The role of rays in the ecosystem

By Simon Pierce

A tropical whipray (*Himantura* sp.) (© Shane Litherland)

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Introduction to rays and skates

The rays are the most diverse of the cartilaginous fishes, encompassing around 600 species worldwide. These range from the gigantic manta rays, with a 'wingspan' of over six metres, right down to skates the size of a person's hand. Though they are diverse in body form, a common characteristic of rays is their flattened bodies. Most stingrays have rounded, flat, expanded pectoral fins that form a body 'disc' so they are ideally adapted to burying themselves in the substrate, where they are both camouflaged and streamlined. The disc is amazingly flexible near its margin, which is important for swimming, burying, and feeding. The pectoral fins of pelagic ray groups, such as eagle rays and mantas, are more wing-like with strong lateral muscles for prolonged swimming, allowing them to 'fly' through the water (figure 1).

Figure 1. A typical encounter with a large ray, swimming close to the sea floor (© Andrea Marshall).

Geographically, rays are distributed from thousands of kilometres inland in South America right up to the Arctic Circle, and from the intertidal zone down to abyssal depths. Most rays live exclusively in the sea, and the majority live over the continental shelves, from the intertidal zone to depths of 200 metres, while skates take over from the stingrays in deeper waters. Their wide distribution and diversity means that rays have an important role in almost all marine ecosystems, with each species having its own distinctive niche.

The ocean is a three-dimensional environment, with underwater habitats structured both vertically and horizontally. Almost all rays feed on prey living close to, on, or just underneath the bottom, acting somewhat like the vacuum cleaners of the ocean. The bottom is generally the most productive part of the ocean as dead things tend to end up there. Hence, the things that directly or indirectly feed on them accumulate on the bottom as well. Rays feed mainly on invertebrates and small vertebrates, with prey ranging from large fish down to tiny crustaceans. All known rays are carnivorous, and as a group they are high in the food web.

Rays can be quite selective feeders, and the various shapes of their mouth and teeth can be a good indication of their food preferences. Eagle and cownose rays have a series of flattened tooth plates for crushing hard-shelled molluscs. Rays that often feed on fish, such as torpedo rays, have an arched lower jaw studded with small spiny teeth which can be thrust forward to suck up small fish. The huge mouth of the plankton-feeding manta ray is at the front of the snout, while the teeth, which are not important in feeding, are minute and covered in skin in the lower jaw and totally absent in the upper jaw (figure 2). Skates and most stingrays have compact rows of strong, pointed teeth in both jaws for holding and crushing their prey (figure 3).

Figure 2. Manta rays can grow to have a wingspan many metres across, but feed on small organisms filtered from the water. They are often accompanied by remoras or suckerfish that 'hitch a ride' to the rays using a specialised suction mechanism on the top of their head (© Andrea Marshall).

Sensory biology

As the majority of rays are bottom dwellers, their mouth is located on the under-surface of the disc. This means that they often cannot see what they are eating. To find their prey without vision, rays have developed a host of other sophisticated sensory systems including good vision (colour

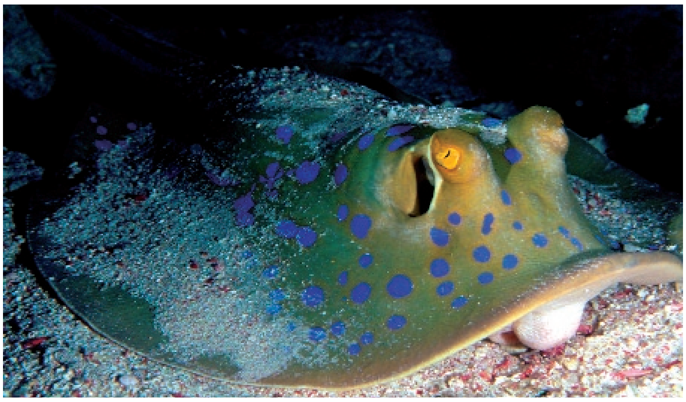

Figure 3. This bluespot fantail ray (*Taeniura lymma*) is commonly encountered on and around coral reefs. Coral sand, thrown up during 'pit-digging' can be seen on the back of the ray. The protruded jaws are visible under the animal as the ray feeds (© Andrea Marshall).

Figure 4. Many rays such as this species of *Himantura* can often be found feeding in very shallow water, usually over sand or mud substrates (© Shane Litherland).

vision in at least some species); an ability to 'touch' things from a distance by using their lateral line systems to detect minute water currents; an acute sense of hearing; and the ability to detect one drop of fish extract in 10 billion drops of water. Rays also possess another sense that is quite alien to humans: electrosensory organs, known as the ampullae of Lorenzini, which are clustered around the head and mouth of rays. The weak bioelectric signals, created by muscle contraction and the nervous system in potential prey, can be detected by rays, which perceive these signals as an 'aura' around the animal. In combination, this sensory capability ensures rays are efficient in detecting subsurface prey.

Shallow water ecosystems

Rays are apex predators in the inshore environment. Tropical estuaries, tidal flats, and mangrove swamps are some of the most productive ecosystems on Earth. Rays may partition themselves within these environments by their daily or seasonal patterns of activity, foraging behaviour or diet, allowing a high abundance and diversity of ray species to share the riches of these habitats.

Stingrays hunt by gliding slowly over soft seabed (figure 4), searching for the water currents created by: filter-feeding bivalves; the electrical signals given off by burrowing crabs; small shrimp darting off, or whatever their particular food preference may be. On detection of subsurface prey, a ray will settle over the spot, pump water through the modified gill opening (the spiracle) behind its eye, and jet this water out through its gills on the under-surface of its body to hydraulically mine the sediment and uncover the prey. This leaves a 'feeding pit' at the site. These pits are most visible in the intertidal zone, where there will characteristically be a depression with a pile of sediment immediately down-current.

This disturbance of bottom sediments can have a major effect on the inshore ecosystem. For example, within intertidal sandflats in northern New Zealand, a particular patch of sediment may be excavated once every 70 days by eagle rays; while in the subtidal environment off La Jolla, California, 5.4 percent of transect areas was disturbed by rays every day during warm months (when ray abundance is high) and 25–100 percent of the bottom area may be in some stage of recovery and recolonisation from ray feeding disturbances. Initially, the formation of feeding pits clears all the infaunal invertebrates, but rapid accumulation of organic material in the bottom of the pit results in elevated food availability, which attracts certain invertebrate species. These species recolonise pits at variable rates, creating a mosaic of infaunal communities throughout the benthic habitat in different stages of recolonisation. Ray impacts over soft bottoms may best be understood as large-scale habitat modification. Since rays are abundant throughout tropical and temperate areas, they are probably important in structuring benthic communities in many locations.

Pelagic zone ecosystems

The pelagic zone, from above the seabed to the surface, is the habitat of rays that feed off the bottom. Only a few species have made this their home, but these include the largest of the rays. The gigantic plankton-feeding manta and devil rays, both of which feed mainly near the surface over the continental shelf, occur throughout the tropical seas of the world from inshore right out into the open sea. Manta rays funnel microscopic plankton into their mouth using its extended cephalic lobes, which remain folded spirally when not in use. Then, with a sophisticated filtering system, it sieves the plankton from the same water that it uses to breathe. Only one stingray has found itself a niche in the pelagic zone, but this species, the pelagic stingray, is found nearly worldwide in tropical and subtropical seas, with its distribution extending to temperate latitudes.

Figure 5. This bluespot maskray (*Dasyatis kuhlii*) seen on the sorting tray of a trawler was caught as bycatch in a prawn fishery (© Peter Kyne).

Deep water ecosystems

Almost half of the world's rays occur only in the cool, deep waters of the outer continental shelves and slopes. Skates are the main group of deep-water rays. Most of the 280 or so species are found throughout the world in the deeper waters along continental margins, on soft bottoms down to depths of 3000 metres or more. Most species have rather restricted ranges geographically, and the skates of nearby regions are often quite distinct, indicating that they probably do not range widely.

Much of the deep-sea floor is muddy ooze. Skates feed on bottom-dwelling animals, such as soft-shelled molluscs, sand worms, crustaceans, and small fishes. Some deep-water skates use their long, firm snouts (covered in sensory pores) to 'grub around' in the soft upper layers. The equally long, but softer and more flexible snout of the sixgill stingrays (Hexatrygonidae) appears to be used like a finger to probe more deeply into the sediments for food, while other skates target the fishes that forage in these areas. Although skates are probably important in the ecology of the deep sea, many species are known from very few specimens and little is known about their biology and lifestyle. It is likely that there are many more species in the deep oceans of the world that remain unknown to science at present.

Threatening processes

Rays are high-level predators within the ecosystem, and as such have few predators. Their low natural rate of mortality has allowed them to adopt a life history strategy focussed on producing a few, large young. Compared to most bony fish, rays are long-lived, slow-growing, and have delayed maturation. Unfortunately, these same characteristics make rays highly vulnerable to human-induced pressures, such as fishing, habitat degradation and pollution.

Rays are a common catch within many fisheries, both inshore and offshore. Although rays are targeted in fisheries elsewhere in the world, in Australia they are largely caught accidentally, as a bycatch of commercial and recreational fisheries targeting other species (figure 5). Most fishing pressure occurs in waters over the continental shelves, putting the species living in this area at risk. Deep-water rays are even more susceptible to fishing pressures than coastal and pelagic species, as the low productivity of the deep ocean floor means that many of the species found here grow extremely slowly and have a low reproductive rate. As a consequence, many of these species are naturally rare. Many species are found in only a small area, while others may exist only in specific habitats over a wider area. Fisheries in the deep sea are still being commercially developed, and rays will increasingly be caught as bycatch in these areas. Unfortunately, the low productivity of these rays means that species can be heavily reduced, even to extinction, before the targeted bony fish species shows a significant decline in catch.

Habitat modification and pollution are also major issues for some inshore species. Estuarine and coastal areas are suffering increasing alteration through development, restriction of river flows, land reclamation and other pressures. The young of many inshore species spend their first few months or years in high productivity 'nursery' areas. Often these are located in estuaries or shallow mangrove-fringed ecosystems where there is plenty of food and protection from larger predators. The removal or degradation of these areas can result in a permanent reduction in the local ray population.

Rays are present in most marine ecosystems worldwide, and have a vital role in maintaining the health and function of these ecosystems. Their ecological niche has been little-studied when compared to sharks, but their diversity, abundance and worldwide distribution testifies to their success. The challenge for marine science now is to ensure these rays are protected, so they do not quietly disappear before we can fully understand just how important they are.

Further information

For terms in this text that may be unfamiliar to you please visit fishbase:
http://www.fishbase.org/search.cfm

Acknowledgements

The following organisations/individuals are acknowledged for their contributions: **Funding:** Natural Heritage Trust and the Fisheries Resources Research Fund (Australian Government Department of Agriculture, Fisheries and Forestry). **Coordination of project:** Marine Industries Environment Branch and the Bureau of Rural Sciences (Australian Government Department of Agriculture, Fisheries and Forestry). **Artwork:** Brett Cullen and Trish Hart. **Reviewers:** Carolyn Stewardson and Albert Caton.