

established, as is their ability to rapidly expand their range.

The western North America invasion has undergone a rapid range expansion, with green crabs expanding their range by more than 750 km in less than ten years since their initial invasion. Green crabs are now firmly established in every significant bay and estuary from Monterey Bay, CA, to Gray's Harbor, WA, and have the potential become established from the Gulf of Alaska to Baja, California. The uniformity of the green crab distribution strongly suggests that green crabs can rapidly expand their range once they are established. In 2000 they continued to expand their northern range in eastern North America by invading the Gulf of St. Lawrence at Prince Edward Island, Canada.

Green crabs are both eurythermic and eurohaline and can survive a temperature range from freezing to 30 °C while utilizing a broad range of habitat types. They exploit a wide range of prey types, including molluscs (clams and snails), crustaceans, annelids, fish, and algae. Several native species have declined significantly as a direct result of green crab predation in western North America. Green crabs have had substantial impacts on some commercially important clam species, *Mya arenaria*, and *Mercenaria mercenaria*, and on the scallop species, *Argopecten irradians*. Green crab predation in invaded communities may indirectly affect feeding rates and foraging efficiency of shorebirds.

Recognizing the ecological and economic impacts, as well as expanding geographic range of the green crabs in North America, *Carcinus maenas* was the first marine organism to be designated as an aquatic nuisance species in 1998 by the Aquatic Nuisance Species (ANS) Task Force. In 2000, the Green Crab Control Working Group was appointed by the ANS Task Force to develop a Management Plan. The management strategies available in the plan to limit the impact of the European green crab, as well as that of other invaders, include a combination of prevention, eradication, and control measures. This plan is the result of several years of planning and research and has identified the following management options for prevention, eradication, and control of *Carcinus maenas* in the United States:

- Prevention and Containment
- Detection and Forecasting
- Eradication, Control, and Mitigation
- Information Access and Data Management

Prevention and Containment

This option provides a detailed description of the priority activities that the Working Group has identified to prevent further spread of the green crab. The goals of prevention and containment are to:

- Identify pathways of invasion and quantify the risk of each pathway; and
- Identify management options available for reducing the risk associated with each pathway.

The Management Plan also discusses the types of information needed to accomplish this management option, as well as the strategies that may be most effective.

Detection and Forecasting

This option provides a detailed description of the priority activities to be undertaken as soon as possible to implement a comprehensive program to detect new invasions and range expansions of the European green crab and to forecast pollution irruptions at invaded sites. The goals for this option are to do the following:

- Outline specific procedures for detecting the presence of juvenile green crabs in previously uninvaded areas. This will provide an "early warning" of new invasions and provide additional time for restricting activities that would potentially delay further spread. It also allows time to develop local education/outreach efforts or other activities aimed at heightening public awareness in order to minimize the probability of unintentional movement of green crabs;
- Track the approximate abundances of green crab populations in previously invaded areas to allow forecasting of "outbreak" years. The ecological and economic impacts of green crabs are directly related to their abundance, so if outbreak years can be forecasted, this would provide an important warning for resource managers, production fisheries, aquaculture, and others that may be negatively affected by a large year class of green crabs. This would also provide additional time to jumpstart necessary management activities, and increase education and outreach efforts that might ameliorate the impacts of these species in years of high abundance;
- Monitor uninvaded areas to detect new invasions and range expansions. This would most effectively be accomplished by detecting the presence of postlarval green crabs and/or the presence of young-of-the-year (YOY) juvenile green crabs. To detect the presence of green crab postlarvae, biweekly to monthly sampling between April and June would be involved. Postlarvae can be sampled by deploying

bag collectors attached to docks, moorings, and buoys at replicate sites in harbors and bays. Bags are exchanged at the desired interval, and collected organisms are rinsed off the collectors, sorted, preserved, and counted. Young-of-the-year (YOY) juvenile green crabs are best sampled by deploying baited minnow traps in intertidal areas at replicate sites in harbors and bays in August and September; and

- Monitor invaded areas to forecast "outbreak" years. This is most effectively accomplished through monitoring the abundance of postlarval green crabs, including juvenile as well as adult crab populations.

Eradication, Control, and Mitigation

The Management Plan has identified and discussed various actions for this option. These actions are dependent upon the data, population abundance, and control tools currently available. Just as crab abundance differs by location, so too may the tools available for controlling the population be different. For example, early detection of new invasions may permit successful rapid response and extirpation at a local level. Small populations with no local recruitment may be easy to eradicate by selective harvest, chemical control, biological control, or genetic control measures, while population established with local recruitment may need control and containment in addition to selective harvest, chemical control, biological control, or genetic control measures. However, if the invasion has proceeded to the point that achieving population control on a broad scale is either perceived to be insurmountable or is not presently being addressed, mitigative control measures may be used in concert with broader regional or local control. Cooperative research on the seasonal dynamic of green crab recruitment and predation, along with field tests on the efficacy of various mitigation measures, should be conducted in those areas where green crab are abundant.

Information Access and Data Management

The objective for this component of the management plan is to share the information source(s) and data management needed to efficiently implement the national management plan. The objectives for this component of the plan are to:

- Provide current information on the research and management activities being conducted under the plan;
- describe standardized research and management protocols that allow others