Diver observations of community structure on a subarctic marine artificial reef in Whittier, Alaska

Charlotte Levy1,2, Eloise Brown2
1Oregon State University, Department of Fisheries and Wildlife, 2Alaska Pacific University

INTRODUCTION

Artificial reefs (AR) are becoming an increasingly popular tool for habitat restoration and enhancement, particularly in tropical and temperate latitudes. However, AR are uncommon in higher latitudes, and few studies address long term successional changes that may impact efficacy. Alaska’s Arctic Shanny

RESEARCH QUESTIONS

1. How have artificial reef (AR) fish and macroalgal assemblages changed from 2007 to 2016?
2. How does reef structure type (FH and RB) and local seasonality affect community structure?

METHODS

Demersal fish, macroalgal and invertebrate assemblages were quantified at two types of artificial reef (AR) structures: Fish Havens (FH) and Reef Balls (RB), and compared to assemblages found in 2007 (Reynolds 2009). Six AR plots containing both structure types (n = 3 RB, n = 3 FH) are located on a slope of mixed hard/soft bottom substrate between depths 12-20 m in Smitty’s Cove in Whittier, Alaska. Each plot consists of n = 30 either RB or FH, totaling 190 structures.

Sampling Design

- Bi-monthly dive surveys between the June-December in 2016; all plots surveyed during each field trip (n = 8). Macroalgal and invertebrate abundance and percent cover were randomly sampled using 0.25 m² quadrats (n = 4-8 replicates per plot); fish observations were recorded with 30 m circular transects around each plot (n = 1 replicate per plot)

Statistical Analysis

- Species richness (N of species), diversity (Shannon’s H’) and density (N/m²) were calculated for macroalgal, invertebrate and fish assemblages and averaged across sampling trips (n = 8) and reef types (n = 3) in 2016 and compared to results from 2007 (Reynolds 2009).
- Using R, paired and unpaired t-tests (n = 0.05) determined differences in assemblages between years, period and reef structure. MANOVA with repeated measures was used to identify between-trip variability, regression analysis determined trends across periods.

RESULTS

Community structure over last decade

- Fish and macroalgal diversity (p = 0.0002) and richness (p = 0.0001) have significantly increased from 2007 to 2016 (Fig. 1), however density was not statistically significant.
- The number of fish species present (n = 11) has increased since 2007 (n = 8), and the demersal fish community is now dominated by Sebastes spp. (Fig. 2).
- Table 1 shows the number of macroalgae species (n = 10) has significantly increased (p = 0.0003) from 2007 (n = 1) and there was a shift in dominant macroalgae from Laminaria saccharina to Agarum clathratum .

DISCUSSION

- Significant increases in overall diversity and richness between 2007 and 2016 (Fig. 1) indicate that the length of time since the establishment of an AR is an important factor to be considered when developing monitoring programs and objectives for an AR.
- Fish density was significantly higher at FH (Fig. 3) and does not appear to be affected by increased habitat complexity, as indicated by higher macroalgal diversity at RB (Fig. 4) than FH in 2016.
- Despite the extreme seasonality at this study site with the onset of winter in Alaska and senescence of macroalgal species, no significant changes were observed in community structure over the June-Dec 2016 time period (Fig. 5). Several understory species were observed to progressively senesce through the second period, and ongoing research includes 1) an assessment of environmental factors influencing dense microhabitats observed within several of the Fish Haven structures and 2) a methods comparison to determine accuracy of in situ diver observations compared to photographic quadrats.

ACKNOWLEDGEMENTS

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Figure 1. Community Diversity. Mean density (a) and richness (b) with SE calculated for macroalgae across sampling trips for 2007 (n=5) and 2016 (n=8).

Figure 2. Fish Community Structure.

Figure 3. Fish Community Structure. Comparison between fish density and richness across reef type in 2016 with SE across sampling trips (n = 8).

Table 1. Summary of reef structure types and period sampling

<table>
<thead>
<tr>
<th>Reef Structure</th>
<th>Period</th>
<th>Number of Species</th>
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<tbody>
<tr>
<td>Fish Haven</td>
<td>2007</td>
<td>11</td>
</tr>
<tr>
<td>Reef Ball</td>
<td>2007</td>
<td>8</td>
</tr>
<tr>
<td>Fish Haven</td>
<td>2016</td>
<td>11</td>
</tr>
<tr>
<td>Reef Ball</td>
<td>2016</td>
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</tr>
</tbody>
</table>

Figure 4. Macroalgae diversity by reef type. Macroalgal diversity and percent cover is shown across sampling trips (n = 8).

Figure 5. Macroalgae density by reef type. Macroalgae density is shown across sampling trips (n = 8).

Table 2. Summary of species richness

<table>
<thead>
<tr>
<th>Species Name</th>
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<tr>
<td>Pugettia boreopacifica</td>
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<tr>
<td>Diaulula leviuscula</td>
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<tr>
<td>Pandalus brevipinnis</td>
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<tr>
<td>Microporina reteporella</td>
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</tr>
<tr>
<td>Reteporella margarites</td>
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<tr>
<td>Membranipora lacy crista</td>
<td>1</td>
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<tr>
<td>Lacy Crust Murex snail</td>
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<td>Periwinkle</td>
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<tr>
<td>Frosted Nudibranch</td>
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<td>Common Name</td>
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