

The Limpet Pivot: Microhabitat Use by Intertidal Limpets on Natural and Artificial Substrates at Friday Harbor Laboratories

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Abstract

Habitat structure strongly influences the distribution and behavior of intertidal gastropods. To examine how microhabitat availability shapes limpet behavior, I conducted a comparative field survey of limpets (*Lottia* spp.) on a natural rocky beach and an adjacent artificial dock environment at Friday Harbor Laboratories (FHL), Washington, USA. Limpets were quantified across microhabitat categories including refuge, exposed, and submerged positions. Limpets were more abundant on the beach ($n = 24$) than on the dock ($n = 10$). Beach limpets were disproportionately exposed (67%), whereas dock limpets exhibited a more even distribution across exposed and refuge positions. These results suggest that natural rocky substrates provide more diverse microhabitats, enabling limpets to occupy shaded and moisture-retaining refuges, while artificial structures constrain microhabitat choice. The findings highlight how anthropogenic substrates alter small-scale habitat availability and may influence limpet distribution and behavior.

Introduction

Intertidal limpets are ecologically important grazers whose morphology and physiology are tightly adapted to life on wave-exposed rocky shores. Limpets possess an incredibly strong muscular foot that lets them cling tightly to surfaces even in heavy wave action and their radula is reinforced with iron, enabling them to scrape biofilm from hard substrates. Their reliance on microhabitat features such as crevices, shade, moisture, and biofilm availability makes them ideal organisms for studying how habitat structure influences

behavior. Natural rocky shorelines provide heterogeneous surfaces, including shaded undersides, crevices, and moisture-retaining pockets. In contrast, human-made structures such as docks and tires offer reduced complexity.

The goal of this study was to quantify how limpet microhabitat use differs between a natural beach and an artificial dock environment at FHL. I predicted that limpets on the beach would occupy more refuge microhabitats (e.g., shaded crevices, moist undersides of rocks), whereas limpets on the dock would be restricted to exposed or submerged positions due to limited structural complexity.

Method and Materials

Surveys were conducted at low tide on a rocky beach adjacent to the FHL dock as well as on the dock itself which included a cement float and car tires.

Beach Survey

Tide -3.2ft at 11:24

Coordinates: 48.54588° N and 123.01268° W

Time: 11:25-11:50 on July 14th 2026

Beach surveys involved examining large rocks, rock faces, and the undersides of rocks. Closer to the shore, most rocks except large boulders were covered in a dried layer of seaweed and kelp. Limpets were frequently found in groups on large rocks farther from shore rather than under small damp rocks.

Dock Survey

Tide -1.24ft at 13:30

Coordinates: 48.54495° N and 123.01254° W

Time: 13:00-13:57 on July 14th 2026

Dock surveys were conducted on the outermost portion of the dock, where the tires are located. Tires were flipped to inspect their surfaces. Visibility inside the inner tire ring was limited due to kelp growth, restricting observations of limpets occupying deeper refuge positions.

Data Collection

Variables recorded about each limpet:

- Microhabitat category: taking refuge, exposed, or submerged
- Substrate type limpet is found on
- Sun Exposure
- Distance from shore
- Nearby organisms
- Shell length (anterior-posterior)
- Time of observation
- Photo documentation

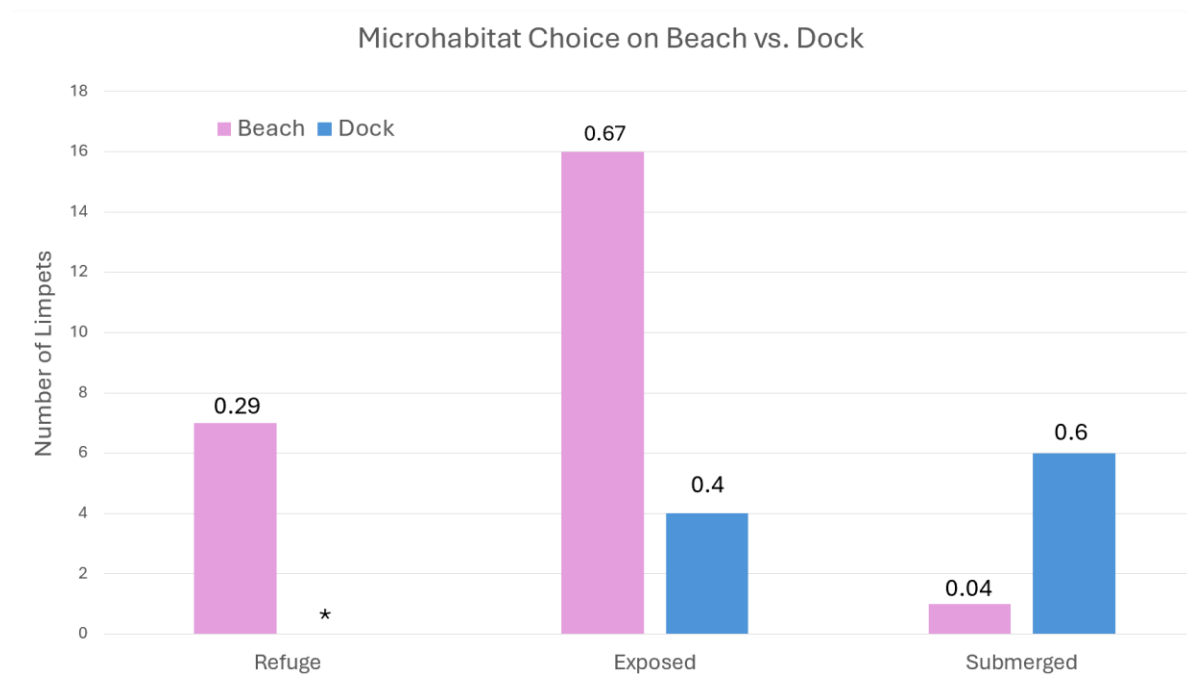
Behavioral Context

Movement patterns observed in both environments relate to tidal-synchronized “zonal shuttling” described for *Cellana grata*, but the behavior differs in this system. *C. grata* inhabits smooth vertical walls and exhibits predictable vertical movements tightly matched to tide height, remaining in the awash zone for most of the tidal cycle. In contrast, limpets at FHL move across more complex surfaces—dock floats, pilings, and uneven beach rocks—so their movement appears influenced not only by tide height but also by microhabitat features such as crevices, shade, moisture, and patchy biofilm. Instead of large vertical excursions, they often make short, localized movements consistent with microhabitat tracking. This comparison illustrates how similar ecological pressures (predator avoidance, desiccation prevention, and grazing efficiency) can produce different movement strategies depending on habitat structure.

Data

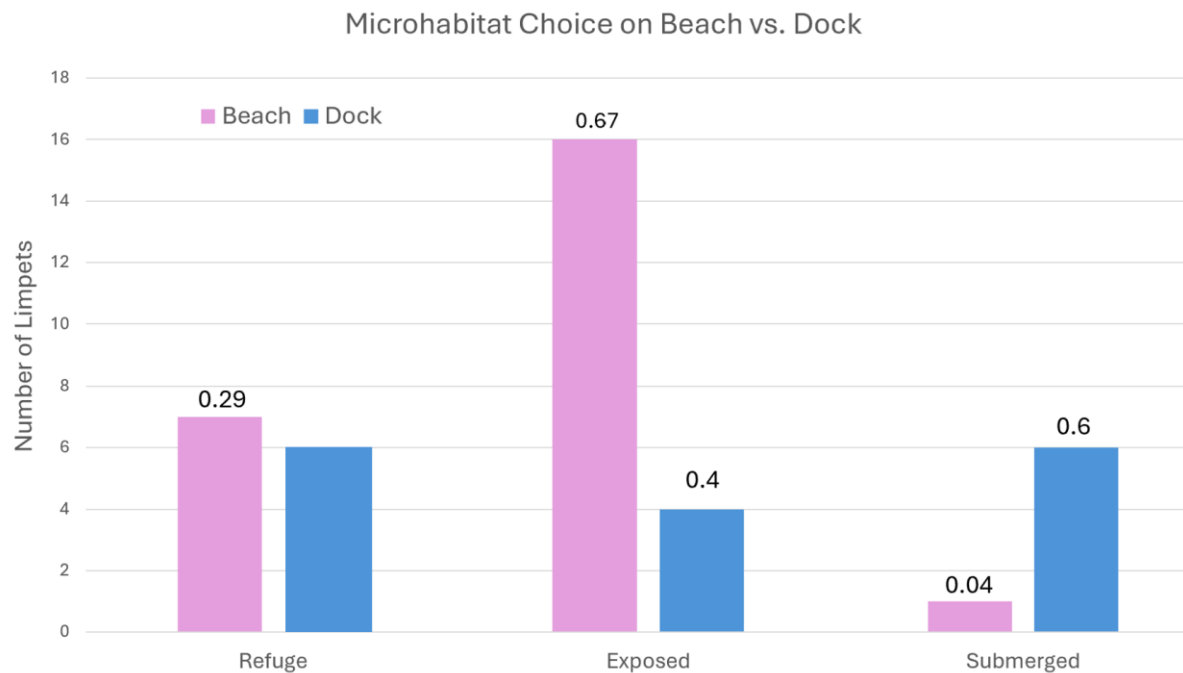
A total of 34 limpets were recorded across both environments: 24 on the beach and 10 on the dock.

Figure 1: Microhabitat Choice of Limpets on the Beach vs. FHL Dock



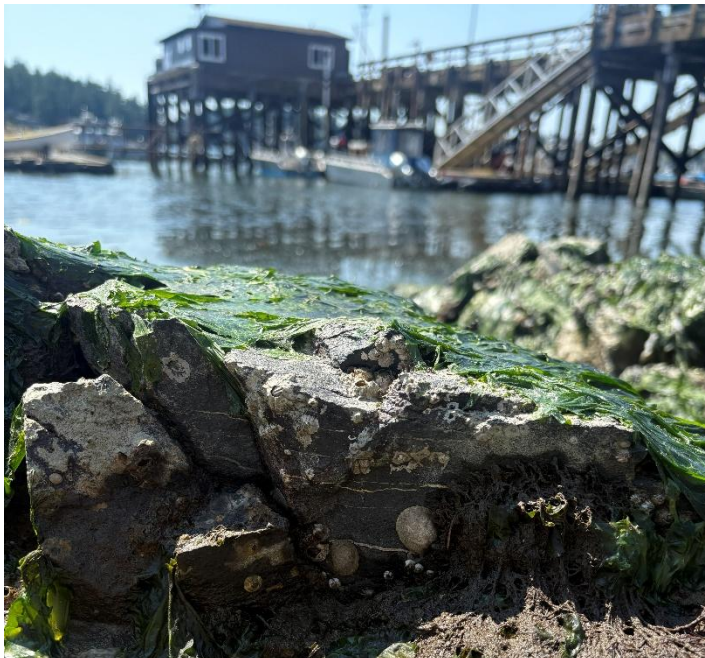
Beach limpets were predominantly exposed (67%), whereas dock limpets were exposed 40% of the time. *: When refuge on dock tires was defined as the beach-facing interior of the tire, the proportion of dock limpets classified as refuge increased.

Figure 2: Adjusted Microhabitat Choice of Limpets on the Beach vs. Dock



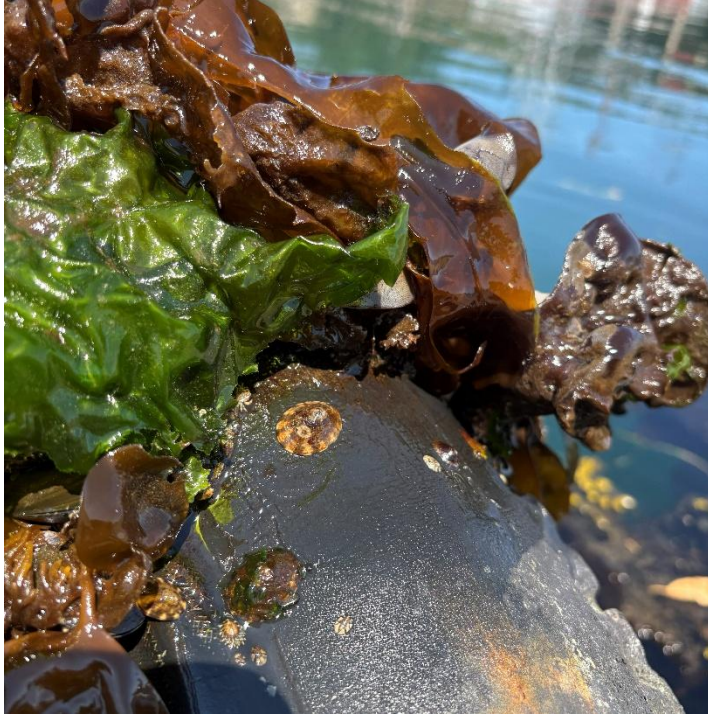
When refuge was defined specifically as the beach-facing side of the tire rather than the ocean-facing side, more dock limpets fell into the refuge category.

Figure 3: Limpets in The Beach Environment Found on a Rock



This is one of the beach limpet microhabitats at FHL. There are two limpets in the shaded part of this rock face and this rock was over 20 feet from the shore. Only small barnacles live around them.

Figure 4: Limpets in The Dock Environment Found on a Tire



This is one of the tires on the dock at FHL. When in the water, these limpets are located on the beach-facing side. When flipped up, they are on the top or front of the tire. There were a couple of limpets here with a small cluster of very small limpets in the bottom left of the image.

Results and Discussion

This study demonstrates clear differences in limpet microhabitat use between natural and artificial substrates. Natural rocky beaches provide abundant crevices, shaded surfaces, and moisture-retaining microhabitats, enabling limpets to select refuges that reduce desiccation risk. Artificial dock structures, by contrast, offer limited complexity, constraining limpets to exposed or submerged positions.

The higher abundance of limpets on the beach likely reflects both greater habitat heterogeneity and larger available surface area. Artificial structures such as floating tires may support limpet communities, but their smooth surfaces and limited microhabitat diversity restrict limpet distribution.

The comparison with *Cellana grata* highlights how substrate structure shapes movement strategies. Whereas *C. grata* exhibits predictable tidal shuttling on smooth vertical walls, limpets at FHL perform localized microhabitat tracking on complex surfaces. This suggests

that limpet movement is shaped not only by tidal cycles but also by fine-scale environmental variation.

Conclusions

Limpets at FHL exhibit distinct microhabitat preferences depending on substrate type. Natural rocky beaches support higher abundance and greater use of refuge microhabitats, while artificial dock structures constrain limpets to more exposed positions. These findings underscore the ecological importance of small-scale habitat complexity in shaping intertidal species behavior and highlight how anthropogenic marine structures may alter the spatial ecology of grazers.

Future Directions

- Micro-CT imaging of limpet radulae to examine structural adaptations, and possibly a comparison of limpet radulae from the dock vs. beach environments
- Long-term monitoring of limpet clusters on dock tires to assess stability and turnover
- Controlled desiccation experiments to quantify tolerance thresholds
- Microhabitat mapping across natural and artificial substrates to quantify structural complexity

Acknowledgements and References

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Williams, G.A., Morritt, D., & Yau, C. *Tidal-synchronized vertical migrations in the limpet *Cellana grata**. **Marine Biology** 124, 245–254 (1995).