

Aquatic Invasions Records

Reports of American lobsters, *Homarus americanus* (H. Milne Edwards, 1837), in British waters

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Abstract

American lobsters (*Homarus americanus*) are native to the east coast of North America and Canada, but have been imported live into Europe for several decades resulting in their escape into the wild. American lobsters have the potential to have a significant impact on the European lobster (*Homarus gammarus*) fisheries in Europe, but the status of American lobsters is not well understood, especially in Great Britain (GB) where reports have been sporadic. Reports were collated from across GB of American lobsters being caught in coastal waters. Between 1988 and 2011, 26 individuals have been positively identified using standard taxonomic techniques. American lobsters were found predominantly in waters off southern England, with no confirmed reports from Wales and a single report from Scotland. However, there are anecdotal reports of American lobsters being found in much greater numbers from around GB. The potential threat that American lobsters pose to fisheries in GB and the rest of Europe is discussed along with recommendations to better estimate the numbers of animals being released.

Key words: *Homarus gammarus*, European lobster, invasive, non-native, disease transfer, threat

Introduction

There have been thriving lobster fisheries of significant economic importance on either side of the Atlantic for many years. The American lobster (Figure 1A), *Homarus americanus* (H. Milne Edwards, 1837), is found predominantly along the East coast of North America and Canada, while its close relative, the European lobster (Figure 1B), *H. gammarus* (Linnaeus, 1758), is found throughout Europe. Importation of American lobsters, into Great Britain (GB - including Wales, Scotland and England) and other European countries was made economically practical with the development of transatlantic jet aircraft (Alderman 1996). The fast and reliable transportation of this valuable,

yet perishable, cargo resulted in the establishment of a retail market, allowing higher-valued European lobsters to be exported to mainland Europe. The importation of live non-native species invariably leads to their release into the wild (Carlton 1985; 2000), either through deliberate or accidental actions. The American lobster is no exception to this rule with reports of it being found in the waters of a number of northern European countries (van der Meeren et al. 2010).

The presence of American lobsters in European waters is a point of concern. The American lobster has biological characteristics (when compared to European lobsters) often associated with invasiveness; they are more aggressive, grow to a larger size, are more

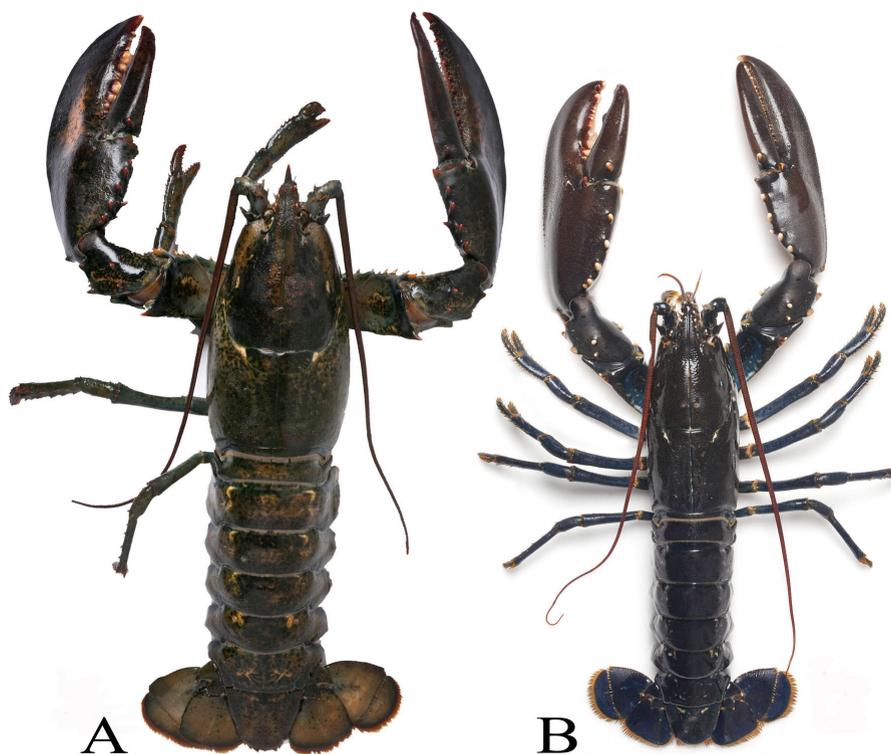


Figure 1. **A)** The American lobster *Homarus americanus* (H. Milne Edwards, 1837);
B) The European lobster *H. gammarus* (Linnaeus, 1758).
 Photos taken by **A)** Phil Hurst; **B)** Harry Taylor, NMH Photo Unit.

fecund, are more adaptive, being found in a broader range of habitat (but with overlap with that of European lobsters), and are highly mobile (see van der Meeren et al. 2000 for comparison). In addition American lobsters have also been found to breed with European lobsters in the wild (A.-L. Agnalt pers. comm.), resulting in hybridisation. It is therefore possible that American lobsters could out-compete European lobsters, and other economically and environmentally important species, such as the brown crab (*Cancer pagurus* Linnaeus, 1758), either directly or indirectly, if they were to become established. Threats from American lobsters also include diseases, for example Gaffkaemia, a bacterial disease that is lethal to *Homarus* spp., which originated from North American (Kellog et al. 1974; Alderman 1996). It was first reported in European lobster holding facilities in Norway and the Netherlands (Roskam 1957; Egidius 1978) then subsequently in GB (Wood 1963). Gaffkaemia has caused significant loss of stock (>100%) in holding facilities where animals are

often held in close proximity. It has subsequently spread into wild European lobster stocks in Norway (Wiik et al. 1987), the Orkneys (Nilsen et al. 2002 in Shields et al, 2006) and GB (Cefas, unpublished data). It has not appeared to have an impact on infected wild populations (Stewart et al. 1996), although mortality events are difficult to identify in marine benthos. Other diseases such as Epizootic Shell Disease may also be transferred with American lobsters to Europe (Stevens 2009). This disease has resulted in the closing of parts of the North American lobster fishery and its impact on European lobster fisheries could be equally severe.

Given the potential impact that American lobsters could have in GB and other parts of Europe, it is important to understand if their numbers are increasing. However, the reporting of marine invasive species in GB to date is limited. This paper presents collated data of confirmed findings of American lobsters in GB waters and discusses the importance of these findings.

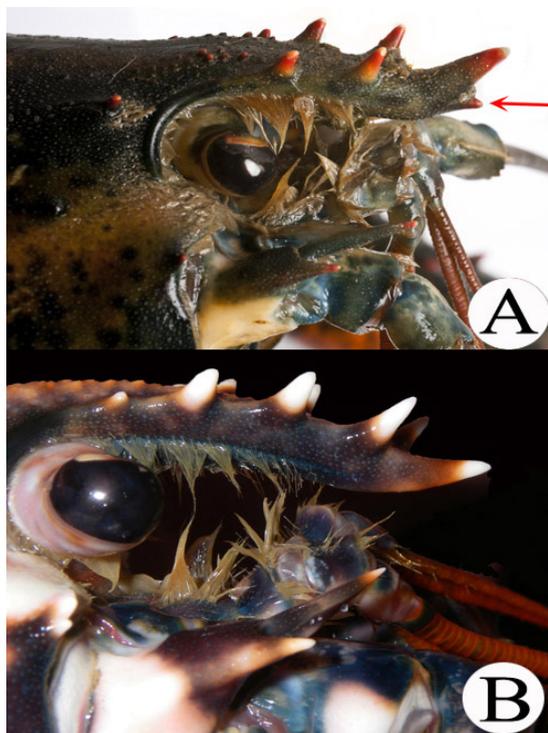


Figure 2. Spine on the ventral rostral margin; **A)** present on the American lobster *Homarus americanus* (H. Milne Edwards, 1837); **B)** absent from the European lobster *H. gammarus* (Linnaeus, 1758). Photos taken by **A)** Phil Hurst NHM Photo Unit; **B)** Paul Stebbing Cefas.

Materials and methods

Reports of American lobsters found in GB waters were collated from a number of sources spanning a 20 year period. During the data collection process additional information was gathered, including: i) the date that the specimen was found; ii) the location; iii) gender; iv) other observations (such as size and the carrying of eggs), and v) if the animal was banded when landed. This final point was considered important as it provided some indication of the length of time that the animal had spent in the water from original release. .

The methodology used to identify the lobsters was not always recorded and may have varied. It is assumed that morphological characteristics were used in all cases as there are no records and, to authors' best knowledge, no attempts to use molecular techniques to identify American lobsters found in GB waters. Characteristics used to taxonomically identify American lobster are normally based on colour and the presence of

one or more spines on the ventral surface of the rostrum (Figure 2A), which is normally absent in European lobsters (Figure 2B) (see van der Meeren et al. 2000 for a description of American lobsters). American lobsters tend to be “dark bluish green to brownish olive mottled with dark greenish black spots, often almost black, pleura with reddish tips”, while European lobsters are “bluish to bluish black dorsally, with white tracings or mottling on the carapace and the abdomen dorsally. Chelipeds have white tubercles; chelae may be suffused with orange tints and walking legs are lighter blue. The whole body may be much lighter in colour and under parts may appear yellowish or white” (Williams 1995, as referenced in Jørstad et al. 2011). There is some debate as to the reliability of taxonomic methods to correctly identify American lobsters due to the occasional occurrence of ventral spines on the rostrum of European lobsters and variations in colour.

Molecular techniques have been used in Norway to distinguish between ‘unusual’ lobsters with spines and ‘true’ American lobsters (Jørstad et al. 2007, 2011). This technique eliminated false positives, with 91 suspect American lobsters having been found in Norway between 2000 and 2011 with only 24 of these being confirmed as American lobster (Jørstad et al. 2011). However, the occurrence of sub-rostral spines is rare in GB waters (Addison and Bannister 1994), with no suspect lobsters having been reported to date. It is therefore suspected that the ratio of ‘unusual’ lobsters may be lower in GB than that observed in Norway, although molecular testing would be the only method of testing this theory. For the purpose of this paper it is assumed that the animals identified were true American lobsters. Several of the reported landings of *Homarus americanus* in 2010 were identified by the Natural History Museum, London using key morphological characters and deposited in the reference collection (NHM reg. 2010.1087), so material is available from some samples for molecular analysis if required.

Results

Between 1988 and 2011, 26 American lobsters caught in the wild have been reported from GB waters (Appendix 1). Of particular interest is the distribution of the landings, with the majority having been found along the south coast of England, with the occasional exception (e.g.,

Discussion

From 1988 to 2011, 26 American lobsters have been reported from GB waters, which is almost certainly an underestimate. There are anecdotal reports of additional American lobsters having been landed from both the North East of England and from North Wales, but no official reports.

American lobsters have been reported from the wild in number of other European countries including Denmark, Ireland, Norway, Sweden (van der Meeren et al. 2010) and Normandy, France in 2003 (International Council of the Exploration of the Sea (ICES) Reports of the Working Group on Introductions and Transfers of Marine Organisms 2001-2008). American lobsters have also been deliberately introduced into a number of locations over the years, including the Pacific coast of America and Japan (Kittaka 1984). Although there establishment in these locations is not clear.

A study conducted in France saw the release of 1,300 juvenile hybrid American/European lobsters (Addison and Bannister 1994). Although male hybrids appeared to be sterile (Audouin and Leglise 1972; Hedgecock et al. 1977; Carlberg et al. 1978; Talbot et al. 1983; Talbot et al. 1984), the females would still breed with European males and produce viable offspring. A 'berried' or ovigerous female was reported from GB waters in 1995. This maybe as a result of breeding in GB waters, rather than the animal being imported in this state, as berried females are protected in the United States and Canada. Female clawed lobsters are able to store sperm for a considerable period, so mating could have occurred sometime prior to capture in GB, or the eggs extruded or mating occurred during transport to GB (Jørstad et al. 2011). The discovery of a berried American female lobster in Norway, which produced hybrid American/European lobsters, is clear evidence that interspecific mating does take place in the wild (A.-L. Agnalt pers. comm.). In van der Meeren et al. (2008) it was shown that if provided with a choice, female *H. gammarus* would select conspecific males, even over a dominant *H. americanus* male. However, evidence would suggest that if a male conspecific was not available then hybridisation may occur in the wild. The potential impact that hybridisation and interspecific mating may have on a population, such as changes in morphology, behaviour,



Figure 3. Map showing the location of American lobsters found in Great British waters between 1988 and 2011 (data taken from Appendix 1).

Scotland). A large number (50%) of the reports were made in 2010, the majority being from two locations along the south coast of England (Figure 3).

Although there is a lack of detail relating to animals caught, it is interesting to note that several had banded claws. This is a process of securing the claws closed with strong elastic bands to control the results of aggression. This suggests that the animals had not been in the water for a prolonged period of time. One ovigerous female was collected in 1995. Gender had been inconsistently reported, but the majority of those that were being male. The number of cases where carapace length (CL) was recorded is small but always ≥ 90 mm, which is about the minimum size imported for human consumption.

dilution of genetic integrity and reduction in breeding capacity is not understood.

Despite American lobsters having been found in European waters for a number of years, it is not clear if they have become established. In many cases it is some years between initial introduction and establishment of an invasive species (Drake and Williamson 1986). This lag phase was observed in other invasive decapod Crustacea in Europe, such as the Chinese mitten crab (*Eriocheir sinensis* H. Milne Edwards, 1853), where there was a significant gap between initial introduction and subsequent population explosion (Clark et al. 1998; Herborg et al. 2003, 2005). *Homarus americanus* in Europe could potentially be going through a similar lag phase between initial introduction and establishment, although there is a lack of current evidence to confirm this.

Documentation of actual release of *H. americanus* into GB waters is scant. However, there are several potential pathways of introduction. Ships and boats have been highlighted as a potential source, for example, cruise liners emptying unused stock overboard. Pleasure boats, such as yachts, have been implicated in the past where it has been suggested that owners may have purchased animals from a local shop, but then did not have the heart to cook them and decided to 'return' them to the wild. Animal activists and well intentioned individuals who are unaware of the ecological consequences of their actions, or as a result of religious belief (see Shiu and Stokes 2008), have also been suggested as the source of other releases. Another potential source of introduction is via holding facilities located near the coast where *H. americanus* have either escaped or have been deliberately released. One obvious source of potential releases is where American lobsters are held in off shore storage pots that are subsequently destroyed by storms or they simply fall into disrepair. It should be noted that it is illegal to hold American lobsters in open waters in this manner in GB under the Lobster (Control of Deposit) Order 1981. The rise in number of American lobsters reported in 2010 may be due to this type of mass release. This is evidence in the high number of reports from Sussex/Hampshire and Devon, with animals of similar commercial size, some banded, and none with significant bio-fouling, being caught over a relatively short time period. Regardless of motive, it is an offence under the Wildlife and

Countryside Act 1981 to release any animal not normally resident in GB to the wild.

Although *H. americanus* would not yet appear to have become established in GB waters, there are significant reasons for concern. If numbers continue to increase then there is a strong possibility that this species could become established in the wild, potentially with substantial negative consequences for native lobster stocks. Despite more ongoing detection of American lobsters in GB waters, there is still an important gap in the information being provided, i.e. pertinent information such as gender and carapace length. There needs to be a significant drive in raising public awareness of this species, ensuring relevant people are aware of potential impacts this species may have if it was to become established. The routine use of molecular identification methods would also be appropriate to confirm species identity if questionable lobsters are reported. Finally, there needs to be a reliable method to report captures and to ensure all of the required information is recorded.

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References

- Addison JT, Bannister RCA (1994) Re-stocking and enhancement of clawed lobster stocks: a review. *Crustaceana* 67(2): 131-155, <http://dx.doi.org/10.1163/156854094X00521>
- Audouin J, Leglise M (1972) Premiers resultats d'experiences relatives aux possibilites d'acclimatation de homard americain *Homarus americanus* en France. ICES Comm Meet E: 34: 1-3
- Alderman DJ (1996) Geographical spread of bacterial and fungal diseases of crustaceans. *Scientific and Technical Reviews, Office of International Epizootics* 15: 603-632
- Carlberg JM, Van Olst JC, Ford RF (1978) A comparison of larval and juvenile stages of the lobsters, *Homarus americanus*, *Homarus gammarus* and their hybrid. *Proceedings of the World Mariculture Society* 9: 109-122
- Carlton JT (1985) Transoceanic and interoceanic dispersal of coastal marine organisms: the biology of ballast water. *Oceanography and Marine Biology Annual Review* 23:313-371
- Carlton JT (2002) Bioinvasion ecology: assessing invasion impact and scale. In: Leppakoski E, Gollash S, Olenin S (eds), *Invasive aquatic species of Europe: distribution, impacts and management*. Kluwer Academic Publisher, Dordrecht, Boston, London, pp 7-9
- Clark PF, Rainbow PS, Robbins RS, Smith B, Yeomans WE, Thomas M, Dobson. G (1998) The Alien Chinese mitten crab, *Eriocheir sinensis* (H. Milne Edwards, 1854)

- [Crustacea: Decapoda: Brachyura], in the Thames Catchment. *Journal of the Marine Biological Association* 78(4): 1215-1221, <http://dx.doi.org/10.1017/S00253154000443X>
- Drake JA, Williamson M (1986) Invasions of natural communities. *Nature* 319: 718-719, <http://dx.doi.org/10.1038/319718b0>
- Egidius E (1978) Lobster Import: two outbreaks of Gaffkemia in Norway. I.C.E.S. Shellfish Committee No. 17
- Herborg L-M, Rushton SP, Clare AS, Bentley MG (2003) Spread of the Chinese mitten crab (*Eriocheir sinensis* H. Milne Edwards) in Continental Europe: analysis of a historical data set. *Hydrobiologia* 503: 21-28
- Herborg L.-M, Rushton SP, Clare AS, Bentley MG (2005) The invasion of the Chinese mitten crab (*Eriocheir sinensis*) in the United Kingdom and its comparison to continental Europe. *Biological Invasions* 7: 959-968, <http://dx.doi.org/10.1007/s10530-004-2999-y>
- Hedgecock D, Nelson K, Simons J, Shleser R (1977) Genic similarity of American and European species of the lobster *Homarus*. *Biological Bulletins* 152: 41-50, <http://dx.doi.org/10.2307/1540725>
- Jørstad KE, Prodohl PA, Agnalt A-L, Hughes M, Farestveit E, Ferguson AF (2007) Comparison of genetic and morphological methods to detect the presence of American lobsters, *Homarus americanus* H. Milne Edwards, 1837 (Astacidae: Nephropidae) in Norwegian waters. In: Cook EJ, Clark PF (eds), Invasive Crustacea. Symposium 7 at the Sixth International Crustacean Congress (ICC6), held at the University of Glasgow, UK, 18-22 July 2005. *Hydrobiologia* 590: 103-113
- Jørstad KE, Agnalt A-L, Farestveit E (2011) The introduced American lobster, *Homarus americanus* in Scandinavian waters. In: Galil BS, Clark PF, Carlton JT (eds), In the wrong place: alien marine crustaceans – distribution, biology and impacts. Springer series in Invasion Ecology. Springer-Verlag, Dordrecht, pp 652-638
- Kellog S, Steenbergen JF, Scharpio HC (1974) Isolation of *Pediococcus homari* etiological agent of Gaffkemia in lobsters from a California estuary. *Aquaculture* 3:409-413, [http://dx.doi.org/10.1016/0044-8486\(74\)90007-6](http://dx.doi.org/10.1016/0044-8486(74)90007-6)
- Kittaka J (1984) Ecological survey of lobster *Homarus* along the coasts of the Atlantic Ocean. Ecology and distribution of *Homarus capensis* along the South Atlantic Ocean. Report to the Ministry of Education, Culture and Science (Overseas Scientific Survey No. 56042009, 57041052 and 58043052), (1984), p 118
- Linnaeus C (1758) *Systema Naturae per Regna Tria Naturae, Secundum Classes, Ordines, Genera, Species, cum Characteribus, Differentiis Synonymis, Locis*. Edition 10. Holmiae. I: iii + 1-824
- Milne Edwards H (1837) Histoire naturelle des Crustacés, comprenant l'anatomie, la physiologie et la classification de ces animaux. Paris, Librairie de Roret. II: 1-532
- Roskam RT (1957) Gaffkaemia, a contagious disease, in *Homarus vulgaris*. I.C.E.S. Shellfish Committee no. 1. (Mimeo)
- Shields JD, Stephens FJ, Jones B (2006) Pathogens, Parasites and other Symbionts. In: Philips B (ed), Lobsters: Biology, Management, Aquaculture and Fisheries. Blackwell Publishing, pp 146-204, <http://dx.doi.org/10.1002/9780470995969.ch5>
- Shiu H, Stokes L (2008) Buddhist animal release practices: historic, environmental, public health and economic concerns. *Contemporary Buddhism* 9(2): 181-196, <http://dx.doi.org/10.1080/14639940802556529>
- Stevens BG (2009) Effects of epizootic shell disease in American lobsters *Homarus americanus* determined using a quantitative disease index. *Disease of Aquatic Organisms* 88: 25-34, <http://dx.doi.org/10.3354/dao02135>
- Stewart JE, Cornick JW, Spears DI (1966) Incidence of *Gaffkya homari* in natural lobster (*Homarus americanus*) populations of the Atlantic Region of Canada. *Fisheries Research Board of Canada* 23(9): 1325-1330, <http://dx.doi.org/10.1139/f66-123>
- Talbot P, Thaler C, Wilson P (1984) Spawning, egg attachment and egg retention in captive lobsters (*Homarus americanus*). *Aquaculture* 37: 239-249, [http://dx.doi.org/10.1016/0044-8486\(84\)90157-1](http://dx.doi.org/10.1016/0044-8486(84)90157-1)
- Talbot P, Hedgecock D, Borgeson W, Wilson P, Thaler C (1983) Examination of spermatophore production by laboratory-maintained lobsters (*Homarus*). *Journal of World Mariculture Society* 14: 271-278
- van der Meeren GI, Ekeli KO, Jørstad KE, Tveite S (2000) Americans on the wrong side- the lobster *Homarus americanus* in Norwegian waters. ICES CM 2000/U:20: 1-15
- van der Meeren GI, Chandrapavan A, Breithaupt T (2008) Sexual and aggressive interactions in a mixed species group of lobsters *Homarus gammarus* and *H. americanus*. *Aquatic Biology* 2: 191-200
- van der Meeren G, Støttrup J, Ulmestrand M, Øresland V, Knutsen JA, Agnalt A-L (2010) NOBANIS – Invasive Alien Species Fact Sheet – *Homarus americanus* – From: Online Database of the European Network on Invasive Alien Species – NOBANIS. <http://www.nobanis.org>
- Wiik R, Egidius E, Goksøyr J (1987) Screening of Norwegian lobsters *Homarus gammarus* for the lobster pathogen *Aerococcus viridians*. *Disease of Aquatic Organisms* 3: 97-100, <http://dx.doi.org/10.3354/dao003097>
- Wood PC (1963) Blood Disease of Lobsters (Gaffkaemia) results of investigations made 1962-1963. I.C.E.S. Shellfish Committee no. 25

Reports of American lobsters in British waters

Appendix 1. Reports of American lobsters caught in British waters between 1988 and 2011.

No	Date	Location	Gender	Observations	Banded	Source of information
1	1988	The Solent (Hampshire, south England)				Cefas
2	1989	Sennen (Cornwall, South England)	Male		Yes	Cefas
3	1991, March	South Devon (England)	Male	93mm CL		Cefas
4	1995, 17th March	30 mile south of Isle of Wight (Hampshire, South England)	Female	Ovigerous		Cornish Marine Life Records
5	2002, 22nd June	Selsey (West Sussex, South England)				ICES, 2002 report
6	2003	English Channel				ICES, 2003 report
7	2004, July	Felixstowe (Suffolk, east England)	Female	90mm CL		ICES, 2003-2007 report
8	2006	Bournemouth (Dorset, south England)				ICES, 2003-2007 report
9	2009	Selsey (West Sussex, South England)				Cefas
10	2009	Selsey (West Sussex, South England)				Cefas
11	2010, 20th May	Off Selsey Bill, 50° 42.20' N 000° 49.30' W (West Sussex, England)	Male		No	Sussex IFCA
12	2010, 1st June	Off Selsey Bill, 50° 40.70' N 000° 49 40' W (West Sussex, England)	Male		No	Sussex IFCA
13	2010, 1st June	East Wittering, 50° 44.67' N 000° 50.90' W (West Sussex, England)	Male		No	Sussex IFCA
14	2010, 23rd June	East Wittering, 50° 44.50' N 000° 55.00' W (West Sussex, England)	Male		No	Sussex IFCA
15	2010, 11th August	Christchurch Ledge, 50° 41.76' N 001° 42.20' W (Dorset, England)	Male	100mm CL		Marine Management Organisation
16	2010, 18th August	Brixham, 50°21.0' N 003° 28.766' W (Devon, England)	Male	94mm CL	Yes	Devon & Severn IFCA
17	2010, August/September	Salcombe 50°13.1' N 003° 45.3'W (Devon, England)			Yes	Devon & Severn IFCA
18	2010, August/September	Salcombe 50°13.1' N 003° 45.3'W (Devon, England)			Yes	Devon & Severn IFCA
19	2010, August/September	Salcombe 50°13.05' N 003° 49.8'W (Devon, England)			Yes	Devon & Severn IFCA
20	2010, 2nd September	East Wittering, 50° 44.28' N 000° 51.30' W (West Sussex, England)	Male		No	Sussex IFCA
21	2010, 21st September	Salcombe (Devon, England)			Yes	Devon & Severn IFCA
22	2010, 26th October	5 miles north of Buckie, Moray Firth (Scotland)	Male	141mm CL	No	Marine Scotland
23	2010, 28th October	East Wittering, 50° 43.65' N 000° 54.70' W (West Sussex, England)	Male	134mm CL	No	Sussex IFCA
24	2011, 22nd April	Off Selsey Bill, 50° 42.90' N 000° 46.30' W (West Sussex, England)	Male		No	Sussex IFCA
25	2011, July	Brixham (Devon, England)				Cefas
26	2011, October	The Wash (Norfolk, England)	Male			Picture in Fishing News