Whales and Ecosystem Services

According to the World Economic Forum\textsuperscript{1}, the failure to mitigate and adapt to climate change is now the single biggest global risk, outpacing weapons of mass destruction, terrorist attacks, and food, water and financial crises. While international agreements, including both the 1997 Kyoto Protocol\textsuperscript{2} and the 2015 Paris Agreement\textsuperscript{3} address global reductions in CO2 emissions, no global efforts have yet considered the significant ecological role whales play in mitigating climate change nor the devastating impacts posed by their intentional removal from the ecosystem. Emerging research demonstrates that whales act as ecosystem engineers both through transferring nutrients within the water column and across latitudes as well as sequestering carbon. As a result, the continued recovery of whale populations is a significant mitigation strategy to combat climate change.

Nutrient exchange and enhanced marine productivity

According to Nicol et al. (2010)\textsuperscript{4}, the limiting micronutrient for the Antarctic marine environment is iron of which approximately 24 percent is stored in krill populations. The iron is freed from krill and recycled back into the euphotic zone as a result of ingestion and defecation by baleen whales (ibid). Therefore, the recovery of large whales in the Southern Ocean can enhance productivity by releasing stored iron back into the ecosystem where, as soluble iron, it can support phytoplankton blooms (ibid).

Research in the Northern Hemisphere documented similar findings with whales playing a critical role in the recycling of nitrogen. Because whales feed at depth but defecate at the surface, they recycle and move nutrients to the euphotic zone where they are available to phytoplankton. Roman and McCarthy (2010)\textsuperscript{5} estimated that whales and seals in the Gulf of Maine are responsible for the release of approximately $2.3 \times 10^4$ metric tons of nitrogen per year into the ecosystem. This nutrient exchange occurs within the vertical migration of whales as they feed but also across latitudes as whales migrate. Urine output in breeding areas by whales appears to also provide a significant source of nitrogen in the breeding areas of migrating whales (Roman et al. 2014)\textsuperscript{6}. For example, blue whales currently transport an estimated 88 tons of nitrogen per year to their calving grounds compared to the ~24,000 tons they transported prior to commercial whaling (ibid).
Climate Change and carbon sequestration

The increase in atmospheric CO² is causing a measurable increase in global climate temperatures. Carbon sequestration, or the removal of carbon from the atmosphere, is a primary mitigation to climate change for which whales can play a significant role. Smith (2006) concluded that the carcasses of great whales are the largest form of detritus on the ocean bottom. Carbon sequestration through whale falls, or carcasses is substantial. Approximately 2 million grams, or more than 2,000 years of background carbon flux, can result from a single 40-ton gray whale carcass fall (ibid). It is estimated that as a direct result of whaling, the current populations of large baleen whales now currently store 9.1×10^6 tons less carbon than before whaling (Pershing et al 2010). Alternatively, rebuilding whale populations (would result in the removal of 1.6×10^5 tons of carbon each year through whale falls, roughly the equivalent of 110,000 hectares of forest (ibid).

Fig. 1. Assumed biomass by Pershing et al 2010 – the authors assume a reduction of whales of at least 75% from whaling and a recovery rate of ~3%:

Along with whale falls, the vast amount of nutrients made available to phytoplankton in the euphotic zone as a result of whales can dramatically enhance carbon sequestration. Nicol et al. (2010) estimated that free iron in fecal plumes from whales is 10 million times greater than ambient levels triggering phytoplankton blooms. The sinking of the blooms could sequester 200,000 tons of carbon per year from the atmosphere (Lavery et al. 2010).

According to the United Nations, climate change now impacts each and every single country on each continent, affecting the lives of individuals and communities as well as disrupting national economies. Scientific evidence indicates that recovering whale populations can enhance primary productivity in the ocean and significantly sequester atmospheric carbon. As a result, the conservation and recovery of whale populations should be adopted as a global mitigation strategy to fight climate change.
References


10. Ibid

