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The Distribution of Chondrichthyan Fishes Around the British Isles and Implications for Conservation

(Elasmobranch Fisheries – Oral)

by

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Abstract

Over 50 species of chondrichthyan fishes are known from waters around the British Isles, of which 26 have been recorded in CEFAS trawl surveys. The distribution and relative abundance of dogfishes, skates and rays are described from groundfish surveys in the North Sea, eastern English Channel, Irish Sea and Celtic Sea. The contemporary distribution of species is examined in relation to their biogeography and their distribution from historical records, and major changes in the distribution and relative abundance of species discussed in relation to stock status. Nursery areas of elasmobranchs are typically in shallower water than adult habitats and such patterns were evident for blonde *Raja brachyura*, thornback *R. clavata*, small-eyed *R. microocellata* and spotted ray *R. montagui*. In contrast, juvenile cuckoo ray *Leucoraja naevus* occurred in relatively deep waters and were most abundant in the western Irish Sea and northern St George's Channel. Nursery areas are typically areas of high productivity with abundant food resources and low predation rates. Oviparous species also require a suitable substratum for the deposition of eggs. Sites where the egg-cases and juvenile stages of dogfishes and rajid skates occur, and may be important nursery habitats, are identified.

Keywords: Elasmobranchii, Scyliorhinidae, Rajidae, Triakidae, Squalidae, distribution, biogeography

Introduction

Elasmobranch fish typically have a slow growth rate, late age at maturity and low reproductive output, and, therefore, are generally considered to be vulnerable to over-fishing (Holden, 1974). Indeed, the populations of several species have been observed to decline in response to commercial fisheries (e.g. Holden, 1974; Rogers and Ellis, 2000) and, in more extreme cases, have also resulted in extirpation from areas within their biogeographical range (Brander, 1981).

Due to the low fecundity of elasmobranchs, there is a better relationship between the stock size of mature females and recruitment than for most commercially important teleosts. Teleost fish are usually more fecund and recruitment is strongly dependent on environmental conditions. As spawning/parturition, and nursery areas may be critically important habitats for fishes, and serve an important ecological role in maximising the survivorship and/or growth of neonatal and juvenile fishes, they may be regarded as Essential Fish Habitat (EFH, which is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" (Cross *et al*., 1997)). Nursery areas are often areas with high production, abundant and suitable food and habitat resources and reduced predation (Castro, 1993; Simpfendorfer and Milward, 1993). Nevertheless, the role of nursery areas in the demography and

life-history of elasmobranch fishes has been little studied, and there is little known about such areas around the British Isles.

The present work uses data collected during annual groundfish surveys to examine the distribution and abundance of demersal elasmobranchs for the preliminary identification of areas that are potentially important for elasmobranch diversity, species of conservation importance and as spawning and/or nursery areas.

Materials and Methods

CEFAS conduct annual groundfish surveys in the Celtic Sea (March, Portuguese High headline trawl) and North Sea (August/September, GOV trawl). Annual surveys using 4 m beam trawls are also conducted in the southern North Sea and eastern English Channel (July/August), Irish Sea and Bristol Channel (September) and western English Channel (September/October). Data from these surveys were used to describe the distribution and relative abundance of chondrichthyan fishes. A taxonomic list of the species recorded in the present study is given in Table 1.

Data from the 4m beam trawl surveys were also used to determine the distribution of juvenile skates and dogfishes. We consider that this gear and sampling protocol is appropriate for the sampling of juvenile rajids, although the gear and location of sampling sites were probably not optimal for the capture of juvenile scyliorhinids (*Scyliorhinus canicula* and *S. stellaris*) and starry smoothhound (*Mustelus asterias*). Data for these species is included for the sake of completeness. Additionally, during 1998 and 1999, all egg cases of oviparous elasmobranchs found in the catch were counted.

Results

Distribution of chondrichthyan fishes around the British Isles

Twenty-six species of chondrichthyan fishes were recorded from groundfish surveys. Six-gill shark (*Hexanchus griseus*) was occasionally recorded in the Celtic Sea in waters of 148–581 m depth. Kitefin shark (*Dalatias licha*) was also only occasionally recorded in deep water (ca. 420 m) in the Celtic Sea. Velvet belly (*Etmopterus spinax*) was caught regularly along the shelf edge of the Celtic Sea (317–581 m deep), with catch rates of up to 162 ind.hr^{-1}. Spurdog (*Squalus acanthias*) was widespread and regularly caught around the British Isles, although it is infrequently caught in beam trawl surveys. This species was captured in waters 15–528m deep. Although the maximum catch was 2 800 ind.hr^{-1}, most catches were much smaller.

Three species of scyliorhinid were recorded. Black-mouth dogfish (*Galeus melastomus*) were caught in the northern North Sea and in the Celtic Sea at depths of 106–433m. Specimens were taken in the NW Irish Sea during the late 1980's, although there are no recent records. Lesser-spotted dogfish (*Scyliorhinus canicula*) was widespread and abundant (maximum catch rates were ca. 500 ind.hr^{-1}) along the southern and western sea boards of the British Isles, although its distribution in the North Sea was more patchy. They were recorded from depths of 6–308 m. Greater-spotted dogfish (*Scyliorhinus stellaris*) were caught occasionally, predominantly in the shallow waters (13–100 m depth) off the southern and western coasts of the British Isles, and they were rare in the North Sea. Most common on rough inshore grounds (e.g. Gower, Pembrokeshire, Lleyn Peninsula) where maximum catch rates were 18 ind.hr^{-1}.

Three species of triakid shark were recorded. Tope (*Galeorhinus galeus*) was caught regularly around the British Isles, although infrequently in beam trawl surveys. This species was recorded from depths of 17–200 m. Starry smoothhound (*Mustelus asterias*) was widespread around the British Isles in waters of 10-199m depth, although more abundant along the southern and western coasts of the UK. High catch rates were recorded in the outer Thames estuary and Bristol Channel. Smoothhound (*Mustelus mustelus*) was recorded less frequently in comparison to the starry smoothhound. It was relatively common along the southern and western coasts of the UK, and rare in the North Sea. Recorded in waters of 9–421 m depth.

Twelve rajid species were recorded, and this family was the most speciose elasmobranch taxa on the continental shelf around the British Isles. Starry ray (*Amblyraja radiata*) was abundant in the North Sea in waters of 32–209 m. Maximum catch rates were 232 ind.hr^{-1}. This species was not recorded from the southern and western coasts. Common skate (*Dipturus batis*) was absent from inshore waters of England and Wales, and catches were restricted

to the northern North Sea and Celtic Sea in waters of 84–271 m. The maximum catch rates were 4 ind. hr^{-1}. Long-nosed skate (*Dipturus oxyrinchus*) were rare, with individual fish very occasionally recorded in the northern North Sea and Celtic Sea in waters of 111–159 m. Once again, this species was absent from the inshore waters of England and Wales. One specimen of black skate (*Dipturus nidarosiensis*) was caught in the Celtic Sea at 124 m depth.

Sandy ray (*Leucoraja circularis*) was only caught occasionally, with individual fishes caught in the northern North Sea and Celtic Sea at depths of 108–432 m. This species was absent from the inshore waters of England and Wales. Shagreen ray (*Leucoraja fullonica*) was also absent from the shallow waters of England and Wales, and catches were restricted to northern North Sea and Celtic Sea in waters of 90–424 m. Maximum catch rates were 7 ind. hr^{-1}. Cuckoo ray (*Leucoraja naevus*) was common in the Irish and Celtic Seas and northern North Sea at depths of 12–290 m. The maximum catch rate was 58 ind. hr^{-1}. This species was rarely recorded in the eastern English Channel and southern North Sea.

Blonde ray (*Raja brachyura*) was common in the inshore waters (14–146 m) off southern and western England. It was caught infrequently in the North Sea and Celtic Sea and was most common in the Bristol Channel and St George's Channel, where maximum catch rates were 72 ind. hr^{-1}. Thornback ray (*Raja clavata*) was widespread around the British Isles, although more abundant along the southern and western coasts of the UK, where maximum catch rates were ca. 200 ind. hr^{-1}. Catches in the central and northern North Sea were patchy. Overall, it was recorded at depths of 7–192 m. Smalleyed ray (*Raja microocellata*) was common in the Bristol Channel, where catch rates attained 40 ind. hr^{-1}. It was caught only occasionally in the English Channel and St George's Channel, and the maximum depth recorded was 112m. Spotted ray (*Raja montagui*) was widespread around the British Isles in waters of 8–283 m. It was more abundant along the southern and western coasts of the UK where catch rates can reach 88 ind. hr^{-1}. Catches in the central and northern North Sea were patchy. Undulate ray (*Raja undulata*) was frequently recorded in the English Channel, albeit at low abundance (<8 ind. hr^{-1}) with occasional specimens recorded from the southern North Sea. The maximum observed depth was 72 m.

Marbled electric ray (*Torpedo marmorata*) was occasionally caught in the English Channel and off Brittany in waters of 13–109 m depth. Electric ray (*T. nobiliana*) was more common in the Celtic Sea and its bathymetric distribution extended to deeper waters (28–413 m). Stingray (*Dasyatis pastinaca*) was only occasionally recorded and specimens were caught in the western English Channel at depths of 17–160 m.

Rabbitfish (*Chimaera monstrosa*) was the only holocephalan recorded, although several other species are known from deeper waters. Catches of *C. monstrosa* were restricted to the northern North Sea and Celtic Sea in waters of 156–592 m depth.

Distribution of juvenile elasmobranchs

The distribution and abundance of rajids (≤ 20cm total length) was examined. Juvenile *Raja brachyura* were infrequently caught, although they were recorded off Poole, Lleyn Peninsula, Start Bay and in the St George's Channel. *Raja clavata* was the most abundant rajid in the surveys and sites with a high relative abundance of juveniles included the north-eastern English Channel, northern Bristol Channel, Cardigan Bay and off the south coast of Scotland (e.g. Luce Bay and Solway Firth). The distribution of *Raja montagui* was similar to that of *R. clavata*, and juveniles were recorded in the north-eastern English Channel, northern Bristol Channel, Cardigan Bay and Luce Bay. Data for *Raja microocellata* were limited, and few fish =20 cm were recorded. Juveniles are known to occur in shallow waters and can be caught by beach seine along the sandy shores of the northern Bristol Channel (Ellis, pers. obs.). *Leucoraja naevus* was rarely caught in the English and Bristol Channels and was most abundant in the southern Irish Sea and St George's Channel. Juveniles are also caught regularly in the Celtic Sea.

Neonatal *Scyliorhinus canicula* were infrequently caught, which was in contrast to the large numbers of mature and maturing specimens that were caught during the surveys. This may be because the eggs are often deposited on sessile invertebrates, including sponges and bryozoans (Ellis and Shackley, 1997), and these taxa are often associated with coarse substrates, which are not always suitable grounds for trawling. Additionally, the mesh size of the net should facilitate the escape of neonatal *S. canicula*. The sporadic occurrence of juveniles of this species was in contrast to the large numbers of egg cases that could be caught. Large numbers of egg cases were caught at certain sites in the northern Bristol Channel and English Channel, and the largest catches of egg cases were associated with dead man's fingers (*Alcyonium digitatum*) and the bryozoan *Flustra foliacea*. Other important

substrates for the deposition of eggs included other bryozoans (*Cellaria* sp.), hydroids (*Hydrallmania falcata, Nemertesia antennina* and *Tubularia indivisa*) and sponges (e.g. *Haliclona oculata*).

Juveniles of *Scyliorhinus stellaris* were occasionally caught in the southern North Sea, eastern English Channel and Bristol Channel, although the adults were most common off the Lleyn peninsula and Anglesey. Indeed, large numbers of *S. stellaris* egg cases can be found on the strandline on beaches along the Lleyn Peninsula (Ellis, pers. obs.), and the egg cases of *S. stellaris* are often laid in shallow water, where they are attached to macro-algae (e.g. Ford, 1921). Neonatal and juvenile *Mustelus asterias* were relatively abundant in the outer Thames Estuary, Bristol Channel, Cardigan Bay and sites east and west of the Solent.

Discussion

Groundfish surveys were used to describe the distribution of chondrichthyan fishes. The elasmobranch fauna in the waters surrounding the British Isles can be broadly attributed to the following biogeographical guilds:

(a) Northern species occurring in the North Sea only (*Amblyraja radiata*).
(b) Deep-water species that were distributed along the outer continental shelf and shelf edge of the Celtic Sea and, for some species, the northern North Sea (*Hexanchus griseus, Dalatias licha, Etmopterus spinax, Galeus melastomus Dipturus oxyrinchus, Dipturus nidarosiensis, Leucoraja circularis* and *Chimaera monstrosa*). *Dipturus batis* also exhibited this distribution pattern, although it is known to have been more widespread at the beginning of the 20th century.
(c) Offshore species found along the continental shelf, but which are not abundant along the edge of the shelf (*Leucoraja fullonica* and *Leucoraja naevus*).
(d) Boreal species occurring all around the British Isles (*Squalus acanthias, Scyliorhinus canicula, Galeorhinus galeus, Mustelus asterias, Raja clavata* and *Raja montagui*).
(e) Southern species that were more abundant along the south-western coasts of the British Isles and rarely recorded in the central and northern North Sea (*Scyliorhinus stellaris, Mustelus mustelus, Raja brachyura, Raja microocellata* and *Raja undulata*).
(f) Southern vagrants that were only occasionally recorded and are more common further south (*Torpedo marmorata, T. nobiliana* and *Dasyatis pastinaca*).

The chondrichthyan fauna of the British Isles is comprised of approximately 40 species (Wheeler, 1992), with the species not recorded during the present study including pelagic sharks and those deep-water species that occur in waters of more than 500 m depth. Demersal species that would have been expected to be present include white skate (*Rostroraja alba*) and angel shark (*Squatina squatina*). The decline in these species from UK inshore waters was documented by Rogers and Ellis (2000).

Marine Protected Areas (MPAs) and No Take Zones (NTZs) have been suggested as measures for protecting biodiversity, habitats, ecosystems and endangered species, and as a tool for fisheries management (Bonfil, 1999). Nevertheless, closed areas do not decrease the overall fishing effort, but displace fishing activities to other areas, and so the potential effects of increased fishing effort in surrounding areas should always be considered. It has been suggested that MPAs and NTZs could be an effective method for the management of some elasmobranch species, providing that they are used in conjunction with other management techniques (Bonfil, 1999; Horwood, 2000). Potential MPAs would include any specific areas that are important for spawning and/or as nurseries. Hence, the identification of areas that are important to species of conservation importance and/or for certain life-history stages of commercially-important elasmobranchs is required if closed areas are to be considered as a possible tool in the management of elasmobranch stocks. Certain species had localised 'hot-spots' where their relative abundance was greater than surrounding areas. Important areas for elasmobranchs include parts of the Bristol Channel (e.g. *R. microocellata, S. stellaris*), and Lleyn Peninsula (e.g. *S. stellaris*).

The knowledge of the location of nursery areas of elasmobranch fishes has been identified as a research requirement for the management of elasmobranch fisheries (e.g. Castro, 1993). Previously published studies have focused on sharks in the north-western Atlantic (Castro, 1993) and Australia (Simpfendorfer and Milward, 1993) and there is little information on nursery areas in North-west European waters. The most commercially important elasmobranchs in British fisheries are rajids and spurdog (*Squalus acanthias*). Most other demersal elasmobranchs in British waters are non-target species, although occasionally landed as by-catch. Many demersal elasmobranchs, especially the

triakid sharks and rajids are also important species in recreational fisheries. Although beam trawls are not suitable for sampling *S. acanthias*, we consider that the gear and survey design can be used to provide important information for the preliminary identification of potential nursery areas for scyliorhinids, rajids and *M. asterias*.

There are several pieces of anecdotal evidence suggesting that rajids and other oviparous chondricthyans, including chimaeroids, heterodontiform sharks and some orectolobiform sharks, have discrete spawning beds (Dean, 1906; Williamson, 1913; Smith, 1942; Hitz, 1964; Able and Flescher, 1991). McLaughlin and O'Gower (1971) reported that the eggs of the Port Jackson shark (*Heterodontus portusjacksoni*) occurred in traditional oviposition sites, which were situated on shallow, sheltered reefs with well-aerated water.

Scyliorhinus canicula deposit their eggs on a variety of upright structures, including macro-algae and, further from shore, erect sponges, hydroids, soft corals and bryozoans (Ellis and Shackley, 1997). Beam trawls retain many of these biogenic organisms, thus identifying the locations of certain oviposition sites. Large numbers of egg cases were collected from an *Alcyonium digitatum* bed in the Bristol Channel and *Flustra foliacea* beds in the eastern English Channel. Able and Flescher (1991) have previously reported an instance where 300 egg cases of the chain catshark *Scyliorhinus retifer*, attached to the hydroid *Eudendrium*, were caught in a bottom trawl. Able and Flescher (1991) suggested that *S. retifer* deposited their eggs in structured habitats and that these areas may also provide nursery areas for juveniles after hatching. Although we have little data regarding the distribution of neonatal *S. canicula*, which hatch at a length of 90–112 mm (Ellis and Shackley, 1997), they may remain close to the sites where the egg-cases are laid.

Within the coastal waters of the NE Atlantic, skates (Family Rajidae) are an important group of elasmobranchs for both commercial and recreational fisheries. Although there are few targeted fisheries for them, they are an important by-catch of many bottom-trawl fisheries and one of the more valuable components of these mixed demersal fisheries. Long-term changes in rajid populations have been observed in the NE Atlantic (e.g. Brander, 1981; Rogers and Ellis, 2000), with these changes including the extirpation of the common skate (*Dipturus batis*) from the Irish Sea and southern and central North Sea. Current conservation measures for rajids in UK waters principally involve a minimum landing size in certain coastal areas, as initiated by several of Sea Fisheries Committees, and a TAC for "skates and rays" in the North Sea. Providing that spawning and nursery areas can be identified and delineated, and juveniles found to reside in these areas, then closed areas would be a possible option for the management of these species if it were deemed appropriate to reduce fishing mortality on juveniles. Such measures, however, may not reduce the mortality of mature females, which is another important consideration for elasmobranch fisheries.

Unfortunately, the egg-laying habits of rajids in the wild are little known. In captivity, *Raja clavata* tend to lay one pair of eggs on alternate days over a spawning period of a few weeks (Ellis and Shackley, 1995), although, for the population as a whole, the egg-laying season is more protracted. Spawning migrations have been suggested for several species, and Holden (1975) described parts of the Wash as grounds where female *Raja clavata* would congregate. Rajid egg cases have horns and an "adhesive film" for anchorage, but little is known about the types of substrates on which they are laid and whether certain sites are preferred. Williamson (1913) reported that large numbers of skate eggs were taken off the shoal water on Aberdeen Bank. Similarly, large numbers of egg cases (up to 152 per 30 minute tow of a scallop dredge) of '*Raja' binoculata* have been reported off the coast of Oregon (Hitz, 1964). In the current study, although rajid egg cases were caught regularly, they were not caught in large quantities and additional information identifying egg deposition sites is required. Data for juvenile rajids indicated that several areas were important for juvenile fish, including the northern Bristol Channel (*Raja clavata*, *Raja microocellata* and *Raja montagui*), St. George's Channel (*Raja brachyura* and *Leucoraja naevus*), and Cardigan Bay, Luce Bay/Solway Firth and the north-east English Channel (*R. clavata* and *R. montagui*).

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Table 1: Taxonomic list of elasmobranchs recorded from the British Isles during CEFAS groundfish surveys.

Family	Species	Common name
Hexanchidae	*Hexanchus griseus* (Bonnaterre, 1788)	Six-gilled shark
Squalidae	*Squalus acanthias* Linnaeus, 1758	Spurdog
Etmopteridae	*Etmopterus spinax* (Linnaeus, 1758)	Velvet belly
Dalatiidae	*Dalatias licha* (Bonnaterre, 1788)	Darkie charlie
Scyliorhinidae	*Galeus melastomus* Rafinesque, 1810	Blackmouthed dogfish
	Scyliorhinus canicula (Linnaeus, 1758)	Lesser-spotted dogfish
	Scyliorhinus stellaris (Linnaeus, 1758)	Nurse hound
Triakidae	*Galeorhinus galeus* (Linnaeus, 1758)	Tope shark
	Mustelus asterias Cloquet, 1821	Starry smooth hound
	Mustelus mustelus (Linnaeus, 1758)	Smooth hound
Torpedinidae	*Torpedo nobiliana* Bonaparte, 1835	Common electric ray
	Torpedo marmorata Risso, 1810	Marbled electric ray
Rajidae	*Amblyraja radiata* (Donovan, 1808)	Starry ray
	Dipturus batis (Linnaeus, 1758)	Common skate
	Dipturus nidarosiensis (Collett, 1880)	Black skate
	Dipturus oxyrinchus (Linnaeus, 1758)	Long-nose skate
	Leucoraja circularis (Couch, 1838)	Sandy ray
	Leucoraja fullonica (Linnaeus, 1758)	Shagreen ray
	Leucoraja naevus (Müller and Henle, 1841)	Cuckoo ray
	Raja brachyura Lafont, 1873	Blonde ray
	Raja clavata Linnaeus, 1758	Thornback ray
	Raja microocellata Montagu, 1818	Painted ray
	Raja montagui Fowler, 1910	Spotted ray
	Raja undulata Lacepede, 1802	Undulate ray
Dasyatidae	*Dasyatis pastinaca* (Linnaeus, 1758)	Common stingray
Chimaeridae	*Chimaera monstrosa* Linnaeus, 1758	Rabbitfish