

Investigating abalone farming in Southeast Alaska: comparison of spat development and survival from open-ocean growth systems in the Inside Passage and coastal Gulf of Alaska.

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Abstract

Mariculture operations in Alaska and the interest to diversify them by adding high-market-value shellfish products have rapidly increased over the past decade. This project investigates the viability of farming northern (or pinto) abalone at sea to support commercial opportunities in Southeast Alaska. Pinto abalone feed exclusively on benthic microalgae and seaweeds, which makes them an excellent choice for an ocean polyculture farming system growing a mix of seaweed and shellfish. In the summer of 2025, we deployed custom-built open-ocean growth systems populated with our laboratory-bred spat at two potential farming locations: within the Inside Passage in Lynn Canal and in the coastal Gulf of Alaska off Annette Island. The goals were to assess the performance of the holding cage systems and measure spat growth and survival rates in the contrasting environments. While the hardware required only minor improvements, the spat growth was drastically different between the sites. Abalone in Lynn Canal were affected by newly spawned barnacles, which settled on the shells and blocked abalone respiratory pores, impeding growth and causing overwhelming mortality. In contrast, spat in the coastal Gulf of Alaska was not considerably affected by biofouling and experienced positive growth and negligible mortality. Outplanting larger abalone spat later in the season, after planktonic barnacle larvae have settled and mostly disappeared from the water column, may improve abalone farming prospects within the Inside Passage. Our results underscore the importance of careful selection of the abalone farming sites, which needs to consider local oceanographic conditions in addition to operational and logistics concerns.

Methods

We designed and built abalone cage prototypes for the outplanting efforts. The materials were obtained from Ketcham Supply, a leading aquatic farming gear manufacturer and distributor located in Maine, as well as sourced locally. The prototype contained 2 plastic baskets secured by removable stainless rods inside the protective cage and lined with 1000 μ m Nitex mesh. Rectangular plastic inserts were attached to the upper and lower sides of the baskets to provide smooth surface for attachment of the abalone.



The outplanting experiments were conducted at Sea Quester Farms site in Lynn Canal near Juneau, and Metlakatla Indian Community at Annette Island near Ketchikan. At the start of deployment, each cage was equipped with a temperature logger and abalone spat cultured in the UAF lab was placed into the plastic baskets. The initial mix of fresh dulse kelp were placed into each basket as ad libitum food source for the abalone spat. The abalone were inspected bi-weekly (weather permitting) and food was replaced with fresh kelp from the corresponding farm sites.

SeaQuester Farm Site

Metlakatla Site



Conclusions and Implications:

- Large concentrations of ready-to-settle larvae directly threaten abalone farming in semi-closed coastal embayments such as sites within the SE Alaska Inside Passage.
- One way to counter this threat in the future would be to outplant abalone spat later in the season (July) after most of the planktonic barnacle larvae settled and disappeared from the water column.
- Alternatively, outplanting older animals with larger respiration pores might decrease detrimental effect of the barnacles on abalone growth.
- The study emphasizes the importance of oceanographic data when choosing potential farm sites and planning abalone farming operations.

Results: SeaQuester Farms site



Operations at the SeaQuester Farms site (Lynn Canal): A – farm site, B – deployment of the cages, C and D – inspection and feeding of abalone spat.

Barnacle colonization of the cages, kelp and abalone spat at the SeaQuester Farms site (Lynn Canal): A – Cage #1 after ~65 days exposure, B – individual basket after ~65 days exposure, C – kelp food, D – abalone shell.

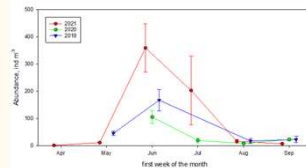
Experimental Cage #1 with 20 (10 per basket) juvenile abalone ~10 mm long was deployed on May 2, 2025. After a two-week initial assessment, Experimental Cage #2 with 20 (10 per basket) juvenile abalone was deployed on May 24. On July 8, 2025, a census accompanied with individual length measurement was done on all experimental animals. Intensive coverage of newly settled barnacle was observed on the cages and animals. In over 50% of the abalone, barnacles covered over half of the shell surface area blocking abalone respiration pores, so the animals suffocated (Figure 3). Only 4 individuals did not have any barnacle growth. While all individuals were still alive, they barely moved and could not easily attach themselves to the surface. It was clear the future barnacle growth would not leave them any chances of survival. We decided to terminate the experiment at that point.

For the period of 45 days starting on May 24, the abalone increased in length by 56% from the initial mean 10.95 ± 0.65 (95% CI) mm to the final 17.13 ± 1 (95% CI) mm length, which corresponds to 0.137 mm day⁻¹ at the average temperature of ~9°C. Larger pinto abalone (40-50 mm of total length) experienced considerably lower increase in length of 8-10% over observation period of 65 days (Paul and Paul, 1981)¹. This indicates that summer conditions for abalone spat growth in Lynn Canal are quite favorable, if damage from barnacle settlement could be avoided.

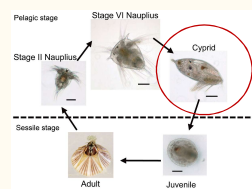
¹ Paul AJ & Paul JM (1981) Temperature and growth of maturing *Haliotis kamtschatkana* Jonas. The Veliger, 23(4): 321-324.

² Chen ZF, Matsamura K, Wang H, Arellano SM, Yan X, Alam I, Archer JAC, Bajic VB, Qian PY (2011) Toward an Understanding of the Molecular Mechanisms of Barnacle Larval Settlement: A Comparative Transcriptomic Approach. PLoS ONE, 6(7): e22913.

Barnacles in Lynn Canal



Interannual abundance of barnacle cyprid larvae in Lynn Canal fjords (Auke Bay, Gastineau Channel, Berners Bay combined) in 2019-2021. Data from the EPSCOR Fire and Ice Project provided by A. Pinchuk and A. Knobloch (UAF).



Barnacle life cycle (from Chen et al 2011)²: the cypid is the settling stage of the barnacle.

Our oceanographic observations in Lynn Canal fjords conducted in summer 2019-2021 show that a well-developed peak in barnacle planktonic larvae abundance consistently occurs in late May and continues through late June. This might explain why abalone natural range does not extend into the Inside Passage and lays within coastal North Pacific waters. Despite otherwise favorable conditions, the lethal effect of barnacle settlement on juvenile abalone shells would prevent the establishment of a self-supporting abalone population in inshore waters.



Water temperature (°C) at the Seaquester Farm site continually increased from ~6°C to ~12°C through the duration of the experiment, indicating that most favorable thermal conditions for abalone growth were set by the middle of June.

Results: Metlakatla site



Operations at Metlakatla Site: A – choosing healthy kelp to feed abalone spat, B – abalone spat after ~30 days of exposure, C – harvesting wild kelp at the site.

The total of 40 (10 per basket) juvenile abalone ~15 mm long were deployed in a protected cove of Annette Island on July 10, 2025. The cove has naturally growing bull kelp field which is used to harvest food for the experimental abalone.

So far, abalone appear to be in good health and increase in size. Minimal barnacle settlement has been observed on the cages, and no spat was infested. We intend to continue the experiment through the winter to determine how spat responds to decreased water temperatures and light levels. Winter is a critical time in northern ecosystems and the data we plan to obtain would improve our knowledge on pinto abalone and feasibility of their farming in Alaskan waters.