

Edible/brown crab

(*Cancer pagurus*)

Summary

Size	300 mm carapace width usually <240 mm (FAO, 2015)
Lifespan	>20 years (Neal and Wilson 2008)
Size of maturity in the English Channel (CW₅₀)	Male 90-115 mm Female 112-126 mm
Fecundity	250,000 - 3 million (Bennet, 1995)
Reproductive frequency	Annual
Capture methods	Parlour pots
Minimum Conservation Reference Size	140 mm (carapace width)
Fishing Season	All year round



Description

Cancer pagurus, commonly known as the brown or edible crab, is broadly distributed from the northwest coast of Norway to Morocco (FAO, 2015) and is found along all British and Irish coasts. The species inhabits a wide range of habitats from the intertidal zone to depths of 100 m including rocky substrates, coarse sediments, under boulders and sandy or muddy seabeds. Habitat is believed to be gender specific once individuals have reached maturity with mature females favouring sand and gravel and mature males mostly found on rocky ground (Pawson, 1995).

Reproductive Life history

In the English Channel brown crab mate during late spring (Brown and Bennett, 1980). The male will locate a female before she has moulted and guard her for 3 to 21 days (Edwards, 1966). Once the female has moulted mating by copulation occurs and the male may continue to guard the female for up to two days before proceeding to find another mate (Edwards, 1966). The female stores sperm in a special organ called the spermathecae until she is ready to spawn. Oviposition (egg laying) takes place four months after copulation although sperm may remain viable in the spermathecae for over six months (Shields, 1991). Prior to spawning females migrate westwards to various locations throughout the English Channel (Hunter et al., 2013). Individuals are not believed to return to the same spawning grounds each year.

Soft sediment is required to enable the female to dig a hollow in which to retreat into and extrude her fertilised eggs and ensure their attachment to the pleopods (small appendages under the abdomen). Brown crab is a highly fecund species as females can hold between 250,000 to 3 million eggs. Fecundity also increases with carapace width (Bennett, 1995; Haig et al., 2015; Ungfors, 2007).

Eggs are brooded for 7 to 9 months, during this period females are inactive and do not feed thus are less likely to be caught in baited traps (Hunter et al., 2013; Bennett, 1995). Hunter et al. (2013) attached tags to 128 mature female crabs across different locations in the English Channel. They found westerly offshore crabs commenced brooding in late October whilst eastern Channel crabs tended to start brooding slightly later in mid to late November.

Larvae hatch from March onwards with peak sightings recorded in the plankton between May and July (Thompson et al., 1995; Bennett, 1995; Pawson, 1995). The larvae are planktonic for 60-90 days before settling on hard substrates in the intertidal zone (Pawson, 1995; Bennet, 1995). Juveniles remain in shallow, rocky habitat for 3 years until they reach a carapace width (CW) of 60-70 mm, at which point they migrate to subtidal areas (Neal and Wilson, 2008).

Brown crab grows by shedding its exoskeleton in a process called ecdysis or moulting. Growth rate varies regionally and is dependent on sex, food supply, temperature, depth and frequency of moulting (Bennett, 1995). Moulting frequency is high for small crabs below 100 mm CW and declines as size increases to ~ 170 mm CW (Bakke et al., 2018). Below 100 mm CW males and females average moult increments are similar however, beyond this point the average moult increment of the female is less than the male resulting in higher growth rates for males (Bennett, 1974). Moulting is more prevalent between early summer to late autumn (Bakke et al., 2018).

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. For crustaceans the SOM is commonly accepted as the carapace width (CW) at which 50% of a population are mature and is referred to as the CW₅₀.

Several definitions can be used to estimate maturity in decapod crustaceans: behavioural maturity; morphometric maturity; functional maturity and physiological maturity (Table 1.). Methods based on morphometric and behavioural maturity criteria are less difficult to determine but they may not always indicate functional maturity (Öndes et al., 2017; Haig et al., 2016).

Table 1. Four definitions of maturity used to infer sexual maturity in crabs (Haig et al., 2016; Öndes et al., 2017)

Maturity term	Description
Behavioural	Individuals show signs of the ability to physically copulate e.g. presence of sperm plugs in females and direct observations of mating behaviour. Doesn't confirm functional maturity.
Morphometric	Crustaceans demonstrate 'allometric growth' where different body parts grow at different rates. Changes in size of secondary sexual characteristics such as female abdomen width and male chelipeds length with growth can be used to estimate onset of maturity. Doesn't always indicate functional maturity.

Functional	Presence of eggs externally attached to a female indicates she is functionally capable of producing offspring. Functional maturity in males is difficult to determine therefore other methods are often used to inform male maturity.
Physiological	Estimated based on microscopic investigation of the gonads or histological observations of ovaries, testes and the vas deferens.
	Used interchangeably with Functional maturity.

The available published literature suggests that SOM for brown crab in waters around the British Isles is highly variable and ranges from 59 – 155 mm CW₅₀ (Table 2.). All studies reviewed indicate SOM differs between sexes as males become sexually mature at a smaller size than females. The smallest SOM recorded for males was found in the Bridlington population in the North Sea at 59 mm (Haig et al., 2016) whereas the smallest CW₅₀ recorded for females was 90 mm, also from individuals sampled from the North Sea (Lawler, 2006 unpubl. In Smith, 2010). The largest estimates of size at 50% maturity for brown crab were recorded as 120-148 mm for male populations sampled along the east and west Coast of Scotland (Mesquita et al., 2020) and 150 mm for females sampled around the Isle of Man (Öndes et al., 2017).

Two unpublished studies undertaken by Cefas established the SOM for populations of brown crab located in the English Channel ranged between 90-115 mm for males and 112-126 mm for female crabs (Lawler, 2006 unpubl. In Smith 2010 and Bennett, 1996 unpubl. In Smith, 2010).

Table 2. Size at maturity estimates (CW₅₀) for brown crab (*Cancer pagurus*) in studies undertaken in the UK and Ireland. Male and female carapace width given in mm. Refer to the Appendix for more information.

Location	Male	Female	Maturity	Reference
England - Selsey	115	125	-	Cefas, Bennett, 1996; unpubl. In Smith 2010
England - Norfolk	105	110	-	Cefas, Bennett, 1996; unpubl. In Smith 2010
England - Eastern Channel	105	126	Physiological	Cefas, Lawler, 2006; unpubl. In Smith, 2010
England - Western Channel	90	112	Physiological	Cefas, Lawler, 2006; unpubl. In Smith, 2010
England – North Sea	89	90	Physiological	Cefas, Lawler, 2006; unpubl. In Smith, 2010
England - Bridlington	59	104	Physiological	Haig et al., 2016
Ireland - Galway Bay	106	117	Physiological	Haig et al., 2016
Scotland - Orkney	92	97	Physiological	Haig et al., 2016
Wales - Colwyn Bay	87	103	Physiological	Haig et al., 2016
Isle of Man	85	107	Physiological	Haig et al., 2016
Ireland	110-117	133-138	Functional	ICES, 2004
East & West coast Scotland	120-148	131-142	Morphological	Mesquita et al., 2020
East & West coast Scotland	101-106	127-128	Functional	Mesquita et al. 2020
Isle of Man	89	108	Physiological	Öndes et al., 2017
Isle of Man	107	155	Morphological	Öndes et al., 2017

Scotland – Shetland Islands	126	134	Functional	Tallack, 2007
Scotland – Shetland Islands	-	123	Behavioural	Tallack, 2007

Size at maturity cannot be absolutely compared between studies due to the differences in methods used to establish 50% maturity. However, in general the SOM for the vast majority of populations sampled are below the current Minimum Conservation Reference Size (MCRS) of 140 mm CW in the Southern IFC District suggesting brown crab will reproduce at least once prior to capture. Only one population of females sampled on the coasts of the Isle of Man identified SOM to be above 140 mm at 155 mm. All studies undertaken in the English Channel found males and females matured below 140 mm CW. Therefore, the literature review suggests that the current MCRS of 140 mm is appropriate for brown crab within the Southern IFC District.

Southern IFCA Fishery

Fishing activity

Brown crab is one of the most commercially important species in the UK. In 2018, 28,900 tonnes of crab (mixed species) worth £69.5 million was landed by UK vessels into the UK (MMO, 2018). Of this, 14,500 tonnes, worth £33.1 million, was landed into England.

Historically, brown crab has been caught across the Southern IFC District; in the Solent, around the Isle of Wight and along the coast of Dorset. The fishery is most prominent in the west throughout Dorset due to the presence of large areas of rocky benthic habitats. Figure 1. illustrates sightings data of crab and lobster potting activity from 2005-2020 in the district. The brown crab fishery supports more than 250 fishers within the Southern IFC District based on fishing permits data. Of the 250 permitted pot fishers in the district 227 fish fulltime.

Potting for brown crab takes place all year round but activity peaks from late winter to spring when meat quality is at its best. The majority of fishers use 'D' creel/parlour pots to target the crabs although some vessels use large rectangular creels. On average vessels will work around 420 pots; however, the number of pots worked can vary greatly, from as few as 50 to as many as 1,200, depending on the size of the vessel and frequency of trips. There are 124 vessels under seven metres and 107 vessels between seven and ten metres in length that pot throughout the District. Due to their small size they tend to fish close inshore however, there are approximately 22 ten to twelve-metre vessels that do fish further offshore (>6nm), outside of the District.

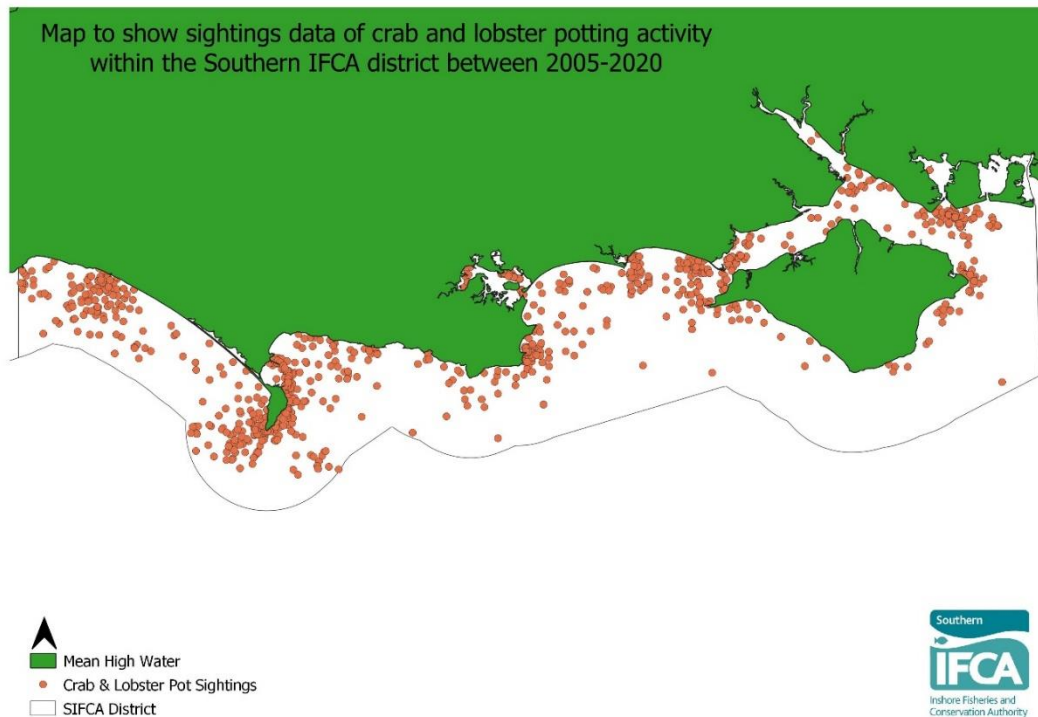


Figure 1. Location of crab and lobster potting activity in the Southern IFC District based on sightings data from 2005-2020.

Recreational potting does occur in the District but the number of active recreational pot fishers is not known. Greater recreational activity takes place around the Isle of Wight, Swanage, Weymouth, Portland, and Lyme Bay.

Landings & Value of Fishery

Southern IFCA do not currently hold effort or catch data for the brown crab fishery. However, landings data from the MMO can help indicate the scale of the fishery over time. In 2019, approximately 720* tonnes of brown crab worth £2,153,330* was landed into ports across the Southern IFC District (MMO, 2020).

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

Landings remained relatively stable at around 1000 tonnes per year from 2005 to 2017 but have declined slightly over the last two years to below 800 tonnes. A peak of 1,204 tonnes was seen in 2015, with the lowest landings at 720 tonnes in 2019 (Fig.2).

Cefas reported the status of the stock of brown crab in the western English Channel to be good with spawning stocks around the level required to produce Maximum Sustainable Yield (Cefas, 2017). Based on the MCRS applied in the region the stock assessment also found that around 96-99% of males and 60-86% of females should be sexually mature.

The value of the recreational pot fishery in the district is not known.

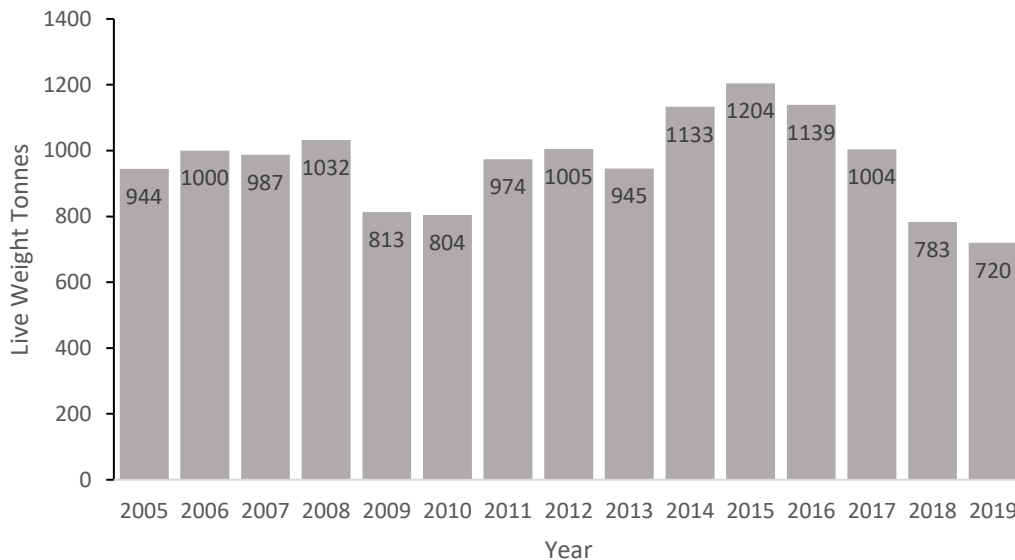


Figure 2. Landings of brown crab (*Cancer pagurus*) into the Southern IFC District from 2005 to 2019. Data sourced from the Marine Management Organisation (MMO).

Associated management

Landings of brown crab are primarily managed through Minimum Conservation Reference Size (MCRS) restrictions to prevent the landing of sexually immature individuals. This allows individuals to grow and reproduce at least once before harvesting. MCRS's for brown crab varies across the IFCA districts from 115 mm to 160 mm carapace width (CW) (Table 3). Minimum sizes are larger throughout the Devon and Severn, Isles of Scilly and Cornwall IFCA districts for male and female crabs: 160 mm MCRS for males and 140-150 mm for females. This is partly due to a statutory instrument 'The Undersized Edible Crabs Order 2000' that prescribes minimum sizes for male brown crabs along the coasts of Devon, Cornwall and Scilly Isles at 160 mm. Cornwall IFCA (Cornwall Sea Fisheries at the time) later introduced a minimum size of 150 mm for female brown crab as a measure to manage fishing effort.

In the Southern IFC District the MCRS for the commercial fishing of brown crab is 140 mm (CW) through European legislation (Regulation (EU) 2019/1241). The Southern IFCA Minimum Conservation Reference Size Byelaw, which at the time of writing is awaiting sign off by the Secretary at State, will apply the MCRS to all fishery participants in the District. The use of escape gaps in crab and lobster pots is promoted on a voluntary basis throughout the district.

Fishing effort is also indirectly managed through the 'Vessels used in fishing 2012' byelaw that prohibits commercial vessels over 12 metres from fishing in the Southern IFC District. The reduction in vessel size naturally restricts fishing effort as it limits the quantity of static gear that can be worked by each vessel.

Table 3. Minimum Conservation Reference Sizes (MCRS) for brown crab (*Cancer pagurus*) in Inshore Fisheries and Conservation Authority (IFCA) Districts in England. All measurements in mm for carapace width (CW).

IFCA	Minimum Conservation Reference Size (MCRS) (mm)
Northumberland	130
North Eastern	140
Eastern	115
Kent & Essex	130
Sussex	140
Southern	140
Devon & Severn	150 female (applies to Mobile Fishing, Potting, Netting and Diving permit conditions. 140mm applies for all other removal) 160 male
Cornwall	150 female 160 male
Isles of Scilly	140 female 160 male
North Western	130

References

- Bakke, S., Larssen, W.E., Woll, A.K., Søvik, G., Gundersen, A.C., Hvingel, C., and Nilssen, E.M., 2018. Size at maturity and molting probability across latitude in female *Cancer pagurus*. *Fisheries Research*, 205, 43-41
- Bennett, D.B., 1974. Growth of the edible crab (*Cancer pagurus*) off south-west England. *Journal of the Marine Biological Association of the United Kingdom*, 54, 803-823
- Bennett, D.B., 1995. Factors in the life history of the edible crab (*Cancer pagurus* L.) that influence modelling and management. *ICES Mar.Sci.Symp.*, 199, 89-98
- Brown, C.G., and Bennett, D.B., 1980. Population and catch structure of the edible crab (*Cancer pagurus*) in the English Channel. *Journal du Conseil*, 39, 88-100
- Centre for Environment, Fisheries and Aquaculture Science, Cefas., 2017. Edible crab (*Cancer pagurus*): Cefas stock status report 2017
- Edwards, E., 1966. Mating behaviour in the European Edible Crab (*Cancer pagurus* L.). *Crustaceana*, 10, 23-30
- FAO, 2015. FAO Fisheries & Aquaculture – Species Fact Sheets – *Cancer Pagurus* (Linnaeus, 1758). <http://www.fao.org/fishery/species/2627/en> (Accessed 27. July 2020).
- Haig, J.A., Rayner, G., Akritopoulou, E., and Kaiser, M.J., 2015. Fecundity of *Cancer pagurus* in Welsh waters, a comparison with published literature. *Fisheries & Conservation Science report No 49*, Bangor University. Pp.24
- Haig, J. A., Bakke, S., Bell, M. C., Bloor, I. S. M., Cohen, M., Coleman, M., Dignan, S., Kaiser, M. J., Pantin, J. R., Roach, M., Salomonsen, H., and Tully, O., 2016. Reproductive traits and factors affecting the size at maturity of *Cancer pagurus* across Northern Europe. *ICES Journal of Marine Science*, 73, 2572–2585
- Hunter, E., Eaton, D., Stewart, C., Lawler, A., Smith, M.T., 2013. Edible Crabs “Go West”: Migrations and Incubation Cycle of *Cancer pagurus* Revealed by Electronic Tags. *PLoS ONE* 8(5): e63991. doi:10.1371/journal.pone.0063991
- ICES, 2004. Report of the study group on the biology and life history of crabs (SGCRAB) ICES living resources committee. ICES CM 2004/G:13, ref.D
- ICES, 2014. Interim report of the working group on the biology and life history of crabs (WGCRAB). 22-24 April 2014; Tromso, Norway. ICES CM 2014/SSGEF:12 35 pages
- Mesquita, C., Dobby, H., Sweeting, S., Jones, C.A., and Pierce, G.J., 2020. Size-at-maturity of brown crab (*Cancer pagurus*) in Scottish waters based on gonadal and morphometric traits. *Fisheries Research*, 229, 105610
- Neal, K.J., and Wilson, E., 2008. *Cancer pagurus* Edible crab. In Tyler-Walters H. and Hiscock K. (eds) *Marine life information network: biology and sensitivity key information reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 27.8.2020]. Available from: Available from: <https://www.marlin.ac.uk/species/detail/1179>

- Öndes, F., Kaiser, M., and Murray, L., 2017. Relative growth and size at onset of sexual maturity of the brown crab, *Cancer pagurus* in the Isle of Man, Irish Sea. *Marine Biology Research*, 13(2), 237-245. <https://doi.org/10.1080/17451000.2016.1248849>
- Pawson, M.G., 1995. Biogeographical identification of English Channel fish and shellfish stocks. Fisheries Research Technical Report (number 99), MAFF Direct Fisheries Research Lowestoft, England. *Hydrobiologia*, 371/372, 143-153
- Shields, J.D., 1991. The reproductive ecology and fecundity of *Cancer* crabs. Crustacean egg production. *Crustacean Issues*. 7, 193-213
- Smith, M., 2010. Development of a multiple indicator framework macro-crustacean fishery assessment and management. Interim/stag 1 report (Seafish project D108; Cefas project C3609) Evaluation of length structured data, assessments and potential proxies (including evaluation of aggregate catch and effort data to provide context)
- Tallack, S.M.L., 2007. The reproductive cycle and size at maturity observed in *Cancer pagurus* in the Shetland Islands, Scotland. *Journal of the Marine Biological Association of the United Kingdom*, 87: 1181-1189
- Thompson, B. M., Lawler, A. R., and Bennett, D. B., 1995. Estimation of the spatial distribution of spawning crabs (*Cancer pagurus* L.) using larval surveys in the English Channel - ICES Marine Science Symposia, 199, 139-150.
- Ungfors, A., 2007. Sexual maturity of the edible crab (*Cancer pagurus*) in the Skagerrak and Kattegat, based on reproductive and morphometric characters. *ICES Journal of Marine Science*, 64, 318–327

Appendix

Table A. Estimates of size at maturity for brown crab (*Cancer pagurus*) in studies undertaken in the UK and Ireland. 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 50% maturity (CW₅₀), size range of mature individuals and maturity definition used to assess maturity. All sizes based on carapace width (CW) in mm.

Study location	Total No. of individuals surveyed	No. of individuals (n)		Length Data		Size at Maturity Data								Reference		
				Size range (mm)		Total No. of individuals	No. of individuals (n)		Size of smallest mature individual (mm)		Size at 50% maturity (CW ₅₀) (mm)		Size range of mature individuals (mm)		Maturity Definition	
		M	F	M	F		M	F	M	F	M	F	M			F
England <i>Selsey</i>	-	-	-	-	-	-	-	-	-	-	115	125	-	-	-	Cefas, Bennett, 1996; unpubl. In Smith 2010
England <i>Norfolk</i>	-	-	-	-	-	-	-	-	-	-	105	110	-	-	-	Cefas, Bennett, 1996; unpubl. In Smith 2010
England <i>Eastern Channel</i>	-	-	-	-	-	-	-	-	-	-	105	126	-	-	Physiological	Cefas, Lawler, 2006; unpubl. In Smith, 2010
England <i>Western Channel</i>	-	-	-	-	-	-	-	-	-	-	90	112	-	-	Physiological	Cefas, Lawler, 2006; unpubl. In Smith, 2010
England <i>North Sea</i>	-	-	-	-	-	-	-	-	-	-	89	90	-	-	Physiological	Cefas, Lawler, 2006; unpubl. In Smith, 2010
England <i>Bridlington</i>	247	82	165	71-148	80-153	-	-	-	80	59	104	-	-	Physiological	Haig et al., 2016	
Ireland <i>Galway Bay</i>	373	154	219	70-171	66-162	-	-	96	79	106	117	-	-	Physiological	Haig et al., 2016	
Scotland <i>Orkney</i>	296	79	217	72-150	79-150	-	-	80	88	92	97	-	-	Physiological	Haig et al., 2016	
Wales	435	229	206	30-220	68-182	-	-	63	68	87	103	-	-	Physiological	Haig et al., 2016	

Isle of Man	274	132	142	67-137	82-152	-	-	-	67	82	85	107	-	-	Physiological	Haig et al., 2016
Ireland <i>Cork, Donegal, Wexford</i>	-	-	-	-	-	925	274	651	102	124	110-117	133-138	-	-	Functional	ICES, 2004
East & West coast of Scotland	1008	-	-	73-211	83-204	-	-	-	-	-	120-148	131-142	-	-	Morphological	Mesquita et al., 2020
East & West coast of Scotland	1008	-	-	73-211	83-204	-	-	-	86	110	101-106	127-128	-	-	Functional	Mesquita et al., 2020
Isle of Man	-	-	-	-	-	297	82	215	-	-	89	108	-	-	Physiological	Öndes et al., 2017
Isle of Man	-	-	-	-	-	309	87	222	-	-	107	155	-	-	Morphological	Öndes et al., 2017
Scotland <i>Shetland Islands</i>	-	-	-	-	-	208	94	114	-	134	126	134	-	-	Functional	Tallack, 2007
Scotland <i>Shetland Islands</i>	-	-	-	-	-	812	-	812	-	-	-	123	-	-	Behavioural	Tallack, 2007