# WHALES - THEIR FUTURE IS OUR FUTURE

WHALE AND DOLPHIN CONSERVATION

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WHALE AND DOLPHIN CONSERVATION

## INTRODUCTION

According to the World Economic Forum[1], the failure to mitigate and adapt to climate change is among the biggest global risks for our planet with significant environmental, economic and health impacts. While international agreements, including both the 1997 Kyoto Protocol[2] and the 2015 Paris Agreement[3] address global reductions in $CO^2$ emissions, no global efforts have yet considered the importance of the oceans as a carbon sink and the significant ecological role whales play in mitigating climate change, nor the devastating impacts posed by their intentional removal from the ecosystem.

The importance of forests in removing carbon dioxide from the atmosphere is well recognised (Pan *et al.*, 2011), however the oceans are by far the largest carbon sink in the world absorbing 25% of atmospheric carbon emissions (Heinze, 2015), with about 90% of the earth's carbon dioxide being stored and cycled through the oceans (Nellemann *et al.*, 2009). It has been estimated that annual carbon capture and storage by the oceans is equivalent to more than 1.5 billion tonnes of carbon dioxide (Rogers *et al.*, 2014).

The contributions that whales make to nutrient fluxes in the oceans and sequestering carbon constitute relatively new fields of research; however the results of studies to date indicate that whales can play a pivotal role in maintaining healthy marine ecosystems. Whales act as ecosystem engineers both through transferring nutrients within the water column and across latitudes as well as sequestering carbon, and by the fact that their carcasses can provide important habitat for deep sea organisms (so called whale falls).

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While moving nutrients throughout the oceans, whales also help to fertilise the oceans and are key in stimulating fish abundance by enhancing ecosystem productivity (Lavery *et al.*, 2014, Roman *et al.*, 2014). In addition, it has been recognised that there is no substantive evidence that cetaceans are detrimental to fish abundance (Morissette *et al.*, 2010, 2012, Corkeron 2008, Young 2000).

The majority of the prey species consumed by whales are invertebrates, including zooplankton such as krill (*Euphausiacea*) and squid (*Teuthoidea*) (Morissette *et al.*, 2012). Furthermore, the fish species consumed by whales are of little to no interest to commercial fishermen (Morissette *et al.*, 2012, Corkeron 2008, Lavigne and Fink, 2001).

The essential role that whales play in a healthy marine ecosystem is increasingly being discussed and recognised in the scientific world. At its 66th meeting the International Whaling Commission (IWC) recognised the potential importance of whales as 'ecosystem engineers' by the adoption of resolution 2016-3 "Resolution on Cetaceans and Their Contribution to Ecosystem Functioning"[4]. The resolution highlighted the important

**{ THE OCEANS ARE BY FAR THE LARGEST CARBON SINK IN THE WORLD ABSORBING 25% OF ATMOSPHERIC CARBON EMISSIONS }**

1 - World Economic Forum. 2017. Global Risks Report 2017 12th Edition. Geneva: World Economic Forum. http://www3.weforum.org/docs/GRR17_Report_web.pdf

2 - 1997 Kyoto Protocol to the UN Framework Convention on Climate Change (UNFCCC). http://unfccc.int/kyoto_protocol/items/2830.php

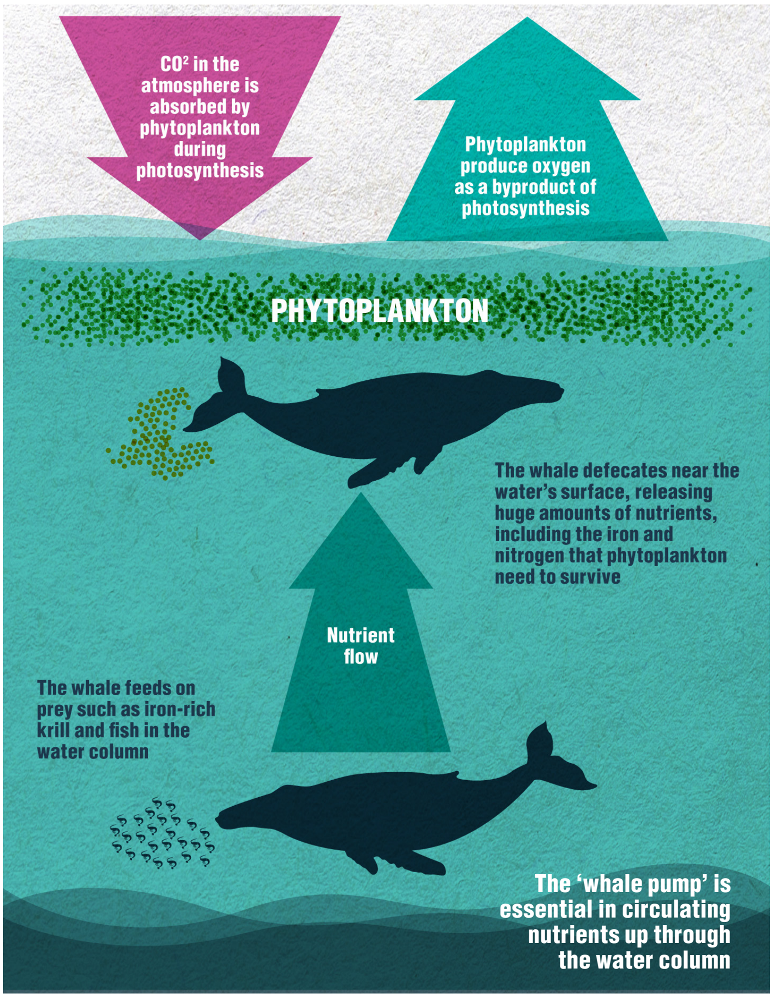
3 - United Nations / Framework Convention on Climate Change (2015) Adoption of the Paris Agreement, 21st Conference of the Parties, Paris: United Nations.http://unfccc.int/paris_agreement/items/9485.php

4 - https://archive.iwc.int/pages/search.php?search=%21collection72&k=

role whales play in cycling nutrients through the oceans and in enhancing ecosystem productivity, as well as the importance of 'whale falls'. Whale carcasses provide a unique habitat for deep sea species, many of which are only found on these 'whale falls'; they also provide important information on the role of dead whales in the ecosystem which can only be obtained through whale falls and stranded animals (Smith and Baco, 2003).

## NUTRIENT EXCHANGE AND ENHANCED MARINE PRODUCTIVITY

Many whale species consume prey at lower depths, and release nutrient rich faecal plumes upon return to the surface (Roman *et al.*, 2014, 2016); this release of nutrients promotes enhanced primary production by phytoplankton, and thus uptake of dissolved carbon dioxide (Roman *et al.*, 2014, 2016). Also, through seasonally changing their habitat by migrating large distances, whales can execute transportation of nutrients captured in their bodies from cold to (often oligotrophic) warm water masses, which geographically are far apart (Roman *et al.*, 2014, 2016).

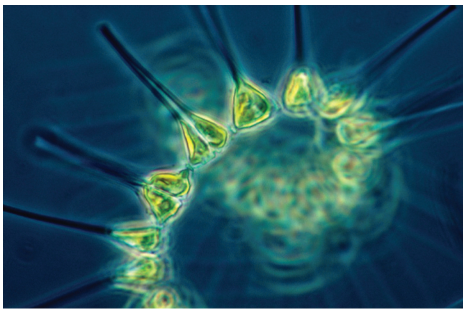



Migratory whales travelling across oceans bring in nutrients via their urine, placenta, carcasses, and sloughed skin from highly productive feeding grounds to low latitudes with reduced nutrient availability (Roman *et al.*, 2014).

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 (Roman *et al.*, 2014). 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).

Through this 'whale pump' mechanism, whales transport nutrients both vertically, between depth and surface, and horizontally, across oceans promoting primary production and thereby the fixing of atmospheric carbon (Roman and McCarthy 2010, Roman *et al.*, 2014).

According to Nicol *et al.*, (2010), the limiting micronutrient for the Antarctic marine environment is iron of which approximately 24 percent is stored in krill populations. The iron is freed metabolically from krill and recycled back into the euphotic zone as a result of ingestion and defecation by baleen whales (Nicol *et al.*, 2010). 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 (Nicol *et al.*, 2010) and, consequently, secondary productivity.


NOAA MESA PROJECT

**Microscopic phytoplankton get a vital source of iron and nitrogen from whale poo**

Roman and McCarthy (2010) estimated that whales and seals in the Gulf of Maine are responsible for the release of approximately $2.3\times10^4$ 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.

An additional way of mixing water, and hence contributing to wider distribution of nutrients and oxygen in the water, results from the physical movement of animals in the water column, including organisms usually aggregated in deeper waters ("deep scattering layers"), but also by fish and especially by larger animals like cetaceans (small and large). As the latter are air breathers bound to the surface, this can lead to significant vertical mixing especially within the upper layer, i.e. the euphotic zone, and the zone below (Lavery *et al.*, 2012).

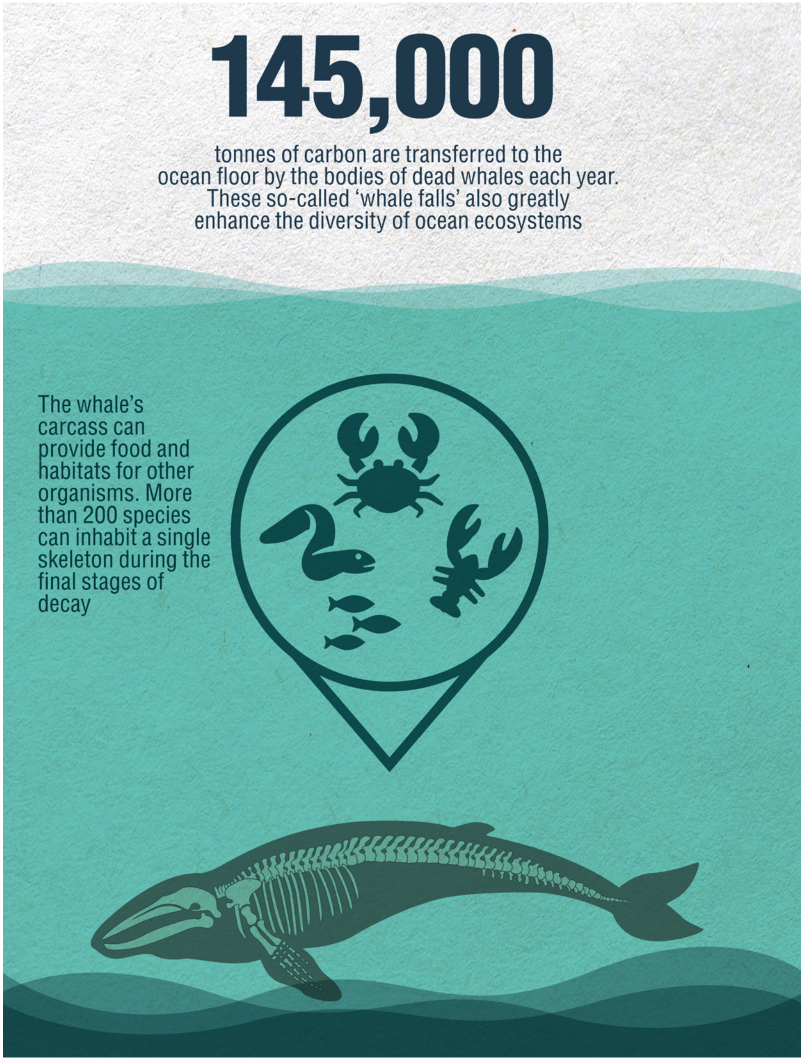
While moving nutrients throughout the oceans, whales also help to fertilise the oceans and are key in stimulating fish abundance by enhancing ecosystem productivity (Lavery *et al.*, 2014, Roman *et al.*, 2014). Lavery *et al.*, (2014) concluded that the rich nutrients released by whales defecating helps sustain fish stocks, provides food for other fish and promotes marine productivity in whale feeding grounds. Blue whales in the Southern Ocean were found to fertilise their own feeding grounds with the nutrients needed to sustain the growth of their prey (Lavery *et al.*, 2014).

## CLIMATE CHANGE AND CARBON SEQUESTRATION

The increase in atmospheric $CO^2$ is causing a measurable increase in global climate temperatures, 2016 was the warmest year since official records began, and was the third year in a row to set a new heat record[5]. 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.

In addition to the release and circulation of nutrients, which stimulate phytoplankton and thereby the fixing of atmospheric carbon, whales contribute to the removal of carbon from the atmosphere through accumulating large amounts of carbon in their bodies, which after death often sink to the sea bottom becoming so called 'whale falls' (Lutz and Martin, 2014).

Carbon sequestration through whale falls, or carcasses is substantial. The carcass of a single large whale transports carbon accumulated in its body when it falls to the sea floor (Lutz and Martin, 2014). Smith (2006) concluded that the carcasses of great whales are the largest form of detritus on the ocean bottom. 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 (Smith, 2006). The implication for oceanic carbon sequestration is that maintenance of healthy populations of whales will enhance the levels of carbon transfer to the deep ocean through 'whale falls' (Lutz and Martin, 2014), possibly at a dimension larger that would have been thought previously.



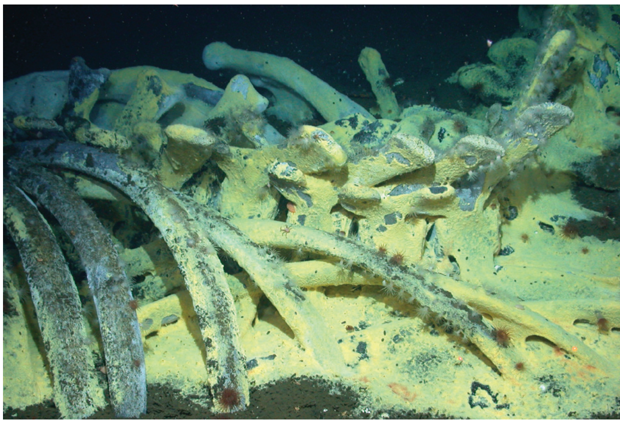

**THE CONTINUED RECOVERY OF WHALE POPULATIONS IS A SIGNIFICANT MITIGATION STRATEGY TO COMBAT CLIMATE CHANGE**

5 - National Oceanographic and Atmospheric Administration (NOAA). National Centers for Environmental Information. Global Analysis 2016. https://www.ncdc.noaa.gov/sotc/global/201613 retrieved February 2017.

Along with whale falls, the vast amount of nutrients made available to phytoplankton in the euphotic zone as a result of whales transferring nutrients from deep waters to the surface, 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).

## WHALE FALLS AS DEEP SEA OASES

In addition to removing carbon from the atmosphere where it can be stored for potentially thousands of years (Lutz, *et al.*, 2007), whale falls create unique small scale ecosystems on their own with a large amount of endemic species (Smith and Baco, 2003); they also provide important information on the role of dead whales in the ecosystem which can only be obtained through whale falls and stranded animals.



CRAIG SMITH / NOAA

**Organisms seen at deep-sea whale falls include shrimp, lobsters and sea cucumbers**

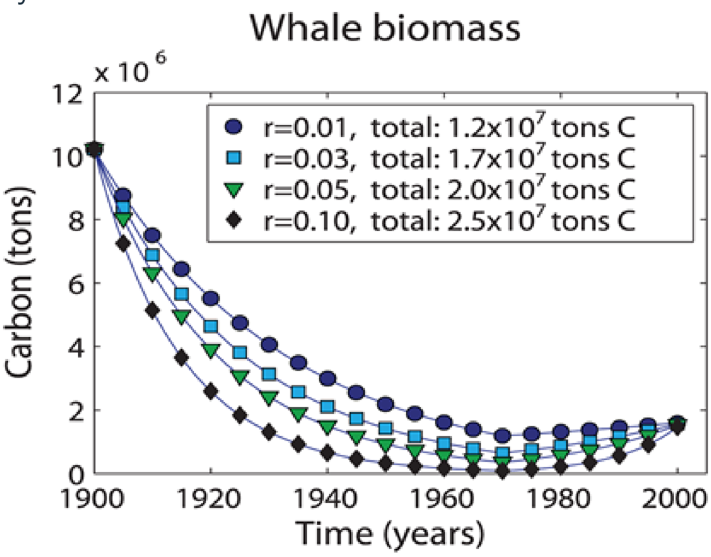
Whale falls generally occur along migration routes, and in breeding and feeding grounds where the carcasses provide persistent and organic and sulphide rich habitat and food for many species at the sea floor (Smith *et al.*, 2015).
Smith *et al.*, 2015 found that whale fall communities can pass through four different stages including mobile scavengers which help to disperse the whale biomass into the surrounding areas leading to increased enrichment in those areas, enrichment opportunists, sulfophiles and suspension feeders.

The extreme food limitation in deep-sea ecosystems resulted in a diverse and specialised deep-sea whale fall fauna, which includes bone eaters and chemolithoautotrophic assemblages (Smith, et al., 2015). Whilst this may not be significant in terms of climate change, but it shows the significance whale falls have on the functioning of the deep sea.

## LARGE SCALE BIOMASS REMOVALS

In the twentieth century alone, whaling killed almost 3,000,000 whales, reducing some populations by 99% of their pre-whaling numbers (Clapham, 2016). It is estimated that as a direct result of whaling, the current populations of large baleen whales now currently store $9.1\times10^6$ tons less carbon than before whaling (Pershing *et al.*, 2010). Rebuilding whale populations (i.e. allowing them to fully recover) would result in the removal of $1.6\times10^5$ tons of carbon each year through whale falls, roughly the equivalent of 110,000 hectares of forest, or an area the size of the Rocky Mountain National Park (Pershing *et al.*, 2010).

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%:



Prior to industrial whaling, sperm whale populations were significantly larger than they are today (Baker and Clapham 2004). The recovery of whale populations to pre-whaling levels could significantly help to reduce the impacts of global warming (Clapham, 2016). Lavery *et al.*, (2010) estimated that if sperm whale populations were at pre-whaling levels, an additional 2,000,000 tons of carbon would be removed every year. Similarly, nutrients released in the fecal matter of North Atlantic right whales in the Bay of Fundy, were found to increase phytoplankton growth. North Atlantic right whales are rare, numbering just c.450 individuals in 2016; however they once numbered c.14,000 and were likely to be a key role in the recycling of nutrients (Roman, *et al.*, 2016).

## CONCLUSION

As the scientific evidence demonstrates, research into the functions that whales can have in healthy marine ecosystems and their contribution to the carbon sequestration is fairly recent, but it has already shown that whales are essential contributors to healthy marine ecosystems, healthy fish stocks and sequestering carbon to combat the increasing impacts of climate change.

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[6]. As a result, the conservation and recovery of whale populations to pre-whaling levels should be adopted as a global mitigation strategy to fight climate change.

**{ RESEARCH SHOWS THAT WHALES ARE ESSENTIAL CONTRIBUTORS TO HEALTHY MARINE ECOSYSTEMS, HEALTHY FISH STOCKS AND SEQUESTERING CARBON TO COMBAT THE INCREASING IMPACTS OF CLIMATE CHANGE. }**

VANESSA MIGNON

6 - United Nations Sustainable Development Goals http://www.un.org/sustainabledevelopment/climate-change-2/

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*A world where every whale and dolphin is safe and free*