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Extreme Biodiversity in the Marine Environment: Mussel Bed Communities of *Mytilus californianus*

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The exposed rocky intertidal component of Pacific Northwest shorelines is dominated by structurally complex beds of the intertidal mussel *Mytilus californianus*. These beds are composed of (1) a physical matrix of interconnected living and dead mussel shells that may occur as a single layer or multiple layers (up to five or six mussel layers deep); (2) a layer of accumulated sediments composed of organic and shell debris; and (3) a diverse assemblage of plants and animals associated with the mussels which represents one of

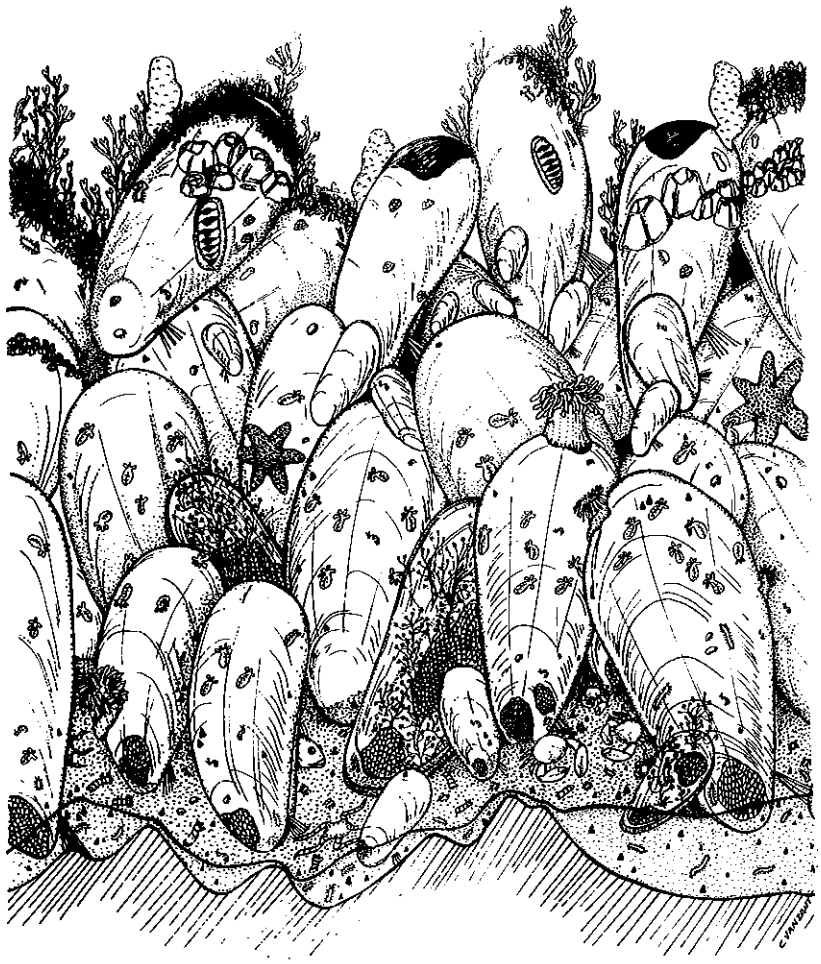

Fig. 1. Cross-sectional diagram of a *Mytilus californianus* mussel bed with its associated community. Over 300 species of plants and animals live within the layers and spaces of these mussel beds. Natural and/or human-induced disturbance events can destroy the mussel beds and the diverse community of organisms dependent upon them. At some protected high intertidal sites, the mathematically projected healing times for mussel beds and associated communities affected by such disturbances are estimated at hundreds to thousands of years.

the most diverse temperate communities described to date—more than 300 taxa (Fig. 1).

For samples of about $\frac{1}{10}$ m^2, the diversity of the mussel bed community ranges from about 25 species (at high intertidal protected sites) to about 135 species (at low intertidal exposed sites). *Mytilus*

community diversity (= species richness) on a region-wide basis exceeds 303 taxa and includes the three divisions of macro-algae, twelve phyla of invertebrates, and at least three species of boney fishes. As *M. californianus* beds age, they become thicker and structurally more complex, thereby increasing the types and numbers of microhabitats within the mussel bed, and increasing the area of colonizable hard surfaces (i.e., mostly mussel shells) five to thirty times above that of the relatively flat rock substratum. As the mussel matrix develops, sunlight is diminished, temperatures are reduced (by 5 to 13° C), relative humidity is increased by about 15%, and sedimentation is increased within the *Mytilus* beds. Species that can benefit from such specialized microhabitat conditions (such as species that require reduced wave shock) are attracted to these mussel beds; the result is an increase in diversity. Mussel bed community diversity is directly related to the structural complexity of the mussel matrix; that is, the thicker the mussel bed the more diverse the associated community.

When *Mytilus californianus* beds are disrupted through disturbance from natural agents (e.g., wave action or floating log damage) or human-caused impacts (e.g., oil spills), the associated community is dramatically impacted as well. Gaps in the mussel matrix caused by disturbance showed a significant lowering of *Mytilus* community diversity by an average of 87% (range = 50–99%). That is, after the initial disturbance event, gaps were later colonized by only ca. 13% of the species that are typically found already within the *Mytilus* matrix. In monitoring these gaps from the point of disturbance to the point of "healing," it appears that disturbance gaps at low intertidal sites in habitats with high wave exposure heal relatively quickly (weeks to months), but disturbance gaps at high intertidal sites with relatively low wave exposure have very low resilience.

Because of the extreme "instability" of some high intertidal components of this community in the face of disturbance agents that disrupt the biological mussel matrix, special care must be taken to protect this uniquely diverse community from human-induced impacts. From a policy and management perspective, this type of information can be used to assign relative sensitivity values to various marine habitats with different abilities to recover from major disturbances, especially those potentially caused by humans. Therefore, based on this information, priority protective listings can be assigned to different types of habitats with varying degrees of sensitivity to disturbance, helping to ensure better protection for these types of marine coastal resources.