SEEKING Weedies

Lured by their beauty and unusual habits, marine ecologist **John Turnbull** is part of a project to find out how weedy seadragons are faring.

The syngnathids are unique among fishes for male incubation of eggs. The seahorses have a brood pouch on their abdomen and the seadragons and pipefishes have a brood pouch on the underside of the tail or abdomen. The eggs can be seen here attached to the tail of the weedy seadragon. Within 24 hours of the eggs being transferred and fertilised, skin grows to cup each egg. The 30 to 38 days of incubation allows for advanced development within the eggs, allowing the young to hatch as juveniles. *Photo: John Turnbull*

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Normally, diving is relaxing for me, but in June 2016 I was anxious. Sydney had been struck the previous week by some of the biggest storms on record. Massive swells ripped out vegetation several metres above the high tide mark, and the stainless steel staircase down to the dive site at Kurnell was so twisted it was almost impassable. I was worried about the resident weedy seadragons. Had these delicate creatures survived?

As my diving buddy and I descended on SCUBA, the signs were not good. The kelp beds were torn and thinned, and the sand-line was a metre higher due to all the sand swept into the bay. We searched nervously among the kelp and boulders. We found our first weedy. Then another, and another. Somehow they had survived the swell and bottom surge that remodelled their habitat, proving hardy beyond our expectations. But they weren't yet out of the woods. Their fate would depend on how well their habitat recovers, and their resilience to future threats.

Concerns have been raised for the future of weedy seadragons (*Phyllopteryx taeniolatus*). The IUCN assessed them as 'near threatened' in 2006, noting a lack of information about population trends, and since then researchers and divers have seen declines at several sites. But we need more systematic information to work out whether the species is in trouble.

Surveying weedy seadragon populations would normally be an expensive and difficult undertaking for biologists. They are usually found only at SCUBA depths (in New South Wales) and are easy to overlook unless a diver is skilled at finding them. But the beauty, fascination and perceived rarity of weedies make them popular with divers and underwater photographers, offering the potential to enlist help from 'citizen scientists' to find out how their populations are faring.

Dedicated fathers

One of the unusual traits endearing weedies to us is male 'pregnancy'. For most animals, the male's role in reproduction starts and ends with sperm donation. Many male fishes, however, take on some parental role, often guarding eggs. Syngnathid fishes (which include the seahorses and pipefishes) take this to an extreme by incubating the eggs from the time they are laid.

Breeding in weedies is a complicated affair. A couple courts for two to four weeks, engaging in parallel swimming and tail curling. As the day of mating approaches, the male's tail thickens and becomes spongy. When the female is ready to lay, the couple swim upwards and entwine tails to transfer the 200 or more bright pink eggs to cup-like receptors under the male's tail. The male releases his sperm and swims in circles to maximise fertilisation of the eggs. These hatch four to six weeks later, often coinciding with warming waters, and then the young are on their own. The most successful males can brood two lots of eggs during the six month spring-to-summer breeding season.

This system of paternal care offers syngnathids several benefits. By carrying the eggs (some species carry them in a pouch) rather than guarding them in one place, the father can remain mobile and continue to feed. With syngnathids having few defences against predators other than camouflage, their body is probably the safest place to keep eggs. While males nourish and aerate the developing eggs, the females can invest their energy in developing the next round of eggs. The male's investment is justified by certainty that he fathered the offspring.

The name 'syngnathid' refers to their jaws, which are united into a tube-shaped snout with a tiny mouth at the end. Syngnathids range across temperate and tropical oceans, with southern Australia having particularly high diversity. The weedy seadragon is one of the largest, ranging up to about 45 centimetres. It is found along much of the southern Australian coastline, from Port Stephens (NSW) to Actaeon Island (Tasmania) to Geraldton (WA). *Photo: John Turnbull*

Weedy seadragons lend themselves to citizen science, for they are highly photogenic and each has a unique spot pattern on its flanks, which allows for photo-identification and long-term monitoring of individuals. *Photos: John Turnbull*

The importance of kelp

Endemic to coastal waters in southern Australia, weedy seadragons are found mostly along the interface between sand (where they feed) and kelp (where they shelter). Their long, narrow snouts limit their food choices, and they mainly eat mysid shrimps, which are tiny crustaceans that school over sand. To snare the shrimps, weedies invert their body and flick their snout while sucking in the prey.

With only tiny fluttering fins, weedies move slowly and rely on camouflage to avoid being eaten by octopuses and large fishes. Often, one or more of their leafy appendages is missing due to a narrow escape. If their kelp habitat is damaged or disappears, they stand little chance against predators, and they cannot move far if their environment changes.

Weedies have been losing habitat, with the loss and degradation of kelp in many areas due to storms, disease, pollution, herbivory, heat events and increasing flows of nutrient-poor, warm tropical waters due to climate change. Another threat – over-collecting for aquariums – has largely receded due to stronger protection under national and state laws, although illegal collection remains a concern.

With the help of citizen scientists

Much of the information we have about weedy seadragon populations around southern Australia comes from Dragon Search, a citizen science project that ran from 1990 to 2005 and compiled over 1700 sightings of weedies. There are indications that weedies have declined at or disappeared from several sites where they were common during that project. In Sydney, for example, weedies are now rare north of the harbour, including in Dragon Alley (at Barrenjoey Head), which was named after a once thriving population.

Concern about these declines has motivated recreational divers and scientists in NSW to embark on a new citizen science endeavour. In early 2015, as president of the Underwater Research Group of NSW, I got together with David Booth, a professor in the School of Life Sciences at Sydney's University of Technology, to scope out the program. The aim is to support the data needs of researchers, with new methods that allow us to identify individual weedies and collect genetic material.

Participating divers can survey a site at any time, and key sites are visited regularly. Each site typically has zero to three or more weedies. Over the past 18 months the team has made over 150 observations in the Sydney area alone. As well as counting weedies and recording their depths, the divers photograph each one, taking care to capture high resolution images of both flanks. Sometimes they take small clippings from the leafy appendages for genetic analysis.

Pattern-matching software allows individuals to be identified from photos by their spot pattern 'fingerprint'. Weedies typically range only within a few hundred metres of their home site, and by tracking the fate of individuals, researchers can learn much more about their movements, reproductive status, injuries and disease. Kris O'Keeffe, citizen scientist in charge of the pattern matching process, reports we have so far collected fingerprints for more than 230 weedy seadragons. 'One beauty of this method,' she says, 'is we can use photos taken before our project started, so long as we have a good shot of the flank of the animal.' By comparing early and recent photos, we have been able to deduce that some residents are eight years old.

The researchers will investigate the extent to which populations are interconnected by genetically analysing the fin clips taken from weedies in different locations. We intend to extend the tissue collection effort over 2016 and 2017 across their entire range. We are also experimenting with GPS-tracked underwater video to monitor the health and coverage of kelp beds.

Kelp are big brown seaweeds that provide food and refuge for vast numbers of marine species, including this golden weedfish (*Cristiceps aurantiacus*, left), which is like weedy seadragons in relying on kelp mimicry to avoid predators. The *Ecklonia radiata* shown here is the most widespread of Australia's four kelp species. *Photos: John Turnbull*

AUSTRALIA'S KELP FORESTS

An underappreciated biological treasure are Australia's kelp-dominated rocky reefs stretching more than 8000 kilometres from northern New South Wales, down the east coast, around Tasmania, along the southern coastline and up the western coast to Kalbarri. They are a global biodiversity hotspot for seaweeds, sponges, crustaceans, chordates, bryozoans, echinoderms, molluscs and other groups, and have far more endemic species than the Great Barrier Reef. Many thousands of species are yet to be discovered. The reefs have recently been dubbed the Great Southern Reef, in recognition of their interconnectedness and to lift their public profile.

Kelp forests are the biological engine of the Great Southern Reef, generating over 16 times more biomass per hectare each year than Australia's most fertile wheat fields. But many are suffering severe stress and degradation due to climate change and pollution.

Seas in the south-east are warming at four times the global average and those in the south-west at twice the rate. Tasmania has lost more than 90% of its giant kelp (*Macrocystis pyrifera*) forests due largely to changes brought by climate warming. The larvae of the kelp-eating long-spined sea urchin (*Centrostephanus rodgersii*) have been carried south by a strengthening of the warm southward-flowing East Australian Current. On subtidal rock shelfs, the urchins turn seaweed-rich reef communities into barrens. This has been exacerbated by overfishing of large southern rock lobsters, the only animal that preys on adult sea urchins.

In Western Australia, between 2011 and 2013, when sea surface temperatures along the south coast rose 2–6°C above long-term maximums, close to a million hectares of kelp forests died, the largest die-off recorded globally. Tropical turf-forming seaweeds have replaced the kelp in many places.

On the eastern and central Great Southern Reef kelp forests have declined near coastal developments due to pollution, including nitrogen enrichment from sewage and storm water.

Most of Australia's kelp-dominated reefs lie within the 5.5 kilometre coastal zone managed by state governments. Although the reefs are interconnected through oceanographic, ecological and evolutionary processes, their management by five different state governments is often not coordinated.

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As researcher David Booth says, 'The weedy seadragon project is a great example of how scientists and divers can combine skills to understand and conserve our marine species.' This sort of long-term information gathering is rare in marine science because of the costs and difficulties of data collection.

It could take several years before we are able to detect population trends. Fortunately, the beauty and charisma of weedies – their delicate structure, fine fluttering fins and dragon-like features – help maintain the motivation of citizen science divers. The weedies' role reversal during breeding helps too – who wouldn't want to catch a glimpse of a pregnant male?

When we returned recently to Kurnell, the site of the severe storms, we found just four weedy seadragons, including a young one. This is fewer than we used to find, but more than at several other sites around Sydney where weedies have become scarce. Their survival of the storm shows a robustness that belies their fragile looks, a quality which is being severely tested by all the changes humans are bringing to their world.

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