Sea Whip (Order Pennatulacea) Resiliency to Simulated Trawl Disturbance

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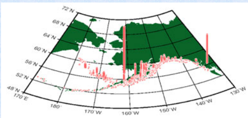
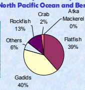
Introduction

Sea whips are pennatulacean octocorals that are broadly distributed across the continental shelf in the North Pacific Ocean and Bering Sea at depths from 20 m to at least 900 m. Sea whips have a relatively simple morphology consisting of a basal peduncle (that serves as an anchor in soft sediments) and a vertical rachis extending distally from the peduncle. The rachis is populated with rows of polyps and the entire colony is supported by an axial rod composed of magnesium calcite. Four genera are known to occur in Alaska: *Halipteris*, *Protoptilum*, *Stylatula*, and *Virgularia*. Sea whip size varies considerably between species. *Halipteris willemoesi* can reach lengths of 3 m, while *Protoptilum* sp. may reach just 30 cm. Sea whips can form dense groves that provide vertical structure to otherwise low relief habitats. Pacific ocean perch (*Sebastes alutus*) and prey taxa commonly utilized by groundfish have been associated with sea whip groves. Sea whips may be particularly vulnerable because they can be removed, dislodged, or broken by bottom fishing gear. Furthermore, because sea whips are believed to be long-lived, recolonization rates may be very slow.

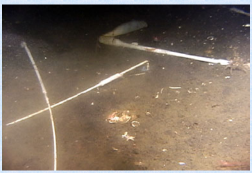


Sea whips and sea pens are closely related pennatulaceans that provide vertical structure to low relief habitats. Above: relative abundance of sea whips and sea pens. Below: percentage of commercially important species caught in trawl survey hauls that contained sea whips and sea pens. Data based on CPUE in NMFS trawl surveys in the North Pacific Ocean and Bering Sea (1975-2000).



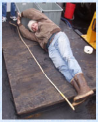
Trawl Disturbance

In 2001, scientists at the Auke Bay Laboratory initiated a study to investigate the immediate effects of intensive bottom trawling on soft-bottom habitat in an area colonized by sea whips in Chiniak Gully, near Kodiak Island. Sea whip biological characteristics and their resistance to two levels of trawling were studied. Within the study site, at least two species of sea whips (*H. willemoesi* and *Protoptilum* sp.) were present at densities up to 16 individuals per m^2. The submersible *Delta* was used to collect *in situ* videographic documentation of the seafloor before and after trawling occurred. A scientist on board the *Delta* observed the seafloor and vocally identified biota and evidence of trawling, including damaged or dislodged sea whips. Analysis of the 2001 data is ongoing and will provide insights about the immediate effects to sea whips from known levels of trawling, including the percentage of sea whips damaged and dislodged, but will not address the resiliency and long-term fate of damaged or dislodged sea whips. Whether sea whips can recover from various trawl disturbances is a question that remained unanswered.



Actual trawling damage to *H. willemoesi*, including dislodgement and fracture of the internal axial rod, observed from the submersible *Delta*.

Sea whip species are quite variable in size. Above: a Pacific cod cruises over 10-30 cm *Protoptilum* sp. Below: *H. willemoesi* can exceed 3 meters.



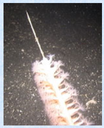
Sea whips are often caught in trawl gear. Above: sea whips entangled in trawl mesh. Below: sea whip caught between roller gear.

A grove of *H. willemoesi* (approximately 1.5 m in length) in Auke Bay served as the study site for trawl disturbance simulations. Numbered PVC stakes identified individual whips randomly assigned to three treatment and one control group.

Trawl Disturbance Simulations

In 2003, Auke Bay Laboratory scientists initiated new studies to investigate long-term effects to damaged and dislodged sea whips. A large grove of *H. willemoesi* was located in Auke Bay at a depth of approximately 30 m. Numbered stakes identified individual sea whips randomly assigned to three treatment groups and one control group. Treatments were designed to simulate the actual trawling-related damage observed *in situ* during the 2001 study, and included dislodgement, fracture of the axial rod, and light tissue abrasion. Light tissue abrasion was performed by sliding *H. willemoesi* between two rubber discs, as may occur when trawl ground gear equipped with "cookies" passes over sea whips. Scuba divers collected videographic documentation of tagged sea whips approximately weekly for four months and will continue to monitor the sea whips at longer intervals for up to a year or more. *Protoptilum* sp. were collected with a 6-m shrimp trawl at a depth of 145 m near the 2001 study site. Live *Protoptilum* sp. were allowed to acclimate before being randomly assigned to control and treatment groups and then observed in living streams lined with 10 cm of fine sediment similar in composition to that found in Chiniak Gully. Dislodged *Protoptilum* sp. were observed to determine their ability to re-bury and position themselves upright.

Above: close-up of the polyp-bearing rachis of *H. willemoesi* Below: flesh abrasion left the distal portion of axial rods bare on some *H. willemoesi*.

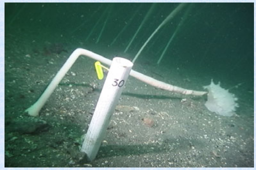


Below: this 15 cm *Protoptilum* sp. was collected in Chiniak Gully, near Kodiak Island and was then observed at the Auke Bay Laboratory.

Below left: before dislodgement, *H. willemoesi* were tethered to numbered stakes to prevent the sea whip from being carried away by currents. Below center: a dislodged *H. willemoesi* begins to rebury its peduncle. Below right: a tethered *H. willemoesi* upright and nearly completely re-buried seven days after dislodgement.

Treatment Results

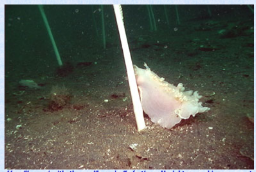
- Dislodged *H. willemoesi* showed a greater ability to re-bury and position themselves upright than did the smaller *Protoptilum* sp. Two weeks after dislodgement, 6 out of 12 (50%) *H. willemoesi* were upright, while just 2 of 33 (6%) dislodged *Protoptilum* sp. were only partially upright. After three months, just 4 (33%) dislodged *H. willemoesi* and none of the *Protoptilum* sp. were upright.
- Light tissue abrasion caused minor damage (up to 4% of tissue was removed) in 6 of 12 (50%) specimens, but after three months the abrasion treatment had no effect on sea whip survival and average tissue loss was less than 1%.
- Fractured axial rods proved to be more damaging than tissue abrasion. After three months, *H. willemoesi* were not able to repair fractured axial rods and when the distal portion of the sea whip was in contact with the seafloor, predation by the nudibranch *Tritonia festiva* resulted in severe flesh damage (up to 80% of flesh loss). Dislodged *H. willemoesi* that were unable to right themselves were also preyed upon by *T. festiva*.
- Sea whips in the control group showed no signs of damage after three months.



***H. willemoesi* with a fractured axial rod being preyed upon by the nudibranch *Tritonia festiva*.**

Disturbance Stimulated Predation

Dislodged and damaged *H. willemoesi* were much more vulnerable to predation by the nudibranch *T. festiva,* which appeared to illicit a strong scavenging/predatory response to sea whips in contact with the seafloor. Before the simulated trawl treatments were performed, we observed only three *T. festiva* in the study area. After the treatments were performed, we consistently observed 18 individuals and up to 25 in the study area. Predation likely reduced the ability of *H. willemoesi* to recover from the simulated trawl damage; and therefore, our study may underestimate the ability of the species to recover from trawl disturbances when predators are not present. However, in areas where predators do occur, trawling disturbances to sea whips may stimulate a predation response that exacerbates trawling effects.



***H. willemoesi* with the nudibranch *T. festiva*. Upright sea whips were not preyed upon despite this nudibranch's efforts.**

Sea Whip Defenses

Halipteris willemoesi lying on the seafloor were readily preyed upon by *T. festiva*. However, the peduncle and the tissue of the rachis below the polyps (about 30 cm) was not eaten by the nudibranchs. Additionally, upright *H. willemoesi* were not preyed upon, suggesting that they may have structural or chemical defenses near their peduncle that deter predators. Future studies may involve the examination of these possible chemical and/or structural defenses which are common among octocorals.