Predicting Pacific cod spawning habitat in a changing climate

Understanding how habitat suitability changes over space and time by coupling physiological experiments with regional ocean models

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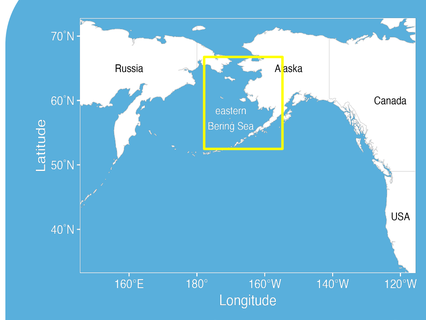
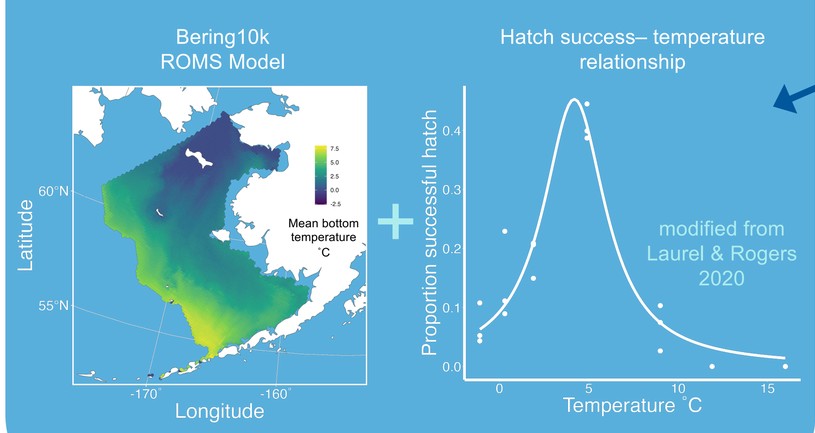
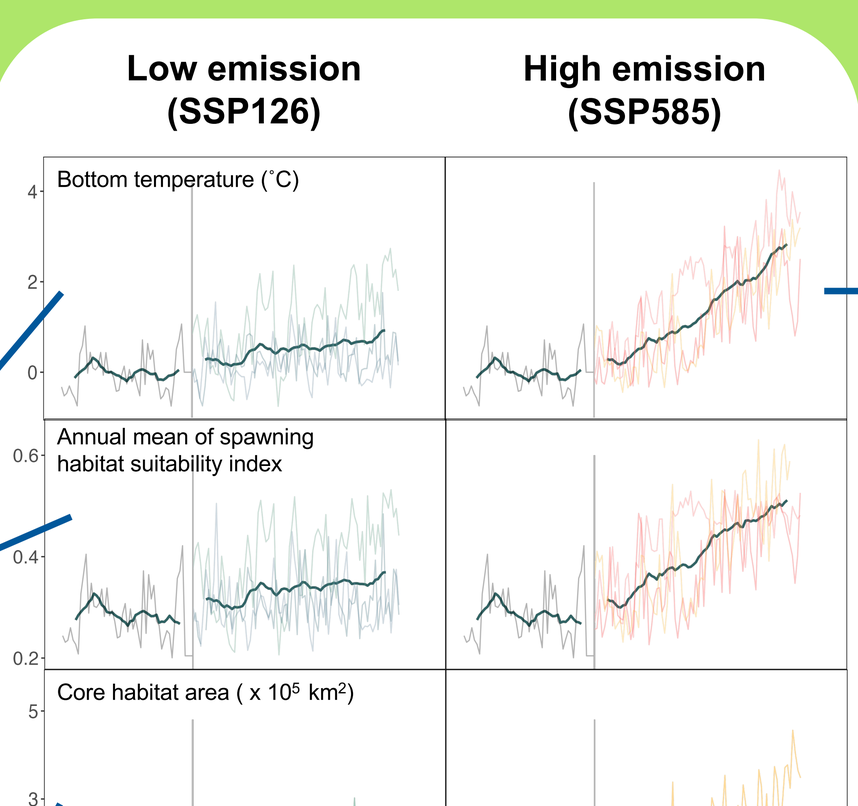
As with other marine species, eastern Bering Sea Pacific cod have expanded their seasonal distribution poleward as waters have warmed, which can affect population dynamics and harvest opportunities. However, it is unknown whether spawning habitat – the combined habitat of spawners and eggs – will also shift with warming due to the narrow thermal sensitivity of developing embryos, which remain close to the seafloor until hatching. Here, we couple downscaled global climate model output under two emission scenarios with the thermal tolerance of eggs to predict how the spatial extent, mean latitude, and consistency of suitable spawning habitat has varied in the past and may change into the future. We find that the availability of suitable spawning habitat increases over time, and hotspots are consistent across shorter time periods but do shift across the shelf by the end of the century such that historical areas with high suitability are not predicted to be suitable in the future. Although there was no relationship between recruitment and the availability of suitable spawning habitat in the past, the predicted increase and spatial shift may have other consequences such as changes to migratory patterns and novel species interactions, as well as socioeconomic impacts including modifications to effort and costs for the fishery.

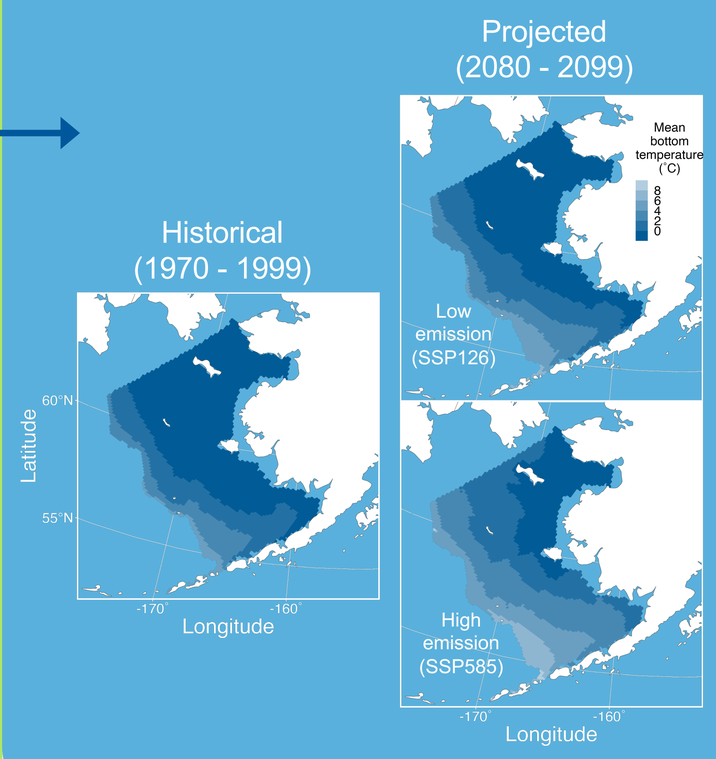


We couple hindcasts and projections of bottom temperature from the Bering 10K ROMS model for the eastern Bering Sea (yellow box, left) spanning (1970 – 2100) with an experimentally - derived hatch success – temperature relationship to predict spawning habitat suitability

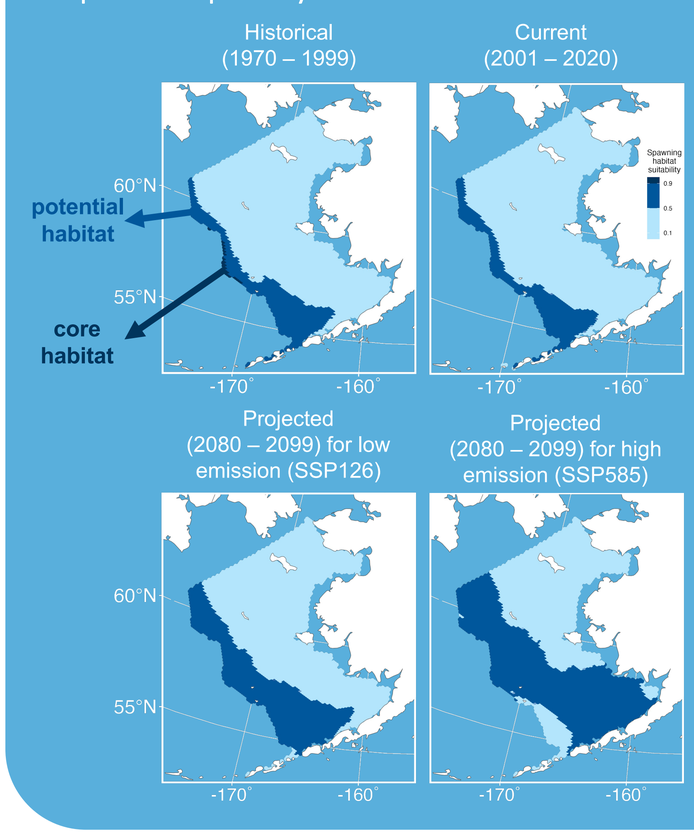




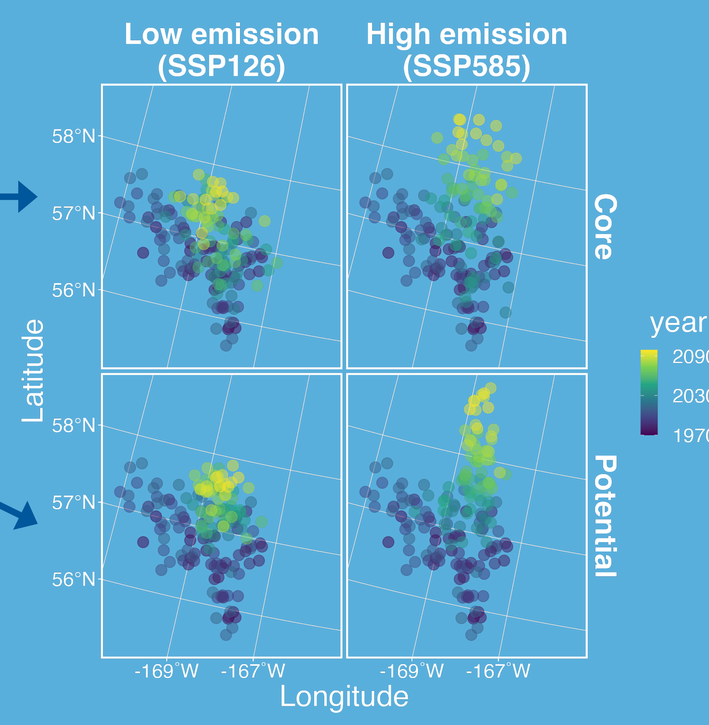
Bottom temperatures (shown here in March, the most important month for spawning), warm over time, particularly on the middle and inner portions of the shelf



Core (spawning habitat suitability > 0.9) and potential (> 0.5) habitat area increased and expanded spatially across the shelf



The mean latitude of both core (spawning habitat suitability > 0.9) and potential habitat (> 0.5) shifted north over time



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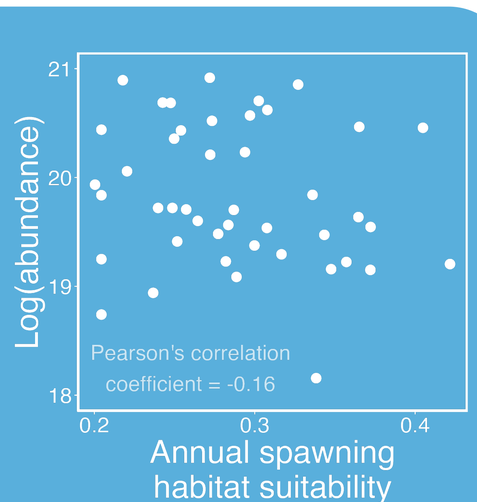
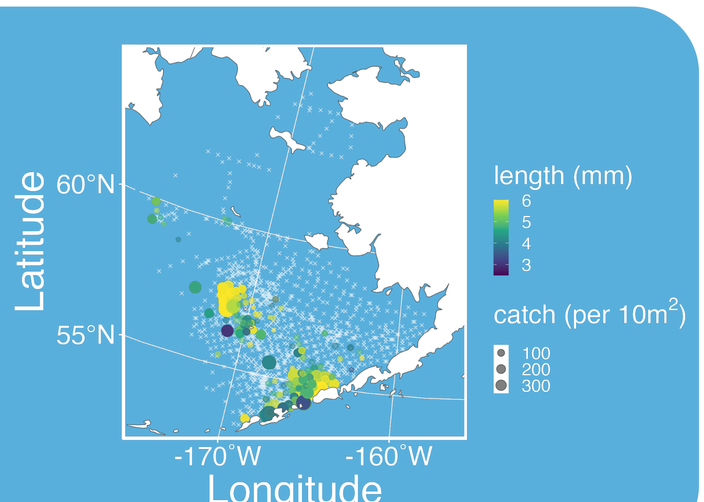
We also examined whether recruitment was correlated with the yearly index of spawning habitat suitability, but we did not find a strong link



The distribution of newly-hatched larvae matched our predictions of spawning habitat based on temperature



Check out the paper on bioRxiv!