



Deepwater Emergence of Red Tree Coral *Primnoa pacifica* in Glacier Bay, Alaska

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Introduction

Red tree corals (*Primnoa*) are large, structure-forming gorgonians with a broad distribution in Alaska. They are dominant biotic components of benthic habitats in some areas of the Gulf of Alaska (GOA) where they form dense thickets. There is much evidence that red tree corals provide important structural habitat for many species, particularly rockfish (*Sebastes* spp.) including gravid females and juveniles. Unfortunately, red tree corals are highly susceptible to disturbance from fishing activities, and the recovery rate of disturbed habitats (based on reported growth rates) is likely on the order of many decades. In recognition of their importance, the North Pacific Fisheries Management Council recently approved closure of five small *Primnoa*-rich areas in the eastern GOA to all bottom contact fishing gear.

In 2003, red tree corals were observed in shallow water (< 25 m depth) during videographic habitat surveys in Glacier Bay National Park in southeastern Alaska. This fortuitous discovery provided a valuable opportunity to advance our knowledge about the bathymetric and geographical distribution, ecology, and habitat requirements of *Primnoa*.

Glacier Bay is a large, y-shaped fjord with multiple tidewater glaciers that was formed by rapid glacial retreat during the past 220 years. An accurate record of deglaciation in the upper reaches of the Bay provided a timeline gradient (chronosequence) with which to examine community succession and validate the growth rate previously estimated for *Primnoa*.

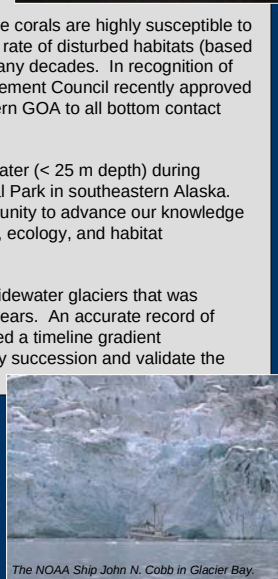


Figure 1. Study area in Glacier Bay. Red lines indicate the approximate historical positions of the glacial termini. Yellow circles indicate dive locations.

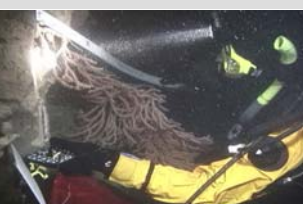
Methods

In April 2004 and 2005, scuba divers conducted surveys at 28 locations in Glacier Bay, Alaska (Figure 1). In 2004, dives were restricted to the East Arm of Glacier Bay whereas in 2005, dives were made in both the East and West Arms. Divers swam between the 20 and 30 m isobath until *Primnoa* was observed and then collected detailed information on bathymetric distribution. Divers also collected samples for taxonomic identification and measured the length of the largest coral colonies present.

Dive sites were selected based on three criteria: (1) the presence of exposed bedrock or boulder along the shoreline, (2) a relatively steep bathymetry, and (3) their systematic location along the axes of the fjords. The first two criteria were established based on the known habitat requirements of *Primnoa*. The third criterion was considered necessary to establish a timeline gradient (chronosequence) among study sites.



The dives sites were characterized by exposed bedrock and steep cliffs.



A diver measures a *Primnoa pacifica* colony in Glacier Bay

Detailed oceanographic data collected by the U.S. Geological Survey (USGS) between 1992 and 2002 (Etherington et al. 2004) were compared between areas with and without *Primnoa* to examine the potential role of temperature, salinity, and euphotic depth on coral distribution.

Results

- Red tree corals (*Primnoa pacifica*) were found only in the upper reaches of the East Arm of Glacier Bay within 23 km of the current glacier terminus (Figure 2).
- Colonies were observed at depths between 9 and 35 m (the maximum depth of dive observations).
- At the shallowest colony (9 m), temperature estimates ranged between 3.58 and 7.85°C (mean = 6.28°C) and salinity estimates ranged between 27.09 and 30.94 psu (mean = 29.62 psu). The upper temperature and lower salinity values likely represent extreme tolerances for the genus.



Figure 2. Map showing dive sites. Circles indicate where *Primnoa* was found and crosses indicate where no coral was found.

Site	Year of deglaciation	Maximum length (cm)	Minimum growth rate (cm a ⁻¹)
1	1978	55	2.12
3	1961	40	0.93
4	1960	20	0.46
5	1942	150	2.42
6	1942	89	1.44
7	1940	155	2.39
8	1937	21	0.31

Table 1. Maximum length and minimum estimated growth rate for *P. pacifica* colonies at sites in the East Arm. Minimum growth rate were calculated by assuming that colonies recruited to the substrate immediately after deglaciation

- P. pacifica* were attached only to exposed bedrock at sites that had been deglaciated between 1937 and 1978.
- We estimated minimum growth rates of 2.42 cm a⁻¹. These growth rates are comparable to those previously estimated (1.60 to 2.32 cm a⁻¹) from growth ring counts (Andrews et al. 2002).

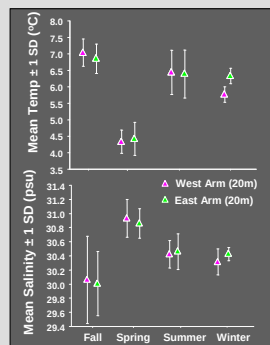


Figure 3. Mean temperature and salinity at monitoring stations in the upper East and West Arms.

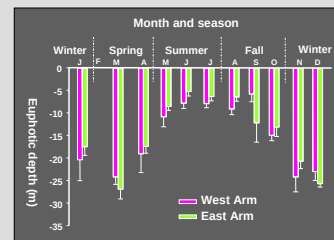


Figure 4. Euphotic depth (depth of 1% ambient radiation) patterns by month for the East and West Arms. Modified from Etherington et al. 2004.

- Neither temperature nor salinity differed significantly between the two areas (Figure 3).
- The depth of the euphotic zone (depth of 1% ambient radiation), however, was consistently shallower in the East Arm than the West Arm (Figure 4).
- The differences in euphotic zone between the two areas may implicate light as an important factor controlling the upper depth distribution of *P. pacifica*.
- High light levels could promote the growth of algae that either out-competes *P. pacifica* for space (e.g. coralline algae) or grows directly on and ultimately smothers the coral (e.g. diatomaceous film). Coralline algae were consistently observed at sites where *P. pacifica* was absent and were rarely present in the upper East Arm.

Conclusions

- Low temperature, stenohaline conditions and low ambient light levels promote deepwater emergence of *P. pacifica* in the shallowwater areas of Glacier Bay.
- Our observations of *Primnoa* at 9m represent a major depth range extension for the genus, which had not been previously documented (*in situ*) shallower than 127 m.
- Oceanographic conditions in the shallow water of the glacial fjord are similar to those in the typical depth range of *Primnoa* in the GOA (>130m).
- P. pacifica* appears to be an important pioneer species in recently deglaciated habitats.
- Despite the slow growth rates confirmed in this study and the sporadic nature of recruitment processes, our observations indicate that *Primnoa* has the potential to quickly recolonize disturbed habitats, including those disturbed by fishing activities.

Literature Cited

Andrews et al. 2002. Age, growth and radiometric age validation of a deep-sea, habitat-forming gorgonian (*Primnoa resedaeformis*) from the Gulf of Alaska. *Hydrobiologia* 471: 101-110.

Etherington et al. 2004. Factors affecting seasonal and regional patterns of surface water oceanographic properties within a fjord estuarine system: Glacier Bay, AK. Report to National Park Service. US Geological Survey, Anchorage, Alaska.

Acknowledgements

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