

The Green Menace: The European Green Crab

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Beware of the green menace! I am not referring here to little critters from Mars, the long arm of capitalism, or environmentalists who have chained themselves to liberated dairy cattle. I speak of something far worse. This menace has two beady eyes, ten legs (two of which are heavily armed), a hard outer shell, and an insatiable appetite for bivalve mollusks. Of course, I can only be talking about one thing—the European green crab (Figure 1).

The European green crab is actually composed of two sibling species, an Atlantic form (*Carcinus maenas*) and a Mediterranean form (*Carcinus aestuarii*). The two are very similar but can be separated by minute differences in morphology or by molecular genetic analysis. The native range of the Atlantic form spans northward to Scandinavia and Iceland, and south through the British Isles to the Canary Islands and North Africa. The Mediterranean form is found in the inland seas of Europe including the Mediterranean, Black, and Asov Seas. The ranges of these two species apparently do not overlap, with the Strait of Gibraltar serving as an effective barrier between them. While their native distributions are well defined and somewhat limited, these species enjoy a cosmopolitan distribution as a result of human activities. The Atlantic form is the most widespread with introduced populations in Australia, Tasmania, South Africa, and both coasts of North America. As far as is known, the only introduced population of the Mediterranean form is in Japan.

While it may be difficult to tell these two species from one another, it is relatively easy to separate the green crab from other North American crabs. The diagnostic characteristics to look for are: (a) five evenly spaced pointy spines on each side of the carapace and (b) three round lobes between their eyes (Figure 2). One characteristic that is not diagnostic is that they are green. The color of the European green crab varies from a medium dark



Figure 1. Adult European green crab captured in Willapa Bay, Washington, summer 1998. Photo by Liz Carr, Washington Department of Fish and Wildlife.

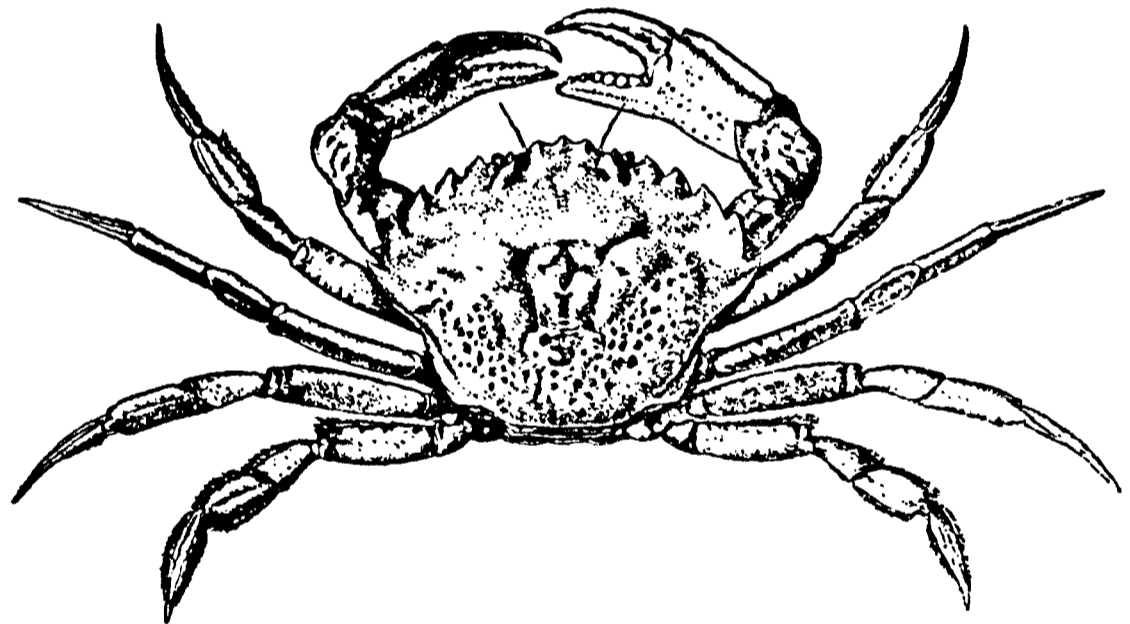


Figure 2. The green crab *Carcinus maenas*. From Ricketts, Calvin, and Hedgpeth; rev. Phillips, *Between Pacific Tides*, Fifth Edition, copyright 1939, 1948, 1952, 1962, 1968, 1985. The Board of Trustees of the Leland Stanford Junior University. Used by permission of Stanford University Press, www.sup.org.

green to a dark muddy brown on top and a pale green to bright yellow, orange, or red below. Furthermore, other crabs can also be green. In the Pacific Northwest, for example, Dungeness crabs (*Cancer magister*), kelp crabs (*Pugettia* sp.), helmet crabs (*Telmessus cheiragonus*), yellow shore crabs (*Hemigrapsus oregonis*), and purple shore

crabs (*Hemigrapsus nudis*) can all appear green at times.

The European green crab is a member of the family Portunidae, commonly known as swimming crabs (the blue crab, *Callinectes sapidus*, of the east coast of North America is a member of this family). In most crabs

in this family, the rear leg is flattened and functions as a paddle for locomotion through the water. The European green crab is the odd member in that the legs are long and slender with the rear leg only slightly flattened. This is not an adaptation for swimming, rather, it is an adaptation for running across mud, something it does with a certain amount of elegance and at relative lightning speeds.

North American Distribution

In North America, the green crab is, at the same time, one of the oldest and the newest of our introduced marine species. It was first noted along the east coast of North America in 1817, where a population became established between New Jersey and southern Massachusetts. The crabs undoubtedly arrived with the flood of human immigration by hitching a ride on the hulls of sailing ships or as passengers among rocks used as ballast. After its discovery in North America it was generally considered rare and restricted to its New Jersey to Massachusetts distribution. Around the turn of the twentieth century, however, ocean temperatures began to rise, to which the green crab responded with a massive population explosion and range expansion. Today it can be found from Virginia to Prince Edward Island, Canada.

The west coast of North America remained free of the green crab until the late 1980s when an established population was discovered in San Francisco Bay, California, in 1989. Genetic analysis of the California population indicates that these crabs most likely derived from the green crab populations found on the east coast of North America. There are two likely theories as to how the European green crab arrived on the Pacific coast of North America. One theory is that the crabs arrived in seaweed used as packing material for Atlantic lobsters or bait worms and the other theory is that they arrived in ballast water that was discharged into San Francisco Bay.

Whatever their mode of transport to the west coast, their dispersal once they arrived was relatively modest. As of 1993, the green crab had spread to only a few other estuaries all within 80 km of San Francisco Bay. However, an El Niño event occurred in

1995, causing ocean temperatures to rise, thus creating favorable conditions for green crab reproduction. This El Niño event also created strong north flowing ocean currents that swept millions of planktonic green crab larvae to locations as far north as Willapa Bay, Washington. Another very strong El Niño event occurred in 1998, further expanding their range as far north as Barkley Sound, located on the outer coast of Vancouver Island, British Columbia. It should be noted that the green crab is still considered rare and not very well established north of Oregon, and it has not yet been found in the Puget Sound region.

Impacts of an Invader

So what is to fear from this elegant decapod? Why has the US National Aquatic Nuisance Species Task Force declared it an aquatic nuisance species? In short, it likes to eat. It is generally omnivorous, but it particularly likes to eat oysters, mussels, and clams—all valuable marine resources for human beings. While the green crab can eat oysters up to 65 mm in length and mussels up to 45 mm, it does the most damage to newly settled shellfish. Where large populations of green crabs are established, the species can essentially eliminate new recruitment of certain types of shellfish. In addition to its appetite, its agility makes it an outstanding competitor with other species in the marine environment. It can also survive long periods without oxygen and is very tolerant of a wide range of water temperatures and salinities, which makes it easily transportable and highly adaptable to new environments.

On the east coast of North America it is difficult to know what the ecological impacts of the European green crab are because it has been there for such a long time. That is, the damage was done before such records were kept, with one notable exception. The soft shell clam (*Mya arenaria*) harvest in New England went from a high of 14.7 million pounds in 1938 without the presence of the green crab to 2.3 million pounds in 1959 after its arrival, an 85% reduction. The European green crab is also credited with having great impacts on the quahog (*Mercenaria mercenaria*) and the soft shelled blue crab (*Callinectes sapidus*)

fisheries. On the west coast of North America it is difficult to know what the impacts will be because the European green crab has not been there long enough. One study in Tomales Bay, California, has shown a 40% drop in the Manila clam (*Tapes philippinarum*) harvest after the arrival of the European green crab.

If this is any indication of what the future will bring once the green crab becomes established all along the west coast of North America, then aquaculturists have much to fear. In Washington State alone, the shellfish industry is valued to be at least \$40 million dollars annually (some estimations place it at as high as \$100 million). It is also feared that the green crab could have a major impact on the Dungeness crab and flatfish fisheries in the Pacific Northwest, collectively valued at approximately \$135 million coast wide. Northwest estuaries are important in the breeding cycles of the Dungeness crab (*Cancer magister*) and English sole (*Pleuronectes vetulus*). If the green crab became established there, then it could potentially become an important predator and competitor to these species.

Management Options

The best plan to manage the European green crab, or any other aquatic nuisance species for that matter, is to avoid introduction. For example, because the green crab has not been found in the Puget Sound, the Washington Department of Fish and Wildlife has put in place restrictions on the import and transfer of shellfish specifically directed at minimizing the introduction of the green crab to this important aquaculture region. Washington State is also in the process of establishing groundbreaking legislation to regulate the discharge of ballast water within the state. Efforts such as these should greatly minimize the risk of further introductions within Washington.

Stopping a green crab introduction before it happens is very important because once an aquatic nuisance species becomes established in a marine environment, there are no known methods for eradication. While there are many examples of the eradication of invasive species in terrestrial ecosystems, there are but two such examples in marine ecosystems—a sabellid worm, *Tere-*

brasabella heterroucinata, in California, and a brackish-water mussel, *Mytilopsis* sp., in Australia. In both of these cases, the invasive species was detected and eliminated before it became well established or widespread. The major problem with trying to eradicate an invasive marine species is our inability to "get them all." In the case of the European green crab, a single female can produce several thousand larvae, which are released into the water and can be dispersed widely. Scientists on both coasts are currently conducting research on possible control methods for the green crab, but disappointingly, there are no known effective methods to eradicate or even control an established population.

The only known method that holds promise is to detect an infestation early and to capture and remove as many individuals from the wild as possible. On the coasts of Washington State, British Columbia, and Alaska, this method is still a viable option. Washington State has an extensive monitoring program in the Puget Sound region, with over 100 monitoring sites established at locations considered at high risk for introduction. Fortunately there have been no

green crab detections to date in the inland marine waters of Washington. If a detection did occur, Washington Department of Fish and Wildlife biologists are prepared to launch an intensive trapping effort to eliminate as many crabs as possible.

In Willapa Bay and Grays Harbor on the Washington coast, where the crabs are already known to occur, Washington Department of Fish and Wildlife biologists have maintained a trapping program since 1998. In each year of the trapping effort a steady decline in the number of crabs captured has been noted in these estuaries. It is unclear whether the decline in the crab population is due to the trapping effort or to other variables. Most likely it is a combination of many variables. Nonetheless, it is hoped that trapping efforts will continue until no more crabs can be found in either estuary. The next few years will show the efficacy of trapping on small populations of European green crabs.

The European green crab typifies aquatic nuisance species issues, in that the associated problems are many while the solutions to these problems are few. Where so-

lutions exist, the cost for implementation is very high. Unfortunately, the European green crab is not alone—the list of unwanted species is long. Globalization, internet commerce, and overnight air delivery from virtually any location in the world provide fertile ground for this list of unwanted species to continue to grow. Dealing with these issues will be one of the biggest challenges that society faces in the coming century.

Most of the information above can be found in the forthcoming book, A Global Invader: The European Green Crab, by Dr. Sylvia Behrens Yamada of Oregon State University. Dr. Behrens Yamada has done an outstanding job in collecting all that is currently known about the European green crab and its management. The book is being published by Oregon Sea Grant and is due sometime in 2001.

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