

## Annotated Bibliography

Baeta, A., Cabral, H. N., Marques, J. C., & Pardal, M. A. (2006). Feeding Ecology of the Green Crab, *Carcinus maenas* (L., 1758) in a Temperate Estuary, Portugal. *Crustaceana*, 79(10), 1181–1193.

In this study researchers aimed to discover whether there were differences in the feeding habits of European Green crabs based on season, sex, size or any other factors. Scientists examined crabs found in the Mondego estuary in Portugal. Crabs were collected, measured, and examined for sex, size, moulting stage, and reproductive condition before their stomachs were removed. The stomach content was analyzed and separated into each prey item. 837 crabs were examined. Researchers found that the crabs in this area tend to be opportunistic predators and have a less diversified diet. Larger crabs also ate larger prey but there was no difference found in the diets between sexes or age groups. They also found that freshly molted crabs and ovigerous females were more likely to have empty stomachs based on the fact that they both tend to have less energy. Finally, researchers found that these crabs do not just feed on benthic dwelling bivalves but also on surface dwelling fish. Because of this and their lack of predators, researchers determine that green crabs in this area are likely a top predator.

Dal Pont, G., Po, B., Wang, J., & Wood, C. M. (2022). How the green crab *Carcinus maenas* copes physiologically with a range of salinities. *Journal of Comparative Physiology B*, 192(6), 683–699. <https://doi.org/10.1007/s00360-022-01458-1>

In this study researchers focused on the green crabs ability to survive in a varying range of salinity. Researchers tested crabs at 5 different salinities ranging from 10-50 ppt for 7 days. After this time period they evaluated oxygen consumption, ammonia excretion, urea-N excretion, and diffusive water fluxes. Three main internal physiological structures were identified as changing in different salinities including the

disturbance of N metabolism and fuel usage at low salinity, the appearance of lactacidosis at high salinities and elevated hemolymph at high salinities. Overall researchers found a complex plasticity of physiological traits at all salinities, especially in the high and low ranges.

Dunagan, C. (n.d.). *Genetics unlock mystery of green crab invasion* | *Encyclopedia of Puget Sound*. Retrieved April 7, 2026, from

<https://www.eopugetsound.org/magazine/genetics-unlock-mystery-of-green-crab-invasion>

This paper focuses on the ability of green crabs to invade different regions and how they ended up in North America. Most likely, a green crab hitched a ride on a ship from Europe to America around 1817. Because of the green crabs' genetic tolerance to a range of environmental factors, it was (and is) the perfect invader. Green crabs also have a free flow of genes between populations making them even more stable to change. They also found through other papers that the phenotypic plasticity of green crabs can not only change their morphology but also their feeding habits meaning they can adapt to a changing environment very quickly.

*Green Crabs and Climate Change*. (n.d.). GREENCRAB.ORG. Retrieved April 7, 2026, from <https://www.greencrab.org/blog/2020/9/26/green-crabs-amp-climate-change>

Green crabs are one of the worst marine invaders. Their ability to interbreed and destroy ecosystems makes them very dangerous to the delicate balance needed to maintain benthic ecosystems. What makes the green crabs such a good invader is their ability to tolerate environmental change. Scientists believe that as climate change increases, green crab populations will increase as well. This is bad because the species most affected by green crabs are also the most susceptible to climate change. Green crabs are also harming important fisheries by eating bivalves and outcompeting lobsters and other crustaceans. They also uproot important ecosystems such as

eelgrass which is very important in the oceans fight against climate change. The authors suggest integrating green crabs into our diet more in order to protect these delicate ecosystems and species.

Kelley, A. L., de Rivera, C. E., Grosholz, E. D., Ruiz, G. M., Yamada, S. B., & Gillespie, G. (2015). Thermogeographic variation in body size of *Carcinus maenas*, the European green crab. *Marine Biology*, 162(8), 1625–1635.

<https://doi.org/10.1007/s00227-015-2698-5>

Scientists gathered data on carapace width as a size measurement of European Green Crabs in 11 different locations (5 in the Pacific Northwest, 5 near the Bay Area in California and 1 in Alaska.). They did this to identify if there was a significant difference in size between green crabs experiencing different sea surface temperatures (SST). They collected crabs with traps in Spring, Summer, and Fall. Scientists found that as SST increased, average carapace width decreased. They believe this is because of the phenotypic plasticity exhibited by ectotherms when subjected to different temperatures as a larvae called the temperature-size rule. They also found that invasive green crabs tend to be larger than green crabs in their native range perhaps due to the fact there is an absence of a parasitic castrator in the invaded regions.

Monteiro, J. N., Pinto, M., Crespo, D., Pardal, M. A., & Martinho, F. (2021). Effects of climate variability on an estuarine green crab *Carcinus maenas* population. *Marine Environmental Research*, 169, 105404.

<https://doi.org/10.1016/j.marenvres.2021.105404>

In this study, researchers aimed to discover whether temperature played a significant role in the distribution of green crab populations in Mondego estuary in Portugal. This study occurred over a 15 year period. Researchers found that temporal and spatial population distributions were heavily influenced by changes in temperature, currents and salinity over this 15 year period. They also found that large scale climates factors

did have significant effects on populations which will become increasingly more common as climate change effects increase.

Pennoyer, K. E., Himes, A. R., & Frederich, M. (2016). Effects of sex and color phase on ion regulation in the invasive European green crab, *Carcinus maenas*. *Marine Biology*, 163(6), 137. <https://doi.org/10.1007/s00227-016-2910-2>

This study aimed to see if there was a difference in physiological change due to coloration and sex under low salinities. Researchers measured the performance of the whole animal as well as the cellular stress and energy status. They found that red and green color phases have different tolerances to low salinities which persist across sex. Females outperform males in tolerance of low salinities across both color phases. Researchers want more studies to focus on the importance of understanding organismal level processes in order to understand the full picture of the green crabs physiological structure.

Rivers, M. L., McKenzie, C. H., & McGaw, I. J. (2024). Physiological Responses of the Green Shore Crab, *Carcinus maenas*, During Acute and Chronic Low Temperature Exposure. *Animals*, 14(21), 3049. <https://doi.org/10.3390/ani14213049>

This study focuses on the physiological responses on green crabs when introduced to low temperatures and after they have become acclimated to the temperature.

Researchers focused on heart rate, oxygen consumption and oxygen expenditure.

Researchers found that green crabs showed a significant decrease in physiological process between temperatures of 4 and 6 degrees celsius. They also found that this is a similar tolerance seen in both native and invasive green crab populations.

Researchers believe this shows there is a genetic temperature dormancy marker in all populations of green crabs.

Styrishave, B., Rewitz, K., & Andersen, O. (2004). Frequency of moulting by shore crabs *Carcinus maenas* (L.) changes their colour and their success in mating and physiological performance. *Journal of Experimental Marine Biology and Ecology*, 313(2), 317–336. <https://doi.org/10.1016/j.jembe.2004.08.013>

This paper focuses on the physiological, reproductive and color changing performance of green crabs based on the frequency of the moulting habits. Researchers found that male crabs may decrease their moulting habits when they become sexually mature to be more prepared to fight. Green crabs that are green tend to grow rapidly and moult frequently as green is the color they turn after that moult. Red crabs are larger and moult less frequently. They may also experience better mating success perhaps due to their increased physical condition and size. Green crabs on the other hand tend to have better thermal tolerances. This study hopes to inform that different life cycle stages of the European green crab exhibit different tolerances and reproductive success in a changing ocean environment.

Yahia, N. H.-B., & Selmi, S. (n.d.). *Biomarker responses to pollution in the Mediterranean green crab *Carcinus eastuarii* living in the Gulf of Gabès (Tunisia)*.

In this study researchers used a number of both internal and external biomarkers to see how pollution levels affect populations of green crabs in Gulf of Gabés, one of the most heavily polluted areas in the Mediterranean. Crabs were collected from two different sites, one more polluted and the other less polluted. Researchers found that crabs in the more polluted site (near a large factory) had poorer body condition and experienced decreased physiological activity and condition. This shows that green crabs and other coastal species are greatly impacted by the pollution from this factory and other forms of pollutants. Researchers also believe that this shows the green crabs ability to be a key species in evaluating the negative effects of pollutants on other organisms in the same environment.

