MES Analytical Essay

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The Environmental and Economic Impacts of European Green Crabs (*Carcinus maenas*) in Washington State

Introduction

Invasive species have spread outside their native habitats and taken up residence in new areas since time immemorial. The first contact European colonizers had with the Americas brought invasive plants, animals, and diseases to this "New World". These novel species can outcompete established, native species and have detrimental effects on the environment. The United States Geological Survey (USGS) now estimates that "there are more than 6,500 invasive species established across the United States."[8] Environmental damage, due to invasive species, in the United States is estimated to cost $120 billion dollars, and $1.4 trillion dollars worldwide.[10] One of these largely detrimental invasive species is the European green crab (*Carcinus maenas*).

It is believed European green crabs made their way to North America, from their native range in Europe, in the ballast water of ships in the 1800s.[11] These crabs have now invaded both the Eastern and Western seaboard of the United States causing significant environmental and economic destruction.[5] According to the National Oceanic and Atmospheric Association, "The green crab is considered one of the most invasive species in the marine environment."[10] This essay will examine the history of the European green crab's invasion in Washington State, their morphology and identifying characteristics, their environmental and economic impacts, and the current mitigation strategies used by Tribal, State, and Federal governments to decrease populations of these aggressive crabs.

History of Invasion of European Green Crabs in Washington State

The first discovery of European green crabs on the Western seaboard of what is now the United States, occurred in 1989 in San Francisco Bay, California.[4] European green crabs were first discovered on Washington's coast in Willapa Bay and Grays harbor in the late 1990's - USGS quotes the first encounter in 1996[8] and the Washington Department of Fish and Wildlife (WDFW) quotes the first encounter in 1998.[4] They were later detected in Makah Bay and in 2016 they were discovered in the San Juan Islands in the Lummi Sea Pond.[1] In 2021, explosions of these established populations garnered attention from Tribal, State, and Federal conservation agencies eventually leading to the development of large, multi-agency, monitoring and mitigation programs.[8] The invasion of European green crabs has continued to spread across the Western seaboard – in the summer of 2022 populations had been identified in Hood Canal, Washington[4] and Southeast Alaska.[11]

Morphology and Identifying Characteristics of the European Green Crab

With a name like European green crab, one would think that these crabs are, well, green; however, they are not always green. Their color can range from dark green to dark brown, their mottling, and underside can be a range of colors as well.[11] Per the Washington Sea Grant, "Juveniles can change color to match their surroundings each time they molt."[7] These crabs belong to the Portunidae family,[2] or the swimming crab family, giving them a "slightly flattened" pair of back legs. Their legs are deemed comparatively long for their body size, their carapace is wider at the front than the back, can be up to 4 inches (diameter across carapace at the widest point), and they have 5 spines, also known as marginal teeth, behind each eye.[7] Due to these crabs having similar characteristics to Washington-native crabs, the Washington Department of Fish and Wildlife (WDFW) has asked the public to not kill, or keep, crabs they believe to be European green crabs.[2]

Impacts on the Environment

Per the Washington Department of Fish and Wildlife (WDFW), "The European green crab (*Carcinus maenas*) is a globally damaging invasive species that poses a threat to native shellfish, eelgrass, and estuary

habitat critical for salmon and many other species."[4] These crabs have been deemed aggressive hunters, eating most anything that fits in their mouth including crabs its own size,[2] juvenile king crabs, and juvenile salmon.[11] Depending on the source, these crabs are thought to have the ability to consume between 22 (USGS) and 40 (WDFW) clams a day – to obtain these clams, they will dig down up to six inches to find them. Through digging, European green crabs destroy eelgrass, estuary, and marsh habitats.[2] The habitats that are being destroyed, such as eelgrass, are protective shelters for many larval fish.[11] These habitat disturbances are destroying the marine ecosystems in and around Puget Sound, as well as the cultural resources of these areas, such as salmon.

As these crabs are relatively low on the food chain, they affect many species above them, such as the Southern Resident Killer Whales (SRKWs). WDFW describes it as "…a complex array of ecological impacts to food webs."[4] Putting it into perspective, European green crabs destroying sheltering environments for larval fish, and their propensity to eat juvenile salmon, could lead to large impacts on these endangered salmon, and for the SRKWs that eat those salmon. As green crabs established themselves on the East coast first in Cape Cod,[4] we can look there for reference to the green crab's destructive abilities – these crabs "…have been associated with crashes in shellfish populations, reduced biodiversity, destruction of eelgrass beds, and declines in native species."[5] This level of environmental destruction is imminent in Washington state if the populations of European green crabs are able to establish in new locations and are not mitigated. Their impacts can spread to the economy as well, impacting many fisheries from wild shellfish, crab, and finfish fisheries to shellfish aquaculture facilities.[4]

Impacts on the Economy

As mentioned previously, invasive species can be costly in their non-native range. The cost of invasives includes the damage they cause to the environment, businesses, such as the fishing industries, and the cost that governments put into mitigation strategies to remove or minimize the impacts of these invasive species. The damage and cost of mitigation of the European green crab is no different. On the East Coast, these crabs have "…been blamed for harming the soft shell clam industry…"[9] With the crabs now being detected in Alaska, as of

2022, their fear is the green crab's impact on their "multi-billion dollar fisheries industries" such as Dungeness crab and salmon.[11] Washington State has many fisheries that mirror Alaska that could also be impacted – there are recreational and commercial salmon and crab fisheries, and shellfish aquaculture businesses that could all be negatively impacted.

In 2018, funding for the Makah Tribe's mitigation strategies came from U.S. Fish and Wildlife Service in the form of $82,000.[8] In 2021, another $71,000 was given to the U.S. Geological Survey, by the U.S. Fish and Wildlife, to determine trapping needs that would help with early detection of the European green crabs.[8] In 2022, green crab populations boomed, causing an emergency order to be enacted by Washington's governor, Jay Inslee. The governor, the governor's office, and other partners, requested $8.9 million to fund European green crab mitigation.[1] This seems a costly expense to deal with crabs, but their environmental impacts could be just as large if not larger, and this additional funding had a big impact – per Washington Department of Fish and Wildlife (WDFW) more than 269,500 European green crabs dispatched from Washington state waters as of November 30, 2022.[3]

Partnerships and Mitigation Strategies

Due to the impacts European green crabs have on the economy and the environment, and how prolific these crabs are, management partnerships are needed to be successful at population mitigation. These partnerships include but are not limited to "…the Washington Department of Fish and Wildlife, Lummi Nation, Makah Tribe, Shoalwater Bay Tribe, Stillaguamish Tribe of Indians, Washington Sea Grant, National Oceanic and Atmospheric Administration, Environmental Protection Agency, Bureau of Indian Affairs, U.S. Fish and Wildlife Service, and U.S. Geological Survey…"[8] Per the Washington Department of Fish and Wildlife (WDFW), they have also partnered with shellfish growers, tideland owners, and the public to report suspected green crab encounters and to develop a rapid response to those suspected sightings.[6] The partners whose mission it is to remove these crabs trap and humanely dispatch them.

Unfortunately, "European green crab are classified as a Prohibited Level 1 Invasive Species in Washington, meaning they may not be possessed, introduced on or into a water body or property, or trafficked,

without department authorization, a permit, or as otherwise provided by rule", which means that crabs - currently - cannot be sold for uses such as food or fertilizer.[6] In places where these crabs are native, they are used for soup stock, as they are too small to be a worthwhile staple food, but per WDFW, "West Coast tribes, agencies, and other partners continue researching responsible ways to use European green crab biomass, including for compost or fish feed."[4]

Conclusion

As mentioned previously, over 269,500 green crabs were able to be removed, and dispatched from Washington state waters in 2022.[3] This number is a large increase from prior years – "Forty-one crabs were captured in 2019, 2,670 in 2020, and a staggering 86,028 in 2021."[1] We may feel at ease with this large victory; however, it may be foreshadowing into what the future holds for the invasion of the European green crab. Will these crab populations continue to boom exponentially? Will the partnered mitigation strategies work? What happens if the populations become too large to manage through trappings by these partnerships, and will we ever reach a tipping point where mitigation costs more than the cost of damage to the environment? As these partnered mitigations are still relatively new, and as this was the first year for major funding, we do not know the answer to these questions. The infiltration of European green crabs is a topic we cannot let slip from the headlines, as our environmental, cultural, and economic resources are, and may continuously be, at stake as long as these invaders reside in Washington state waters.

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