

# *Zearaja maugeana*

## Maugean skate

### TASMANIAN THREATENED SPECIES LISTING STATEMENT



Maugean skate © Neville Barrett.

**Scientific name:** *Zearaja maugeana* (Last and Gledhill, 2007)

**Common names:** Maugean skate, Port Davey skate

**Previous names:** *Raja* sp. L

**Group:** Vertebrate, Chondrichthyes (cartilaginous fish), family **Rajidae**

**Status:** *Threatened Species Protection Act 1995:* **Endangered**

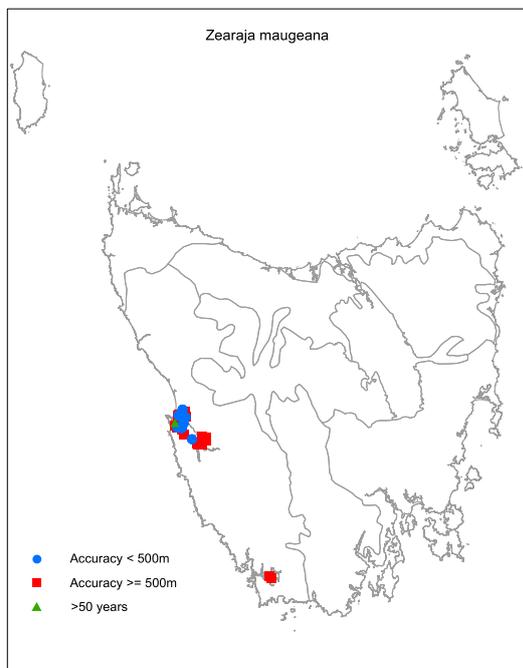
*Environment Protection and Biodiversity Conservation Act 1999:*  
**Endangered**

*IUCN Red List:* **Endangered**

**Distribution:** Biogeographic origin: **Endemic to Tasmania**

Tasmanian NRM region: **South and Cradle Coast**

Tasmanian marine bioregion (IMCRA 4.0): **Franklin and Davey**



**Figure 1.** The distribution of *Zearaja maugeana*, (from Natural Values Atlas).

**Plate 1.** Maugean skate © Neville Barrett.

**SUMMARY:** The Maugean skate (*Zearaja maugeana*) is a cartilaginous fish endemic to Tasmania, Australia. This species is only known from two isolated estuaries in southwestern Tasmania, Macquarie Harbour and to a lesser extent, Bathurst Harbour. It mostly occupies benthic habitats in shallow and brackish channels, although it can utilise a range of depths. Threats to this species include habitat degradation and loss, especially in Macquarie Harbour, particularly declines in dissolved oxygen levels, sediment health, and increased pollution linked to altered river flows from hydroelectric production, historic mining runoff and increased nutrient loadings from salmonid aquaculture operations. Other threats include mortality associated with recreational fishing activities, introduced species and stochastic events.

#### IDENTIFICATION AND ECOLOGY

*Zearaja maugeana* (Maugean skate) is a cartilaginous fish in the Rajidae family (skates). Its genus, *Zearaja*, comprises a small group of skates recognised for having a long snout with a quadrangular disc, dark-edged ventral pores, and claspers with extremely spatulate distal lobes (Last & Gledhill, 2007). The genus consists of only three species, the New Zealand rough skate (*Zearaja nasuta*) found in New Zealand, the yellownose skate (*Zearaja chilensis*) found in Chile, and the Maugean skate (*Zearaja maugeana*) found in Australia.

The Maugean skate is a medium-sized species that is distinguished from its sister (*Zearaja*) species by its smaller size at maturity. Maugean skates possess a longer snout with a narrower disc and head, and a smooth dorsal surface. Mature males will reach a maximum of 70 cm in total length, and females will reach a maximum of 84 cm in total length.

The Maugean skate is only known from two remote estuaries in western Tasmania - Macquarie Harbour and Bathurst Harbour.

It is the only species of skate in the world known to mostly inhabit brackish waters (Treloar et al., 2017).

The skates have a restricted diet mostly consisting of small epibenthic crustaceans, including crab and shrimp, although some small teleosts (ray-finned fish) have been reported as minor dietary items (Weltz et al., 2019).

The Maugean skate lives to approximately 10 years of age with adults maturing early (4 – 6 years) (Awruch et al., 2020).

Fertilisation is internal, with oviparous (egg laying) females having an asynchronous and discontinuous reproductive cycle in which only a proportion of females are reproductively active at any given time (Awruch et al., 2020). In Macquarie Harbour, egg capsules are found across different depths and habitats, suggesting that there are no dedicated egg nurseries (Moreno et al., 2020).

Conditions in Macquarie Harbour have been impacted by historical and ongoing anthropogenic activities. In recent years, environmental conditions in the benthos and water column have deteriorated due to decreases in dissolved oxygen levels. Although this species is well adapted to cope with naturally low dissolved oxygen levels, recent research indicates that these deteriorated dissolved oxygen levels may impact survival of all life stages, including developing embryos (Moreno et al., 2020). Therefore, monitoring the health and status of the Macquarie Harbour subpopulation remains a high research priority.

#### Survey techniques

The species is currently monitored in Macquarie Harbour in quarterly surveys using monofilament gillnets. This monitoring work requires a permit under the *Threatened Species Protection Act 1995*. Gillnet surveys have also been used in Bathurst Harbour, but limited numbers of Maugean skates have been caught in this location.

Environmental DNA, remote operated vehicles, tow cameras, dive transects, and baited remote underwater video have also been used to survey the population. However, there are considerable logistic and resourcing considerations that currently limit the feasibility of applying these techniques in routine monitoring.

### Taxonomic issues

The Maugean skate was first identified as an undescribed species (*Raja* sp. I.) taken from Bathurst Harbour in 1989 (Edgar, 1991). Similar (*Raja*) species were assigned to the genus *Dipturus*, although the Maugean skate conformed more closely to the unrecognised genus *Zearaja*. In 2007, the Maugean skate was formally described and has since been classified within the genus *Zearaja* (Last & Gledhill, 2007). However, a recent study assigned the genus *Zearaja* as a junior synonym of *Dipturus* (Concha et al., 2019). Taxonomic work is currently underway to allocate its appropriate genus, although *Zearaja* will be used herein until superseded by supporting data.

### Confusing species

The common thornback skate (*Dentiraja lemprieri*) has previously been mistaken for the Maugean skate (Edgar, 1991). *D. lemprieri* is a small skate observed in both estuarine and marine systems in Tasmania (Last & Gledhill, 2007). However, *D. lemprieri* is smaller in size, has a short, rounded snout and long and narrow claspers.

### DISTRIBUTION AND HABITAT

The Maugean skate has been recorded in two isolated estuaries in southwestern Tasmania, Macquarie Harbour and to a lesser extent, Bathurst Harbour (see Figure 1) (Last & Gledhill, 2007).

The mechanisms isolating the Maugean skate to two remote estuaries are unknown, although may be related to intermittent warming and cooling during the Pleistocene geological epoch (often referred to as the Ice Age). Only a few Maugean skates have been observed in Bathurst Harbour and the species has not been recorded in this location since 1992.

Macquarie Harbour is considered to be the stronghold for the species, with most individuals found in the Liberty Point and Table Head regions of Macquarie Harbour (Moreno et al., 2020).

Both Macquarie Harbour and Bathurst Harbour are highly stratified with a tannin-stained surface layer that prevents light penetration (Edgar et al., 2010). The top layer consists mostly of freshwater and exhibits seasonal thermal fluctuations (Morash et al., 2020). The middle layer is brackish with little thermal variation and reduced dissolved oxygen, and the bottom benthic layer is nearly marine with no thermal variation.

This species shows high site fidelity, with a relatively small (<3-10 km<sup>2</sup>) home range. The skates have a strong preference for benthic habitats in shallow channels between 5 and 15 metres deep where environmental conditions are moderate (Bell et al., 2016). Egg capsules have been detected across a wide range of depths (5 – 30 m), suggesting that they occasionally use areas outside their core range (Moreno et al., 2020), which is also supported by electronic tracking research (Bell et al., 2016). There are no sex-specific patterns in site utilisation or distributional range (Bell et al., 2016).

The limited distribution and small population size of this species indicates that all remaining habitat within which this species is detected is important habitat.

### POPULATION PARAMETERS

*Number of subpopulations:* 2

*Number of locations:* 2

*Extent of occurrence (IUCN criteria):* ~1600 km<sup>2</sup> (~330 km<sup>2</sup> excluding Bathurst Harbour)

*Linear extent:* 150 km (30 km excluding Bathurst Harbour)

*Area of occupancy (actual):* 24 km<sup>2</sup> (20km<sup>2</sup> excluding Bathurst Harbour)

*Area of occupancy (IUCN criteria)* = 116 km<sup>2</sup> (100 km<sup>2</sup> excluding Bathurst Harbour)

*Number of mature individuals:* Unknown

*Largest subpopulation:* ~3200

*Generation length (mean):* 7.4 years (IMAS unpublished modelling)

**Table 1.** Population summary for *Zearaja maugeana*.

	Subpopulation or locations	Tenure	NRM region*	1:25 000 mapsheet	Year last (first) seen	Area occupied (IUCN criteria) (km <sup>2</sup> )	Number of individuals
1	Macquarie Harbour	Southwest National Park, Macquarie Harbour Historic Site, Farm Cove Game Reserve, unreserved waters	Cradle Coast	Phillips, Sarah, Teepookana, Table Head, Kelly, Strahan	2021 (1994)	100	~3200
2	Bathurst Harbour	Southwest National Park, Port Davey Marine Reserve	South	Melaleuca	1992 (1989)	~16	4 recorded

\* NRM region = Natural Resource Management region

The Maugean skate population is possibly one of the smallest of any chondrichthyan species (Bell et al., 2016). The population is comprised of two subpopulations (Macquarie Harbour and Bathurst Harbour) separated by a geographic region. The subpopulations may be genetically distinct (Bell et al., 2016).

There are limited records of the Maugean skate in Bathurst Harbour, with only four confirmed observations. One individual was captured in 1988, photographed and released (G. Edgar, pers comm), two individuals were captured in 1989 during gillnet diversity surveys, and one was captured on rod and line in 1992 (Last & Gledhill, 2007). There have been no recorded sightings in Bathurst Harbour since 1992, despite multiple surveys between 1992 and 2016 (Last & Gledhill, 2007; Forbes et al., 2016; Treloar et al., 2017). As such, there are no subpopulation estimates for Bathurst Harbour.

Higher numbers of Maugean skates have been captured in Macquarie Harbour (Lyle et al., 2014), although since 2018 there have been extended periods where the skate was difficult to catch (IMAS, Unpublished). In 2016, the subpopulation was estimated to be approximately 3200 individuals at this site, however, there is some uncertainty with this estimate (95% CL of 1827-6247) (Bell et al., 2016). The population size of this species is likely determined by limited habitat and low productivity of estuarine systems.

### RESERVATION STATUS

Bathurst Harbour occurs within the Port Davey Marine Reserve and the Southwest National Park, which are reserved under the *Nature Conservation Act 2002*. It also comprises a 'No Take Zone' for fishing under the *Living Marine Resources Management Act 1995* (DPIPWE, 2017).

About two thirds of Macquarie Harbour (waters southeast of an imaginary line from Liberty Point to Sophia Point) is part of the Southwest Conservation Area, the Macquarie Harbour Historic Site and the Farm Cove Game Reserve, all of which are reserved under the *Nature Conservation Act 2002* (DPIPWE, 2017). Fishing restrictions apply in the deeper internal waters of the harbour.

Additionally, all of Bathurst Harbour and about one third of Macquarie Harbour occur within the Tasmanian Wilderness World Heritage Area and are managed under the *Tasmanian Wilderness World Heritage Area Management Plan 2016* (DPIPWE, 2017).

Despite large parts of Macquarie Harbour being protected by reserves, the unprotected sections such as Swan Basin, Table Head and part of Liberty Point include important habitat, suggesting that the species also requires protection in these areas.

## CONSERVATION STATUS

The Maugean skate is listed as endangered under the Tasmanian *Threatened Species Protection Act 1995* (the Act). It was first listed under the Act in 2002 based on Criteria B (1 & 2c).

The Maugean skate has been listed as endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EBPCA) since 2004.

The Maugean skate (previously *Raja* sp.) has also been listed as endangered on the International Union for the Conservation of Nature (IUCN) Red List since 2000.

## THREATS, LIMITING FACTORS AND MANAGEMENT ISSUES

Threats, limiting factors and management issues for the Maugean skate include:

**Habitat degradation:** Habitat degradation and loss is a serious threat to the survival of this species, especially in Macquarie Harbour. Of particular concern are the documented declines in dissolved oxygen to levels significantly lower than previously recorded in the harbour, as well as declines in sediment health (Ross & MacLeod, 2017; Ross et al., 2020). Both modelling and empirical studies have demonstrated that river flows and increased nutrient loadings from salmonid aquaculture operations both play a role in influencing the dissolved oxygen status of the harbour (Ross & MacLeod, 2017; Wild-Allen et al. 2020). Modelling by Wild-Allen et al. (2020) also highlights the influence that altered river flows from hydroelectric production may have on the hydrodynamics and dissolved oxygen status of the harbour. Furthermore, Moreno et al. (2020) demonstrated the potential for mortality events in all life stages in the Macquarie Harbour subpopulation due to declining dissolved oxygen in the harbour. Low dissolved oxygen levels may also be detrimental to the well-being of the predominately crustacean prey of the subpopulation (Weltz et al., 2019). Additionally, heavy metal contamination of the sediments linked to historic mining runoff may also be degrading the habitat of the Maugean skate in Macquarie Harbour (Edgar et al., 1999).

**Climate change:** Climate change, or the occurrence of extreme weather events, potentially challenges the Maugean skate's capacity to cope with unstable environmental conditions (Moreno et al., 2020). The species' ability to tolerate environmental changes, including reduced salinity and thermal fluctuations, can be energetically costly. Long-term metabolic stress could have important implications on vital processes such as growth and reproduction, and ultimately survival.

**Pollution:** The release of heavy metals found in sediments from historical mining operations, and the discharge of effluent and waste, threaten the health of estuarine ecosystems (Edgar et al., 2010). The release and discharge of pollutants may perpetuate undesirable effects on water quality in ecosystems that are already susceptible to anthropogenic nutrient enrichment, such as Macquarie Harbour. In addition, bottom-dwelling invertebrates may accumulate and pass on such pollutants to their predator, the Maugean skate, which may threaten its overall health and fitness.

**Fishing activities:** Direct interactions with recreational fishing activities potentially threaten the survival of the Maugean skate. In Macquarie Harbour, they are susceptible to capture in gillnets with long soak times (i.e., overnight) (Lyle 2014; Bell 2016) and inadvertent capture by fishing lines (R Pearn 2021 pers. comm. 14 Dec), which has resulted in some mortalities. Current management strategies reduce recreational fishing interactions within key habitats in Macquarie Harbour in deeper internal waters but still permit overnight netting in shallower areas of habitat. Limited commercial net fishing is also permitted in Macquarie Harbour (NRE 2022), which may also result in incidental mortality.

**Introduced species:** The introduced dinoflagellate (*Gymnodinium catenatum*) is known to produce toxins in Bathurst Harbour (Edgar et al., 2010). The bioaccumulation and biomagnification of these toxins up the food web could poison animals at higher trophic levels, such as the Maugean skate.

**Stochastic risk:** Small populations with low genetic diversity (Weltz et al., 2018), restricted diets and limited geographic distributions are more at risk of extinction (Weltz et al., 2019). The likelihood of extinction following a stochastic event is high given the skate's low genetic diversity and small subpopulation size in Macquarie Harbour and potential localised extinction of the Bathurst Harbour subpopulation (Weltz et al., 2017).

## MANAGEMENT STRATEGY

### Management objectives

The primary objective for the recovery of the Maugean skate is to conserve the main subpopulation at Macquarie Harbour. Other objectives include the protection and restoration of environment and habitat to support the growth and survival of the Macquarie Harbour subpopulation. This includes minimising negative impacts on benthic invertebrate communities which are the main prey of this species.

### What has been done?

- **Conservation sites:** Sites identified as Maugean skate habitat in Bathurst Harbour have been protected within the Port Davey Marine Reserve, located within the boundaries of the Tasmanian Wilderness World Heritage Area and the Southwest National Park (DPIPWE 2017). Similarly, some regions of Macquarie Harbour have been conserved within the boundaries of the Tasmanian Wilderness World Heritage Area, the Southwest Conservation Area, the Macquarie Harbour Historic Site and the Farm Cove Game Reserve (DPIPWE 2017). In addition, Macquarie Harbour has been separated into fishing zones under the *Living Marine Resources Management Act 1995* (DPIPWE 2020). Many fishing zones which overlap with key skate habitats have been restricted or closed to netting activity.

- **Fishing restrictions:** Harvesting of this species is prohibited. Gillnetting is prohibited in deeper areas of Macquarie Harbour's internal waters but is still permitted in some shallower areas (DPIPWE n.d.). Individuals incidentally caught are expected to be immediately released.
- **Education and awareness:** A range of educational materials about the Maugean skate have been produced, including information signage at the Strahan boat ramp and information included in the annual State Government *Recreational Sea Fishing Guide* (e.g. DPIPWE 2021).

The species was included in an educational pamphlet for recreational fishermen distributed in 2013-15 by the West Coast Recreation Association.

- **Water quality and benthic monitoring program:** Sediment conditions and dissolved oxygen levels are regularly monitored in Macquarie Harbour to inform management measures to minimise the impact of marine farming on benthic communities (Ross et al., 2020).

This environmental monitoring may assist in informing any fluctuations noted during population monitoring of the Maugean skate. In addition, this monitoring may help predict future responses by the Maugean skate to environmental change.

### What is needed?

- To assess population size effectively – develop a robust, non-harmful and logistically feasible sampling method.
- To assess population status and trends and support effective and adaptive conservation management – develop and resource an ongoing annual monitoring program.
- To determine the health of the Maugean skate's habitat and consequently how this affects the Maugean skate – continue monitoring and analysing water quality and benthic sediments.

- To minimise anthropogenic impacts – devise strategies to remediate critical habitat. In particular, reduce nutrient inputs and manage water flows to maintain physico-chemical characteristics, particularly dissolved oxygen and sea surface temperatures, within acceptable species limits. In addition, investigate strategies to remediate pollutants.
- To determine the impact on the species by gillnetting - quantify the bycatch of Maugean skates in gillnets in areas where gillnetting is permitted, to assist decision making.
- To decrease incidental catch mortalities – assess introducing further restrictions such as reduced gillnet soak times, expanding the areas closed to gillnetting in its area of occupancy, and promoting alternative fishing techniques.
- To improve fisheries interactions – increase awareness of the species and on handling and release techniques among recreational fishing groups who regularly encounter this species.
- To determine the extent of the species' distribution – establish whether the Maugean skate continues to occur in Bathurst Harbour.
- To investigate the feasibility of *ex situ* management interventions to supplement the wild population if needed.
- To determine the species' uniqueness - clarify taxonomic issues.

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**Permit:** It is an offence under Tasmanian legislation to collect, catch, damage, injure, destroy, or kill a threatened species listed under the *Threatened Species Protection Act 1995*, without a permit.