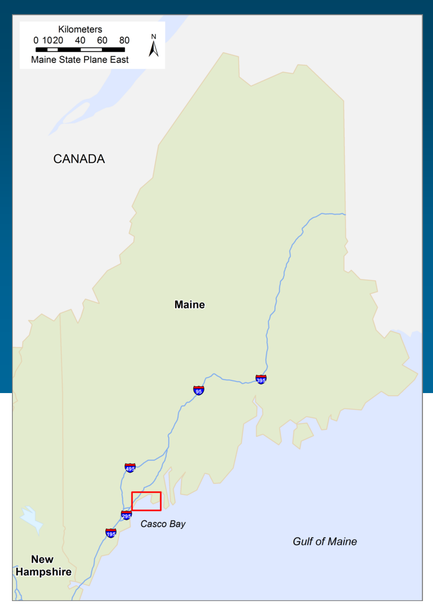
Maine's Declining Soft-Shell Clam Population

Predation by European Green Crabs and Using Eelgrass Loss to Identify At-Risk Zones

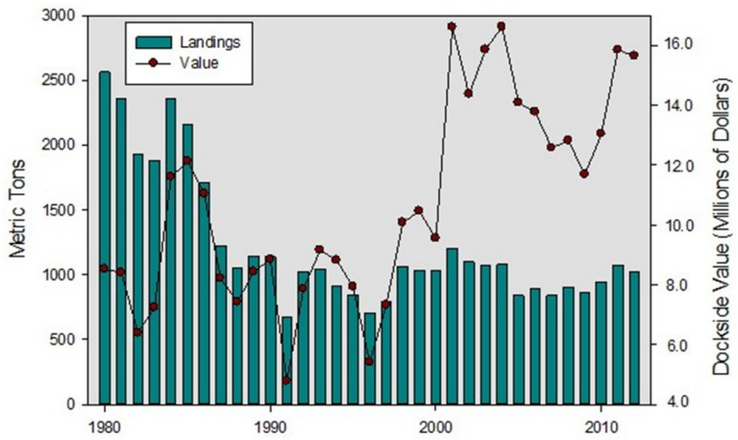


Introduction

Maine's Casco Bay is rich in marine resources and plays a significant role in the state's economy. In 2013, the roughly $500 million worth of commercial marine landings in Maine accounted for about 1% of the state's total gross domestic product. Soft-shell clams consistently rank as the second or third most valuable commercial marine species in Maine. In 2013, the $18.1 million worth of harvested soft-shell clams accounted for about 4% of Maine's total commercial landings.

A steady decline in total soft-shell clam landings over the past few decades has both the industry and the environmental community concerned about the species' future. Landings have decreased by about 60% since 1980 (see figure 1). Current research points to two primary causes of the decline: i) predation by the invasive European green crab (*Carcinus maenas)*; and ii) increasing acidification of ocean water.

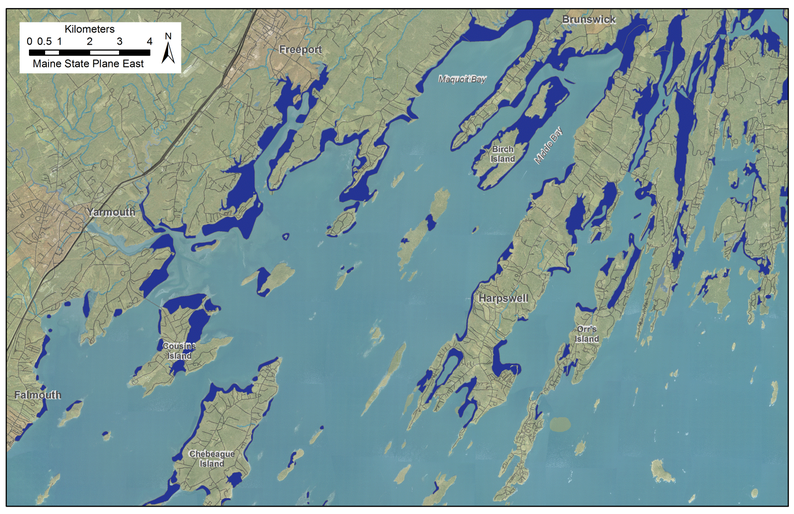
Figure 1: Maine Soft-shell clam landings and dockside value (1980-2012)



Source: *Maine Department of Marine Resources, 2013*

While some towns have undertaken local studies to estimate the green crab problem, no comprehensive bay-wide study has been conducted. This analysis aims to provide a starting point for setting the scope of such a study by answering the question, ***which sections of the Casco Bay's harvestable soft shell clam flats are most at risk of decline due to predation by the invasive European green crab?*** The analysis uses eelgrass loss, which has also been closely linked to green crab population increase, as an indicator for zones at risk of green crab predation. Answering this question will help implicated actors to: i) set the scope of a more robust study on the green crab predation problem; and ii) better understand where to target actions to address the problem. Map 1 presents data on all soft-shell clam harvestable locations in the study area.

Map 1: Casco Bay Soft-Shell Clam Harvestable Locations

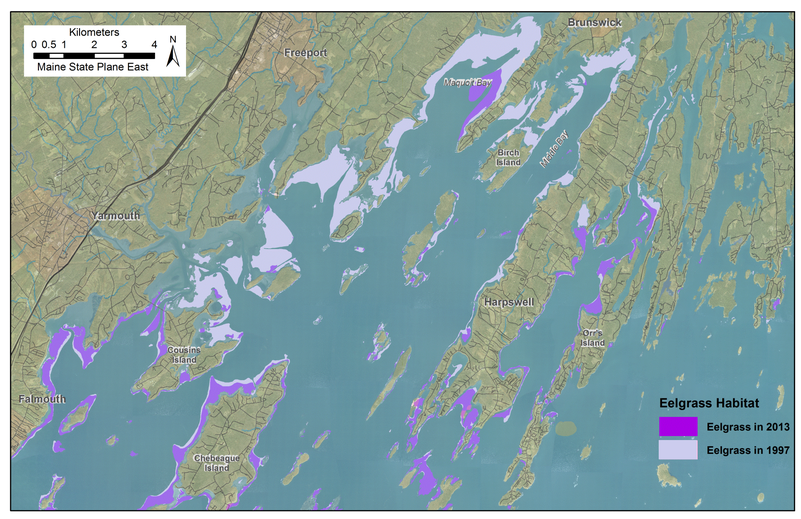


The map presents distribution data on the location of soft-shell clam harvestable areas on the coast of Casco Bay. The data were collected by the Maine Department of Marine Resources (DMR). The areas in blue were indicated as harvestable areas by town officials, harvesters, Harbormasters, DMR biologists, DMR specialists or DMR scientists. The data likely contain some inaccuracies due to human error, potential change in the distribution of soft-shell clam beds over time, and potential omission of parts of the Casco Bay coast. The data were collected in May 2009 and have not been updated since.

The Model

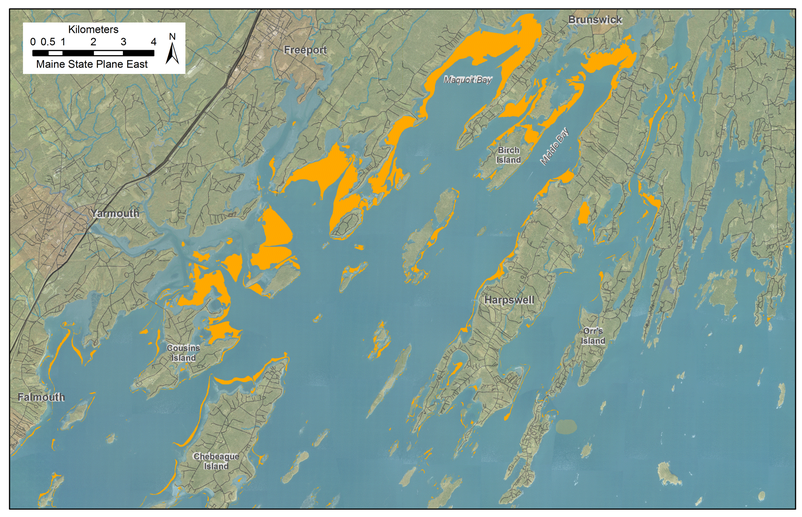
Multiple studies show a strong relationship between European green crab invasion and eelgrass loss. The primary mechanisms for loss are sediment disturbance, which causes a reduction in light, and direct damage to shoots while foraging for food. Map 2 presents distribution data on the location of eelgrass beds in Casco Bay in 1997 and in 2013.

Map 2: Extent of Eelgrass Beds in Casco Bay (1997, 2013)



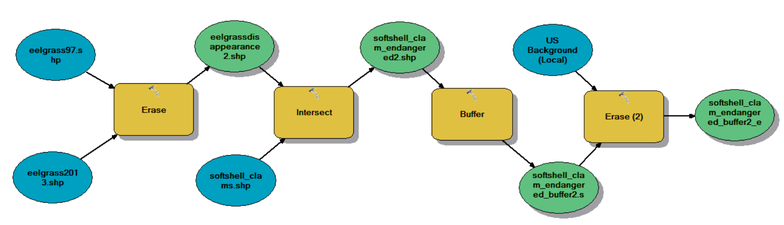
The data were collected by the Maine Department of Environmental Protection (DEP) using aerial photography at low tide and then verified by boat, on foot and by plane. According to DEP, a conservative estimate of the minimum mapping unit is 150 square meters. Data updates are irregular. The model (see figure 2 below) overlays the eelgrass bed layers from 1997 and 2013, and then uses the erase tool to create a new layer of those areas where the eelgrass beds have disappeared. Map 3 presents the new data layer, which represents eelgrass loss in the Casco Bay.

Map 3: Eelgrass Loss in the Casco Bay Since 1997



This new data layer of eelgrass loss is used as an indicator of European green crab invasion. The model then overlays the soft shell clam harvestable areas in Map 1 with the eelgrass loss layer in Map 3. The intersecting areas are identified as soft-shell clam harvestable areas at-risk of decline due to European green crab predation. These at-risk areas are presented in red in Map 4. To broaden the scope a bit — providing some margin for error and accounting somewhat for the likelihood that green crab range extends beyond the area of eelgrass loss — a 50 meter buffer is placed around those at-risk areas. The buffer is then overlaid with the U.S. Background land layer, and clipped along the coast lines to ensure that the identified at-risk areas do not extend onto land, which soft-shell clams do not inhabit. A graphic representation of the geoprocessing model is presented below in figure 2.

Figure 2: Geoprocessing Model



Analysis

Map 4 presents the final analysis. It presents data on the total harvestable area for soft-shell clams in the Casco Bay and highlights areas potentially at-risk of decline due to predation by the European green crab. The data suggest that soft-shell clam flats around Maquoit Bay and Middle Bay are at high risk, as well as flats on Cousins Island and along portions of the Freeport coast.

Data Critiques

The eelgrass loss data are an imperfect indicator for presence of a green crab problem. It would be preferable to have actual systematic data about green crab populations. The soft-shell clam harvestable area data from 2009 are likely outdated. More recent data would help the analysis. Also, adding a quantitative element (either catch size or monetary value) to the spatial distribution data would make for a more interesting analysis. The model could further refine at-risk areas based on economic importance.

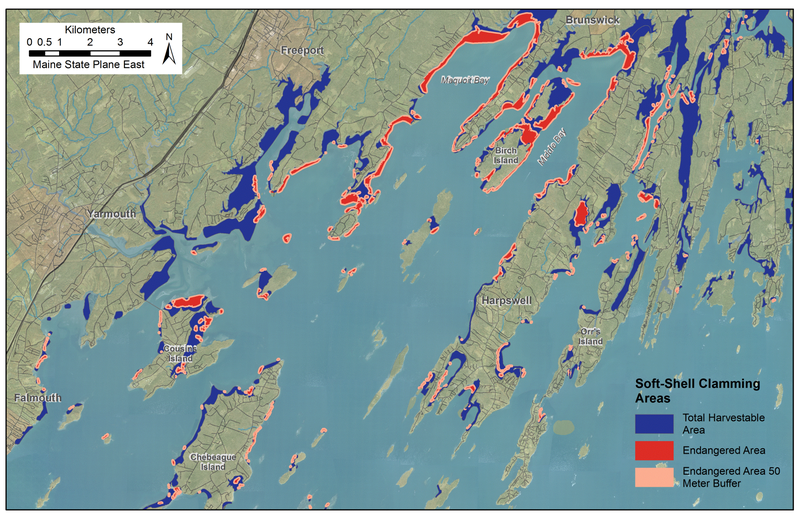
Model Critiques

The intersect function may be too precise in this instance. Even with the 50 meter buffer, the mobility of green crabs likely extends further. Also, there are several areas of eelgrass loss that are quite close to soft-shell clam harvestable areas but do not overlay. These areas are missed by the intersect tool. The model almost certainly underestimates, but it does provide a good starting point for further investigation.

Limitations and Next Steps

Because of the limitations of the data and the model mentioned above, this analysis should not be used for a definitive indication of which soft-shell clam flats are or are not at-risk. Rather, it should be used as the initial scope for a more comprehensive, systematic study of the distribution and size of the green crab population and its impact on soft-shell clams. If further study reveals that eelgrass loss is a good indicator of a green crab infestation, it could be used as a relatively simple method for identifying potential problems in the future.

Map 4: Soft-Shell Clam Harvestable Areas at Risk of Decline due to European Green Crab Predation



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Projection: Maine State Plane East

Data Sources:

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