# Large whales fill a vital role in the ocean ecosystem, making their conservation an essential aspect of overall ocean health

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## Large whales within the ocean ecosystem

There are several ways large whales impact their marine environment: nutrient cycling, supporting primary productivity, physical engineering, carbon sequestration (within their biomass), and habitat creation. They also fill a cultural role and possess intrinsic value, but those discussions are outside the scope of this succinct letter. With so many ways that large whales impact the marine environment, conservation efforts must be strengthened to ensure their survival.

These massive mammals can grow up to 33 m in length, with the blue whale topping out as the largest known animal to ever grace this planet (NOAA). The runners-up include right, bowhead, fin, humpback, sperm, and grey whales, all of them averaging from 30 to 100 tonnes as adults (International Fund for Animal Welfare, 2025). This collection includes whales from multiple taxa, as most are baleen whales, but the sperm whale is a member of the Odontocetes class (International Fund for Animal Welfare, 2025). Their similar size and feeding habits allows them to be grouped together functionally.

### Nutrient Cycling and Primary Productivity

These large whales require several tonnes of food per day, in the form of plankton and other marine invertebrates, as well as fish for some (Baumgartner *et al.*, 2007), to support their large body mass. Feeding methods vary with each species, but mostly involve variations on filter feeding upon dense prey patches, many of which are found near the ocean floor (Baumgartner *et al.*, 2007). The subsequent fecal waste these whales produce is rich in nutrients and is typically deposited near the surface (Roman, *et al.*, 2016). This represents an influx of nutrients ripe for fertilizing the photosynthetic organisms that remain near the surface where sunlight can still penetrate (Roman, *et al.*, 2016). In this way, whales are moving these limiting nutrients to where they are needed, allowing micro- and macro-algae to take up carbon dioxide from the atmosphere adjacent to the water and convert it into sugars through photosynthesis.

### Ecosystem Engineering

Additionally, when these whales move through the water column on deep dives to forage on the seafloor, their massive size allows them to act as physical engineers, altering the marine landscape, even creating upwelling zones as they resurface (Roman, *et al.*, 2014). Evidence of mud on the rostrums of some whales indicates they may be digging through the substrate to forage (Hamilton and Kraus, 2019).

### Carbon sequestration

As they feed and grow, these large cetaceans hold within their bodies a significant amount of carbon (Smith, 2006). Lipids consist of about 77% carbon and 54% protein (Jelmert and Oppen-Bernsten, 1996). After accounting for dry biomass of 40%, about 10% of their body consists of carbon (Jelmert and Oppen-Bernsten, 1996). While uncertainty lies within any calculations of carbon storage by whales, their large mass and long lifespan may allow them to be considered a carbon sink, especially when coupled with the previously mentioned ability to stimulate carbon dioxide uptake by marine algae (Pearson, *et al.*, 2023). They continue to sequester carbon after they die and sink the the ocean floor (Pearson, *et al.*, 2023).

### Whale Falls

Even in death, these whales continue to play a supportive role. When a large whale dies and falls to the seafloor, they create a unique habitat similar to hydrothermal vents (Smith and Baco, 2003). These ‘islands’ or zones of underwater productivity can support a large number of species, many of whom are unique to whale carcasses (Smith and Baco, 2003). Researchers have identified four unique stages of whale decomposition, each with its own complement of community members, such as fish, sharks, crustaceans, worms (especially of the genus *Osedax*), and bacteria that play different roles in breaking down the massive carcasses into nutrients to be recycled by these benthic dwellers (Smith, *et al.*, 2015). Some of these species are also at risk of extinction because of reductions in whale populations, highlighting a potential cascade of ecological impacts (Smith, *et al.*, 2019).

### Whale conservation

Many groups worldwide are working to further whale conservation, some who focus on single species, such as the North Atlantic Right Whale Consortium (NARWC), to more general organizations such as World Wildlife Federation (WWF) and International Fund for Animal Welfare (IFAW). Marine Protected Areas (MPA’s) can create an umbrella of protection by minimizing harm for an entire ecosystem and all the components within it, both biotic and abiotic (Marcos *et al.*, 2021). Protecting even just one keystone species can lead to wider ranging protections, as they support ecosystem functions (Bell, 2025). Ecosystem-based management is an ever-growing strategy, considered the best option for protecting our oceans (Roberge and Angelstam, 2024).

### Conclusion

Large whales boost primary productivity, cycle nutrients, physically restructure the marine environment, sequester carbon, and create unique habitat. When we protect whales, we support an entire marine community, one that relies on the ecosystem services these whales provide.

## References

Baumgartner, M., Mayo, C., and Kenney, R. (2007) ‘Enormous Carnivores, Microscopic Food, and a Restaurant That’s Hard to Find’ In: (Kraus, S. and Rolland, R, eds.) *The Urban Whale: North Atlantic Right Whales at the Crossroads*. United States of America: Harvard University Press, pp. 138-171 Also available at: https://www.whoi.edu/cms/files/Urban_Whale_Chapter5_59401.pdf

Bell, J. (2025) ‘The ripple effect: How protecting one species can safeguard an entire ecosystem’ International Fund for Animal Welfare. Available at: https://www.ifaw.org/au/journal/ripple-effect-protecting-one-species-safeguard-entire-ecosystem

Hamilton, P. and Kraus, S. (2019) ‘Frequent encounters with the seafloor increase right whales’ risk of entanglement in fishing groundlines’ *Endangered Species Research*, 39:235-246 DOI:10.3354/esr00963

IFAW.org (2025) https://www.ifaw.org/ca-en/journal/types-of-whales November 20, 2025

Jelmert, A. and Oppen-Berntsen, D. (1996) ‘Whaling and Deep-Sea Biodiversity’ *Conservation Biology*, 10(2):653-654 DOI:10.1046/j.1523-1739.1996.10020653.x

Marcos, C., Diaz, D., Fietz, K., *et al.*, (2021) ‘Reviewing the Ecosystem Services, Societal Goods, and Benefits of Marine Protected Areas’ *Frontiers in Marine Science* 8:613819 DOI: 10.3389/fmars.2021.613819

NARWC.org North Atlantic Right Whale Consortium

NOAA (no date) https://www.fisheries.noaa.gov/species/blue-whale

Roberge, J. and Angelstam, P. (2004) ‘Usefulness of the Umbrella Species Concept as a Conservation Tool’ *Conservation Biology* 18(1):76-85 DOI:10.1111/j.1523-1739.2004.00450.x

Roman, J., Nevins, J., Altabet,M, et al., (2016) ‘Endangered Right Whales Enhance Primary Productivity in the Bay of Fundy’ *PLoS ONE*, 11(6):e0156553 https://doi.org/10.1371/journal.pone.0156553

Roman, J., Estes, J., Morisette, L. et al., (2014) ‘Whales are marine ecosystem engineers’ *Frontiers in Ecology*, 12(7):377-385 https://doi.org/10.1890/130220

Smith, C., and Baco, A. (2003) 'Ecology of Whale Falls at the Deep-Sea Floor' *Oceanography and Marine Biology: An Annual Review*, 41:311-354 Available at: https://www.soest.hawaii.edu/oceanography/faculty/csmith/Files/Smith%20and%20Baco%202003.pdf

Smith, C. (2006) 'Bigger Is Better: The Role of Whales as Detritus in Marine Ecosystems' in Estes, J., Demaster, D., Doak, D., et al., (eds.) *Whales, Whaling and Ocean Ecosystems*, United States: University of California https://doi.org/10.1525/california/9780520248847.003.0022

Smith, C., Glover, A., Treude, T., et al., (2015) 'Whale-Fall Ecosystems: Recent Insights into Ecology, Paleoecology, and Evolution' Annual Review of Marine Science, 7:571-96 DOI:10.1146/annurev-marine-010213-135144

Smith, C., Roman, J., and Nation, J. (2019) 'A metapopulation model for whale-fall specialists: The largest whales are essential to prevent species extinction' *Journal of Marine Research*, 77 (Supp.): 283-302 DOI:10.1357/002224019828474250

World Wildlife Fund (WWF) (2024) 'Meet the Biggest Animal in the World' Available at: https://www.worldwildlife.org/stories/meet-the-biggest-animal-in-the-world