Weedy seadragon long-term abundance changes in Sydney, Australia: using reliable citizen divers to compile temporal patterns

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Abstract The weedy seadragon *Phyllopteryx taeniolatus* (family Syngnathidae) is an iconic fish endemic to Australia's southern coast. There are indirect indications of population declines over the last decade, with large numbers of individuals washed up in 2022, and the impacts of such events are exacerbated by limited dispersal and spatial differences in genetics. Given the limited data from scientific surveys, we compiled citizen science data for south-east Australia over 3 decades (1990–2025) from long-term divers who regularly record the seadragons they encounter (seadragons are popular targets for divers, especially for photography). These data suggest a peak of seadragon abundance (measured as maximum number and number seen per dive) in 2000–2003, followed by a decline, with a possible increase from 2021. A recent stranding event on the 100 km of coastline around Sydney and in South Australia adds to concerns of population declines in these regions, despite some sites having high densities. We highlight both the efficacy and shortcomings of using data from long-term citizen scientists to assist in population assessments of marine species.

Keywords Australia, citizen science, divers, decadal abundance patterns, *Phyllopteryx taeniolatus*, Sydney, Syngnathidae, weedy seadragon

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Long-term (decadal) changes in organismal abundance are key criteria that may trigger management action and status level changes (e.g. IUCN Red List assessments), but data from rigorous scientific monitoring are often not available. This is especially the case in coastal seas; however, programmes are increasingly targeting citizen divers for data gathering (e.g. Redmap, 2026; Reef Life Survey, 2026). The Syngnathidae, including seadragons (Plate 1), seahorses, pipehorses and pipefishes, are a family of morphologically diverse fishes characterized by small home ranges, sparse distributions and low fecundity (Foster & Vincent, 2004; Sanchez-Camara & Booth, 2004; Sanchez-Camara et al., 2005). Species are associated with benthic habitat such as kelps, seagrasses and sponges. These habitats support an abundance of food for syngnathids, such as small crustaceans (Foster & Vincent, 2004; Manning et al., 2019), and facilitate predator avoidance (Curtis & Vincent, 2005). There are three species of seadragons: the weedy or common *Phyllopteryx taeniolatus*, leafy *Phycodurus eques* and ruby *Phyllopteryx dewysea*, categorized as Vulnerable (Tustison et al., 2025b), Least Concern (Pollom, 2017b) and Data Deficient (Aylesworth & Pollom, 2016), respectively. They are the largest members (adults are 35–45 cm in length) of the Syngnathidae, and all three species are endemic to southern Australia, occurring in seagrass or shallow rocky reef habitat, at a depth of 2–40 m (Tustison et al, 2025a). Seadragons are highly site philopatric, with limited dispersal (Sanchez-Camara & Booth, 2004), so local disturbances and abundance declines may have a disproportionate effect on spatial structuring (e.g. Klanten et al., 2020), and recovery following local loss of seadragons can be slow (Pollom 2017a,b).

The categorization of the weedy seadragon (Plate 1) as Vulnerable was based on abundance data for the decade 2011–2021. A substantial contribution to the assessment was made by citizen science SCUBA divers, many of whom target this iconic species for photography, and who keep dive logs noting number of seadragons seen per dive. Divers can submit their photographs to online portals such as iNaturalist (2026), Atlas of Living Australia (2026) and SeadragonSeach (2026), but counts of seadragons (including zeros when none are seen) are required to estimate long-term changes in abundance.

We contacted divers who had recorded weedy seadragons seen per dive for > 5 years ('reliable' divers) in the Sydney region and were willing to provide their dive log data. The divers generally spent similar times (45–90 min) each diving at the same sites. We know that only a fraction of weedy seadragons is observed on any dive (c. 50%, Andrew Trevor-Jones, pers. comm.) but we assumed that each diver would sight a similar proportion of seadragons on each dive. Firstly, we plotted an index of abundance (number of weedy seadragons seen per dive) over time using data for two dedicated long-term divers (Andrew Trevor-Jones and Michael McFadyen). Figure 1a (from Michael McFadyen) shows that the number of weedy seadragons per dive increased to 9–10 individuals from 1990 to c. 1998, and has fallen since, with only 2–3 seen per dive in 2025. Figure 1b (from Andrew Trevor-Jones) shows an

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PLATE 1 The weedy or common seadragon *Phylopteryx taeniolatis*. Photograph: Erik Schlogl.

average of 3–4 seen per dive for 2014–2020, an increase to 12 in 2024, and 8–9 in 2025. The trends in these two sets of data are similar for 2012 onwards. Secondly, we combined data from all other reliable divers across all Sydney dive sites to determine the maximum number of weedy seadragons seen on any dive for 1990–2021 (Fig. 1c). Weedy seadragons were rare prior to 1990 (Clarrie Lawler dive logs, pers. comm.), after which there was an increase in the maximum number seen per dive until 2003, a decline until c. 2012, followed by a slight increase until 2021.

Although in 2025 weedy seadragon numbers in the Sydney region were similar to a decade before, they were considerably lower than 2 decades previously, yet higher than 25 years prior. This suggests the importance of considering long-term (multi-decade) abundance data to evaluate a species' status. The Red List temporal scale for consideration of population declines is c. 10 years for weedy seadragons (c. 3 generations). Dive log data from the early 1960s (Clarrie Lawler, pers. comm.) indicated that only 0–3 seadragons were sighted on any dive, again suggesting historically lower abundances.

Recent use of individual recognition of seadragons (tagging, photographs: Martin-Smith, 2011) to refine abundance measures (e.g. SeadragonSerarch) is a promising method for monitoring changes using mark–recapture, but this has limitations. It assumes all seadragons are photographed on a dive, does not record zero data (i.e. no seadragons seen on a dive), and does not utilize data from the many divers who do not take photographs but keep dive log records of seadragons seen.

Overall, the datasets presented here indicate the long-term value of data collected by citizen divers. The low

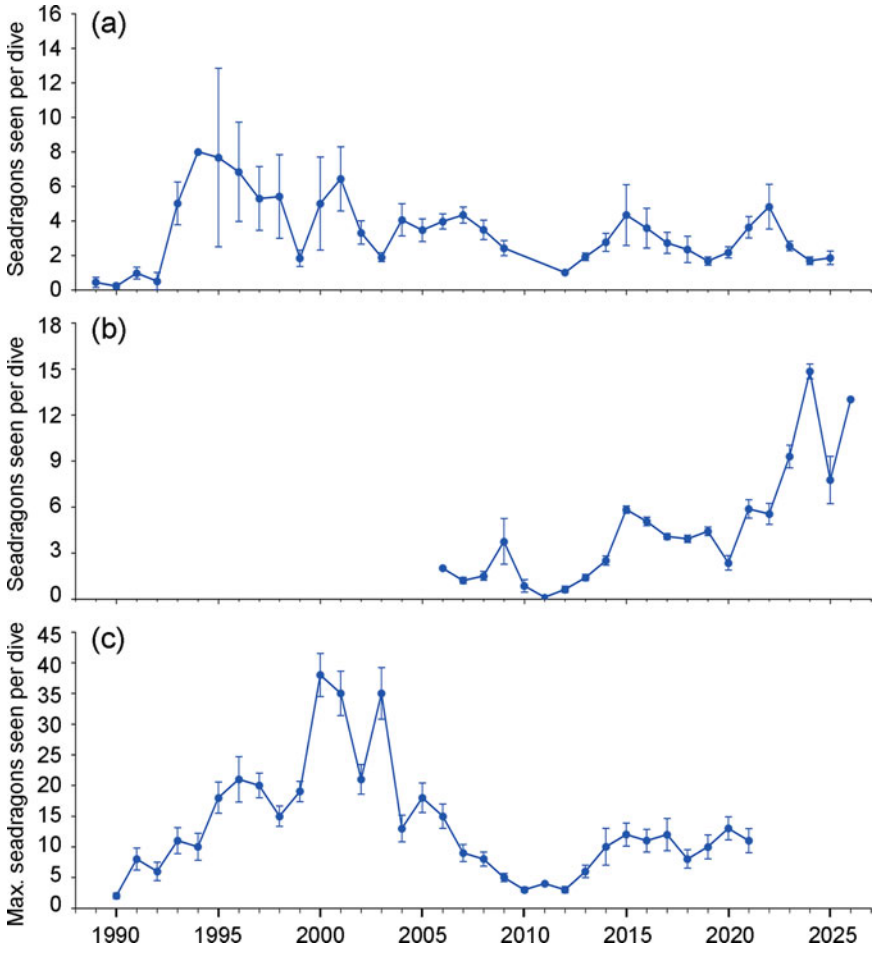


FIG. 1 Citizen diver counts of the weedy seadragon *Phylopteryx taeniolatis* (Plate 1) in Sydney, Australia: number seen per dive in (a) Botany Bay by Michael McFadyen and (b) Botany Bay (Kurnell) by Andrew Trevor-Jones, and (c) maximum number seen per dive in the Sydney region by 15 long-term divers other than McFaydyen and Trevor-Jones, at all sites combined. See Supplementary Table 1 for the number of dives per year. Note the 2025 IUCN Red List assessment of the weedy seadragon used the 2011–2021 data. Locations (recorded by GPS) are: Botany Bay (33.992100°S, 151.231988), Kurnell (34.002167°S, 151.223816°E), North Head (33.795400°S, 151.231988°E), Northern Beaches (33.795400°S, 151,294911°E), Port Hacking (34.079005°S, 151.155922°E), Royal National Park (34.119307°S, 151.138777°E), South Head (33.848581°S, 151.287241°E) and Sydney Harbour (33.817154°S, 151.268881°E).

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abundance of seadragons in Sydney before 1990 provides a perspective for the recent declines (e.g. Sanchez-Camara et al., 2011), showing that longer-term, multi-decadal changes in seadragon abundance may occur irrespective of more recent climate-change related impacts (e.g. the mass wash-up event of weedy seadragons in 2022 from Gosford to Wollongong in the Sydney region; Booth et al., 2025). Increasing anthropogenic impacts, especially human-caused climate change and habitat disturbance, threaten the persistence of seadragon populations (e.g. Tustison et al., 2025a) yet scientists alone do not have the capacity to fully monitor seadragons. Reliable citizen divers will be critical for both assessment and conservation of seadragons and other charismatic marine fauna.

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Conflicts of interest None.

Ethical standards No specific approval was required, and this research abided by the *Oryx* guidelines on ethical standards.

Data availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

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