

**Why do so many porpoises starve to death and wash up on the coast in the summer when there is plenty of prey swimming around? After ten years spent investigating porpoise stomachs, Mardik Leopold concludes that the young animals in particular find it difficult to catch enough oily fish. And there is the threat of grey seals.**

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TEN YEARS OF RESEARCH ON THE PORPOISE'S MENU

# Porpoises can starve



**in a sea full of fish**

**I** didn't believe it at first,' says Mardik Leopold. The marine mammal and seabird researcher from IMARES Wageningen UR in Den Helder will not easily forget the time when a fellow researcher told him that porpoises in captivity can die of starvation after as little as three days without food. Leopold spent ten years studying the menu of the harbour porpoise, which is common in the North Sea and one of the world's smallest cetaceans. One of his findings is the discovery why this small mammal needs to eat so much in the wild too. His research helped the Netherlands to meet its EU obligation to collect data on the Dutch population of harbour porpoises, which are a protected species. Leopold also looked at whether the fishing industry and the fish-eating porpoises were in competition. In November 2015, he obtained his doctorate at Wageningen University for this research. In his study, Leopold figured out the porpoise's feeding habits from the stomach contents of dead animals that were washed up on the Dutch coast during the research period. At the same time, he also provided proof for the hypothesis that the mysterious injuries to the porpoises were caused by attacks by hungry grey seals.

### STINKING STOMACH CONTENTS

'Investigating stomach contents is an indirect method of studying the choices that the animals make,' says

Leopold, talking in mid-January on the island of Texel. He is in the Royal Netherlands Institute for Sea Research (NIOZ) building, which was where he worked until IMARES' recent move to Den Helder. Leopold used the stomach contents of dead animals to reconstruct which fish species are on the menu of porpoises and in what quantities. Do porpoises differ in their choice of prey according to their age and state of health? Are there seasonal patterns in their diet? These questions were at the heart of Leopold's research. He found the answers in the undigested remains of the prey left in porpoise stomachs, such as otoliths, fish bones and the horny beaks of squid.

The food pulp in a porpoise's stomach does not exactly smell nice. 'But the research is fascinating,' says Leopold. He explains that diet studies usually aggregate the data from individual stomach examinations. 'But that only tells us what the average animal eats.' In this study, veterinary pathologists at Utrecht University carried out autopsies to determine the cause of death and assess the 'nutritional status' of the dead animals, from very well fed to starved. The body length was also recorded. This enabled Leopold to build up a picture of the diet of porpoises in different seasons, different age categories and different states of health.

The study shows that the main prey of porpoises along the Dutch coast are small whiting, young herring,



PHOTO: KEES CAMPHUYSEN

### STOMACH CONTENTS

Mardik Leopold used the stomach contents of dead animals to reconstruct which fish species are on the menu of porpoises and in what quantities. The stomachs contain the undigested remains of their prey such as otoliths and fish bones. Otoliths vary depending on the fish species and grow in size as the fish grows. It is possible to count the number of growth lines under a microscope and so work out the age of a fish. Leopold and his colleagues examined more than 150,000 otoliths from porpoise stomachs.

An opened stomach containing a semi-digested goby and a pulp containing large numbers of fish otoliths.

sprats, the lesser sand eel and gobies. None of these are important commercial species for the Dutch fishing industry. Sole and plaice, which are fished in large numbers, rarely end up in porpoise stomachs.

### YOUNG AND STARVED

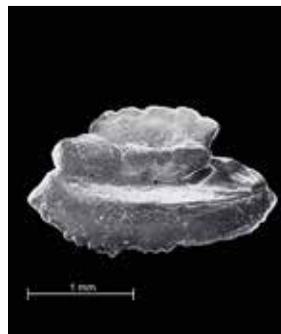
The detailed stomach examinations allowed Leopold to discover why relatively large numbers of young porpoises wash up starved to death in the summer months even though there are plenty of fish in the sea then. According to Leopold, the explanation lies in a biological limitation of this small cetacean species. Warm-blooded animals such as whales require a great deal of energy to maintain their body temperature. The smaller their body, the greater the relative energy requirement because they have a relatively large surface area through which heat is lost. This effect is even stronger in marine mammals because water has such good thermal conductivity and because temperatures are usually lower. Whales have a subcutaneous layer of fat that prevents heat loss to the surrounding water but they still have relatively high energy requirements. Porpoises in captivity need to eat about ten percent of their body-weight in food every day to remain healthy. That is a higher proportion than for other cetacean species, which reflects their smaller size. Leopold concluded on the basis of his research that young porpoises, which are of course even smaller, get into problems in the summer because they are unable to obtain enough energy from their food.

A porpoise's menu includes not only oily, energy-rich fish species such as herring, sprats and the lesser sand eel, but also gobies, which are both very low in fat and relatively small. The whiting on the menu is also low in energy but is relatively large compared to the other species. Small, young porpoises turn out to mainly eat small gobies, sometimes in staggering quantities – the record was almost 5400 gobies in a single stomach. Medium-sized porpoises have far more oily herrings and sand eels in their diet. The largest porpoises eat a great deal of whiting. Leopold: 'You would expect animals to choose the prey that is most beneficial in terms of energy. But young porpoises don't do that.'

### EATING JUNK FOOD

According to Leopold, young porpoises are in a kind of energy Catch 22: it appears that because they are young

## Young porpoises do not get enough energy from their food



### Otoliths

The otoliths in a porpoise's stomach can be used to determine what fish species were eaten, in what quantities and how old the fish were. From left to right: otoliths from a goby, herring, sprat, whiting and lesser sand eel.

## PORPOISE COMEBACK

Porpoises had virtually disappeared from the coastal waters around the Netherlands by around 1970. This dolphin-like aquatic mammal with an adult body length of about one-and-a-half metres lives on its own or in small groups in shallow coastal waters in the northern hemisphere. Now large numbers of porpoises can be found swimming in the Dutch part of the North Sea, the Wadden Sea and the Eastern and Western Scheldt estuary. They are among an estimated total population of 300,000 porpoises in the North Sea. The porpoise's distinctive 'rolling' back and dorsal fin are no longer a rare sight at the water's surface, to the delight of nature lovers. Although the quality of the seawater has improved and there is less pressure from fishing, the increase in the number of porpoises in the southern reaches of the North Sea is mainly due to the decline in the lesser sand eel population further north in the North Sea. The lack of food has caused the population in the north to spread to the south. The porpoise population is currently stable according to the most recent North Sea-wide counts.



PHOTO WILDAPHOTO

## ‘Porpoises have to root gobies out one by one’

and inexperienced, they are not yet able to catch prey that swim fast such as herring and sprats, and therefore have to make do with gobies. Leopold suspects that these little fish with an average weight of about one gram are easy to catch. ‘We don’t know much about the distribution or population density of gobies but that must be the case.’ Going by the stomach examinations, the young porpoises were regularly eating a couple of thousand gobies a day. ‘That means eating at least one per minute, around the clock.’ Gobies live on the ocean floor and do not form schools, ‘so the porpoises have to root them out one by one.’ Yet even in such huge numbers, gobies do not provide enough energy for young porpoises.

The thin layer of fat in the porpoise carcasses in the summer is further evidence of malnourishment. Leopold: ‘This does give you a chicken-and-egg problem: were the animals starving because they were not eating enough energy-rich fish, or were they not catching enough energy-rich fish because they were in poor condition?’

It seems that as porpoises become older and more experienced, they are better able to bag the faster-swimming herrings, sprats and sand eels — prey that do supply sufficient energy. The whiting consumed by the oldest animals reflect the larger amounts of food required for larger bodies. Indeed, Leopold thinks porpoises represent the smallest size that is biologically possible for a cetacean: ‘Porpoises evolved from larger forebears in the whale family. The adaption that gave them a smaller body lets them live in shallow coastal waters that are rich in food. Furthermore, this lets porpoises avoid competition with large toothed whales that easily become stranded — take the sperm whales at the opposite end of the size spectrum that end up on the Dutch North Sea beaches. But this does mean that the porpoise’s body is so small when young that energy can

## CARCASSES

Leopold examined more than 800 porpoise carcasses. He obtained them through an extensive network of volunteers and people working for organizations that care for aquatic mammals. The 'Acknowledgements' in Leopold's doctoral thesis lists their names, which take up almost an entire page and include people who came across a porpoise while strolling along the beach and reported it. In his research, he collaborated with veterinary pathologists from Utrecht University, who carried out autopsies on the dead porpoises.

The cause of death of the washed-up porpoises can be broken down roughly into fishing bycatches, disease, starvation and attacks by grey seals, each of which accounted for about 20 percent. The cause of death in the remaining 20 percent is still being investigated.



PHOTO HOLLANDESE HOOGTE

sometimes be a problem.' But Leopold discovered that the porpoise's size also results in another biological risk, as it turns the porpoise itself into prey.

### CSI NORTH SEA

Animal lovers and biologists, including Leopold, had been puzzling over the mystery of what was causing the incisions – often horrific injuries – found on the corpses of porpoises washed up since 2006. People thought it might have been fishermen who were trying to cover up for unintentional bycatches of porpoises. The solution to the mystery came with a discovery in 2012 by a Belgian aquatic mammal researcher who compared the wounds on fresh porpoise carcasses to the teeth in museum skeletons of grey seals. There could be no doubt about the match. Leopold was one of the first to hear about the discovery. This prompted him to look again at some of 'his' porpoise carcasses. A DNA specialist from NIOZ was brought into the research team to apply forensic techniques to porpoises for the first time, just like in the

CSI TV series where murders are solved by examining DNA traces. The DNA extracted from the porpoises' injuries turned out to be identical to the DNA of grey seals. Then the injuries were compared with those on other porpoise carcasses. About 17 percent of all dead porpoises turned out to have been attacked by grey seals. Because porpoise carcasses with signs of seal attacks were generally fresh and the stomach examinations showed that the animals had been hunting prey just before they died, Leopold concluded that grey seals were targeting and attacking live porpoises rather than gnawing at animals that were already dead. Leopold: 'Young porpoises are the most likely to be attacked. They are about the same size as a large cod, which is a favourite prey of grey seals. Those young animals represent the future of the porpoise population, so grey seals can have a major impact on the population.' ■

[www.wageningenur/porpoises](http://www.wageningenur/porpoises)