



### Conceptual approaches to the differentiation of natural and anthropogenic disturbances in benthic ecosystems, with considerations of impacts of geoduck aquaculture operations



The Evergreen State College

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### Purpose of the presentation




Geoduck  
*Tresus nutalli*

Comatarium

1. Placement of geoduck aquaculture in the context of disturbance ecology;
2. Description of ecological aspects of disturbances associated with harvest activity.

### Defining ecological disturbance:



Guapavale

803264 Alamy Images

**A disturbance is any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substratum availability, or the physical environment**

[Pickett, S.T.A., and P.S. White. 1985. The ecology of natural disturbance and patch dynamics. Academic Press, Orlando, Florida, USA.]



Natural disturbances on large scales

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### Natural disturbances on smaller scales

This collage illustrates various natural disturbances on smaller scales. The images include: a tree trunk with exposed roots (National Park Service), a walrus underwater (National Park Service), three ground squirrels (National Park Service), a large rockfall (US Geological Survey), a sand dune (US Geological Survey), and a forest fire (© Goran Ehlmé (Sweden)).

### Anthropogenic disturbances

This collage illustrates various anthropogenic disturbances. The images include: a large tree being cut down, a bulldozer, a construction site, a ship, and a diagram of demersal trawling. The diagram shows a ship pulling a trawl net with labels for 'HEADLINE', 'BUOY', 'NETS', and 'GROUND ROPE'.

### Operating premises:

1. Natural disturbances occur in all biological communities;
2. The ability of biological communities to resist, accommodate, and recover from anthropogenic disturbances depends on the similarity between anthropogenic and natural disturbances to which the community is exposed.

National Snow & Ice Data Center

### Metrics for characterizing disturbances, and for comparing disturbances of different types:

- Frequency and duration:** How often and for how long?
- Intensity:** How disruptive?
- Size:** How big?
- Chemical and Physical Attributes:** By what mechanisms does disruption occur?
- Community resistance/resilience:** What are the spatial and temporal patterns of recovery of the disturbed community to the pre-disturbance configuration?

### Natural versus anthropogenic disturbances

- Compare similarity of effects and consequences across all disturbance metrics: frequency & duration, intensity, size, chemical/physical attributes, and population response patterns:
- If similarity is **high**, the potential for lasting ecological damage by the anthropogenic disturbance likely is **low**.

RELATIVE SIMILARITY

ANTHROPOGENIC DISTURBANCE

NATURAL DISTURBANCE

The diagram shows two overlapping circles, one orange (Anthropogenic Disturbance) and one green (Natural Disturbance). The intersection is a yellowish-brown color. A blue arrow points to the intersection, labeled 'RELATIVE SIMILARITY'. Green arrows point from the text labels to their respective circles.

### Natural versus anthropogenic disturbances

- Compare similarity of effects and consequences across all disturbance metrics: frequency & duration, intensity, size, chemical/physical attributes, and population response patterns:
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RELATIVE SIMILARITY

ANTHROPOGENIC DISTURBANCE

NATURAL DISTURBANCE

The diagram shows two overlapping circles, one orange (Anthropogenic Disturbance) and one grey (Natural Disturbance). The intersection is a very small, light-colored area. A blue arrow points to the intersection, labeled 'RELATIVE SIMILARITY'. Green arrows point from the text labels to their respective circles.

### Effects of harvest

Harvest components:

1. Liquification of plot using high-pressure water jets;
2. Removal of dislodged clams;
3. Repetition, possibly several times, over a period of 5-10 days.

Save Our Shoreline (both)

The top image shows a person in a wetsuit using a high-pressure water jet to harvest clams. The bottom image shows several orange crates filled with harvested clams.

### Effects of harvest

Biological consequences of harvest:

1. Initial dislodgement, injury, or mortality to resident biota;
2. Attraction of predators and scavengers to disturbed site to consume dead or injured biota;

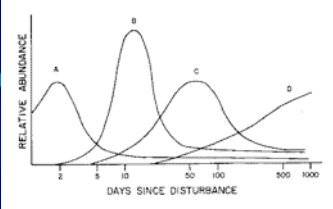
Puget Sound Action Team

The image shows a large, curved, textured object, likely a clam shell or biological specimen, against a white background.

### Effects of harvest

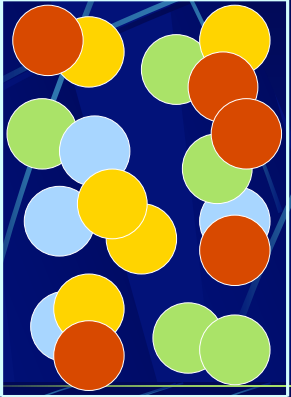
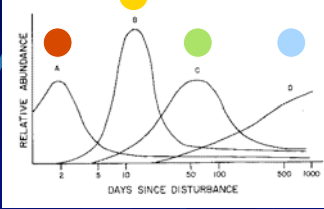
Biological effects of harvest:

- Physical modification of habitat;
- Utilization of modified habitat by opportunistic species;
- Successional transition over time in the physical characteristics of the disturbed location, and in the composition and abundance patterns of biota in the disturbed location



VanBlaricom 1982

### Ultimate effects of harvest (or of spatially discrete natural disturbances): The spatial-temporal mosaic

VanBlaricom 1982

### But before we get over-confident:

Analytical challenges:

- Five metrics of disturbance to consider;
- Dozens, if not hundreds, of species in ecosystems of interest;
- An infinite number of possible abundance patterns post-disturbance


**Result: Analytical and computational hurdles**



Gary Hershorn, Reuters/Corbis

### Experimental field ecology: Plausible as a source for answers

- Temporal and spatial scales of harvest activities and likely ecological responses are appropriate for field experimental approaches;
- Appropriate methods are tractable and relatively inexpensive.
- Sources of the natural disturbance regime likely can be identified.
- As noted, the challenge will be in the quantitative evaluation of differences in effects of natural and harvest-related disturbances



The GEODUCK (Panopeus generosus)  
Native of Puget Sound, often reaches great size. Geoduck hunting is a very popular sport in the neighborhood of HOOD CANAL—WASHINGTON

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