



Message from the NSTF Executive Director

An octopus for October

Everyone's favourite animal must be the star of the instantly popular [documentary by Craig Foster](#) on Netflix. It is apparently rare for a documentary to be so successful. However, *My Octopus Teacher* is unusually appealing as it is a personal story of the South African videographer, as much as it is the story of a certain nameless octopus off the shores of Cape Town. I had to ask my marine biologist (student) stepdaughter whether the plural of octopus is octopi. It turns out it isn't. Octopus is based on a Greek word and not a Latin word (the latter would have made the plural end in i). In any case, this movie has made waves across the planet, and set my mind wondering about the distribution and habits of this extraordinary creature. To what extent is it threatened by human activities? What must we do to ensure its survival? My stepdaughter says that people can easily disrupt the sensitive ecosystem where the movie star octopus lived and hunted. Foster found that being part of the octopus's world was deeply meaningful, but if too many people seek such meaningful encounters, their habitat and that of other sea life will be greatly disturbed.

This is **National Marine Week** as declared by the [South African National Biodiversity Institute \(SANBI\)](#) (an NSTF member). During this week we celebrate our marine biodiversity, and SANBI says it is an opportunity to appreciate how South Africa's new 'Marine Protected Areas' (MPAs) benefit people and help support "South Africa's emerging oceans economy, sustain fisheries, protect marine biodiversity and help us cope with climate change". The 20 new MPAs declared last year added approximately 53 000 km² to South Africa's protected area network, an area more than twice the size of the Kruger Park.

The movie star's relatives

In taxonomy the word *octopus* is a genus of the family *octopodidae*, and sub-family *octopodae*, and it is the largest genus in the family, including more than 100 species. There are another 200 species (more or less) in the *octopodidae* family. The species range in size from [Octopus wolfi](#) at 1.5 cm, in the Indo-Pacific Ocean, to the [Giant Pacific Octopus](#), *Enteroctopus dofleini*, with an average span of 5 metres. The Giant Pacific Octopus has the longest life of them all and lives an average of 3-5 years.

[The common octopus](#) (*Octopus vulgaris*), which is the star of the movie, occurs widely, from the Mediterranean Sea and down the west coast of Africa. Its arms can grow up to a metre long.

An octopus found around Australia and New Zealand, *Octopus tetricus*, also known as the Sydney octopus or gloomy octopus, displays many similarities to *vulgaris* (to my layman's eye) – e.g. it is about the same size. It is speculated that *tetricus* is remarkably 'sociable' after two areas off the coast of Australia were found to be unusually 'crowded' in 2017, with [16 gloomy octopuses](#) occupying dens in the one area and 15 in another. The octopuses were competing for nesting space in their areas, chasing each other and using threatening poses to intimidate each other. Octopuses are solitary animals, so this phenomenon was surprising.

Are octopuses 'threatened'? – Yes and no

Octopuses are not considered as threatened, as they are found all over the globe, and no one knows how many there are of each species. Being solitary animals and masters of camouflage, they are probably difficult to count unless they are hauled in by trawling. It appears that the Giant Pacific Octopus is not growing to the size that it did in previous decades, so it is speculated that human

activities have been preventing it from growing to full size. All octopuses could be affected by pollution, their skins not being protected and thus in direct contact with any pollutants in the water.

The [Red List](#) categorises *Octopus vulgaris* as of 'least concern', but it has been caught by bottom trawls on a huge scale off the north-western coast of Africa. The Red List says: "There is no information on the population status of this species. However, the estimated fisheries landing for this species was approximately 149,000 mt in the eastern-central Atlantic (ECA) in 2001, with most of this catch taken in western Sahara and Mauritanian waters. There is clear variation in landings between years, and recruitment, in Mauritanian waters at least, appears to be dependent on strong upwelling conditions." I do not know what has happened thereafter, in the past 19 years, but I am sure that trawling has not stopped.

As with all species of flora and fauna, it is usually too late to stop the decline of a species once it is recognised as endangered. When will the concern about the sustainability of octopus species begin? Bottom trawls are also known to catch mountains of marine life forms that are useless to the trawlers, destroying habitats and killing untold numbers of organisms, and diminishing the numbers of various species in an area.

Noise pollution

Marine life is negatively affected by offshore drilling, ship motors, use of military grade sonar and pile driving (driving piles into the sea floor). The harm caused by sonar has been the subject of study and court cases in relation to the effects on whales. The effects of sonar used continuously by the United States military off the shores of California on whales and other marine mammals are disastrous. However, it could be having equally devastating effects on other marine life forms, including cephalopods. In an [article](#) by Brendan Borrell in November 2008, *Octopuses and squids are damaged by noise pollution*, it is said that while there was prospecting off the coast of Spain with compressed air guns in 2001 and 2003, mass strandings of giant squid (*Architeuthis dux*) took place.

The [laboratory study](#) that followed to investigate such effects is reported in a paper in [Frontiers in Ecology and the Environment](#), published online in 2011. The effect of low-intensity, low-range sound (50 to 400 hertz) on common octopuses (*Octopus vulgaris*), European squid (*Loligo vulgaris*), common cuttlefish (*Sepia officinalis*) and squid in the genus *Illex* was tested in the laboratory. Although the noise was of low intensity and range, and the animals were only exposed over relatively short periods of two hours at a time, some of the animals died. Examining the victims closely, it was found that there was substantial damage to the statocyst (responsible for spatial orientation and hearing). They found large lesions, missing or damaged hairs and ruptured plasma membranes.

"If the relatively low intensity, short exposure used in our study can cause such severe acoustic trauma, then the impact of continuous, high intensity noise pollution in the oceans would be considerable," says the main author, Michel André. If the noise does not actually kill an individual cephalopod, it would most certainly affect its ability to hunt, evade predators and reproduce. Low- and mid-intensity noise has not been found to cause such severe damage in fish and marine mammals.

Changes in cephalopod health and populations would affect entire food chains and ecosystems.

Legal protection for octopuses

O. vulgaris was the first invertebrate animal to be protected by the [Animals \(Scientific Procedures\) Act 1986](#) in the United Kingdom (as amended in 1993): "This Order extends the scope of the Animals (Scientific Procedures) Act 1986 in two ways as from 1st October 1993. First, it extends the definition of "a protected animal" for the purposes of the Act to include *Octopus vulgaris*...", from the point when it can feed independently. Further revised legislation came into force on 1 January 2013. The Act was then expanded to protect - "...all living vertebrates, other than man, and any living cephalopod. Fish and amphibia are protected once they can feed independently and cephalopods at the point when they hatch."

Although *O. vulgaris* is not protected by name in South African legislation, we have our own excellent legislation that provides for the protection of whole marine areas where octopuses breed and

hunt. SANBI is mandated to do related research and to implement [The National Environmental Biodiversity Act](#), “for the management and conservation of South Africa’s biodiversity within the framework of the National Environmental Management Act, 1998”. The Act specifies:

“Application of Act 4. (1) This Act applies- (a) in the Republic, **including- (i) its territorial waters, exclusive economic zone and continental shelf described in the Maritime Zones Act, 1994 (Act No. 15 of 1994)**; and (ii) the Prince Edward Islands referred to in the Prince Edward Islands Act, 1948 (Act No. 43 of 1948); and (b) to human activity affecting South Africa’s biological diversity and its components.”

SANBI’s role

[The SANBI Marine Programme](#) is a “small team of scientists that work across the science-policy continuum. This team works to deliver on the marine aspects of SANBI’s mandate as outlined in the Biodiversity Act, i.e. monitor and report on the state of biodiversity in South Africa’s marine territory, co-ordinate research, provide knowledge and information, give planning and policy advice and pilot best-practice management models in partnership with stakeholders.”

Among other functions it provides “independent co-ordinated science based advice to the Department of Environmental Affairs (DEA), the Department of Agriculture, Forestry and Fisheries (DAFF), and the Dept of Mineral Resources (DMR) and their respective stakeholders”.

The **National Biodiversity Assessment 2011**, published in 2012, led by SANBI’s Marine Programme, was a milestone for marine biodiversity. Major new contributions included a new habitat classification, national habitat maps for the coast, ocean floor and the open ocean, a comprehensive review of pressures on marine and coastal biodiversity and a data driven assessment of biodiversity state for 136 habitat types.

The 20 new Marine Protected Areas (MPAs) declared in 2019 add approximately 53 000 km² to South Africa’s protected area network, an area more than twice the size of the Kruger Park. This includes the first protection for 51 different ecosystem types. “South Africa can be proud of its efforts to balance protection and economic development in an emerging oceans economy.”

“MPAs provide safe spaces in which fish can breed undisturbed, and protect spawning and nursery areas that let young fish mature into adulthood.” Internationally acclaimed research by South African scientists has demonstrated the positive spill-over effect when marine species are allowed to grow to their full adult size, in the Goukamma MPA.

More remarkable characteristics of octopuses

As Craig Foster shows in his movie, an octopus is impressively intelligent.

I read a fascinating [article](#): *The Mind of an Octopus - Eight smart limbs plus a big brain add up to a weird and wondrous kind of intelligence*, by [Peter Godfrey-Smith](#), published in Scientific American on 1 January 2017. It gives a description of octopus encounters similar to Craig Foster’s first meeting with ‘his’ octopus.

Godfrey-Smith says: “Octopuses and their relatives (cuttlefish and squid) represent an island of mental complexity in the sea of invertebrate animals. Since my first encounters with these creatures about a decade ago, I have been intrigued by the powerful sense of engagement that is possible when interacting with them.

“They are probably the closest we will come to meeting an intelligent alien.”

Human and octopus brains have no common anatomy, and have evolved along totally different lines. The octopus’s brain is distributed throughout its body, with most of it in its arms. However, octopuses also have something like long- and short-term memory, a version of sleep, the ability to recognise individual humans and to explore objects.

Octopus vulgaris has about 500 million neurons in its body, in the same range as various mammals, e.g. close to the range of dogs. (Human beings have many more—something nearing 100 billion.)

Anecdotes testify to their intelligence. At two separate aquariums, octopuses learned to turn off the lights by squirting jets of water at the bulbs and causing short-circuiting. “At the University of Otago in New Zealand, this game became so expensive that the octopus had to be released back to the wild.”

Octopuses appear to have an ability to adapt to the special circumstances of their captivity and to their interactions with individual human keepers. They can recognise and behave differently toward different keepers.

Philosopher Stefan Linquist of the University of Guelph in Ontario, says that fish don't seem to know that they are in captivity, but with octopuses it is different. “They know that they are inside this special place, and you are outside it. All their behaviours are affected by their awareness of captivity.” He found that octopuses would deliberately plug the outflow valves by poking in their arms, which of course, flooded his entire lab. (The flooding was probably caused inadvertently,)

An innovator in cephalopod research, Jennifer Mather of the University of Lethbridge in Alberta, Canada, along with Anderson, did the first studies of playing behaviour, which have been investigated in detail. Some octopuses will blow “pill bottles around their tank with their jet, “bouncing” the bottle back and forth on the stream of water coming from the tank's intake valve”. Work by Michael Kuba, now at the Okinawa Institute of Science and Technology in Japan, has confirmed that octopuses can quickly tell that some items are not edible and are often still quite interested in exploring and manipulating them.

Experimental research in the lab of neurobiologist Binyamin Hochner of the Hebrew University of Jerusalem showed how an octopus can combine the abilities of one of its arms with its vision, to reach a treat inside a maze. In 2011 researchers Tamar Gutnick and Ruth Byrne, along with Hochner and Kuba, conducted this experiment. The task was set up so that the arm's own chemical sensors would not on its own be able to find the food; and the arm would have to leave the water at one point. The target location could be seen by the octopus through transparent maze walls. The octopus would have to guide an arm through the maze with its eyes. It took a long time for the test octopuses to succeed at this task, but most of them did. They used both their arms' ability to search independently, as well as central control of the path that the arm was taking. This result confirmed the suspicion that octopuses use both their arms and their heads to coordinate actions in a systematic way.

“[T]here is a lesson here about the ways that smart animals handle the stuff of their world. They carve it up into objects that can be remembered and identified despite changes in how those objects present themselves. This, too, is a striking feature of the octopus mind—striking in its familiarity and similarity to how we two-legged types make sense of our world.”

In conclusion

Octopus species are remarkable creatures, part of food chains and the ecology of coastal waters, and should be respected in particular for their high intelligence. Chemical pollution and noise pollution pose extreme threats to the sustainability of cephalopods including octopuses. Research and monitoring of these factors and effects must be done to inform legislation and curtail harmful human activities. South Africa's excellent environmental protection legislation has to be enforced to ensure the future of these creatures living off our coastline.

Happy National Marine Week, everyone!

The opinions expressed above are those of the Executive Director, Ms Jansie Niehaus, and do not necessarily reflect the views of the [Executive Committee](#) or [members](#) of the NSTF.