

Undulate ray

(*Raja undulata*)

Summary

Size (total length)	Max 120 cm (Ellis et al., 2012)
Lifespan	13 years (Serra-pereira et al., 2015)
Size of maturity (L₅₀)	74-86 cm
Fecundity	30 – 70 egg capsules
Reproductive frequency	Annual
IUCN Status	Endangered (Coelho et al., 2009)
Capture methods	Bycatch (nets, trawls)
Minimum Landing Size	78 cm total length
Maximum Landing Size	97 cm total length
Fishing Season	Currently no fishery allowed. Small by-catch quota in place for English Channel



Description

The distribution of the undulate ray (*Raja undulata*) ranges from Morocco and the Mediterranean to its northern limits of south-west Ireland and southern England in the eastern North Atlantic (Ebert and Stehmann, 2013). The species generally has a patchy distribution across its range however, it is frequently recorded in the English Channel and is locally abundant in some areas such as the Isle of Wight. Undulates are less common in the southern North Sea and Bristol Channel (Ellis et al., 2005; Ellis et al., 2012). They tend to occur inshore on soft and coarse substrate at depths less than 100 m but are more commonly found in waters less than 50 m deep (Ellis et al., 2012).

The diet of the undulate ray changes as it increases in size from juvenile to adult. Young juveniles inhabiting nursery areas have a generalised diet preying upon a diverse range of species including shrimps, fish and crabs. As juveniles grow larger and leave the nursery area their diet becomes more specialised with the main prey source being crabs, particularly species of swimming crab. Large adults rarely eat anything other than crab which is unique amongst adult skates and rays that normally eat a variety of fish (Moura et al, 2008).

Reproductive Life history

The life history of the undulate ray is characterised by slow growth, late maturity and low fecundity. Females are oviparous (egg-laying) and eggs are fertilised internally before the egg capsules are extruded onto the seabed. Geographical differences in

breeding season have been observed for populations studied in Portugal. Along the west coast of Portugal undulates breed throughout the winter and spring whereas the breeding season in southern Portugal is less extensive and occurs mainly in the winter (Moura et al., 2007; Coelho and Erzini, 2006). Differences in reproductive cycles are thought to be related to colder water temperatures on the west coast of Portugal where winter conditions occur for a longer duration allowing for a longer breeding season (Moura et al., 2007). In the UK the breeding season is assumed to be from March to September (Ebert and Stehmann, 2013).

The total fecundity of the undulate ray has been estimated to range from as little as 30 eggs up to 70 (Last et al., 2016 cited in Shark Trust, 2020; Serra-Pereira et al., 2015). Egg extrusion takes place in inshore areas such as estuaries and shallow coastal lagoons and bays (Moura et al., 2007; Ellis et al., 2012). After several months of development, the embryo's hatch and emerge resembling miniature adults at 13.5 cm in length (Serra-Pereira et al., 2015). The young juveniles remain in shallow inshore nurseries until they reach a larger size, around 55 cm (Moura et al., 2008). However, they do not venture far as undulate rays display high site fidelity in the English Channel (Ellis et al., 2011). This results in discrete localised populations and areas of local abundance. A tagging study undertaken in Division 7.e (western Channel) found 58% of tagged undulates were recaptured within less than 5 km of their release site (ICES, 2020a). The undulate ray has been observed to reach at least 114 cm in length and could possibly grow up to 120 cm (Banon et al., 2008 cited in Ellis et al., 2012). Longevity estimates range from an observed maximum age of 13 years to a theoretical maximum age of 29 years (Serra-Pereira et al., 2015). Based on the maximum observed age females could reproduce at least three to four times during their life time (Serra-Pereira et al., 2015).

Size of maturity (SOM)

Size of maturity (SOM) is often used to help establish an appropriate Minimum Conservation Reference Size (MCRS) to ensure individuals can reproduce at least once before capture. SOM for skates and rays is commonly accepted as the total length (L) at which 50% of a population are mature and is referred to as the L_{50} . Some studies may also measure SOM based on the total disc width (DW) of a specimen (wing tip to wing tip). Table 1 includes total length-disc width conversions based on conversion factors in McCully et al, (2012).

Maturity in skates and rays is determined using criteria to define maturity stages either externally or internally. External observations are based upon analysing the length of claspers in males and the cloaca in females in relation to total body length. Internal examination includes macroscopic inspection of reproductive organs e.g., coiling of the vas deferens and development of the testes in males; development of the ovaries, ova and nidamental glands in females (Saglam and Ak, 2012).

Sexual maturity of undulate rays has not been widely researched in British waters. McCully et al, (2012) sampled 91 specimens from the combined eco-regions of the Celtic Seas and North Sea, of these 29 individuals were classed as mature. Due to the limited data 50% maturity could not be calculated for females but was estimated

at 82 cm for males (table 1). The lengths of first maturity were found to be similar in both sexes at 80 cm (males) and 79 cm (female). The largest immature male and female recorded were 88 cm and 83 cm respectively.

Outside of the British Isles SOM for undulate rays has been recorded between 74-86 cm (table 1). Females mature at a significantly larger size than males, up to 9 cm larger, between 76-86 cm whereas SOM for males ranges between 74-77 cm. The size at which female undulate rays mature was also found to be significantly different between regions. Specimens sampled on the north/central coast of Portugal reached maturity at 86 cm, 10 cm larger than specimens sampled in the south. It has been suggested regional differences in SOM may be caused by environmental adaptations to warmer waters or by different levels of fishing intensity (Serra-Pereira et al., 2015). Age at 50% maturity for undulate rays from the two Portuguese regions was the same at 8.7-8.9 years for females and 7.6 years for males (Coelho and Erzini, 2006; Serra-Pereira et al., 2015).

Table 1. Size at maturity estimates (L_{50}/DW_{50}) for undulate ray (*Raja undulata*) in studies undertaken around and outside the British Isles. Male and female total length (L_{50}) has been converted to disc width (DW_{50}) using conversion factors ($DW = 0.5648L_{50} + 4.7130$) presented in McCully et al., 2012. Measurements given in cm and figures rounded. Refer to the Appendix for more information.

Location	L_{50}		DW_{50}		Reference
	Male	Female	Male	Female	
UK*	82	-	51	-	McCully et al., 2012
Outside British Isles					
Bay of Biscay	80	-	50	-	Stephan et al., 2013
Portugal, South Coast	74	76	46	48	Coelho and Erzini, 2006
Portugal, Peniche & Matosinhos	77	86	48	53	Serra-Pereira et al., 2015

*ecoregions of Celtic Sea and North Sea combined

The minimum size for undulate rays in the Southern IFCA district is set under European legislation at 78 cm total length (measured from the tip of the nose to the end of the tail). This is below the SOM recorded for male undulate rays in British waters (82 cm) however more data is required to confidently estimate SOM for undulates in the English Channel. Under European legislation undulate ray is also subject to a maximum landing size of 97 cm total length.

Southern IFCA Fishery

Fishing activity

Despite being listed as Endangered across its distribution under the IUCN's red list the undulate ray is locally abundant in parts of the English Channel and is one of the main species found in the Southern IFCA district (ICES, 2018; local fishers 2020, personal communication, 29 October). However, due to the Endangered status of the species across its whole distribution the EU designated the undulate ray as a prohibited species for commercial vessels in 2009. In 2015 the UK and other EU member states were granted limited bycatch quotas for areas where undulate ray is

locally abundant. Fishers in areas VIId and VIle can now retain on board and land as bycatch 40 kg of undulate ray (subject to minimum and maximum landing sizes) per fishing trip (Category A Licence: Schedule 11 and 91).

Undulate ray is caught as bycatch by a number of different gear types including gill, entangling and trammel nets and demersal trawls. Undulates can be problematic in net fisheries as they tend to twist and rip the net when captured causing damage to fishing gear (Local fishers 2020, personal communication, 29 October).

The wings of skates and rays are usually removed at sea rather than landed whole because it is not always practical to retain the whole fish due to their size and market prices are based upon wing weight. However, undulate ray must be retained on board and landed whole or gutted with wings attached.

Recreational

The undulate ray is a prized species for both shore and sea-based recreational anglers and is targeted from April to November with peak season between May and June. Due to the species classification as Endangered by the IUCN the Angling Trust recommend that all undulates are returned alive.

The Southern IFCA district encompasses the two largest charter boat ports in the UK at Weymouth and Poole (Williams and Davies, 2018). Many of these boats provide specialised trips to target skates and rays, including undulate ray. A recent review undertaken by the MMO to map recreational sea angling activity in England found skates and rays to be the most valued species for charter boats operating in the South Inshore marine planning area (Devon and Severn, Southern and Sussex IFCA districts) and amongst the top three most valued species across England (MMO, 2020).

Landings & Value of Fishery

Between 2009 and 2014 the undulate ray was listed regionally as a prohibited species in EU waters and could not be retained or landed by commercial vessels. Zero landings into ports in the Southern IFCA district throughout this period reflect the prohibition conservation measure (figure 1.). Prior to 2009 undulate ray was recorded under a general category of skates and rays therefore it isn't possible to view specific undulate ray landings in the district before the prohibition was introduced. In 2015 a limited by-catch TAC was established for stocks in the English Channel and was allocated to individual fishermen for use in scientific trials run by CEFAS. From 2018 onwards the TAC is open to all vessels with an English licence who may experience by-catch of undulate ray. Figure 1 demonstrates by-catch landings in the Southern IFCA district between 2015 to 2019, starting at one* tonne in 2015 and rising to 18* tonnes in 2019 in line with the revised by-catch quota over the years. ICES advises no more than 183 tonnes of bycatch should be landed from the English Channel (Divisions 7.d-e) in each of the years 2021 and 2022 (ICES, 2020b). This is an increase of 68 tonnes from 2020. ICES outline since 2011 there has been a consistent increase in the stock size indicator (ICES, 2020b).

*these figures represent vessels that land into ports in the Southern IFCA district, some of which would have fished outside the district and be >12 metres in length.

The value of the recreational undulate ray fishery or the quantity of retained catches in the district is not known. However, all recreational anglers are advised to return undulate rays alive.

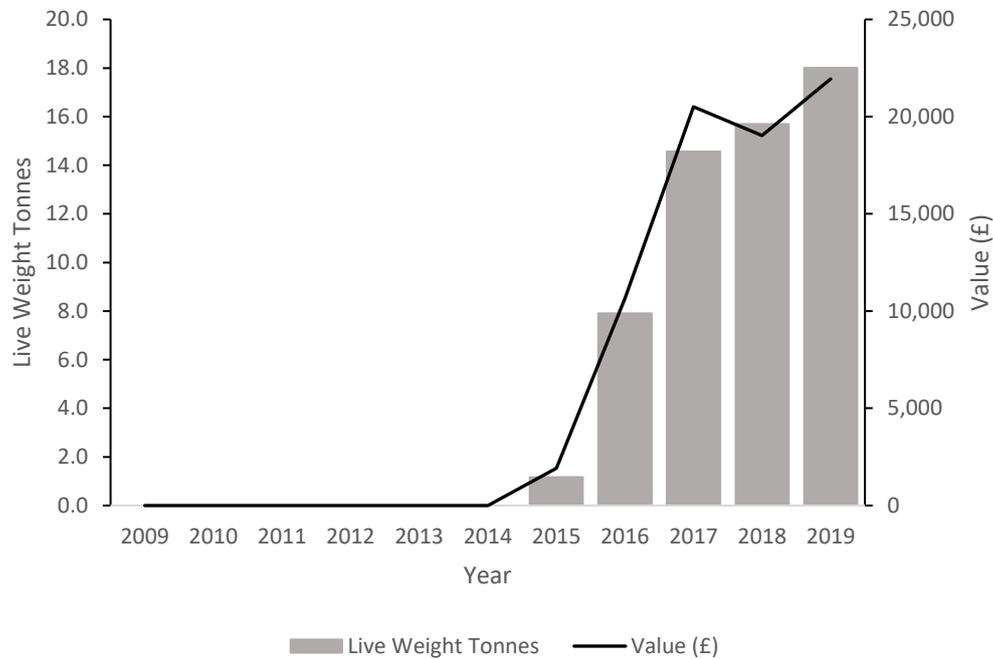


Figure 1. Landings of undulate ray (*Raja undulata*) in the Southern IFCA district from 2009 to 2019. Data sourced from the Marine Management Organisation (MMO).

Associated management

Undulate ray is subject to EU/national conservation measures due to their global Endangered status (CEC, 2009; 2010). Undulate ray cannot be specifically targeted however, between January - April and August - December a fishing vessel may retain on board and land 40 kg of undulate ray caught in ICES area VIId and VIle as bycatch per fishing trip. Specimens must be retained and landed whole or gutted (wings must be attached) and no undulate ray that measures less than 78 cm or more than 97 cm (total length) can be retained. The maximum landing size is designed to protect large females of high reproductive value. Additionally, there is no bycatch allowance during the months May, June and July to protect individuals during the breeding season.

Landing advice provided by ICES is based on the assumed high survival rate of discarded skates and rays, which is potentially up to 80% (ICES, 2018). Observations of skates caught by otter trawl and tangle nets found the undulate ray to be the least affected by capture, displaying greater vigour than other species. In tangle net fisheries there was no observed at vessel mortality (AVM) for undulate rays compared to 6.4% AVM for spotted ray in the same fishery (Ellis et al., 2018). Therefore, the release of undulate rays is advocated as it is likely individuals will survive after capture and the bulk of fishing mortality is related to landings not catch rates (ICES, 2018).

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Appendix

Table A. Size at maturity estimates (L_{50}/DW_{50}) for undulate ray (*Raja undulata*) in studies undertaken in the UK and outside the British Isles. Male and female total length (L_{50}) has been converted to disc width (DW_{50}) using conversion factors ($DW=0.5648L_{50} + 4.7130$) presented in McCully et al., 2012. Measurements given in cm. Number of individuals in brackets represents the number of mature individuals within sample.

Study location	Total No. surveyed	No. of individuals (n)		Length Data		Size at Maturity Data										Reference	
				Size range		Total No. of individuals	No. of individuals (n)		Size of smallest mature individual		Size at 50% maturity (L_{50})		Size at 50% maturity (DW_{50})		Size range of mature individuals		
		M	F	M	F		M	F	M	F	M	F	M	F	M		F
UK	91	58	33	22-89	17-60	119 (29)	85 (28)	34 (1)	80	79	82.3	-	51.1	-	-	-	McCully et al., 2012
Outside British Isles																	
Bay of Biscay	1805	-	-	-	-	431 (191)	431 (191)	-	74	-	80	-	49.8	-	-	-	Stephan et al., 2013
Portugal south coast	187	94	93	23-83.2	19.4-88.2	35	19	16	70.7	75.5	73.6	76.2	46.2	47.7	-	-	Coelho and Erzini, 2006
Portugal, Peniche & Matosinhos	474	213	261	23.5-95.7	37.4-95.9	-	-	-	74	73.5	76.8	86.2	48	53.3	-	-	Serra-Pereira et al., 2015