RECOVERY OF ROCKWEED FOLLOWING EXPERIMENTAL REMOVAL

Ruth Yender
National Oceanic and Atmospheric Administration
Hazardous Materials Response and Assessment Division
Biological Assessment Team
7600 Sand Point Way NE
Seattle, Washington 98115

ABSTRACT: *Recovery following experimental removal of rockweed along rocky shorelines was monitored at five study sites in Washington and Alaska. Rockweed plants were cleared from experimental plots using methods that simulate cleanup techniques applied to rocky shorelines that have been affected by oil spills. Three treatments were evaluated: removal of rockweed only, complete removal of rockweed and all other biota, and an undisturbed control. One year after treatment, results indicate that the percent cover of rockweed remained lower at treated plots compared to control plots, and was lowest where all biota had been totally cleared.*

Rockweed, a brown algae, often dominates the rocky intertidal zone in temperate and subarctic regions, forming a canopy that provides shelter and forage for many species. In the event of contamination following shoreline oiling, removal of heavily oiled rockweed plants may be a necessary component of shoreline cleanup to minimize oil exposure to other natural resources, such as birds and marine mammals, and to people. Intensive shoreline cleanup techniques can provide relatively rapid and efficient oil removal, but may severely impact communities of intertidal algae and invertebrates. Intertidal communities on some shorelines in Prince William Sound, Alaska, that were washed with hot water under high pressure after the *Exxon Valdez* oil spill reportedly were more severely affected than oiled, unwashed sites and did not recover for several years after treatment (Mearns, 1993, 1995; DeVogelaere and Foster, 1994; Houghton *et al.*, 1993). The purpose of this investigation is to determine whether rockweed reestablishes more rapidly following treatment with techniques that remove the rockweed canopy only (such as manual cutting), rather than when following techniques that also eliminate other epibiota (such as pressurized hot water washing). The study results will help guide future cleanup of oiled rocky shorelines when the "no-action" alternative is deemed an unacceptable response.

Methods

A simple intertidal experiment was initiated in 1994 to compare rates of recovery of the rockweed *Fucus gardneri* and associated intertidal species following application of two types of rockweed removal techniques. Five study sites were established in Prince William Sound, Alaska and Anacortes, Washington on uncontaminated sheltered bedrock shorelines. A randomized block design was employed at each study site to establish three transect lines parallel to the shoreline in the upper intertidal zone where rockweed is abundant and risk of oiling following a spill is greatest. Three permanent 0.1 m^2 quadrats (rectangular plots) were established at least 0.5 meter apart along each transect line. All quadrats met criteria for substrate homogeneity.

Three treatments, randomized within each block, were evaluated: (1) removal of the rockweed canopy only, (2) total removal of all biota, and (3) no removal, to serve as a control. The first treatment was intended to simulate manual rockweed removal methods. All rockweed plants within quadrats receiving this treatment were cut approximately one centimeter above the holdfast in a manner simulating what would be done by a typical minimum-wage cleanup worker supplied with a sharp (but not dangerous) cutting instrument. The second treatment was intended to simulate the effects of pressurized hot water washing. Within quadrats receiving this treatment, rockweed holdfasts and all other biota were completely cleared using wire brushes and scrapers. The quadrat surface was then heated with a propane torch to kill any remaining epibiota. Control quadrats were not treated. Percent cover of rockweed and abundance of other key species within each quadrat were counted or estimated prior to treatment in June 1994 and again one year later.

Results and discussion

A comparison of mean percent cover of rockweed for each treatment category prior to, immediately after, and one year after treatment is shown in Figure 1. Preliminary data analysis indicates rockweed canopy cover for both removal treatment categories remained substantially lower than the control group one year after treatment. Mean percent cover was lowest where all biota had been cleared. Complete clearance quadrats showed no rockweed canopy reestablishment at three of the five study sites, and less than 20% cover at the other sites. Rockweed recovery appears to be more rapid in quadrats where only the canopy was removed, though still below control and pretreatment levels of cover after one year. Results also indicate that several associated intertidal species demonstrated generally the same recovery pattern as rockweed cover within the first year following treatment. This is the case for limpets and the Sitka periwinkle (*Littorina sitkana*), gastropod grazers that rely on the rockweed canopy for protection from desiccation, predators, and surf conditions. Sampling of experimental plots in Washington two years after treatment indicates rockweed cover for both removal treatment categories had reached levels comparable to the control group. Recovery of rockweed canopy cover does not necessarily imply reestablishment of normal age structure. Alaska study sites were not sampled in 1996. Comparisons between Alaska and Washington recovery trends in the first year after treatment are being evaluated.

Preliminary results of this study suggest cleanup techniques that remove the rockweed canopy are likely to result in reduced rockweed cover for at least one year following treatment. Results also indicate intensive cleanup techniques that clear all or most biota result in relatively longer recovery times for rockweed and several associated intertidal species. Large-scale application of such techniques over broad, continuous areas is expected to result in longer recovery periods than observed with the small patches manipulated in this experiment. Accordingly, when the "no action" cleanup option for an oiled rocky shoreline is considered to be unacceptable, selection of cleaning techniques that preserve intertidal biota to the maximum extent possible is advisable.

Biography

Ruth Yender is an ecologist with the Biological Assessment Team of NOAA/Hazmat, based in Seattle, Washington. She provides remote and on-scene scientific support on biological issues to NOAA scientific support coordinators and the U.S. Coast Guard during responses to spills of oil and hazardous materials.

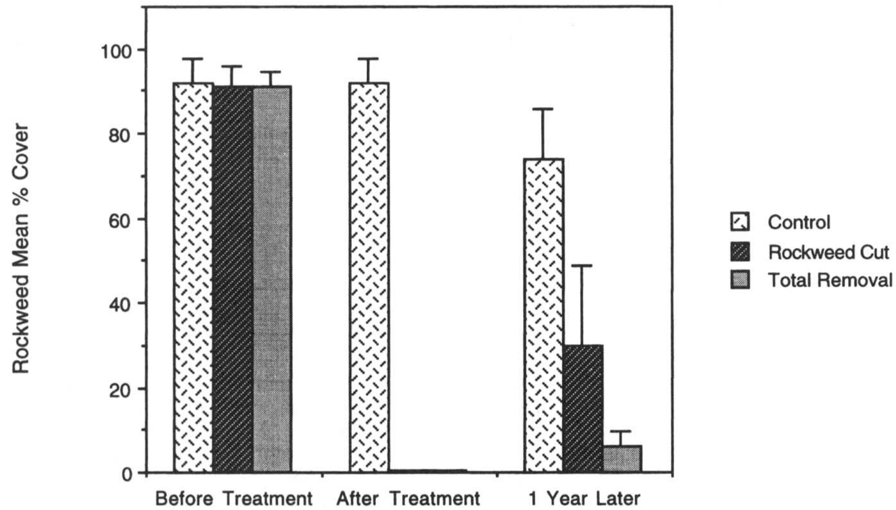

Figure 1. Rockweed *Fucus* mean percent cover (±SE, n = 5) for each of three treatment groups immediately before and after treatment and one year later

References

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TOXICITY OF DISPERSANT, OIL, AND DISPERSED OIL TO TWO MARINE ORGANISMS

Ismail Gulec and Douglas A. Holdway
Oil Spill Research Group, Department of Applied Biology and Biotechnology
Faculty of Biomedical and Health Sciences
RMIT-City Campus, GPO Box 2476V
Melbourne, VIC, 3001
Australia

ABSTRACT: *Acute lethal bioassays using semistatic conditions were conducted to assess the toxicity of crude oil, dispersant, and dispersed oil using the amphipod* Allorchestes compressa *as a test species. Sublethal bioassays (suppression of burying behavior over 24 hours of exposure) were conducted for these toxicants using the marine sand snail* Polinices conicus. *Both lethal and sublethal bioassays were also carried out for two reference toxicants: sodium dodecyl sulphate (SDS) and zinc sulphate.*

Mean (n = 4) *acute 96-hour LC_{50} (SE) values for* A. compressa *exposed to Corexit 9527, dispersed crude oil, and water-accommodated fractions (WAF) of crude oil were 3.03 mg/L (0.05), 16.2 mg/L (2.8), and 311,000 mg/L (5760), respectively. EC_{50} (SE) concentrations for* P. conicus *exposed to Corexit 9527, dispersed crude oil, and WAF of crude oil (30 minutes' exposure) were 50.2 mg/L (2.10), 65.4 mg/L (1.95), and 190,000 mg/L (5600), respectively. These sublethal EC_{50}'s were reduced to 33.8 mg/L (0.7) for Corexit 9527, 26.3 mg/L (1.3) for dispersed crude*