Edge/Open</td>
<td>0.716</td>
</tr>
<tr>
<td>Open/Pilefield</td>
<td>0.839</td>
</tr>
<tr>
<td>Pilefield/Open</td>
<td>0.537</td>
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</tbody>
</table>

Table 2. Results of ANOVA single factor test with 95% confidence interval, comparing large fish distributions between habitats, P = 0.0083.

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Day vs. Night</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edge</td>
<td>0.3213</td>
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</tr>
<tr>
<td>Open water</td>
<td>0.4650</td>
<td></td>
</tr>
<tr>
<td>Pilefield</td>
<td>0.828</td>
<td></td>
</tr>
<tr>
<td>Under pier</td>
<td>0.3769</td>
<td></td>
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</tbody>
</table>

Table 3. Results of ANOVA single factor test with 95% confidence interval, comparing each habitat during the day versus night at 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.

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.

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

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

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

Figure 3c. Two larger fish swimming oriented a fish school under the pier.

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

Figure 4. We sampled 235 transects (214 day, 21 night) among 8 piers between September and October 2007 and June and October, 2008, and June 2009. DIDSON recorded 86 sightings of large fish (740 day, 560 night). Each transect was about 6 minutes long.

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

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

Figure 7. Mean number of large fish during the day and night at piers 40, 45, and 57 show no difference.

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