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Brasseale, E., Grason, E. W., McDonald, P. S., Adams, J., & MacCready, P. (2019). *Larval Transport Modeling Support for Identifying Population Sources of European Green Crab in the Salish Sea*. *Estuaries and Coasts*, 42(6), 1586–1599.
<https://doi.org/10.1007/s12237-019-00586-2>

- West coast spreading northward with advection from PDO and high ENSO
- Reproduction, brood and egg development are dependent on seasonal temperatures and resource availability. 12°C Dec-Feb. With salinity constant at 35 ppt, higher temp 18°C reduces the total development time of larvae
- All stages of green crab larvae undergo diel vertical migration as planktonic species- 3 m depth at sunset to 15 m depth at sunrise
- Female times release of egg with strong tidal event at night- high dispersal and low predation
- Larvae do not survive in salinity 20 ppt or less, spring Columbia River plume freshens from river flow to 5-15 ppt -> if female green crabs are put in low salinity environments, will they withhold from releasing their eggs?

Erns, N. J., Harvey, B., Davies, M. M., Thomson, H. M., & Meyers, K. J. (2022). *The Green Wave: reviewing the environmental impacts of the invasive European green crab (Carcinus maenas) and potential management approaches*. *Environmental Reviews*.
<https://www.jstor.org/stable/27223132?seq=1>

- *C. maenas* populations have high persistence and reproductive potential, making them a potent invader
- Wide habitat depth ranges from rocky shores to seagrass to 55 m deep, only restricted by temperature as a limiting factor (though still eurythermal). Adult crabs thrive in 13-22°C but can survive from 0-35°C
- Origin of invasion from Atlantic N America in ballast waters shipped from New England to California (1989)
- *Callinectes sapidus* and *Cancer productus* can outcompete, prey upon, or exclude *C. maenas* from their ranges. *C. sapidus* (Atlantic) and *C. productus* (Pacific) prey in lab and field settings and seem to keep populations in check in overlapping habitats -> experiment and conservation idea to release red rock chemical cues in areas to flush out the green crabs from an area in need of protection (eelgrass beds, bivalve fisheries)
- Large decapod species such as the American lobster (*Homarus americanus*) are prey for green crabs as juveniles, then switch to predator and dominant competitor once reaching 72 mm size and maturity -> experiment idea to compare green crab response to juvenile lobster cues and adult lobster cues

- Interesting resource- listing different regional management strategies with successes and commentary. Use of toxic nonspecific pesticide- carbaryl in WA, parasite *Sacculina carcini* -> is there a way to inject crabs so the same response as this parasite stops the function in their gonads without the danger of the parasite spreading to other species?

Jensen, G., McDonald, P., & Armstrong, D. (2002). *East meets west: competitive interactions between green crab *Carcinus maenas*, and native and introduced shore crab *Hemigrapsus* spp.* Marine Ecology. Progress Series (Halstenbek), 225, 251–262.
<https://doi.org/10.3354/meps225251>

- *C. maenas* dominated food competition over *H. oregonensis*
- Predation tied with competition for resources to seek refuge with / in -> bottleneck effect
- Shelter (rocks) allows crabs to hide from predators, prevent desiccation, buffer temperature changes, shield strong currents and high wave action
- Large physiological tolerance of green crab allows for potential range from Baja California to the Aleutian Islands
- East coast invasion notable effects on intertidal snail morphology and bivalves
- *Carcinus maenas*, *H. oregonensis*, and *H. sanguineus* all are more active and preferentially feed at night / in the dark
- *C. maenas* occupied more shell plots and spent greater time at bait feeding than *H. oregonensis*
- Introduced shore crab had significant influence on juvenile green crabs competing for intertidal shelter

Khodikian, E., Roggatz, C. C., Yoon, G. R., & Porteus, C. S. (2025). *Acute, static, and fluctuating ocean acidification effects on the olfactory system of the yellow shore crab, *Hemigrapsus oregonensis*.* Canadian Journal of Zoology, 103, 1–15.
<https://doi.org/10.1139/cjz-2025-0001>

- Ocean acidification stress response for shore crabs, intertidal inhabitants already used to wide range of pCO₂s
- Olfaction for marine organisms is used to detect food odors, conspecifics, predators, and potential mates - OA impairs olfactory-mediated tasks
- High proton environment can disrupt the electrostatic interactions for binding for chemoreception - binding affinity lowers, decreasing olfactory sensitivity, higher threshold needed for a response
- Antennular flicking is the form of the olfactory sensilla interacting with odorants- high pCO₂ decr antennular flicking and olfactory behavior
- Stimulated acidification negatively affected olfactory behavior for both acute and static exposures, decrease in protein expression, olfactory receptor gene expression?

Quinn, J., Lee, S., Greeley, D., Gehman, A., Kuris, A. M., & Wood, C. L. (2021). *Long-term*

change in the parasite burden of shore crabs (Hemigrapsus oregonensis and Hemigrapsus nudus) on the northwestern Pacific coast of North America. Proceedings of the Royal Society B : Biological Sciences, 288(1945), 20203036.

<https://doi.org/10.1098/rspb.2020.3036>

- Parasites widely understudied, abundance changes from human impacts
- Dissected crabs and counted parasites behind digestive tissue within body cavity
- Difference of parasite presence between historical and contemporary sampling of parasite *P. conformis* for *H. oregonensis*, not for *H. nudus*
- Increase in parasitism over time
- 4 main drivers of long-term change in parasite abundance: 1, shifts in the abundance of *H. oregonensis* and *H. nudus*, 2, shifts in the encounter rate between *H. oregonensis*/*H. nudus* and parasite propagules, 3, shifts in the abundance of parasites or parasite reproductive rates in obligately required hosts other than *H. oregonensis*/*H. nudus*, and 4, shifts in the relative susceptibility of *H. oregonensis*/*H. nudus* to infection

Petersen, T., Gransten, S. B., Elbrønd, F., Johnstad-Møller, C. A., Christensen, C. V., &

Brodersen, K. E. (2025). *Effects of European green crabs (Carcinus maenas) on transplanted Eelgrass (Zostera marina): potential protective measures*. Restoration Ecology, 33(5). <https://doi.org/10.1111/rec.70074>

- Worldwide seagrass decline by human activities, worsened by European green crabs, preventative measures: cages, biodegradable establishment structure (BESE) elements, stone anchors, and mussel banks
- Eelgrass broadcasting requires low hydrodynamic stress and low bioturbation activity to avoid uprooting from weather events or crabs
- Green crab eelgrass effect in native range Europe
- Experimental design: 5 aquarium treatments with 5 shoots of eelgrass, quantified the amount of uprooted shoots and cut leaves
- 58% of loss of transplanted eelgrass shoots in + control from bioturbation, 42% from grazing
- Cage treatment was the most effective protective measure for transplanted shoots against green crabs, 90% survival of transplanted shoots after 11 days
- Green crab preferential feeding on eelgrass seeds (51% starch), then rhizomes and meristems. No leaves or roots (fibrous)

Rato, L. D., Simoes, T., Novais, S. C., Damasceno, J. M., Meer, J. V. der, Thieltges, D. W.,

Marques, J. C., & Lemos, M. F. L. (2024, August 2). *Thermal performance of native and invasive crab species: Investigating the invasion potential of Hemigrapsus Takanoi in southern European carcinus maenas' habitats - biological invasions*. Springer Nature Link. <https://link.springer.com/article/10.1007/s10530-024-03396-1>

- Native threats to European green crabs- almost the reverse of the issue on west coast which is interesting to consider the environmental conditions that might cause this
- Study of different shore crab- *H. takanoi*, brush-clawed. Native PNW shores, came to N European coasts
- In 25°C for 30 days, *C. maenas* displayed lower survival, growth, and feeding intake compared to *H. takanoi*, lower plasticity
- Temperature is an important factor on whether a marine ectotherm can become invasive, dependent on their physiology, ecology, and evolution restricting range and tolerance
- Experimental design: Natural seawater ppt 34 17°C ph ~8, DO 6-8 mg, 16:8 light:dark photoperiod. uniform conditions across crab species. 17, 21, 25°C for local thermal range of late spring in situ records of S European shallow water bodies native for *Carcinus maenas*
- Significant interaction with temperature and different sexes for *C. maenas* - males at high temp survived less than females
- Thermoregulatory mechanisms: burrowing and hiding behavior, migrating to deeper waters

Venkataraman, Y. R., Kelso, J. C., Payne, C., Freitas, H. L., Kohler, J., & Tepolt, C. K. (2025).

Plasticity, not Genetics, Shapes Individual Responses to Thermal Stress in Non-Native Populations of the European Green Crab (Carcinus maenas). Integrative and Comparative Biology, 65(4), 1148–1165. <https://doi.org/10.1093/icb/icaf131>

- European green crab has expressed a broad thermal tolerance and flexibility (5-30°C as extreme ends in lab, 4-23 native thermal optima range), including cold tolerance.
- Reduction in genetic diversity, phenotypic plasticity driven by temperature cause bottlenecked populations
- Invasive North American *C. maenas* have a broader thermal range than in their native range in Europe
- Experimental design: temperature stress, short term- 24 hours. Long term- 94 hours.
- Around time of molt, green crabs have weakened tolerance to range of physiological stressors
- Adaptive plasticity from sub-lethal temperatures

Websites sources:

European Green Crab. Washington Department of Fish & Wildlife. (2025).

<https://wdfw.wa.gov/species-habitats/invasive/carcinus-maenas#desc-range><https://link.springer.com/article/10.1007/s10530-024-03396-1>

- Threaten eelgrass beds, estuaries, and shellfish aquaculture

- El Niño currents in late 1990s helped facilitate the invasion of green crabs to PNW
- Threat to Washington- economic, environmental, cultural aspects
- Green crab traps most efficient in shallow areas exposed at low tide

Freeman, C. (2025, November 26). Invasive species discovered in WA's Skagit Bay. The Seattle Times. <https://www.seattletimes.com/seattle-news/invasive-european-green-crabs-discovered-in-was-skagit-bay/>

- The green crab is continuing to spread throughout Puget Sound- detecting in Whidbey Island and Skagit Bay despite prior resistance due to Deception Pass narrow inlet
- Puget Sound has high water retention, risky once the first sighting is recorded because it can spread
- The size of these crabs indicate the population has been around for several years
- Reflective of broader trends across Washington's inland waters of the wide scale invasion