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survival of 0+ (young-of-the-year, YOY) Dungeness crab, *Cancer magister*, in Grays Harbor Estuary, Washington. Intertidal shell serves as critical refuge for 0+ crab, and crab densities are significantly greater in shell than in mud habitats. However, the constant turnover of sediments through burrowing activity of ghost shrimp, *Neotrypaea (Callianassa) californiensis*, and mud shrimp, *Upogebia pugettensis*, can reduce sediment compaction and alter soft-bottom species assemblages. To assess the potential impact of burrowing shrimp on the long-term success of intertidal shell mitigation, we quantified patterns of adult distribution and larval settlement at two shell-mitigation sites within the estuary. Laboratory experiments also examined the impact of 0+ crab predators on recruitment success of infaunal shrimp in shell.

Monthly surveys of small-scale test plots in 1991 indicated that the burrowing activities of infaunal shrimp were partially responsible for the loss of crab habitat through shell subsidence. This often occurred within one month after shell placement. Results from 1992 indicate that 0+ shrimp are over four times more dense in open mudflats than shell habitats (58 vs 13 shrimp · m^{-2}). Laboratory experiments conducted on crab foraging behavior and predation rates on 0+ shrimp in shell habitat indicate that a single YOY crab (18–22 mm carapace length) can eat as many as 12 shrimp within a 24-hour period. Although the two sites chosen for full-scale mitigation are devoid of high adult shrimp densities (e.g., <40 shrimp · m^{-2}), it is uncertain whether continued recruitment of 0+ shrimp will degrade the quality of these shell habitats over time or whether, as the results of laboratory experiments conducted in 1992 suggest, 0+ crab resident in the shell will reduce the abundance of settling shrimp through predation.

APPROACHES TO THE BIOLOGICAL CONTROL OF ZEBRA MUSSELS. **Daniel P. Molloy,** Biological Survey, New York State Museum, Albany, NY 12230.

This paper examines what role biological control techniques may play in the integrated pest management of zebra mussels, *Dreissena polymorpha*.

Predators: Numerous organisms are known to prey on zebra mussels, but each would appear to be of little usefulness in actual control projects. Predators, however, have been reported to significantly reduce localized field populations of zebra mussels and could play an important role in the long-term reduction of zebra mussels in lakes, rivers, etc.

Parasites: Very little research has been conducted on zebra mussel parasites. A recent study in the Netherlands, however, has reported a severe and apparently lethal protozoan infection. Future use of parasites as biocontrol agents can not be dismissed. In terms of environmental impact, parasites are ideal control agents since they have been fine-tuned through evolution to be host specific and thus should cause negligible nontarget problems. Parasites, however, often have complex growth requirements and elaborate life cycles; these two characteristics can represent formidable obstacles toward economical mass production—a requirement for commercialization.

Toxin-Producing Microbes: A third and novel approach to developing a biological control method for zebra mussels is the screening of microorganisms (primarily bacteria) to find strains that are selectively lethal to these mussels. The microorganisms screened are not truly invasive parasites of zebra mussels, but rather microbes which are fortuitously lethal to zebra mussels when the mussels are exposed to artificially high densities of these microbes or their metabolic byproducts. Once a promising strain is found, these microbes can often be economically mass produced in vitro—a characteristic which can lead to their rapid commercialization. Such a screening process has a clear record of success in the development of microbial insecticides and may well prove valuable for zebra mussel control also. Laboratory data on lethality of bacterial stains will be presented.

AN INTEGRATED PEST MANAGEMENT PLAN FOR THE CONTROL OF BURROWING SHRIMP POPULATIONS ON OYSTER BEDS IN SOUTHWESTERN WASHINGTON STATE. **John L. Pitts,*** Aquatic Farm Program, Washington State Department of Agriculture, Olympia, WA 98504-2560.

Two species of burrowing shrimp (*Neotrypaea californiensis* and *Upogebia pugettensis*) occur in Pacific Coast estuaries with varying impacts on oyster and clam culture. The Pacific Coast currently produces more than a third of the nation's oysters, therefore, pest infestation is of regional and national concern.

The carbamate pesticide carbaryl (Sevin) is the only effective tool currently approved for control of excess shrimp populations on oyster beds in Washington State. Objections by some crab fishers and environmentalists has led to the development of a multifarious Burrowing Shrimp Control Committee (BSCC). The BSCC developed an Integrated Pest Management Plan (IPMP) designed to evaluate alternative pest control methods and implement a plan using suitable strategies which allow continued oyster culture. Alternative methods identified include alternative culture techniques, mechanical control, enhancement of shrimp predators, electrofishing, and modification of carbaryl application. Critical timing for shrimp control requires additional study. A three year non-target species impact study commenced in 1992. Agriculture engineers are currently exploring alternative culture methods and modification of terrestrial pest control methods. Economic Threshold Determination studies are needed to determine "trigger" points for shrimp control maximum efficiency.

ALASKAN SHELLFISH INDUSTRY PANEL

PROMISE AND CONSTRAINTS OF SHELLFISH AQUACULTURE IN ALASKA. **Raymond Ralonde,** Marine Advisory Program School of Fisheries and Ocean Sciences University of Alaska; **James Cochran,** Mariculture Coordinator, Fisheries Rehabilitation Enhancement and Development Division Alaska Department of Fish and Game; **Jeff Hetrick,** President of the Alaska