



8 December 2010

First annual review

Summary of findings for the Port of Friday Harbor

The Friday Harbor Marine Health Observatory, a collaborative effort of the Lopez based nonprofit conservation laboratory Kwiáht and WSU Beach Watchers, has deployed volunteer teams on Port docks since the beginning of the year, conducting an inventory of invertebrates living on docks, floats and pilings. Our primary objectives for our first year of work have been: (1) a baseline inventory of invertebrate species utilizing the marina as habitat; (2) selection of a short-list of species to serve as bioindicators for monitoring the health of the port and the bay; (3) collection of seasonal abundance and distribution data for bioindicator species, as a starting point for identifying trends—*e.g.*, changes in timing due to climate change—and for evaluating the effects of human activities on bay wildlife. A major concern has been the potential adverse impact of Spring Street runoff on the bay, and the possible remedial effect of biofiltration measures the county plans to install along Spring Street in 2011.

This document is a summary of the data collected in 2010, highlighting results of our baseline surveys that help us better understand ecological processes in the bay and the sensitivity of bay ecosystems to anthropogenic and climate forcing.

Methods

Data on species' abundance has been adjusted to "observer days"—that is to say, the number of days each month that volunteers were on conducting surveys on the docks. Volunteers are organized in teams, and each team is permanently assigned to a small part of one dock or pier in the port complex, with responsibility to visit its assigned location at least once monthly. Each team's study site includes a small dock or float segment for the most meticulous examination from month to month, within arm's reach; and a larger area that is surveyed at a walk, for larger, and more conspicuous animals. Each team's area of study is constant, and comparable with other teams' sites, making quantitative inferences possible: differences in species' abundance in different parts of the port complex, as well as seasonal differences in total abundance.

It should nevertheless be borne in mind, in reviewing this first report, that the first few months of 2010 fieldwork necessarily involved challenges and learning for the entire team. Adequate reference materials for identifying animals were compiled as we learned what species were actually present, and this changed substantially between winter and the warmer months of late spring and summer. Considerable time was invested in learning to identify animals reliably, and only gradually were we able to focus our attention on those species that we concluded were not only useful indicators, but also relatively easy to find and count consistently. Nudibranchs ("sea slugs") are conspicuous and, as very seasonal visitors to the bay, and also highly specialized in their choice of prey, useful as indicators of climate change and indicators of variations and trends in habitat quality. Barnacles, by comparison, can be *too* numerous to count meaningfully, while sea cucumbers, especially

the small white species *Eupentacta quinquesemita*, are so scarce and difficult to find that they cannot be counted reliably.

Dock letters are used to locate the distribution of animals within the port complex. FD is the fuel dock. FHL refers to the Friday Harbor Labs dock, which we include in the baseline study and monitoring as a “negative control” site—one that is sufficiently distant from the downtown, storm sewer and sewage treatment outfalls, and docks to represent a relatively “undisturbed” condition for comparison with the developed waterfront. We are mindful that there is some boat traffic at FHL, however, and evidence of organisms from other parts of San Juan County being released from the FHL dock rather than returned to the waters from which they were collected.

Data are included in this summary from a complementary study carried out by the environmental science class at Friday Harbor High School, focusing on sediment toxicity. The full report of that study is available separately. FHHS will continue to participate in the Friday Harbor Marine Health Observatory by conducting annual ecotoxicity studies.

Results in Brief

As expected, invertebrate abundance and diversity was generally highest at Friday Harbor Labs, our control site. Some of the port docks were also relatively rich in marine life, however: the fuel dock for nudibranchs, and outer dock H for nudibranchs and crabs, for example. Greater richness outer H dock may reflect greater depth, higher circulation, and greater distance from downtown streets and storm sewers. Ironically it may also be a function of the location of the town’s sewage treatment outfall, near the marina entrance, a source of additional nutrients.

Seasonal migration patterns were evident for many species: the nudibranchs were most abundant from winter to spring (February-May), starfish in spring (March-May) and crabs from spring to mid-summer (April-July). On the whole, invertebrate activity in the port complex was greatest in spring, decreasing from June to August and remaining quite low in the fall. This pattern dovetails with the life cycles of phytoplankton, the miniscule photosynthetic micro-algae, diatoms and dinoflagellates that are the foundation of marine food webs. Algal “green-up” can occur as early as late February in our area and is rarely later than April. Many animals congregate and reproduce just before, or during green-up, to take advantage of the rich seasonal food source. In future years this annual biological event may occur earlier or later as the seas around San Juan Island grow slightly warmer.

Climate change may affect the ecological clock of the bay, but in the near term, at least, human activity—in particular our chemical “footprint”—will likely be the primary factor affecting invertebrate abundance and diversity. As shown in Figure 6 below, there is reason for concern over levels of copper in bay sediments. Petroleum residues amount, at present, to 4 percent of sediments by weight, which is not trivial; however carcinogenic PAHs from petroleum products appear relatively low. Toxic loading of shellfish from the bay should be investigated to assess possible bioaccumulation of sediment contaminants.

1. **Nudibranchs** (“sea slugs”) were most numerous *and* most diverse in winter. The conspicuous white and orange Clown nudibranch, *Triophae catalinae*, was by far the most abundant nudibranch species, and congregates in the marina presumably to reproduce, although we did not observe any identifiable egg masses. Sea slugs were most numerous and diverse at FHL, the Fuel Dock, and dock H, which does not admit to a simple explanation.

Figure 1A: Nudibranch abundance and diversity by month 2010

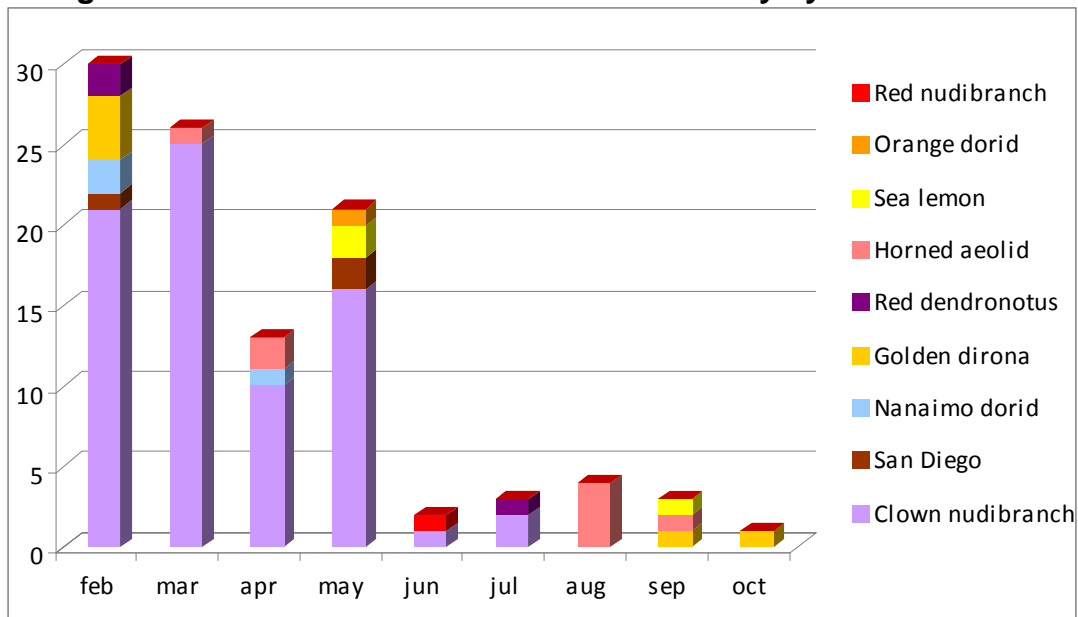
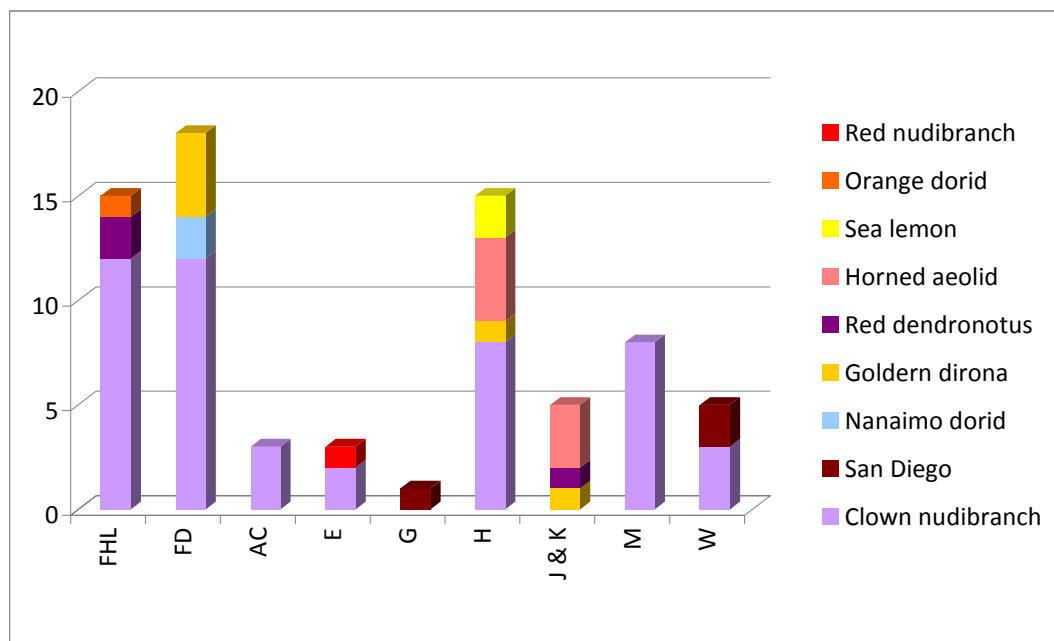


Figure 1B: Nudibranch abundance and diversity by location 2010



2. **Starfish (Asteroidea)** were most abundant and diverse in the spring, increasing in March, about a month after the peak in nudibranch abundance. The voracious and highly mobile Sunflower star, *Pycnopodia helianthoides*, was the most commonly seen throughout the year, and is probably a year-round resident of the bay. Friday Harbor Labs was *much* richer in starfish than any of the port docks. It is possible that this is due, at least in part, to disposal of animals by researchers at the Labs—but also plausible that deeper, rockier habitats near the Labs afford more prey for starfish, most of which prefer bivalves.

Figure 2A: Starfish abundance and diversity by month 2010

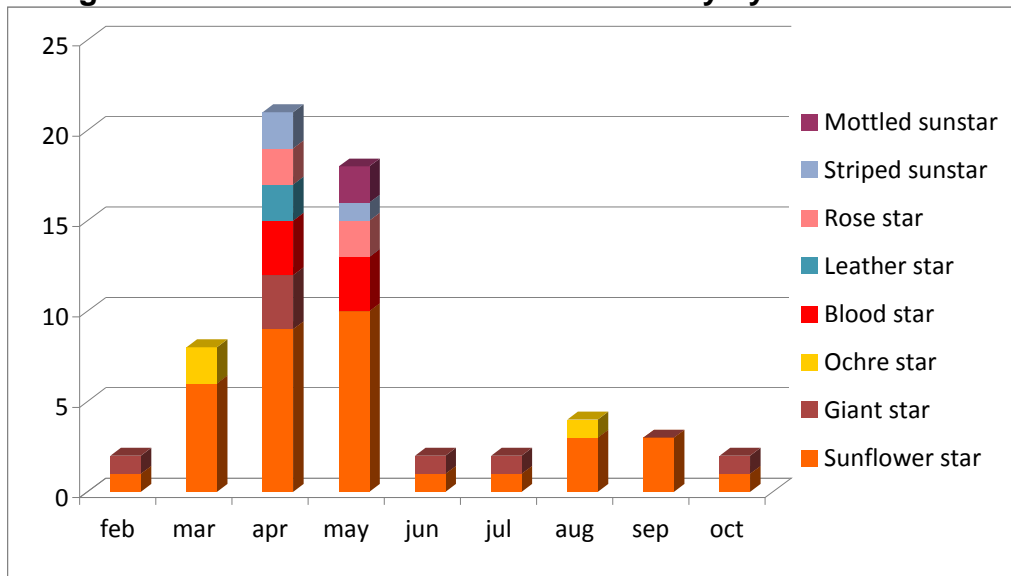
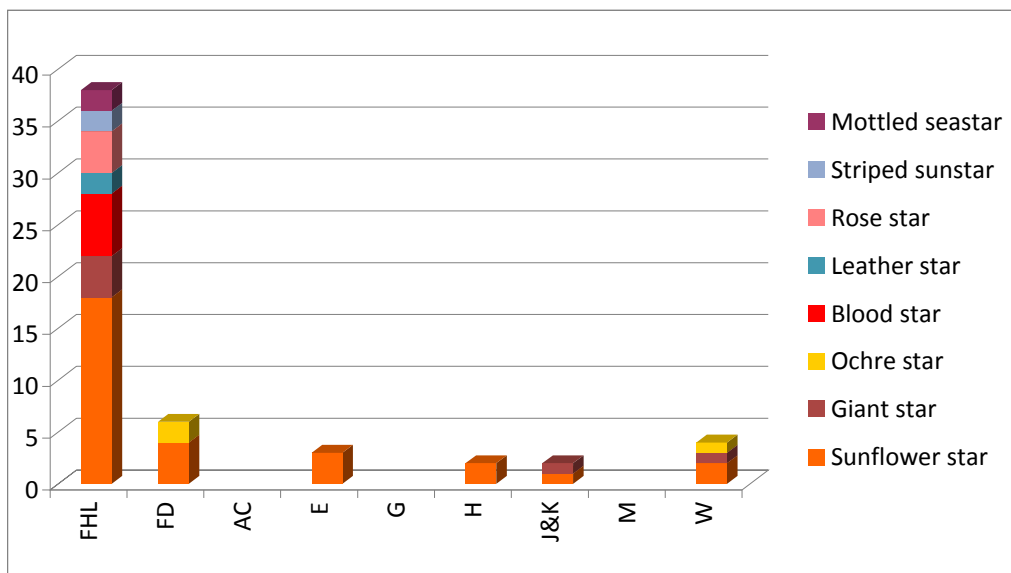


Figure 2B: Starfish abundance and diversity by location 2010



3. **Crabs (Decapoda):** are highly mobile scavengers and can be predators of smaller invertebrates. Many crab species migrate seasonally to shallows for reproduction, and this may help explain why crabs were so much more abundant around the port in spring to early summer (April-July). Many juvenile crabs were seen, as well as some adults carrying eggs. Graceful kelp crabs (*Pugettia producta*) and decorator crabs (*Pugettia gracilis*), two closely related species, were most commonly seen. Abundance and diversity was greatest at Friday Harbor Labs as expected, but also very high at dock H. Note that the dominant species differed between these sites!

Figure 3A: Abundance and diversity of crabs by month 2010

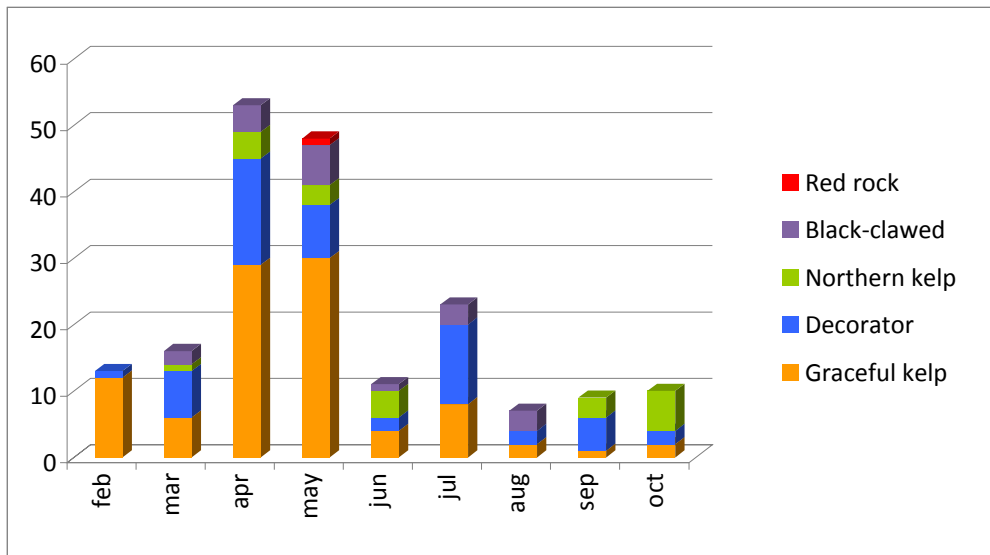
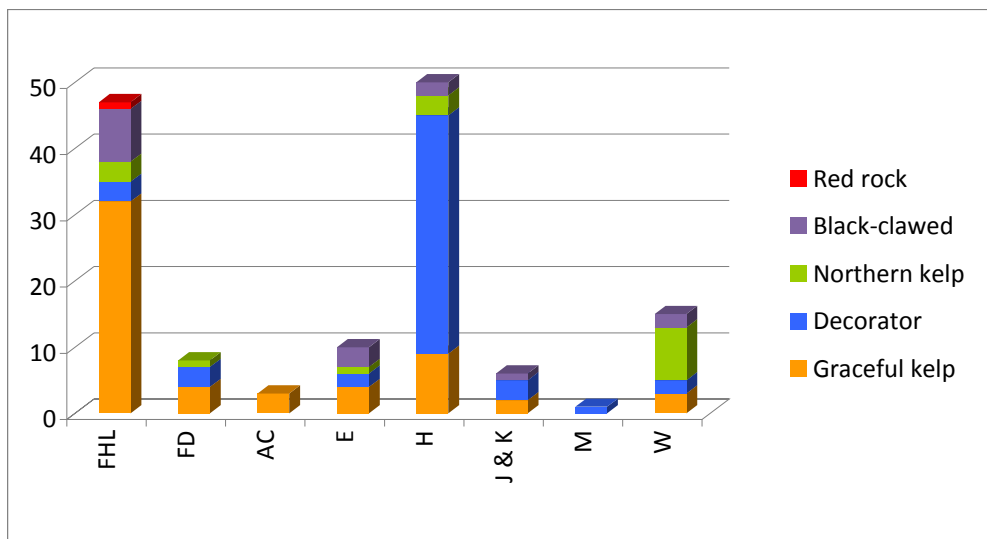
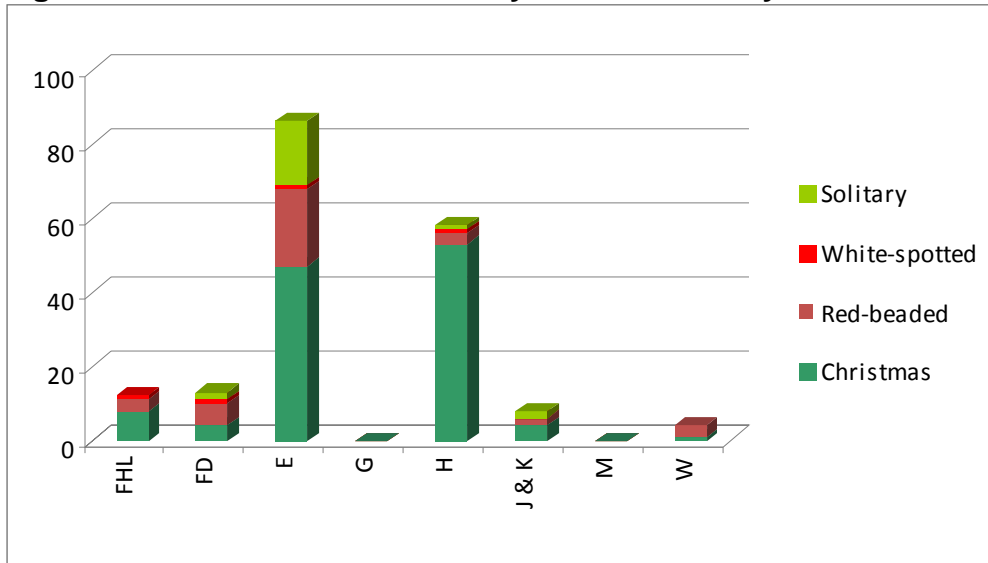


Figure 3B: Abundance and diversity of crabs by location 2010



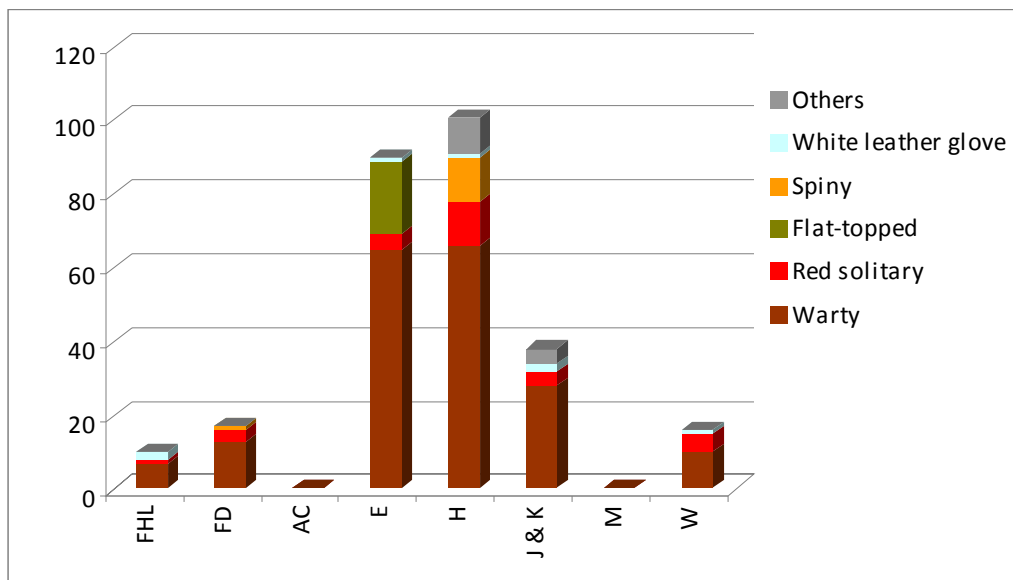
4. **Anemones** (Actinaria): are sessile although some can detach and “swim” to safety when threatened by a predator. As suspension feeders, they should thrive in areas of high nutrient inputs and strong circulation. Two closely related white species, *Metridium farcimen* and *Metridium senile*, are so abundant in the port that there is no practical way of counting them. Instead, we focused on several less common species. Interestingly they appear to favor docks E and H.

Figure 4: Abundance and diversity of anemones by location 2010



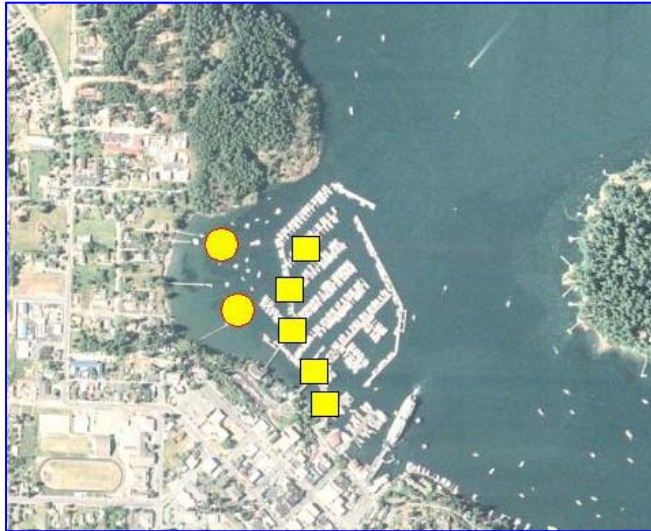
5. **Ascidians** (sea squirts, tunicates): are also sessile suspension feeders. We found a dozen species on the docks, including the invasive Flat-topped ascidian *Pyura hastor*, but many are inconspicuous and difficult to count reliably. Ascidians seem to thrive on docks E and H, like anemones.

Figure 5: Abundance and diversity of ascidians by location 2010



6. **Sediment quality:** five surface grabs (yellow squares, Figure 6) and two shallow cores (yellow circles) were collected in April tested for petroleum residues (TPH), carcinogenic polycyclic aromatic hydrocarbons (PAHs), boat-paint metals copper and zinc, and siltiness (percent of grains 0.1 mm in diameter and smaller). Means are shown below. Sediment copper is an immediate concern. About 1 percent of sediment copper can be expected to be taken up by the food web, and one part per million copper can be toxic to fish. A sediment load of 39.5 ppm in the bay is the equivalent of 0.4 ppm in fish and invertebrates—close enough to toxic levels to be managed carefully. Sediment PAHs, by contrast, may significantly underestimate the loading of biota. Our study of False Bay Creek (Barsh et al. 2010b) suggests a bioaccumulation rate of an order of magnitude or greater from water and sediment loading to loading of fish and invertebrates.

Figure 6: Sediment quality from 2010 cores and grabs



Mean results, all cores and grabs		
TPH	4.0	% by weight
PAHs	0.76	Parts per million
Copper	39.5	Parts per million
Zinc	4.2	Parts per million
Siltiness	65	% by weight

7. **Larval recruitment:** Pairs of box-like traps constructed of stone or ceramic tiles were suspended under port complex docks at five locations and, for comparison, under the main dock at Friday Harbor Labs, and left undisturbed for four months. Our objectives were to test these devices as a way of monitoring larval production in the bay as a whole—which may differ from the assemblage of animals already attached to the docks—and to detect any differences in larval survival on different docks that might be due to contaminants. We recovered 34 animal species from traps, 16 of them sessile. Nearly all were species we have also recorded on docks; the exception was the Brittle star, *Ophiopteris papillosa*. Animals found hiding in traps but not attached to them included gunnels, ascidians, and small juvenile sea stars, pink scallops, sea urchins, crabs and shrimp. The only significant difference between sites was that most Orange cup corals were seen at Spring Street dock for reasons not yet known. Stone tiles attracted about twice as many barnacles, and more other animals, than ceramic tiles – but not *different* animals.

References

- Barsh, R., C. Clark, and T. Stephens. 2010. Sediment Quality in Fisherman Bay and Friday Harbor, WA; Petroleum Residues, Polycyclic Aromatic Hydrocarbons, Pyrethroid Pesticides, and Toxic Metals. KWIAHT (Center for the Historical Ecology of the Salish Sea), Lopez, WA, May 2010.
- Barsh, R., J. Bell, E. Blaine, G. Ellis, and S. Iverson. 2010. False Bay Creek (San Juan Island, WA) Freshwater Fish and their Prey: Significant Contaminants and their Sources. KWIAHT (Center for the Historical Ecology of the Salish Sea), Lopez, WA, September 2010.

