Manila clam

(*Ruditapes philippinarum*)

Summary

Size (max. size in the SIFCA district)	78 mm Max. size recorded Usually, 55-64 mm
Lifespan	13 years (maximum) (Ponurovsky and Selin, 1988 cited in Harris, 2016)
Size of maturity in the SIFCA district	25-30 mm (shell length) (Tumnoi, 2012)
Fecundity	256,000 – 1.5 million (Chung et al., 2005)
Reproductive frequency	Annual
Capture methods	Dredge, hand gathering
Fishing Season	*Dredge Fishing*: May-December (Poole Harbour) November – February (Solent) *Hand Gathering*: Year-round

Description

The manila clam (*Ruditapes philippinarum*) also referred to as the Japanese carpet shell or small-neck clam is native to the Indo-Pacific region including the Philippines, South and East China Seas and the Sea of Japan (Goulletquer, 1997). Through a mixture of deliberate and accidental introductions the species is now widely distributed along the Pacific coast of America, the Atlantic coast of Europe and is also found in the Adriatic and Aegean Seas (Jensen et al., 2004; 2005). Manila clams were first introduced to Poole Harbour in 1988 by Othniel Shellfisheries for aquaculture (Jensen et al., 2005) and quickly became a self-sustaining population (Jensen et al., 2004; Humphreys et al., 2007). In 2005 the manila clam was introduced to the Solent.

The successful naturalisation of the manila clam in Poole Harbour is due to the harbour's favourable environmental conditions which are similar to the native range of the species. Poole Harbour provides a relatively sheltered, nutrient rich, shallow water habitat with extensive intertidal mud flats, and temperatures up to 27°C in the summer, providing optimum reproductive conditions (Jensen et al., 2004, 2005; Humphreys et al., 2007; Toba and Miyama, 1995; Chung et al., 2005).

Manila clams inhabit fine sand and mud sediments in the intertidal zone and shallows (Jensen et al., 2005). They reside in the top 4 cm of the substratum, but can bury as deep as 10 cm, and filter phytoplankton and sedimentary organic matter from the water (Lee, 1966; Dang et al., 2009).

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Reproductive Life history

The manila clam is a highly fecund species that becomes sexually mature at an early age and displays an extended spawning season. The species is a broadcast spawner, releasing eggs and sperm into the water column where fertilisation takes place. In Poole Harbour the spawning season occurs from July to September whereas in Southampton Water spawning takes place slightly earlier from May to September with a peak between June and August (Jensen et al., 2005; Grisley, 2003; Tumnoi, 2012). Following the breeding season, the gonads are reabsorbed and individuals become sexually inactive from November to January (Tumnoi, 2012; Drummond et al., 2006).

The spawning season of manila clams in north-west Ireland also takes place between May and September yet, populations in southern Ireland were found to spawn later in the year between September and November (Drummond et al., 2006; Xie and Burnell, 1994). This delay in spawning is thought to be caused by low water temperatures (Xie and Burnell, 1994). Gonadal maturation and ripening is triggered by an increase in water temperature and occurs between 8°C and 27°C as the warmer water provides suitable conditions for larval development (Chung et al., 2005; Drummond et al. 2006; Moura et al., 2018). Below this threshold manila clams are thought to be sexually inactive. However, this is not the case for manila clams in Southampton Water where gametogenesis (production of gametes) has been observed in February at 4.8°C (Tumnoi, 2012). This population has adapted to lower water temperatures compared to its native range. One factor which has helped the species overcome low temperatures may be the availability of food as it is thought high food levels have a greater effect on sexual maturity and spawning than temperature (Chung et al., 2005; Delgado and Pérez-Camacho, 2007).

The number of spawning events varies throughout the range of the manila clam. Generally, spawning takes place once in northern populations and twice in southern populations (Ponurovsky and Yakovlev, 1992; Laurell et al., 1994). In Poole Harbour manila clam are capable of spawning more than once throughout the summer depending on environmental conditions with peak activity in September (Humphreys et al., 2007; Jensen et al., 2004;). Grisley (2003) concluded spawning could occur continuously from late May until the end of September. In regions close to the equator manila clams can spawn year-round (Ponurovsky and Yakolev, 1992; Yap, 1977).

The mean number of eggs released by females increases with an increase in shell length. Chung et al, (2005) found females ranging between 20-25 mm in size (1 year old) spawned around 256,000 eggs whereas females between 40-45 mm (4 years old) released over 1.5 million egg. Larger females also produce larger eggs which provide a greater chance for successful reproduction and viable larvae (Tumnoi, 2012).

After fertilisation the egg develops within 24 hours into the first larva stage known as the trochophore which is free swimming and remains in the surface water between 12-48 hours. It then sinks to the sea bed, develops a shell and foot, and settles on the substratum by attaching itself with a byssus (silk-like filaments). The complete larval process takes between 2-4 weeks before metamorphosis into a juvenile manila clam (Tumnoi, 2012). Growth rate is dependent on environmental conditions and food availability, therefore varies geographically (Tumnoi, 2012). In Poole Harbour juveniles grow up to 20 mm in their first 24 months (Jensen et al., 2004). The rate of growth then reduces once individuals have reached sexual maturity. In Southampton Water

annual growth rate is around 2.9 mm in shell length (Tumnoi, 2012). The maximum size for manila clam encountered in stock surveys across the District is recorded at 78 mm in Portsmouth. However, this size is rare as the largest specimens in Portsmouth are usually between 55-60 mm. In Poole Harbour, Southampton Water and Langstone Harbour the largest recorded specimens are 64 mm, 55 mm, and 63 mm respectively. The maximum age recorded for manila clam is 13 years in part of the species native range in Vostock Bay, Russia (Ponurovsky and Selin, 1988 cited in Harris, 2016).

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. The SOM of manila clams is commonly accepted as the total shell length at which 50% of a population are mature and is referred to as the L_{50}. In the reviewed literature (table 1) the majority of studies did not outline a value for L_{50} instead a size range for first sexual maturity has been provided.

Tumnoi (2012) studied the size at maturity of manila clams in Southampton Water and found 87.5% of individuals were mature between 25-30 mm and all specimens over 30 mm were fully mature. The smallest sexually mature male and female were 17.9 mm and 20.2 mm, respectively and no individuals below 15 mm in length were found to be mature. A previous study undertaken at Bird Pile in Southampton Water in 2009 found the smallest observed spawning individuals were 22 mm (male) and 27 mm (female) (Cooke, 2009).

There is no further data available for SOM in introduced manila clam populations in the UK and Ireland but in populations across the species range maturity ranges between 15 – 35 mm (table 1 – note not all these values refer to 50% maturity). In France, male and female manila clams were found to mature between 15 and 20 mm (Devauchelle, 1990 cited in Ponurovsky and Yakovlev, 1992) whereas further south in the Tagus Estuary (Portugal) 50% maturity was reached at 29.4 mm for both sexes. Seventy-five percent of individuals were mature at 31.4 mm and all specimens were mature at 40 mm (Moura et al., 2018). The smallest mature individual in the Tagus Estuary was found to be 28 mm. Along the west coast of Korea 56.3% of females reached first sexual maturity between 15.1 – 20 mm in length and all females greater than 25.1 mm were sexually mature. The smallest mature female was 10.1 mm in length (Chung et al., 2005). First sexual maturity of male manila clams sampled along the western coast of Korea was found to range from 15.1-20 mm in length and all individuals greater than 25.1 mm in shell length were mature (Chung et al. 2013). The L_{50} for this population was calculated at 17.2 mm. In the Sea of Japan manila clams mature between 10-35 mm depending on location and males were found to mature at a smaller size of 10-15 mm in Possjet Bay compared to females that matured between 15-20 mm (table 1). In all the populations reviewed age at maturity ranged between 1-3 years with the majority of manila clams becoming sexually mature in their first year. The variation in gonadal development between populations of manila clam is due to the differences in environmental conditions (water temperature, food availability, day length) and internal factors such as hormonal (Chung et al., 2005).

Table 1. Size of maturity for manila clam (*Ruditapes philippinarum*) across its range. Sizes given in mm (rounded) and 50% size at maturity annotated with L_{50}. For more details refer to the appendix

Location	Male	Female	Reference
Southampton Water, England	25-30*		Tumnoi, 2012
France	15-20		Devauchelle, 1990 cited in Ponurovsky and Yakovlev, 1992
Tagus, Portugal	$29.4_{L_{50}}$		Moura et al., 2018
Simpo, Korea	$17.2_{L_{50}}$	-	Chung et al., 2013
Gomso Bay, Korea	15.1-20**		Chung et al., 2005
Possjet Bay, Sea of Japan	10-15	15-20	Ponurovsky and Yakovlev, 1992
Vostok Bay, Sea of Japan	20-30		Ponurovsky and Yakovlev, 1992
Melkovodnaya Bay & Olga Bay, Sea of Japan	30-35		Ponurovsky and Yakovlev, 1992

*87.5% of sample mature at this size ** 56.3% of sample mature at this size

The Minimum Conservation Reference Size (MCRS) for manila clams caught within the Southern IFC District is 35 mm. Based on the literature review a 35 mm landing size allows all specimens to reproduce at least once before removal from the fishery. Older females are larger and reproductively more valuable as they release a greater number of eggs compared to smaller individuals that have poorly developed gonads and less viable eggs (Yap, 1977; Tumnoi, 2012). The current MCRS provides the opportunity for larger, older females to contribute to the population.

Southern IFCA Fishery

Fishing activity

Manila clam is one of the main commercial species caught within the Southern IFC District. In 2019, clams were the third most caught species in the District after whelk and brown crab with 223 tonnes landed. The main fisheries take place in Southampton Water and Poole Harbour where dredges are used to harvest the clams from the seabed. In Southampton Water a toothed box dredge is typically used and towed from the stern of the boat, with one or two dredges used per vessel, whereas in the shallower water of Poole Harbour pump-scoop dredges are utilised. A pump-scoop dredge consists of a small metal basket that penetrates the first few centimetres of the seabed. The pump-scoop dredge is towed alongside the vessel and water is pumped into the basket to rinse sediment off the shellfish as it's caught. The dredge is powered by an auxiliary pump and is a unique technique developed by fishers in Poole Harbour. Previous to the pump-scoop dredge, clams were dredged by hand using a hand-held "scoop". This activity only takes place on small vessels 10 m or less in length. In 2015 a permit scheme was introduced in Poole Harbour under the 'Poole Harbour Dredge Permit Byelaw' to help manage the clam and cockle fishery and ensure its sustainability. The fishery currently supports 45 permits. In Poole Harbour the clam and cockle fishery achieved a global first in 2018 by being certified under the Marine Stewardship Council and Fisheries Standard as a well-managed and sustainable

fishery and, at the same time, having a number of skippers in the fishery certified under the Seafish Responsible Fishing Scheme.

The fishery in the Solent (Southampton Water, Portsmouth Harbour and Langstone Harbour) is currently regulated under the Solent Dredge Fishing Byelaw 2016. A permit scheme is due to be introduced for dredging in the Solent in 2021. Both regulations in Poole Harbour and the Solent set a fishing season for dredging for clams and cockles. The fishing season takes place between 25th May and 23rd December in Poole Harbour and 1st November to end of February (inclusive) in Southampton Water, Langstone Harbour and Portsmouth Harbour. This, along with other measures under the regulations, ensure that the fisheries are compatible with conservation requirements.

Commercial hand gathering for manila clams also takes place in Poole Harbour and the Solent where clams are hand-gathered from the sediment at low tide.

Recreational

Manila clams are gathered by recreational hand gatherers at low tide, particularly in Poole Harbour and Langstone Harbour. When hand-gathering in the Southern IFC District clams may only be removed from the sediment by hand picking. Tool use such as forks and hand rakes is prohibited. Hand gathering takes place throughout the year but temporal and permanent closures do apply to certain areas within the District.

Landings & Value of Fishery

In 2019, around 223 tonnes of manila clam worth £930, 700 was landed into ports across the Southern IFC District (fig 1). Between 2013 and 2019 (excl. 2015) landings remained between 160-223 tonnes per year. Prior to 2013 annul landings were much higher ranging between 328 tonnes in 2008 and peaking at 542 tonnes in 2010. Landings between 2005 and 2007 were below 50 tonnes per year. In 2015 landings were in line with pre 2013 at 457 tonnes. Price per tonne of manila clams has increased from an average of £2,000 between 2008-2015 to £3,960 between 2016-2019. In 2019 price per tonne of manila clams was around £4,180.

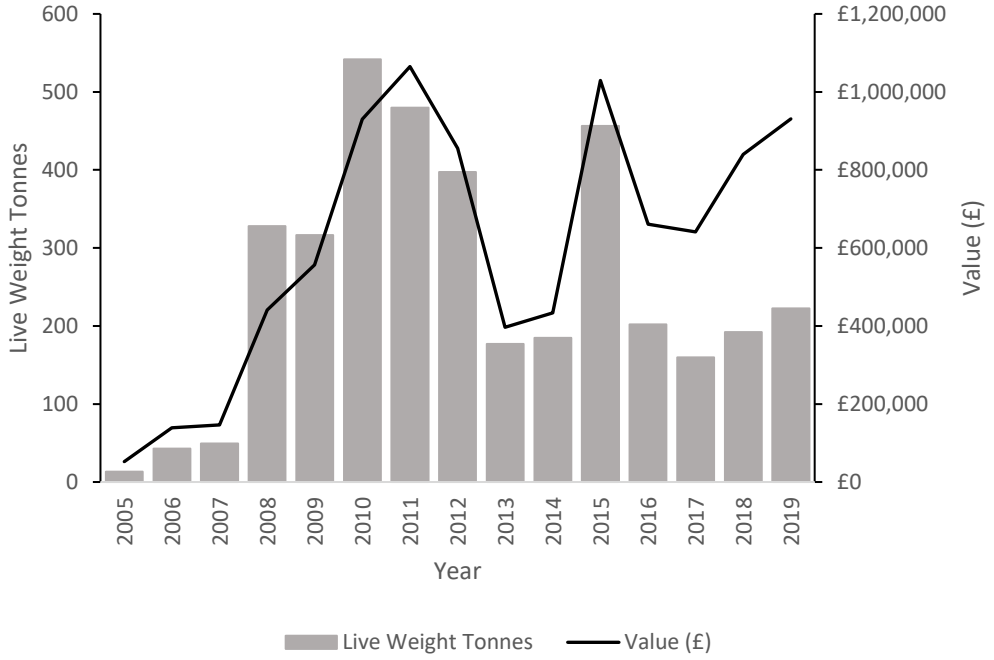

Figure 1. Landings of manila clam (*Ruditapes philippinarum*) into the Southern IFC District from 2005 to 2019. Data received from the Marine Management Organisation (MMO).

Since 2016 Southern IFCA have conducted annual bivalve stock assessments in Poole Harbour. In 2019 the spring stock assessment (undertaken in April prior to the beginning of the fishing season) suggested the manila clam is currently fished within sustainable limits (Cox and Birchenough, 2019).

Bivalve surveys are also undertaken in the Solent across three defined management areas: Southampton Water, Portsmouth Harbour and Langstone Harbour. There are two surveys undertaken each year, one before the opening of the dredge fishery in the autumn and one after the fishery closes in the spring. In the spring 2019 survey the biomass and average size of manila clams was found to be above the MCRS of 35 mm in Portsmouth and Langstone Harbour (Southern IFCA, 2019). In Southampton Water the average size was mostly under 35 mm across sites and the biomass was higher for undersized manila clams. These differences reflect the level of fishing pressure as Southampton Water supports the largest commercial clam fishery of the three sites. The spring survey also takes place directly after the end of the open fishing season (November – February inclusive) therefore larger quantities of undersized manila clams are expected. Future surveys are required to help establish a time series of data to enable detailed analysis of the extent to which fishing pressure influences the manila clam populations.

Associated management

There are a number of measures within the Southern IFC District that contribute to the sustainable management of the manila clam. A Minimum Conservation Reference Size (MCRS) of 35 mm (measured across the longest part of the shell) prohibits the removal of any specimen that measures less than 35 mm. This minimum size is applied throughout UK and European waters. However, a larger minimum size of 40 mm is enforced in a specific area of the North Western IFCA district due to a legacy byelaw of the former North Western Sea Fisheries Committee district. The increased size applies to manila clams caught between the Welsh border in the Dee Estuary to Haverigg Point in Cumbria.

In addition to an MCRS, there are several byelaws that limit fishing effort for manila clam through gear restrictions, spatial and temporal closures, and permitted access to the fishery (table 2).

Table 2. Southern IFCA byelaws that contribute to the sustainable management of the manila clam (*Ruditapes philippinarum*).

Management Measure	**Summary of Measure**
Solent Dredge Fishing Byelaw 2016	• Spatial and temporal restrictions for using a dredge in Southampton Water, Portsmouth Harbour and Langstone Harbour • Closed season 1st March – 31st October • Byelaw to be replaced by the Solent Dredge Permit byelaw from 1st November 2021
Poole Harbour Dredge Permit Byelaw	• Permit required to dredge fish in Poole Harbour • Permit conditions adhered to incl. gear specifications, mandatory 18 mm riddle bar, spatial and temporal restrictions, catching restrictions and reporting. • Fishery open between 25th May and 23rd December
Fishing for Oyster, Mussels and Clams Byelaw	• Clams, oysters and mussels in the district can only be harvested by dredge towed from a vessel or hand-picked. No tools can be used when hand gathering e.g. hand rake or fork
Poole Harbour Shellfish Hand Gathering byelaw	• Hand gathering within certain areas in Poole Harbour is prohibited between 1st November and 31st March
Bottom Towed Fishing Gear Byelaw	• Bottom towed gear including dredges are permanently prohibited from certain areas within the Southern IFCA district to protect sensitive Marine Protected Area features such as reef and seagrass
Prohibition of Gathering (Sea Fisheries Resources) in Seagrass Beds Byelaw	• No hand gathering or digging in prohibited areas of seagrass beds in the District

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Appendix

Table A. Estimates of size at maturity for manila clam (*Ruditapes philippinarum*) throughout the species' range. Table shows study location, total number of individuals sampled overall, size range sampled, total number of individuals used to assess size at maturity, size of smallest mature individual, size at maturity at age at maturity. 50% size at maturity annotated with L_{50}. Maturity values without annotations refer to sizes at first maturity not 50% maturity. All sizes based on total shell length (L) in mm.

Study location	Total No. surveyed	No. of individuals (n)		Length Data		Size at Maturity Data									
				Size range		Total No. of individuals	No. of individuals (n)		Size of smallest mature individual		Size at maturity		Age at maturity (years)		Reference
		M	F	M	F		M	F	M	F	M	F	M	F	
Southampton Water, England	83	-	-	-	-	-	-	-	17.9	20.2	25-30*		-	-	Tumnoi, 2012
France	-	-	-	-	-	-	-	-	-	-	15-20		1		Devauchelle 1990, cited in Ponurovsky and Yakovlev, 1992
Tagus, Portugal	-	-	-	-	-	88	-	-	28		29.4L_{50}		<1		Moura et al., 2018
Simpo, Korea	-	-	-	8.6-54.6		135	135	0	-	-	17.16 L_{50}	-	1	-	Chung et al., 2013
Gomso Bay, Korea	-	-	-	8.1-54.9		123	-	-	-	10.1-15	-	15.1-20**	-	-	Chung et al., 2005
Possjet Bay, Sea of Japan	148	-	-	-	-	-	-	-	7-8		10-15	15-20	1		Ponurovsky and Yakovlev, 1992
Vostok Bay, Sea of Japan	3031	-	-	-	-	-	-	-	-	-	20-30		-	-	Ponurovsky and Yakovlev, 1992
Melkovodnaya Bay & Olga Bay, Sea of Japan	~190	-	-	-	-	-	-	-	-	-	30-35		-	-	Ponurovsky and Yakovlev, 1992

*87.5% of sample mature at this size ** 56.3% of sample mature at this size