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THE MANTIS SHRIMP *Rissoides desmaresti* IN THE SOLENT AND AROUND THE ISLE OF WIGHT

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Abstract

The burrowing mantis shrimp Rissoides desmaresti (Risso, 1816) is considered scarce in the British Isles where populations are at the northern edge of their geographical range. Yet parts of the Solent region have been a known 'hot spot' since the mid-19th Century. From 2004-2007, a local partnership between fishermen, anglers and conservation organisations sought to increase knowledge of the species distribution, ecology, and reproductive biology. The capture of over 200 specimens was mapped and shrimps were examined and measured to determine their seabed substrate preferences, breeding condition and population age structure. Using a combination of SCUBA, towed video sled, beam trawl, oyster dredge and Van Veen grab, surveys were conducted to attempt to locate burrows and characterise the species habitat and associated fauna and flora, the results of which are appended.

Records of shrimps captured combined with more recent observations 2007-2021 show the species to be widespread in the eastern Solent with a preference for sandy-mud substrate yet were also recorded on firmer ground in the west and south-west of the Isle of Wight. The number of females observed with mature ovaries and cement glands increased between October and April and individuals kept in aquaria were observed brooding eggs in March and April. Length measurements showed evidence of recruitment and establishment in the region. The species is a 'flagship' for the Solent benthos and the importance of local populations has been recognised by its inclusion in the Isle of Wight Biodiversity Action Plan (BAP).

Key Words: Stomatopoda, Benthic invertebrates, English Channel, oyster fishing, North-east Atlantic

Introduction

Mantis shrimps (Crustacea: Stomatopoda) are mostly associated with tropical and warm temperate regions and are widely known for their aggressive predatory and territorial behaviour and sophisticated visual communication. They are often separated in to two groups according to the structure of their raptorial claws: the 'smashers', which have club-like appendages that inflict a remarkably powerful hammer blow to shells of molluscs and crustaceans and the 'spearers' which have several barbed spines used to capture softer prey including fish and other shrimps (Caldwell & Dingle, 1976).

In British waters, we have two 'spearer' species that occur more commonly in southern Europe and the Mediterranean, *Platysquilla eusebia* (Risso, 1816) and *Rissoides desmaresti* (Risso, 1816). The two species are both burrowing animals and may be distinguished by the number of spines on their raptorial claws (Mauchline, 1984). British records of *P. eusebia* have been mostly of planktonic larvae; however in 2005 a settled juvenile was found on the Dogger Bank in the North Sea (Lewis & Gittenberger, 2013). Although much more frequent, *R. desmaresti* has been included in a provisional list of rare and scarce marine species i.e. those which occur in nine to fifty-five 10km X 10km grid squares containing sea (or water of marine saline influence) within the three mile territorial limit (Sanderson, 1996). Yet the Solent region has long been known as a 'hot spot' for *R. desmaresti.*

In *A History of British Stalk-Eyed Crustacea*, Bell (1844-52 p356) refers to the species being '*taken repeatedly*' by Bembridge fisherman on a muddy bottom with eel grass (*Zostera*). In the 19th and 20th Century a significant number of records from the British Isles were from the Solent and south-coast of England (Yarell 1833; Morey, 1909; Clark 1985; Herbert, 2001), with a good number of specimens collected by oyster fishermen. Some of the early literature suggested an association with beds of *Zostera* (Bell, 1844-1852; Morey, 1909; Clarke, 1985), however, in 1999 there was a surprise discovery of a population in Tremadog Bay, North Wales (Ramsay & Holt, 2001). More recent surveys in the eastern Channel, Outer Thames estuary and Suffolk and Norfolk coast have since revealed populations in the southern North Sea to latitude 52°N (Ellis *et al.* 2006; Griffin *et al.* 2011).

From 2005-2007 an opportunity arose to further our understanding of the distribution, biology and ecology of *R. desmaresti* in the Solent and Isle of Wight region through the *Solent Mantis Shrimp Survey.* This project was supported by the 'Marine aggregates and biodiversity: stakeholder engagement in the South-East initiative' and co-ordinated by the Hampshire and Isle of Wight Wildlife Trust (Herbert, 2007). The main aim of this contribution is to summarise the results of this survey, including the species ecology and reproductive biology, and to provide additional habitat information and up to date distribution for *R. desmaresti* in the region.

Methods

Survey

To encourage widespread recording, information about the *Solent Mantis Shrimp Survey,* including an illustrated identification guide, was distributed to licenced oyster fishermen via the Southern Sea Fisheries District Committee, offering a bounty of £10 for each shrimp caught. Most of the earlier Solent records of *R. desmaresti* have been from fishermen dredging for native flat oysters (*Ostrea edulis*). The fishery, which was only active in the eastern Solent, was open from November till March, with a break in January. One or two dredges, each 1.5m across with mesh size 5cm, are towed behind vessels (<10m length) and shrimps are taken as by-catch, caught up with the oysters, weed, shell and other debris in the net. The shrimps have no

commercial value in this fishery and are usually thrown back overboard.

Charter boat operators, sea anglers and bait diggers also participated in the survey. Anglers found specimens in fish stomachs and bait diggers reported the shrimps in burrows within intertidal flats. Shrimps were collected from fishermen to establish the sex of the specimens and their reproductive condition. Using callipers, the Total Length (TL) and Carapace Length (CL) of each individual was measured to the nearest 0.1mm to establish evidence of multiple age cohorts, including young-of the-year. Fishermen also provided details of dredge tow positions, depth, seabed substrate and the capture of any associated species. Live weight of animals was determined using an electronic balance.

To establish any relationship between position of capture and sea-bed substrate, all records of mantis shrimps were plotted using ArcGIS on a sea-bed sediment map at scale 1:250,000 (British Geological Survey, 1990).

Burrow and habitat surveys

Between 2003-2006 attempts was made to locate shrimps in burrows and characterise the species habitat and benthic community. SCUBA surveys with volunteer *Seasearch* divers were conducted off the North-East coast of the Isle of Wight during June and July 2006. Further detail on benthic assemblages was obtained by sampling using a video-sled and beam trawls, oyster dredges, and Van Veen grabs deployed from the University of Southampton's RV *Bill Conway*. Details of habitat surveys and locations are presented in Appendix 1.

Reproduction

Mantis shrimps are dioecious and females brood eggs within their burrows, from which planktonic larvae are released into the water column. During the breeding season the developing ovary is visible dorsally as a red stripe, which occupies more of the abdominal region of the body as the eggs mature (Fig. 1, 2). Very little was known about the reproductive biology of *R. desmaresti*, but in other species the ovary develops in synchrony with the cement glands (Wortham-Neal, 2002). The cement glands secrete a substance that sticks the individual eggs together creating a mass that may be brooded externally by the female. As the ovaries develop the whiteness of the cement glands increases and they become visible ventrally through the exoskeleton on the sixth, seventh and eighth sternites of the thoracic region (Fig. 3). The method of staging the cement glands was adapted from Wortham-Neal (2002) (Table 1).

Table 1. Stages of cement gland development in *R. desmaresti* (after Wortham-Neal, 2002 and Herbert, 2011).

Stage 0	No cement gland development.
Stage 1	Gland development. Three narrow white parallel bands visible on the sixth, seventh and eighth sternites.
Stage 2	Highly opaque, thick white bands developed.
Stage 3	Dense thick white bands that are connected medially and almost filling the ventral region of the thoracic cavity.

Results

Survey

During the main survey between February 2005 and March 2007 a total of 212 records of mantis shrimps were obtained from fifteen commercial fishermen and six anglers (Fig. 4). Most reports were from oyster fishermen operating in the eastern Solent between Osborne Bay and Ryde at depths between 5-20m. During the autumn oyster fishing period in 2003-2006, the mean catch per unit effort (CPUE) for a single Solent fishing vessel running two standard oyster dredges varied between 0.43-2.21 individuals per 5-day working week (Herbert, 2011). However, shrimps were also found in prawn pots and in beam trawls throughout the year, often by the same boat crews. On 16th February 2005, fifteen females, all showing signs of reproductive development, were caught in a beam trawl in a deep sandy hole 5km south of the Needles. In October 2006,

Fig. 1: Mature male (Top) and female *R. desmaresti* from the Solent. In the breeding season, the ripening orange-red eggs within ovaries of the female contrasting with lighter brown male. Total length of male between anterior tip of the rostrum and end of the telson 80mm.

Fig.2: Three female *R. desmaresti* from the Solent at different stages of reproductive development. Left to Right, Cement gland Stage 1, 2, 3. Note the red colouration as the ovaries develop and occupy more of the abdominal region.

Fig. 3: Cement gland development from Stages 1-3 visible in the ventral thoracic region of female *R. desmaresti* from the Solent. See Table 1 for details of stage development.

eight were found by bait diggers at Portchester corner in Portsmouth Harbour at Mean Low Water Neap Tide Level and in November 2006, eleven shrimps were caught in prawn pots off Bembridge Lifeboat Station. Overall, 64% of the shrimps caught were females and there was a marked seasonality in capture with most shrimps collected between December and January. Relatively few females were caught in the late spring and early summer.

Since 2007, there have been relatively few records (Fig. 4, Table 2). The recent closure of the Solent oyster fishery is partly responsible, as is the termination of the bounty! Records from April 2007 to March 2022 are shown in Table 2.

In comparison with specimens from southern Europe (Mauchline, 1984; Lewinsohn & Manning, 1980, Manning & Lewinsohn1982), the propodus of the raptorial claw of Solent shrimps most resemble specimens from the western Mediterranean yet vary in having a squarer distal end and uniform width, except at the proximal end. The curvature of the outer margin of the propodus also varies; however in most other respects the specimens match the description. Captured animals were between 26-97mm TL, with both the largest and smallest being females. In each of the four winters between 2003 and 2007, two modal classes were identified by application of a separation index (IS) (Bhattacharya, 1967; FAO, 2009; Herbert, 2011). New recruits (young-of-the-year) were evident in 2005-6 and 2006-7 (Fig.5).

Habitat

Mantis shrimps were found on a wide range of substrata between Mean Low Water Neap tide level and 30m depth. Of subtidal captures, approximately 50% were on sandy-mud, 16% in muddy-sand and 17% on sandy-

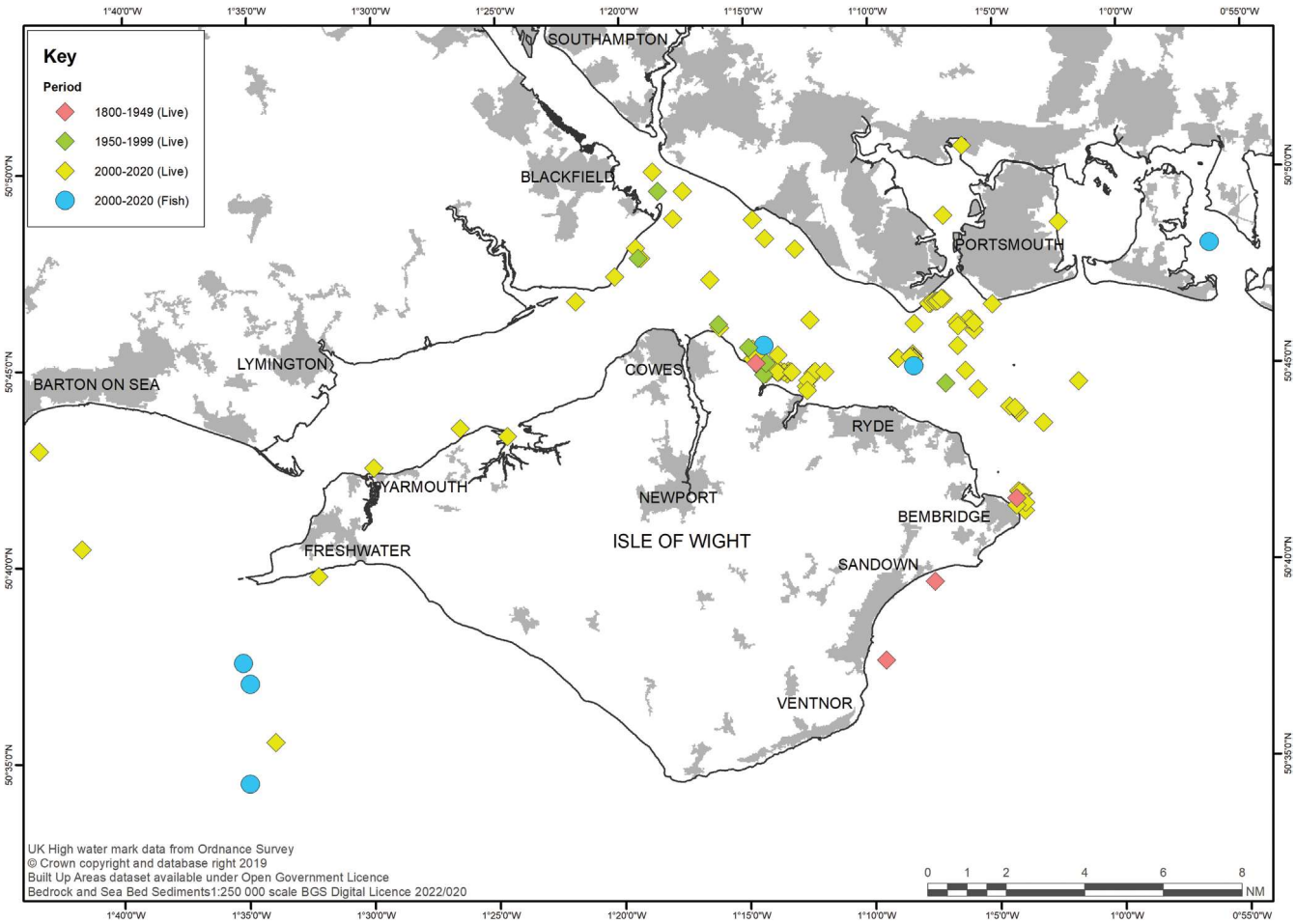

Fig.4: Position of *R. desmaresti* recorded in the Solent and around the Isle of Wight since 1800. Approximate location is given for records pre 1949. Those indicated in the key 'Fish' were found within stomachs of fish caught by anglers.

gravel (Fig 6). The few captures over gravels were on the south-west coast of the Isle of Wight and the western Solent; however it is possible these were also within finer sediments not shown due to the coarse resolution of the map. Two small male specimens sampled at Portchester Corner in Portsmouth Harbour between Mean and Extreme Low Water Spring tide level, were in sandy-mud and specimens in the upper harbour were in 'mud'.

Aquarium experiments at the Medina Valley Centre and by students at the University of Southampton confirmed that burrowing was only possible in 'mud' and 'mud with gravel' and was not observed in sediments consisting of purely sand or gravel, although some 'scrapes' were created.

Surveys of the benthic assemblages in the eastern Solent, where many mantis shrimps were captured, revealed dominance of the slipper limpet *Crepidula fornicata,* sponges, ascidians, and hydrozoans (Appendix 1). Of particular interest off Sturbridge were the slit limpet *Emarginula fissura* and butterfly blenny *Blennius ocellaris,* found in holes within a small boulder. Species recorded during the surveys are presented in Appendix 2. Associated with *R. desmaresti* within intertidal sandy-mud sediments at Portchester Corner in Portsmouth Harbour were lugworm *Arenicola marina*, king ragworm *Alitta virens* and the prawn *Upogebia deltaura*. Although many holes in the sea-bed sediments resembling *Rissoides* burrows were observed by *Seasearch* divers and revealed in footage from the video sled, residency was unconfirmed.

Anglers reported *R. desmaresti* in the stomach of Tope (*Galeorhinus galeus*), Smooth-hound (*Mustelus mustelus*), Thornback ray (*Raja clavata*), Bass (*Dicentrarchus labrax*), Black bream (*Spondyliosoma cantharus*) and Pouting (*Trisopterus luscus*). Some tope and Smooth-hound caught off the Needles contained up to four shrimps. Shrimps were also found in Smooth -hound taken from Chichester Harbour. In a fine example of a Solent food chain one intact specimen of *Rissoides*, found in the stomach of a Tope caught by an angler, held a prawn (Hippolytidae) in one of its raptorial claws (2nd thoracopod).

Reproduction

Ovarian and cement gland development increases throughout the autumn and winter months and between January and April between 80-100% of females had cement glands at Stage 3 (Herbert, 2011). Cement gland development and mature ovaries were not observed in two juvenile females, estimated to be under one year old, suggesting that brooding may not be possible in the first year. In spring 2005, females kept in aquaria at the Medina Valley Centre were seen brooding newly spawned eggs on 19th March and the 5th and 14th April (Fig. 6). Eggs within a gelatinous mass are orange and ovoid in shape and are held and rotated between the second thoracopods and cleaned. This was observed for no more than six days when a visibly reduced mass of the spawn was left on the aquarium floor.

Discussion

There is no doubt that the Solent and Isle of Wight coast accommodates a substantial breeding population of *R. desmaresti*. New records confirm the species has been resident in the region for at least 180 years and likely very much longer. The species has been observed over a wide range of sediment types and at depths of up to 30m and is not confined to *Zostera* beds as originally thought. Bembridge remains a 'hot spot' for the species as reported by Bell (1844-52), yet other areas of the eastern Solent also have high densities. To a large extent the distribution maps reflect sampling effort as most records have come from oyster fishermen working particular beds regularly each season. There have been no recent records from Sandown Bay where '*a good many*' were washed up at Yaverland during a storm in 1904 (Morey, 1909). Although there is much less benthic trawling and dredging in this area, there are currently

Table 2. Records of *R. desmaresti* October 2007-2021 from the Solent and Isle of Wight. Previous records are available on National Biodiversity Network (nbn.org.uk).

Date	Location	Number of shrimps	Notes	Observer/Recorder
11/10/2007	Bembridge, off Coals Rocks	1	Fisherman record	R. Herbert
15/11/2007	Off Mudeford	1	Fisherman record	R. Herbert
November 2007	Off No-Mans Land Fort	Many	Fisherman record	R. Herbert
16/10/2008	Langstone Harbour. Sword Sands	1 Female	Substrate with *Sabella pavonina*	G. Watson
4/11/2008	Chichester Harbour	1	In Smooth-hound guts	A. Longford
12/11/2008	Chichester Harbour	1	In Smooth-hound guts	A. Longford
17/04/2010	Osborne Bay	16 of which 10 males. Some females yet to spawn. Lengths 60-181mm	In Smooth-hound guts.	R. Spink
06/06/2010	Off Wootton Creek	1 female, faint cement gland	While otter trawling. Water depth 8m.	M. Doggat
28/09/2011	Bembridge Lifeboat Station	1	In rock pool at extreme low tide amongst kelp beds	S. Taverner
July 2012	Yarmouth Pier	1	Caught by angler using sand eel as bait off bottom	J. Chesworth
August 2019	Yarmouth Pier	1	Filmed on video at night.	S. Greenhill & R. Herbert
6/9/2021	Binnel Bay	1	Moult caught on pot rope observed while diving.	T. Vikers & L. McConnell

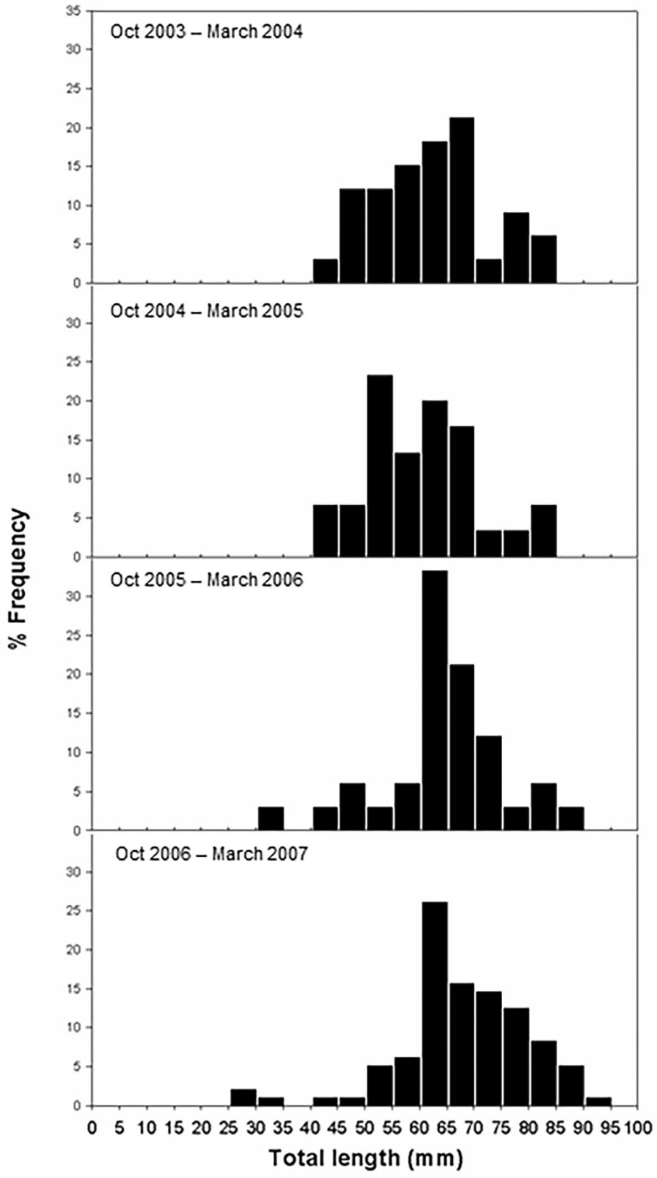

Fig. 5: Size-frequency of live *R. desmaresti* caught in Solent and Isle of Wight waters. Winter 2003-4 (n = 30); 2004-5 (n=30); 2005-6 (n = 33) and 2006-7 (n = 96).

Fig. 6: Lateral view of head and thoracic region of female.

R. desmaresti brooding egg mass in aquarium at Medina Valley Centre in 2005. Note five spines on the raptorial claw.

many interested beachcombers reporting observations of other washed-up species on social media!

It is interesting to note that despite oyster dredging activity over many decades, populations of these burrowing shrimps appear not to have been adversely affected. Fewer oysters are now caught in the western Solent, due to disease and reduced populations, yet the seabed here is firmer and oyster dredges may not disturb shrimps as readily as in softer ground. Records from the south of the Isle of Wight and elsewhere on the east coast do confirm that the species can burrow into substrate with a gravel component, so it would not be surprising if larger populations existed in the western Solent. The species preference for sandy mud is consistent with observations of other populations, such as in north Wales (Ramsay & Holt, 2001). It seems likely that mud is important for burrow construction and to prevent their collapse. The accuracy of the BGS sea-bed sediment map in Fig. 7, derived from samples obtained over a 30-year period, is likely to vary spatially as there will have been some changes since publication due to dredging and other disturbances and developments. The map is also of insufficient resolution to show finer scale distributions of sediments that will accumulate around new structures and developments such as the Cowes breakwater. Inshore, *R. desmaresti* has been recorded from Newtown Harbour and beneath Yarmouth Pier, where a live individual was filmed on video (Herbert *et al.* 2021).

Being of subterranean habit, the species is likely to be under-recorded, as suspected by Morey (1909). Yet anecdotally, fishermen considered that captures had increased since the 1980s and 1990s which would not be surprising as sea temperatures are rising, and this is a southern species at the northern edge of its geographical range. Yet it is unclear whether the species range has recently expanded eastwards into the North Sea or whether new populations have been discovered through increased survey effort (Griffin *et al.* 2011). However, after a long absence, larvae appear to have become more frequent in the Belgian part of the North Sea (Vansteenbrugge *et al.* 2012).

The reproductive cycle of *R. desmaresti* appears similar to the larger *Squilla mantis* (L.1758) in the Mediterranean which also develops cement glands over the winter and spawns from April to June (Do Chi, 1978; Maynou *et al.* 2004). Prior to spawning, female *S. mantis* remain in their burrows and do not feed (Piccinetti and Picinetti-Manfrin, 1970; Do Chi, 1978). This behaviour has yet to be confirmed for *R. desmaresti;* however the larger numbers of females captured in the autumn months may be linked to a higher feeding rate prior to brooding in burrows. Several mature female shrimps captured in a static baited prawn pot at Bembridge in January supports this assertion. It was disappointing not to find any shrimps during the *Seasearch* dives or on footage from the video-sled, however most of these surveys were carried out from May-September when captures were fewest. In the Ebro Delta in the Mediterranean, where fishing effort for the commercially important *S. mantis* is constant throughout the year, catches are also reduced in the summer months (Abello' and Martin, 1993), therefore, it is possible that there is significant mortality post-spawning. Although rearing *R. desmaresti* eggs brooded in the aquarium was unsuccessful, larvae have

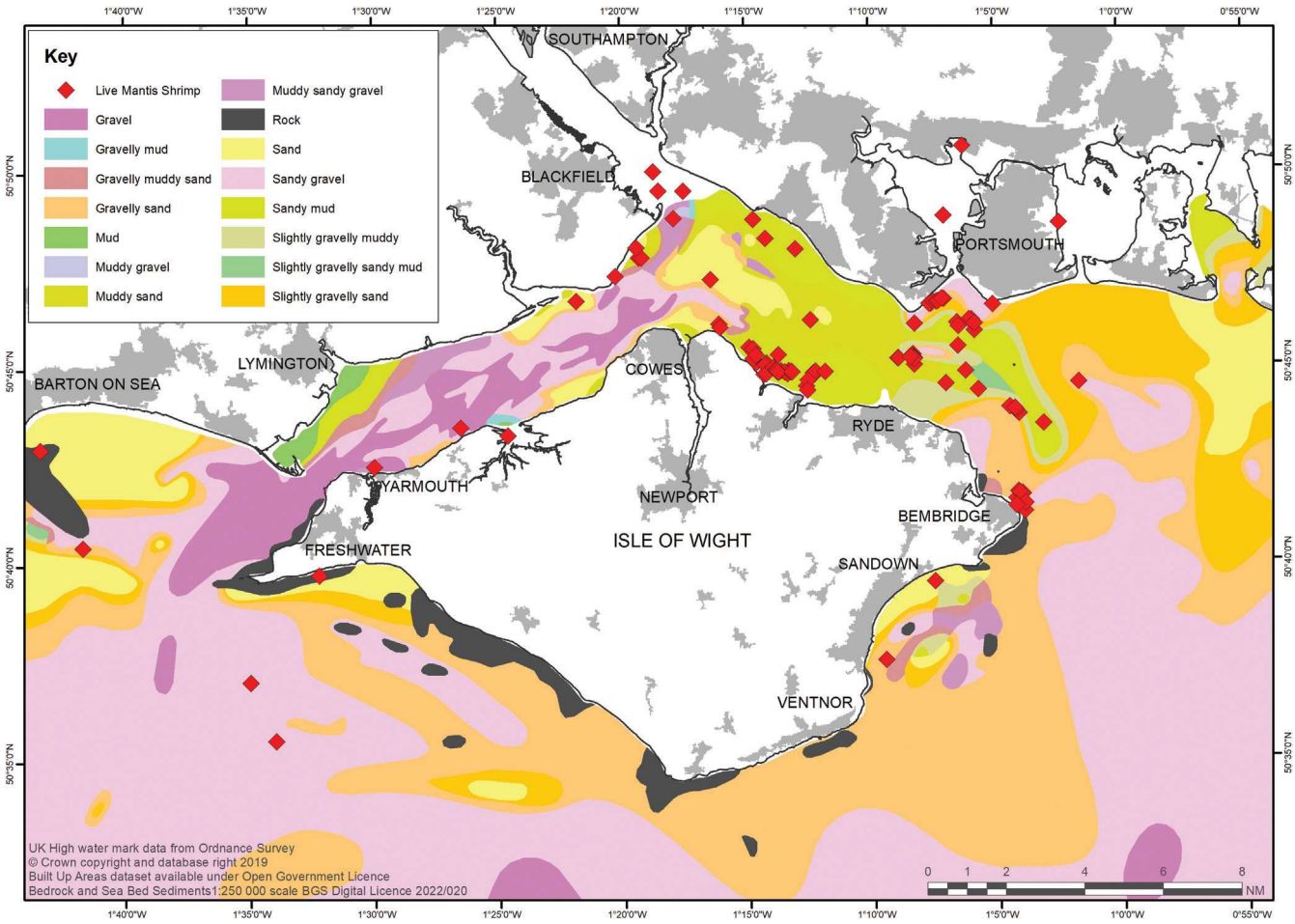

Fig 7: Position of live *R. desmaresti* caught in the Solent and around the Isle of Wight superimposed on seabed sediments (British Geological Survey, 2003).

been found in plankton trawls in July off Hurst Castle (M. Sheader personal communication) and off Calshot and in Southampton Water in July and August (Muxagata, 2005). The presence of shrimps less than 35mm TL in November 2005 and December 2006 suggests these are likely to be young of the year.

Within the Solent ecosystem, *R. desmaresti* is likely to be important both as predator and prey. With just one exception, all records of shrimps within fish stomachs were in April and May, when fish feeding starts to increase as waters warm. Shrimp burrowing activity will also be important for the biogeochemical recycling of important nutrients. In 2002, the species was included within the Biodiversity Action Plan (BAP) for the Isle of Wight owing to its nationally scarce status and locally important populations. It is sometimes seen as a 'flagship' species for the Solent benthos! Currently the species it is not unduly threatened, however aggregate and navigational dredging activity and coastal development may have a localised impact on populations.

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Appendix 1: Details of habitat survey sites and methods used.

Site	Location	Position	Method	Depth (m)	Date	Notes
1	Between Norris & Wootton Creek		Oyster dredge with 10mm net	<10	1/5/2003	Substrate dominated by *Crepidula*. Sand and gravel inshore with *Zostera*. Mud present.
2	Off Kings Quay	50° 44 -583'N; 01° 18. 59.9'W	Oyster dredge with 10mm net	2-4	9/9/2003	Much *Zostera*.
3	Sturbridge Shoal off Ryde	50° 45.238 -112 N; 01° 8.758-236 W	2m Beam Trawl	6-19.4	28/1/2004	Substrate mainly clean shell *Crepidula*. Water temperature 7.5 °C
4	Sturbridge Shoal off Ryde	50° 45.103 -021 N; 01° 8.879-516 W	2m Beam Trawl	17.3-20.2	28/1/2004	Substrate mainly clean shell *Crepidula*
5	Sturbridge Shoal off Ryde	50° 44.973 -890 N; 01° 9.960-8.443 W	2m Beam Trawl	20	28/1/2004	Substrate mainly clean shell *Crepidula*. Just off pipeline
6	Sturbridge Shoal off Ryde	50° 44.797 -759 N; 01° 9.891-8.316 W	2m Beam Trawl	13.6-17.5	28/1/2004	Substrate mainly clean shell *Crepidula*. Just off pipeline
7	Sturbridge Shoal off Ryde	50° 44.922-45.065 N 01° 8.114-8.417 W	3'clam dredge; 3.5'oyster dredge; Van Veen grab	7.7-19.9	7/5/2004	Substrate mainly stones, oyster shell and *Crepidula*
8	Sturbridge Shoal off Ryde	50° 45.242-195 N 01° 08.192 W	Oyster dredge; Van Veen grab; Night survey 19:30-22:00	6.2-15	9/2004	Substrate muddy gravel, *Crepidula*
9	River Yar, Yarmouth		Video sled	<5	2/6/2006	Mud – no burrows seen
10	Off Fresh-water	50 ° 35.373 N; 01 ° 32.574 W	Video sled	26	2/6/2006	Shingle with some shell. Patches of clay bedrock, some bored with piddocks. ?*Rissoides* burrows occasional.
11	Off Totland	50° 40.89 N; 01° 33.15W	Video sled	~5	2/6/2006	Sand and weed with some *Zostera*. No burrows seen.
12	Near Peel Wreck Buoy off Wootton Creek	50° 44.21 –45.065 N; 01° 13.824-8.417 W	Video sled	8.0	7/6/2006	?*Rissoides* burrows present
13	Off Peel Wreck Buoy Wootton Creek	50 ° 44.854-44.98N; 01 ° 13.184 -598 W	SCUBA (drift)	8.0	17/6/2006	Mixed sediments comprising mud with shell. ?*Rissoides* burrows 1 per m^2
14	Off Peel Wreck Buoy	50 ° 44.86-854 N; 01 ° 13.17-152 W	SCUBA	8.0	2/7/2006	Mixed sediments comprising mud with shell. ?*Rissoides* burrows 2 per m^2
15	Off Peel Wreck Buoy	50 ° 44.86 N; 01 ° 13.17 W	SCUBA	7-8	7/7/2006	Sandy mud with shell. Many burrows. *Alcyonidium* on shells. 1?*Rissoides* burrow per m^2
16	Off Peel Wreck Buoy	50 ° 44.85 N; 01 ° 13.18 W	SCUBA (Night) from 17:45-18:33	9.0	16/10/2006	Silty fine sediment. *Crepidula fornicata* shell predominant. ? *Rissoides* burrows common

Appendix 2: Species recorded within different habitats where *R. desmaresti* had been reported. See Appendix 1 for Survey details. Abundance: S-Superabundant; A-Abundant; C- Common; F-Frequent; O-Occasional; R-Rare; P-Present.

See text for further details and Seasearch surveyor guidance available at:
http://www.seasearch.org.uk/downloads/Survformguide%202-14.pdf.

		Surveys														
Group	**Species**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Algae	*Calliblepharis ciliata*				R		R										
	Ceramium sp.			R	R		F	O									
	Corallina sp.							O									
	Cryptopleura ramosa						R										
	Saccharina latissima						R	R					O				
	?Lomentaria articulata							O									
	Osmundea pinnatifida						R	O									
	Palmaria palmata							O					R				
	Plocamium cartilaginum				R												
	Rhodophyta spp.															A	
	Sargassum muticum							R									
	Ulva sp.						R						O				
Plants	*Zostera marina*	P	F														
	Zostera sp.	P										O					
Porifera	*Amphilectus fucorum*						O	O									O
	Clathria sp.						R										O
	Cliona celata														O	O	
	Dysidea fragilis						O	O									R
	Halichondria ?bowerbankii				R		R							O	O		O
	? Hymeniacidon perlevis							O									F
	Myxilla sp.													P			O
	Pachymatisma johnstonia													O			
	Porifera spp.										P		O				
	Suberites ficus			R				O									R
	Suberites massa						O										
	Suberites sp.								P					O	O		
	Tethya aurantium								P								
Cnidaria	*Actinia equina*															O	
	Actinothoe sphyrodyta							R									
	Anemonia viridis	R												R	R		
	Halecium sp.					R											
	Hydrallmania falcata				O	R	O	O			R				O	O	O
	Hydroidea sp.								P					C			
	?Kirchenpaueria pinnata							O									
	Nemertesia antennina							O			O						
	Plumularia setacea							O									
	Sertularella ?gaudichaudi				O			O									
	Sertularia argentea				R			O							O		
	Sertularia sp.																O
	Urticina felina										O		R				
Annelida	Aphroditiformia sp.							R									
	Myxicola infundibulum													R	O	R	
	Sabellaria spinulosa								P						O	F	
	Spirobranchus triqueter						R	O									
Crustacea	*Alpheus glaber*							R									
	Anapagurus sp.							O									
	Austrominius modestus	R	R	O													
	Balanus crenatus	O	O	O	O		O	O	P					O			
	Carcinus maenas	O		R	R												
	Galathea squamifera								P								
	Galathea sp.							O									
	Hyas araneus						R							R	R	O	
	Ebalia tumefacta	R															
	Inachus dorsettensis							O									
	Inachus phalangium			R			R										

Appendix 2: continued

		Surveys														
Group	**Species**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Crustacea (continued)	*Inachus* sp.								P						O	C	P
	Liocarcinus arcuatus					R	R	O									
	Liocarcinus depurator			R													
	Liocarcinus sp.																P
	Macropodia ?rostrata	O		O	O	R	F		P					R	O		P
	Maja bachydactyla							O	P					R			P
	Necora puber								P								
	Pagurus bernhardus													R	R		
	Pagurus cuanensis							O									
	Perforatus perforatus								P								
	Pilumnus hirtellus					R		O	P								
	Palaemon serratus		R														
	Pisa tetraodon						R										
	Pisidia longicornis			O				C	P								
	Porcellana platycheles								P								
	Sacculina ?carcini			R													
Mollusca	*Aequipecten opercularis*				O		O	R						O		F	
	Akera bullata and spawn									C							
	Anomia ephippium								P								
	Buccinum undatum				O		O		P							O	R
	Calliostoma zizyphinum							O	P								
	Mimachlamys varia	F					R	O	P				R				
	Crepidula fornicata	C	C		C	F	F	F	P		O		P	C	C	F	C
	Doris pseudoargos (with spawn)													R			
	Emarginula fissura							R									
	Loliginidae sp.																P
	Nassarius incrasstus							R	P								
	Nassarius reticulatus					O		O					O	O	R		P
	Nucula sp.							O	P								
	Ocenebra erinacea (* with eggs)								P					P*			
	Ostrea edulis	O	O	O				F	P		O		O	O	O	O	R
	Pecten maximus							R	P					P		R	
	Steromphala cineraria							F	P								
	Sepiola sp.	R															
	Sepia officinalis	R						R									
	Sepia sp.																P
	Trivia arctica						R										
Bryozoa	*Alcyonidium diaphanum*	P	P	O	O	O	O	O					O	C	F	A	
	Disporella sp.							O									
	Encrusting bryozoan							O									
	Flustra foliacea		O	O	F		C	F	P								
	Parasmittina sp.							O									
	Vesicularia spinosa																P
Echinodermata	*Asterias rubens*										O						
	Crossaster papposus										O						
	Henricia oculata										O						
	Ophiothrix fragilis	R															
Ascidia	*Ascidiella aspersa*																C
	Ciona intestinalis															O	
	Corella eumyota															R	
	Dendrodoa grossularia			R	O	O	O	F								O	R
	Polycarpa scuba																R
	Styela clava				R				P						F	O	
	?Styela coriacea				R		R	O									
Pisces	*Blennius ocellaris* (Butterfly blenny)							R	P								
	Callionymus sp. (Dragonet)				O		O		P								

Appendix 2: continued

		Surveys														
Group	**Species**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Pisces (continued)	?*Ctenolabrus rupestris* (Goldsinny wrasse)										R						
	Gobiidae sp.																C
	Gobius niger (Black goby)			R			F										
	Lepadogaster candolii (Connemara clingfish)							R									
	Mullus surmuletus (Red mullet)		R														
	Nerophis lumbriciformis (Worm pipefish)		R														
	Platichthys flesus (Plaice)		R														
	Pholis gunnellus (Butterfish)								P								
	Pomatoschistus spp. (Gobies)	O	O		R						R			O	F	C	
	Scyliorhinus canicula (Lesser spotted dogfish)				R												
	Spinacchia spinnachia (Fifteen-spined stickleback)		R														
	Syngnathus sp.													R	R		
	Syngnathus acus (Greater pipefish)	R	R														
	Symphodus melops (Corkwing wrasse)		R														
	Syngnathus typhle (Broad-nosed pipefish)	R	R														
	Trisopterus luscus (Bib)		O		F		F										
	Trisopterus minutus (Poor cod)			R	O	R	O										
	Taurulus bubalis (Long-spined Sea scorpion)		R				O										