CHAPTER FIVE

# Rock Habitats

**Relatively little hard substrate** occurs naturally in the estuary, owing mainly to the vast quantities of fine sediment that have been deposited by the rivers. Rock habitat is one class of hard substrate, the other being artificial structures (Chapter 6). Rock habitat in this chapter encompasses boulders to bedrock; that is, rock that is not normally moved by currents.

Rock habitat occurs mainly as scoured low-relief bedrock in the deep, narrow channels where the estuary passes through the Coast Range and as bedrock outcrops and boulders in the areas of the Central Bay where currents are strong. Many rock outcrops, especially those near the entrance to San Francisco Bay, have been lowered by blasting to reduce the hazards they present to ships, and they may be lowered further as ships with greater draft are built (Sea Surveyor 2000). See Figure 5-1. Some rock outcrops are flat-topped and are surrounded by boulder fields, presumably a result of previous blasting (Garcia and Associates 2001, Chin et al. 2004).

A kayaker navigates over rocky subtidal habitat.

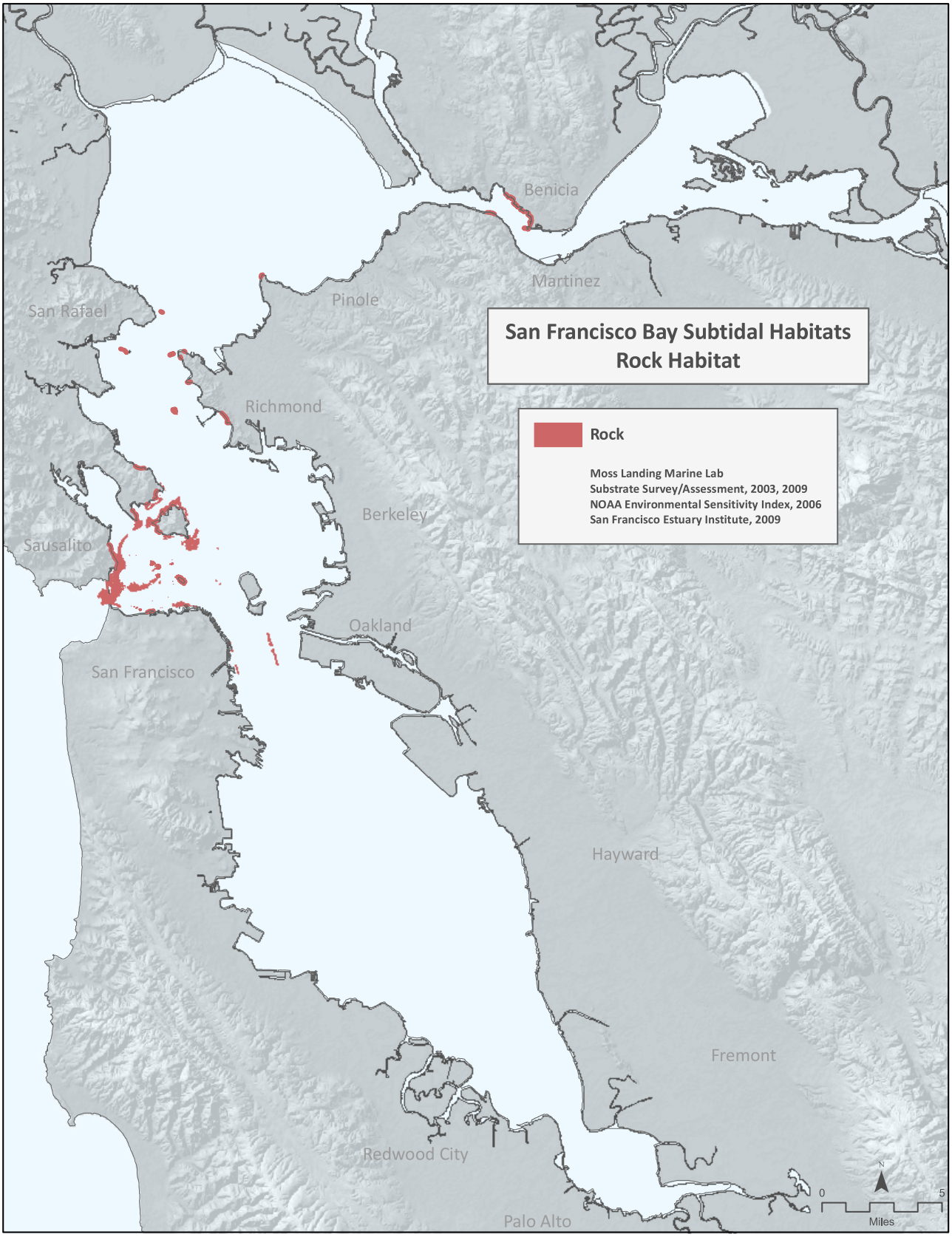



Figure 5-1: Distribution of Rock Habitats in San Francisco Bay.

West Marin Island in the Marin Islands National Wildlife Refuge provides critical nesting area for egrets and herons.

## Conceptual Model for Rock Habitats

Rock substrates alter flow fields, distorting patterns of sedimentation and altering surrounding soft-bottom habitat (Appendix 2-2; Figures 5-1 and 5-2). Once a bacterial film has been established, submerged rock can be colonized by a variety of organisms. These organisms include attached algae and animals such as sponges, bryozoans, tunicates, hydrozoans, anemones, barnacles, mussels, and oysters. Numerous other invertebrate animals (for example, amphipods, isopods, crabs) and fishes (for example, prickly sculpin, rockfish) reside on, under, or near areas of hard substrate, using rocky habitats for protection or food supply.

Some fish species such as rockfish use alterations in the tidal flow field caused by irregularities of bottom topography, including rocky substrate, to their advantage in feeding. Some fish (for example, sculpin) reside among hard substrate features, and their association with these features may be obligatory or opportunistic. Some species, notably Pacific herring but also some invertebrates, use rock and other hard substrate as well as attached vegetation for spawning. Other fish and invertebrates found around hard substrates, for

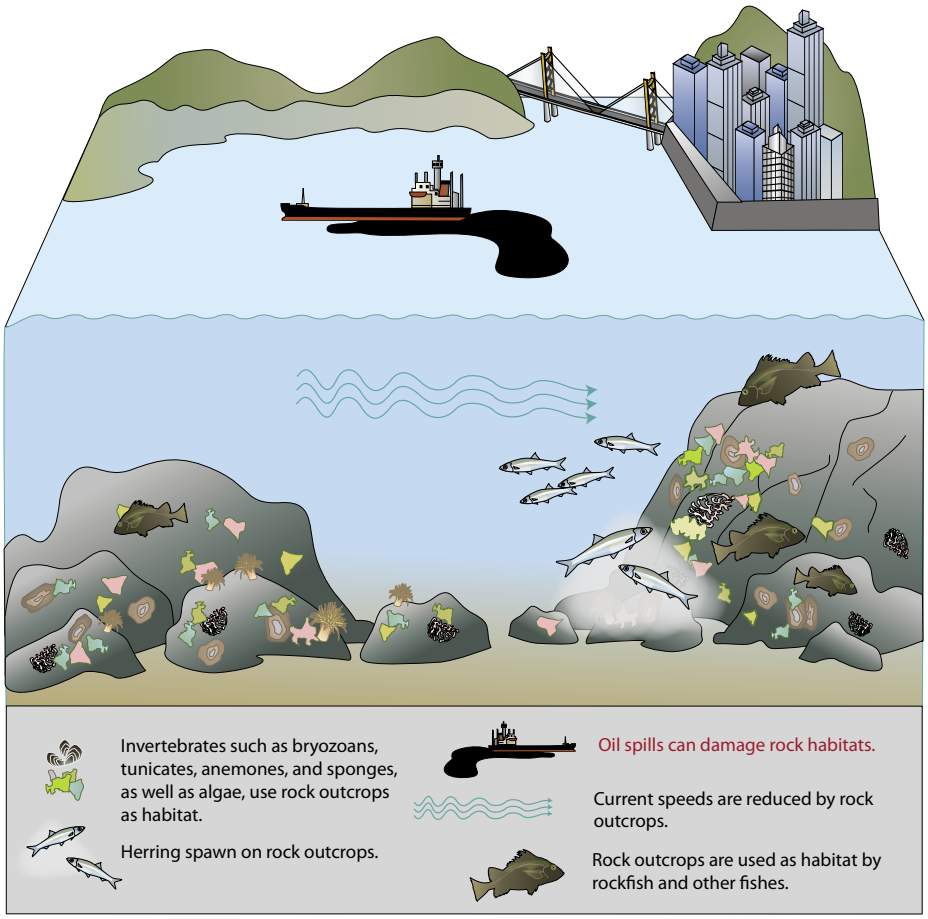


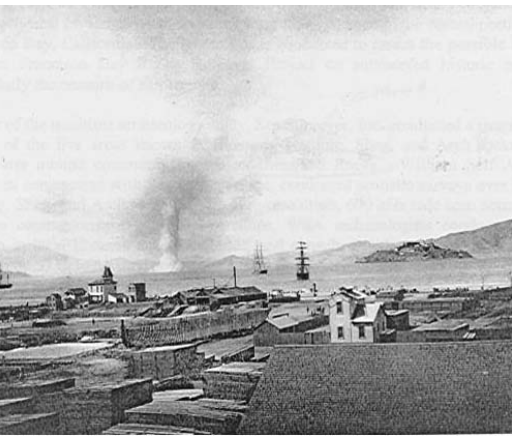

Figure 5-2: Conceptual diagram for rock habitat in the San Francisco Estuary. This diagram displays key processes that occur in and on rock, and some of the ecosystem services these substrates may provide.

Seals rest on rocks at the Brothers Islands near Point Molate in Richmond.

example, pelagic fishes such as anchovy, are equally abundant elsewhere. Birds use exposed sections of hard substrate for resting and nesting, and seals and sea lions also rest on them at low tide.

Because most rock outcrops occur in saline water within a tidal excursion of the Golden Gate, species composition of the flora and fauna should be similar to those on other extensive rocky subtidal habitats along the Central California coast. Detailed species composition of animals has not been determined for bay rock outcrops although video and photographs taken from a remotely operated vehicle (ROV) identified several species also found commonly outside the bay (Garcia and Associates 2001). The bay outcrops were covered with a "turf" of sessile organisms including bryozoans, tunicates, anemones, and sponges. Rocky shores are confined to a few areas near the Golden Gate, and may also harbor organisms found in similar sites on the outer coast.

A total of 162 species of attached algae have been reported from surveys within the estuary, most attached to hard substrate; of these, most were species also found on the open coast. Thirty-three species classified as estuarine were found mostly on artificial substrate (Josselyn and West 1985).



Historic photo of rock blasting to remove navigational hazards inside the Golden Gate.

### *Threats to Rock Habitats*

Blasting to remove or deepen outcrops for safety of navigation is a significant threat to rocky habitats. Potential threats also exist from sediment deposition and, for intertidal rock, oil spills and trampling by humans. Colonization by invasive species is also a threat to these habitats. See Figure 5-3, and Chapter 3.

## Rationale for Establishing Goals for Rock Habitats

Applying the approach outlined in Chapter 2 (Figure 2-1), it is clear that rock habitats support valued ecosystem services and are in short supply in the estuary (Figure 5-3). However, restoration of rock habitat in the sense of providing more of it seems impracticable. This directs our attention to protection and maintenance rather than restoration. There are restoration methods directed at the biota associated with rock habitat but those are primarily discussed in the shellfish, macroalgal, and living shoreline sections.

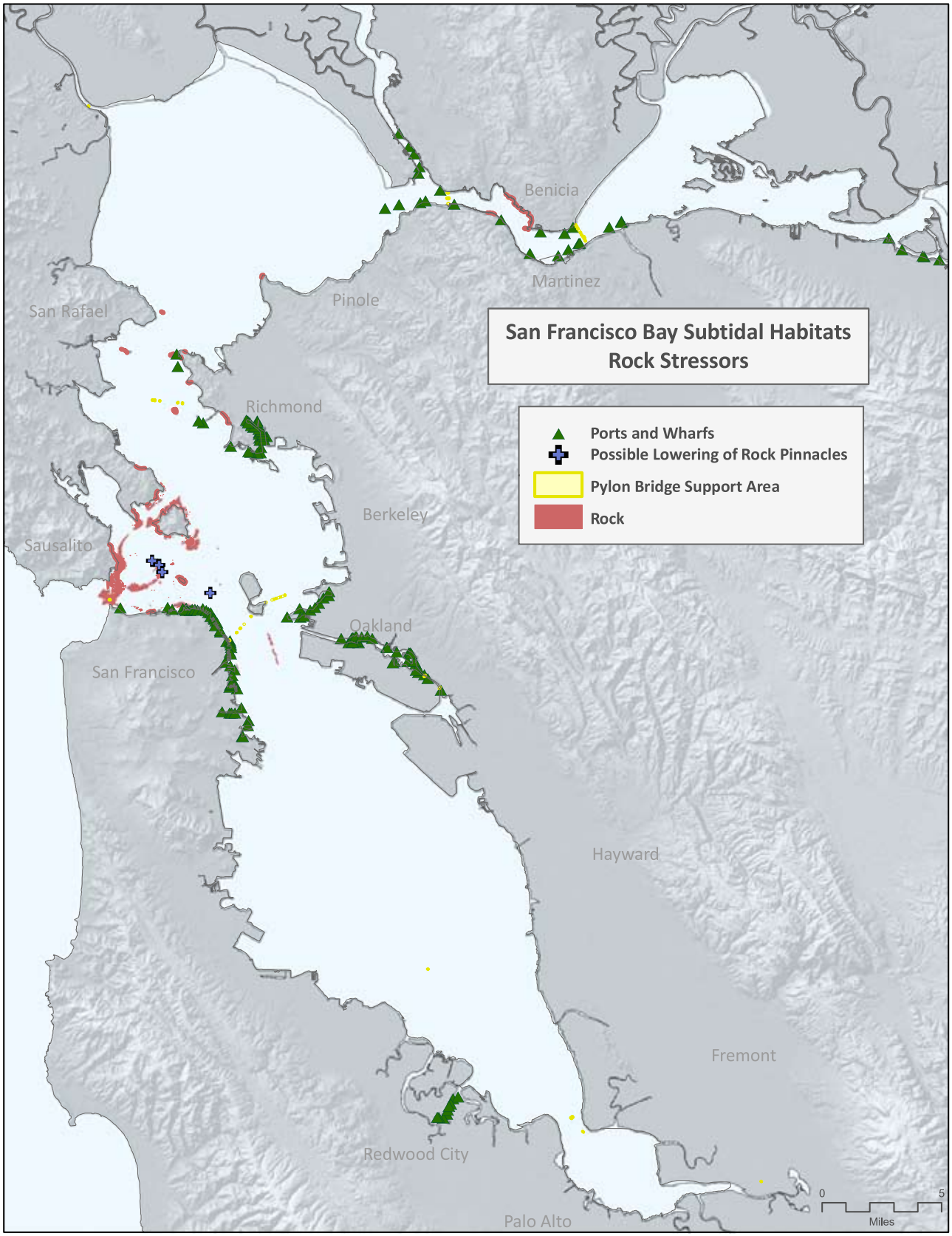



Figure 5-3: Locations of Rock Habitat Stressors in San Francisco Bay.

The increase in size and draft of vessels using San Francisco Bay could require further deepening of the channels and blasting of the rock outcrops (Carlson et al. 2000) to provide safe navigation. It would be useful to know which species are using these habitats to assess the environmental impacts of any proposed blasting. In the interim while waiting for the data based on the research questions, our recommendation is to protect these rock outcrops as much as possible.

Goals for rock habitat focus on protecting existing intertidal and subtidal rock from being removed for vessel traffic and damaged by public access; on enhancing this habitat by removing invasive species and debris; and on improving our understanding of the ecosystem services this habitat provides and the species that utilize rock habitats.

## Science Goals for Rock Habitats

### ROCK HABITATS SCIENCE GOAL 1

**Understand the ecosystem services provided by rock habitats and the species dependent on them.**

*Question A. What lives on the rock outcrops, and in what abundance?*

Without knowing what is there, it is difficult to say what would be lost by further deepening of the outcrops. By knowing which species are present and how abundant they are it should be possible to estimate the relative value of these habitats. In particular, the presence of or potential for re-establishing endangered, special-status, or important fishery or forage species known to associate with rock outcrops should be determined.

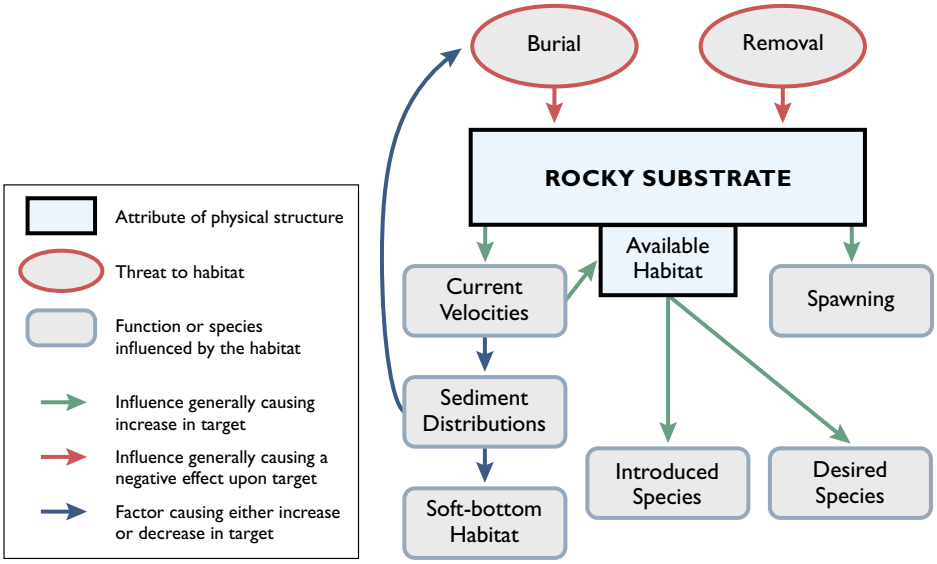



Figure 5-4: Influences on rocky habitat, and functions and services provided by submerged rock. "Available habitat" refers to rocky substrate that provides habitat for one or more species.

Above: Rocky intertidal shoreline extends to rocky subtidal habitat. Rocky intertidal shoreline provides habitat space for seaweeds, oysters, and other invertebrates.

*Question B. What lives on rocky shores, and in what abundance?*

Although these sites are much more visible (and visited) than rock outcrops, little information on species composition has been published. Such information would help us understand what can be gained by protecting these habitats.

### ROCK HABITATS SCIENCE GOAL 2

**Understand the ecosystem services provided by restored rock habitats.**

*Question A. What are the ecological consequences or benefits of using quarried rock in restoration?*

Quarried rock may be used for restoration and shoreline protection as sea level rises. It is important to understand how rock habitat placed through restoration actions functions relative to existing, natural rock habitats.

## Protection Goals for Rock Habitats

### ROCK HABITATS PROTECTION GOAL 1

**Promote no net loss of natural intertidal and subtidal rock habitats in San Francisco Bay.**

- Rock Habitats Protection Objective 1-1: Promote preservation of natural rock habitats in the bay by minimizing removal or lowering of rock pinnacles and outcrops.
- Rock Habitats Protection Objective 1-2: Provide access to natural rock habitats in the bay that encourages appreciation of the habitat and its inhabitants while protecting it from human trampling. See additional actions under Chapter 3, Public Access and Awareness section.

## Restoration Goals for Rock Habitats

### ROCK HABITATS RESTORATION GOAL 1

**Restore and maintain natural intertidal and subtidal rock habitats in San Francisco Bay.**

- Rock Habitats Restoration Objective 1-1: Remove invasive species from San Francisco Bay that may impact rocky intertidal habitats (see Chapter 3, Invasive Species section, *Undaria* and *Ascophyllum)*.
- Rock Habitats Restoration Objective 1-2: Provide funding and programs to clean up and prevent debris and derelict equipment at boating facilities (such as installing fishing line recycling stations) and upland sites adjacent to or within rock habitat. (See Chapter 3, Marine Debris*)*.
- Rock Habitats Restoration Objective 1-3: Incorporate living shoreline techniques to enhance the function of existing natural rock (see Chapter 10, Living Shoreline section).

Ochre star in the rocky intertidal zone.