FISH AND CRUSTACEAN CAPTURES AT HINKLEY POINT B NUCLEAR POWER STATION: REPORT FOR THE YEAR APRIL 2006 TO MARCH 2007.

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APRIL 2007

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ABSTRACT

This report is the annual summary of results from the long-term impingement monitoring at the British Energy Hinkley Point 'B' Power Station. Data for the number of fish and crustaceans captured on the intake screens of Hinkley Point Power Station over the year April 2006 to March 2007 are presented together with an analysis of long-term trends in animal abundance. The summer of 2006 was notable as seawater temperature reached 23 ºC in July. For the many fish and crustacean species that favour warmer conditions, abundance levels were at historically high levels. Using the 26-year time series of monthly samples, it is clear that the fish community of Bridgwater Bay is rapidly responding to changes in seawater temperature, salinity and the North Atlantic Oscillation (NAO). The number of fish caught each year has followed an increasing trend, which can be related to increased temperature and decreased salinity. In 2006, record numbers of herring, pipefish and prawns were captured. No new species were recorded in 2006/7.

1. INTRODUCTION

This report presents the biological data collected during regular sampling at Hinkley Point Power Station for the year 2005/2006. These data contribute to the long-term time series of animal abundance which, together with physico-chemical and meteorological data, form the Severn Estuary Data Set (SEDS) - see reference list at the end of this report.

The end of 2005 marked the completion of 25 years of monthly sampling at Hinkley Point. We are grateful for the support of British Energy Plc for enabling us to continue the collection of this unique data set, which is one of the largest time series for an entire animal community in the world. We are also pleased to acknowledge the generous support of the Environment Agency. The data set holds time series for about 80 species of fish, 20 species of macro-crustacean and about 40 species of mysid and other small planktonic organism. In terms of the number of species monitored, the proportion of the higher organisms living in the system observed, and the length of time of the observations SEDS is a unique ecological resource. It has four principal uses. First, it provides for the detection and analysis of ecological change caused by both climate change and industrial water users such as power stations. Second, it provides a robust indicator of recent trends in animal abundance in the Bristol Channel. This benefits fisheries management interests, the examination of long-term trends in environmental quality, and the understanding of ecological systems. Third, it provides a superb database for the study of population dynamics and community ecology. Finally, it allows Hinkley Point Power Station to monitor the health of the estuary and address any concerns of regulatory organisations.

The value of the data set to fundamental ecological research has been demonstrated by the publication of two recent papers in major international journals. The first was in Nature was on the abundance distribution within animal communities (Magurran & Henderson, 2003). The second in Oikos by White *et al*. (2006) is on changes in species richness through time. Other recent publications include a collaborative paper with the MBA, Plymouth entitled '*Regional climatic warming drives long-term community changes in British fish*' (Proc Roy. Soc., 2003). The Hinkley Point data are also making a valuable contribution to knowledge on climate change. In early 2005 a paper on the effect of climate on sole recruitment was published in the Journal of the Marine Biological Association (JMBA) (Henderson *et al*., 2005). More recently, a second paper, the effects of climate change on population dynamics of common shrimp has also been published in the JMBA (Henderson *et al*., 2006).

The fish and crustacean time series for Hinkley Point, from January 1981 to April 2006 can be obtained from Pisces Conservation Ltd. These data include information on the size of the fish and their gut contents. Pisces Conservation Ltd also have considerably more data collected during periods of intensive study when the impingement of fish was followed every day for extended periods. We also possess information on the plankton. This annual report is a brief summary of the available data. More information can be obtained from the web site **www.irchouse.demon.co.uk**. Please contact Pisces if you should wish further information or access to the data.

The data are the subject of continuing research. Present collaborative areas of investigation include the structure and organisation of communities and their stability (with Prof. A. Magurran, University of St Andrews) and a comparison of long-term fish dynamics in the Thames and Bristol Channel, Dr M. Attrill, Plymouth University). Dr L. Newton of the University of the West of England is planning a student project on the plankton samples from

Hinkley this spring. Drs P. A. Henderson and R. Seaby are undertaking research on gadoid population dynamics, predator-prey interactions and the effects of climatic change. Further collaboration with other researchers would be welcomed and our data set is available free of charge for pure research purposes.

2. MATERIALS AND METHODS

Quantitative monthly sampling of fish and crustaceans at Hinkley Point 'B' Nuclear Power Station started in October 1980; this report is the most recent in a series of annual reports on these catches. For the period April 2006 to March 2007 12 samples were successfully collected, using the established methodology (Henderson & Holmes, 1991). All sampling dates were chosen to work tides of intermediate range in the spring-neap cycle. On each visit, six consecutive one hour samples were collected in plastic baskets of 6 mm mesh size, positioned to collect all the debris washed from two of the four 'B' station drum screens. This debris was sorted, with the fish and crustaceans identified to species and the number captured per hour recorded. The standard length of the fish was measured. Plankton samples were also collected from the 'B' station intake forebay.

3. TEMPERATURE AND SALINITY

3.1 Temperature (Fig 1a)

2006/2007 was another exceptionally warm year with the July seawater temperature of 23 ºC the highest recorded since 1980. The winter minimum was 7 ºC, which is above the long-term winter minimum. The long-term linear trend shown in Fig 1 shows a gradual increase in average seawater temperature.

3.2 Salinity (Fig 1b)

The salinity of 33 ppt in September 2006 was the highest ever recorded at Hinkley Point and reflected the low river flow rates during the 2006 drought. Salinities in Bridgwater Bay continue to show a decline since 2003 reflecting the gradual increase in average rainfall. The long-term trend, also shown on Fig 1b, shows a small downward trend.

4. OBSERVATIONS ON FISH ABUNDANCE

In this section data collected over the period April 2006 to March 2007 are placed within the context of the longer-term trends over the period 1980 to 2006.

4.1 New records and unusual observations

There were no new species of fish recorded in 2006/2007.

4.2 Cod Gadus morhua (Fig 2)

It has been previously reported that since 1986 cod have become more abundant within Bridgwater Bay, and from reports from fishermen it would appear cod have generally increased in abundance in the Bristol Channel and the waters surrounding Devon and

Cornwall. However, from 2001 to 2004 abundance declined. This trend was reversed in 2006 and 2007.

4.3 Whiting __Merlangius merlangus__ (Fig 2)

While still remaining one of the most abundant fish, whiting numbers continued to decline from the peak abundances observed in the 1990s. This may be related to the decline in sprat upon which whiting feed (see Henderson & Holmes, 1989 for a discussion of whiting - sprat relationship).

4.4 Poor cod __Trisopterus minutus__ (Fig2)

A common fish in 2006/7, abundance was close to the long-term average.

4.5 Pout __Trisopterus luscus__ (Fig2)

After strong recruitment in 2002 and 2003 pout abundance has been declining and in 2006 and 2007 was notably low.

4.6 Hake __Merluccius merluccus__

No hake have been caught over the last year and this once quite common fish can now be considered an infrequent visitor. The last individual was caught in April 1999.

4.7 Pollack __Pollachius pollachius__

This species is never abundant but continues to be caught in low numbers. 5 were caught in 2006/7.

4.8 Norway pout __Trisopterus esmarkii__

Only 1 individual was caught in 2006/7. Numbers are always low, a more typical catch of 6 individuals was recorded in 2005/06.

4.9 Bass __Dicentrarchus labrax__ (Fig 3)

After the very large 2002/3 year class, bass abundance has remained lower. Recruitment in this species is highly variable and is much higher in exceptionally warm years that occur after a run of cool years. Cannibalism results in a quasi 3-year cycle, as a strong year class dominates the estuary for 3 years (see Henderson & Corps, 1997).

4.10 Common eel __Anguilla anguilla__ (Fig 3)

The long-term decline in the rate of capture of this species has continued during 2006/07, when only 1 was caught. The reasons for this are obscure but are possibly related to a number of factors including excessive fishing for elvers, freshwater habitat destruction, and introduction of the parasite *Anguillicola crassus* from Asia. There are no indications that power station intakes are responsible, as a similar decline has been observed in rivers throughout Western Europe. Indeed similar declines have also been observed in North American east coast rivers such as the Hudson. It is notable that elver landings recorded in South Wales are highly correlated with power station patterns of capture. As we have warned in the past, *this species must be given greater protection or it will be lost to our rivers*. Our data show that we may be witnessing the loss of eel from Bristol Channel rivers. The indifference shown to this disaster is saddening and shames the authorities charged with protecting our wildlife.

4.11 Grey mullets, Liza aurata, Liza ramada and Crenimugil labrosus

Thin-lipped mullet have continued to be caught in modest numbers. No golden-grey or thick-lipped mullet were recorded in 2006/7.

4.12 Five-bearded rockling Ciliata mustela (Fig 4)

The abundance of this rockling has increased since 1997 and it is now appreciably higher than it was in the 1980s. Abundance in 2006/07 was again higher than the long-term average.

4.13 Northern rockling Ciliata septentrionalis

This species was once considered rare in Southern British waters. It is notable that while uncommon at Hinkley Point it is regular in its seasonal pattern. Only 1 individual was caught in 2006/7.

4.14 Conger Conger conger (Fig 4)

The rate of capture of conger eel in 2002/03 was the highest since records began; numbers have subsequently declined so that the catch in 2006/7 was close to the long-term average.

4.15 Lumpsucker Cyclopterus lumpus

A single lumpsucker individual was recorded in 2006/07. This species has declined in abundance since the 1980s.

4.16 Sea snail Liparis liparis (Fig 4)

The abundance of sea snail is negatively correlated with winter seawater temperature (Henderson & Seaby, 1999). Thus since 1987 the increase in mean water temperature has resulted in generally lower numbers being captured during the 1990s and 2000s as compared with the 1980s. The notable exception was the winter of 1996 when low water temperatures during January triggered a sudden migration into inshore waters. There is no evidence that the decline in abundance in Bridgwater Bay reflects an actual decline in the population of the species within the estuary, it seems to simply reflect the avoidance of shallower, warmer waters during the autumn. However, the loss of shallow habitat where their favoured food, shrimp, are highly abundant must surely have some impact on total population number. Sea snail numbers in 2006/7 were similar to those recorded annually since 2000.

4.17 Sand goby Pomatoschistus minutus (Fig 4)

Abundance in 2006/07 was typical for that recorded since the mid 1990s.

4.18 Twaite shad Alosa fallax (Fig 5)

The 'O' group, which comprise the vast majority of the individuals of this species caught, tend to be more abundant in warmer years (Holmes & Henderson, 1990). However, there are signs of a long-term decline and abundance is now, on average, lower that that observed between 1988 and 1991. During 1993/94 only a single specimen was captured. However numbers increased slightly in 1994/96 and fell again between 1997 and 1998. Above average recruitment occurred again in 1999. No O-group shad were caught over the 2000/2001 winter suggesting poor recruitment in 2000. In 2001/2002 14 O-group fish were caught, indicating improved recruitment. In 2002/03 only 4 were caught clearly a year with poor recruitment. In the 2003 and 2004 winters 13 and 10 were caught respectively, indicating fair recruitment. 17 juveniles were captured in 2006/7, while still low compared with earlier years, it is a considerable increase over 2005/6. This protected and endangered species is showing signs of decline; possibly it is influenced by changes in the North Atlantic Oscillation and the effects of this oscillation on plankton abundance. Such an effect is known to influence salmon.

4.19 Transparent goby Aphia minuta (Fig 5)

Abundance in 2006/7 was close to the long-term average.

4.20 Herring Clupea harengus (Fig 5)

Herring in 2006/7 recorded the greatest monthly catch, of 94 individuals, since work began in 1980. There are now clear indications that herring abundance in the Bristol Channel is on an upward trend.

4.21 Sprat Sprattus sprattus (Fig 5)

Sprat abundance during the 2006/7 winter was close to the long-term average. Sprat is the commonest pelagic fish captured at Hinkley Point and captures in late 1998 were the highest since recording began in 1980. This huge peak tends to dominate the time series overshadowing the appreciable numbers that have been caught in more recent years.

4.22 Dab Limanda limanda (Fig 6)

Over the total period of study this is one of the more abundant flatfish within Bridgwater Bay. The individuals captured during 2006/7 were ‘O’ group juveniles, which enter the Bay in late summer. Henderson & Seaby (1994) and Henderson (1998) have reported a highly significant negative correlation between dab numbers and seawater temperature. Dab were not abundant in the estuary in 2006/7; this probably reflects high water temperatures. Henderson (1998) also noted that dab in Bridgwater Bay grow faster during colder autumns and winters. It is striking that dab abundance has remained consistently low and remarkably stable since 1998. If we are entering a period of increasing seawater temperature it is likely that the dab population will remain depressed.

4.23 Flounder Platichthys flesus (Fig 6)

There are indications that flounder have become more abundant since 1986, however abundance in 2006/7 was low and indicates a return to the long-term average abundance.

4.24 Dover sole Solea solea (Fig 6)

This species has continued to be abundant within the estuary. Most of the sole captured were ‘O’ group juveniles, recent recruitment has, for the 13th year in succession, been above that observed in the 1980s. The effect of climate on the abundance of this fish is discussed in Henderson and Seaby (1994) who demonstrated a highly significant positive correlation between sole abundance and water temperature. This work was extended by Henderson & Seaby (2005) who demonstrated that sole growth and abundance was related to both temperature and the NAO winter index.

4.25 Plaice __Pleuronectes platessa__ (Fig 6)

15 plaice were recorded in 2006/7. Within Bridgwater Bay plaice is the least abundant of the common British flatfish. In the summer of 1996/97 a peak of 21 specimens were recorded followed in 2002 and 2003 by peaks of 15 and 11 respectively.

4.26 Dragonet __Callionymus lyra__

This species does not live on a mud substrate within estuaries, and is best viewed as an occasional, but regular, visitor. However, 12 were recorded in 2006/7; this is the largest annual catch since records began in 1980.

4.27 Grey gurnard __Eutrigla gurnardus__

This species has become a regular seasonal visitor; 8 individuals were caught in 2006/7.

4.28 Hooknose __Agonus cataphractus__

6 individuals were caught in 2006/7. As in the case of the dragonet, Bridgwater Bay does not offer the preferred habitat of this species and it is best considered as an occasional visitor.

4.29 Nilsson's pipefish, __Sygnathus rostellatus__, **Greater pipefish***, __Sygnathus acus__* **and snake pipefish***, __Entelurus aequoreus__.*

No greater or Nilsson's pipefish were caught in 2006/7. 49 snake pipefish were caught in 2006/7 with a maximum monthly number of 17 individuals. This is the largest annual and monthly catch ever recorded. This species has become more abundant in Bridgwater Bay since 2003.

4.30 Thornback ray __Raja clavata__

This species became more abundant in Bridgwater Bay in the mid 1980s, when mean water temperatures were lower. Six were captured in 2006/7, a notable increase over recent years and in line with the expectation that abundance would increase as the North Atlantic Oscillation enters a different phase.

5. CRUSTACEAN ABUNDANCE

5.1 New species observations

No new crustacean species were recorded.

5.2 Trends in abundance

The numbers of common crustaceans captured per month are presented in Fig 7. During 2006/7 the normal patterns of seasonal abundance were observed for all species. There are clear indications that the numbers of crabs and prawns have increased since the 1980s.

Crangon crangon has remained the most abundant animal caught at Hinkley Point, and the population has, until recently, remained remarkably stable, however, in 2002 there was a remarkable explosion in abundance with the capture of more than 30,000 individuals in a single monthly sample. From 2003 to the present numbers returned to more typical levels.

The number of recruits has changed greatly between years, and has been found to be positively correlated with both average water temperature from January to August and river flow rate, and negatively correlated with the Winter North Atlantic Oscillation Index (Henderson *et al*., 2006).

The second most abundant macro-crustacean, the pelagic prawn *Pasiphaea sivado*, which was exceptionally abundant in 1999, was closer to the long-term average abundance in 2006/7, however abundance is higher than in the 1980s. The large edible prawn *Palaemon serratus* has showing a clear trend of increasing abundance within the estuary (Fig 7). In the 1998 report it was noted that the highest number of *P. serratus* in a single sample was found in October 1997 (403 individuals). This record was broken by the capture of 700 individuals in September 1998. In June 2000 this record was broken again with the capture of 1195 individuals. In 2000 the peak abundance was in June whereas in 2001 there were two later peaks in July and September/October. In April 2002 some berried females were observed suggesting that the mild conditions are allowing an extended breeding season and possibly enhanced recruitment. Abundance remained high in 2006/7 with a catch of 1245 individuals in October 2006, which is the largest monthly catch ever recorded (see Fig 7). This species can now be caught in all months of the year. The Pink shrimp, *Pandalus montagui*, is also showing a trend of increasing numbers, the catch of 2290 individuals in October 2006 was the highest monthly catch since records began (see Fig 7).

6. GENERAL OBSERVATIONS

Using our 26-year time series of monthly samples, it is clear that the fish community of Bridgwater Bay in the outer Severn Estuary is rapidly responding to changes in seawater temperature, salinity and the North Atlantic Oscillation (NAO). The number of fish caught each year has followed an increasing trend, which can be related to increased temperature and decreased salinity. In contrast to this smooth change, there have been two discrete transitions in fish community structure around 1986 and 1993. The first of these step changes, which altered the relative abundance of the dominant species, was linked by Henderson (2007) to a change in the NAO. The second, which was caused by a change in the set of occasional visitor species, was linked to an increase in average seawater temperature. A marked increase in population variability for many fish in recent years was linked to increased seawater temperature. Considerably more information on the changing structure of the fish community and the possible future response to climate change can be found in Henderson (2007).

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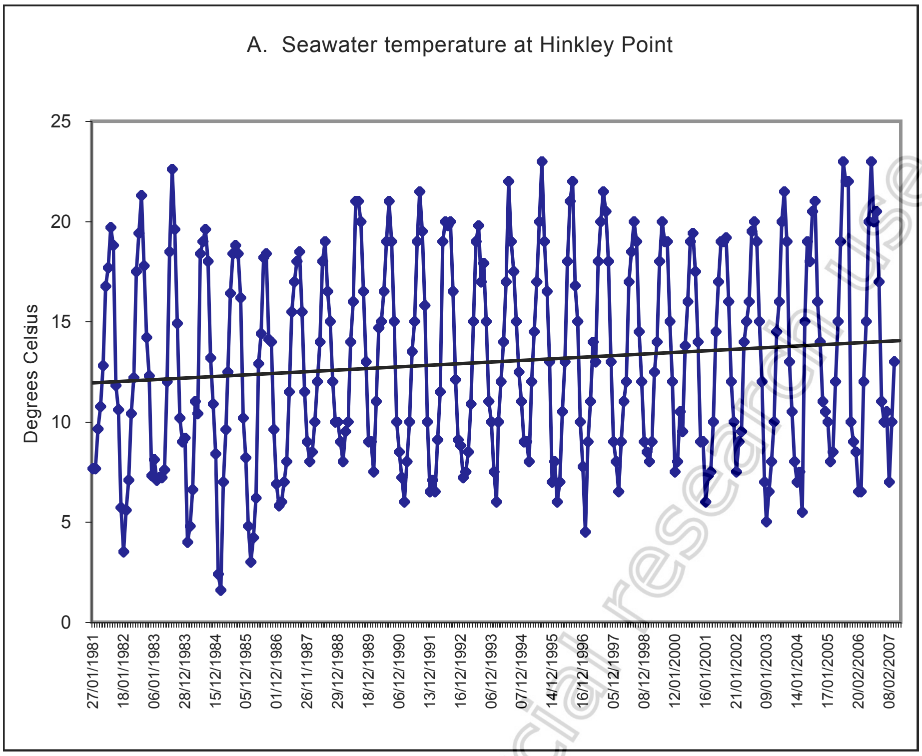
Figure 1


A. Seawater temperature at Hinkley Point
Degrees Celsius
25
20
15
10
5
0
27/01/1981
18/01/1982
06/01/1983
28/12/1983
15/12/1984
05/12/1985
01/12/1986
26/11/1987
29/12/1988
18/12/1989
06/12/1990
13/12/1991
16/12/1992
06/12/1993
07/12/1994
14/12/1995
16/12/1996
05/12/1997
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20/02/2006
08/02/2007

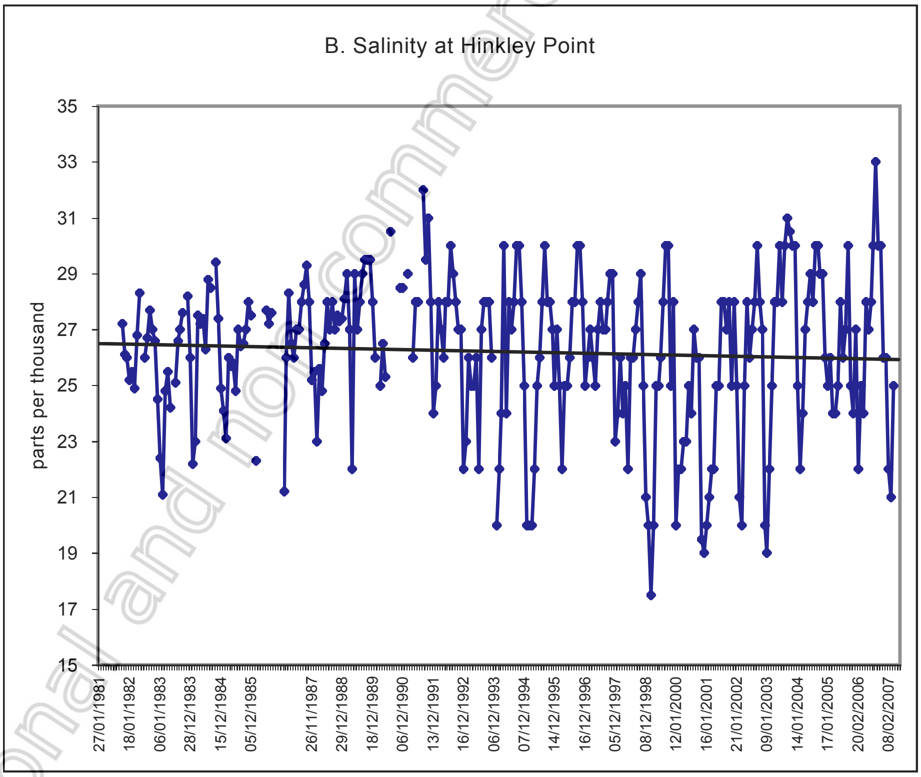
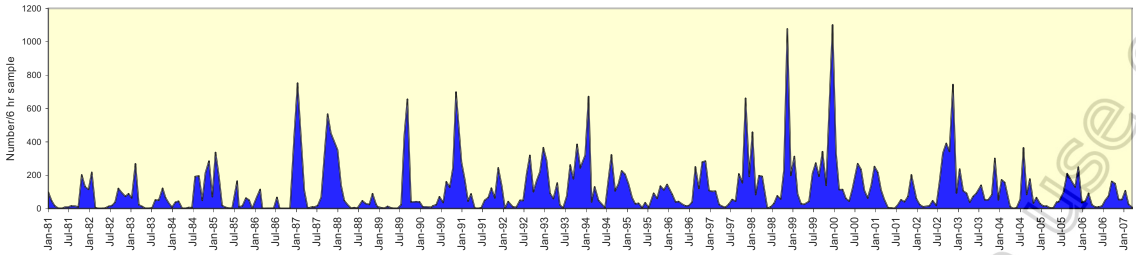
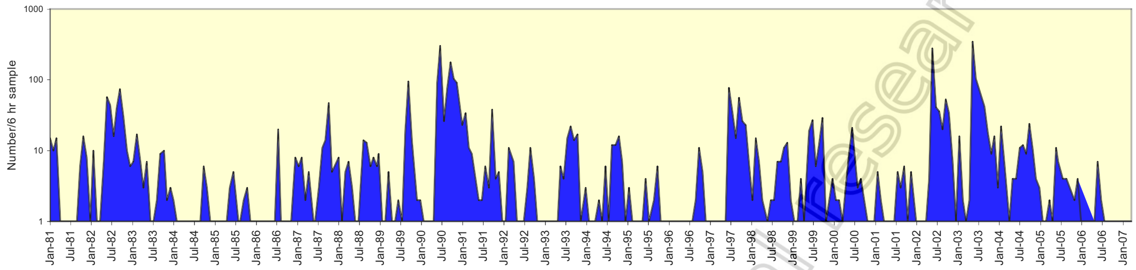

B. Salinity at Hinkley Point
parts per thousand
35
33
31
29
27
25
23
21
19
17
15
27/01/1981
18/01/1982
06/01/1983
28/12/1983
15/12/1984
05/12/1985
26/11/1987
29/12/1988
18/12/1989
06/12/1990
13/12/1991
16/12/1992
06/12/1993
07/12/1994
14/12/1995
16/12/1996
05/12/1997
08/12/1998
12/01/2000
16/01/2001
21/01/2002
09/01/2003
14/01/2004
17/01/2005
20/02/2006
08/02/2007

Figure 2: The cod family

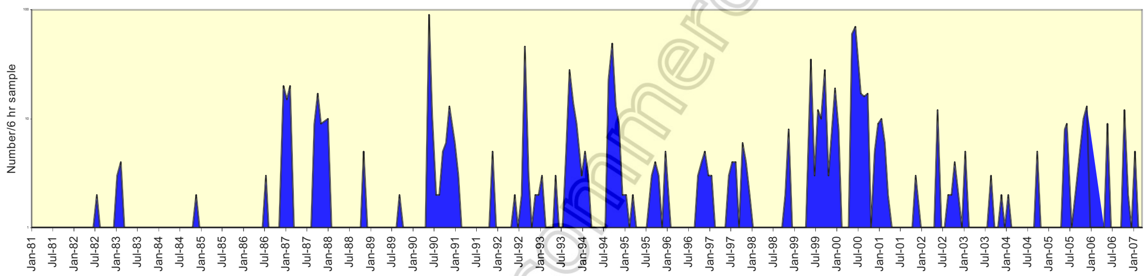
Whiting



Pout



Cod



Poor Cod

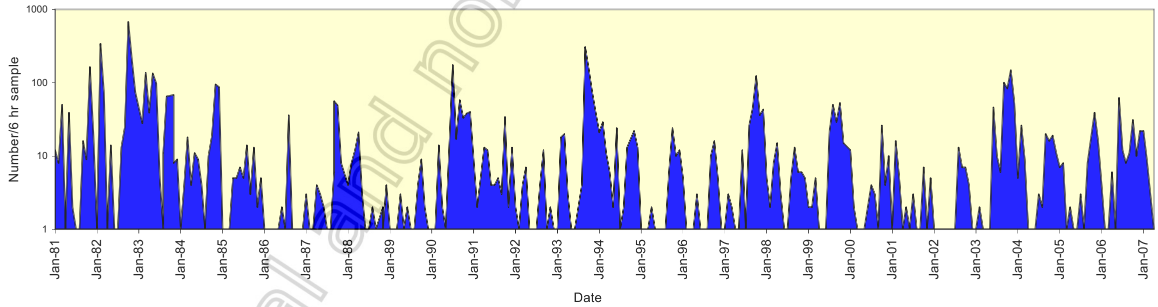
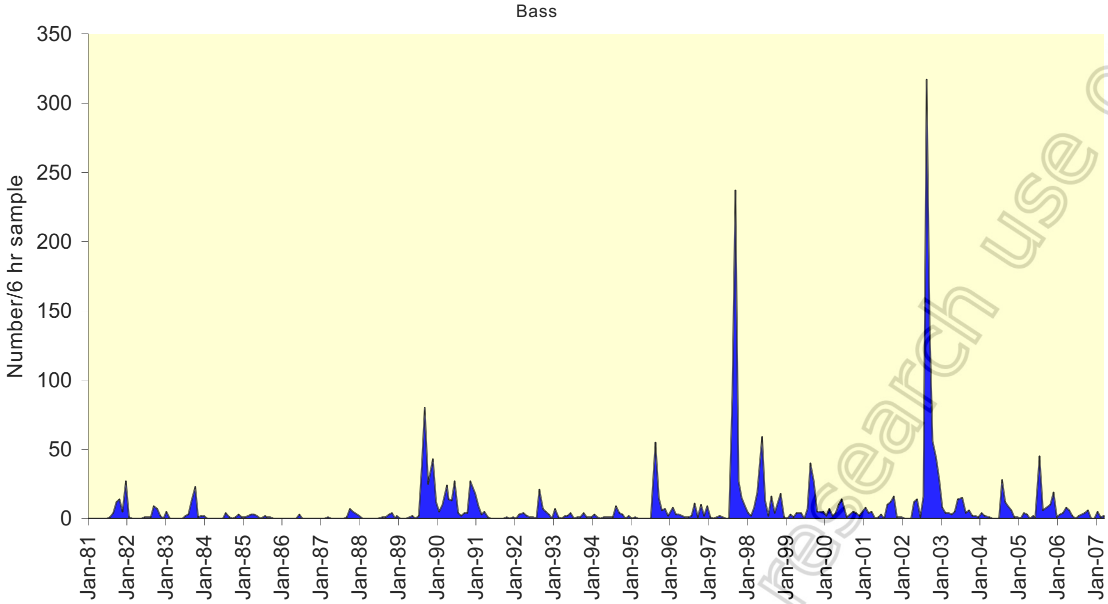


Figure 3: Bass and eel



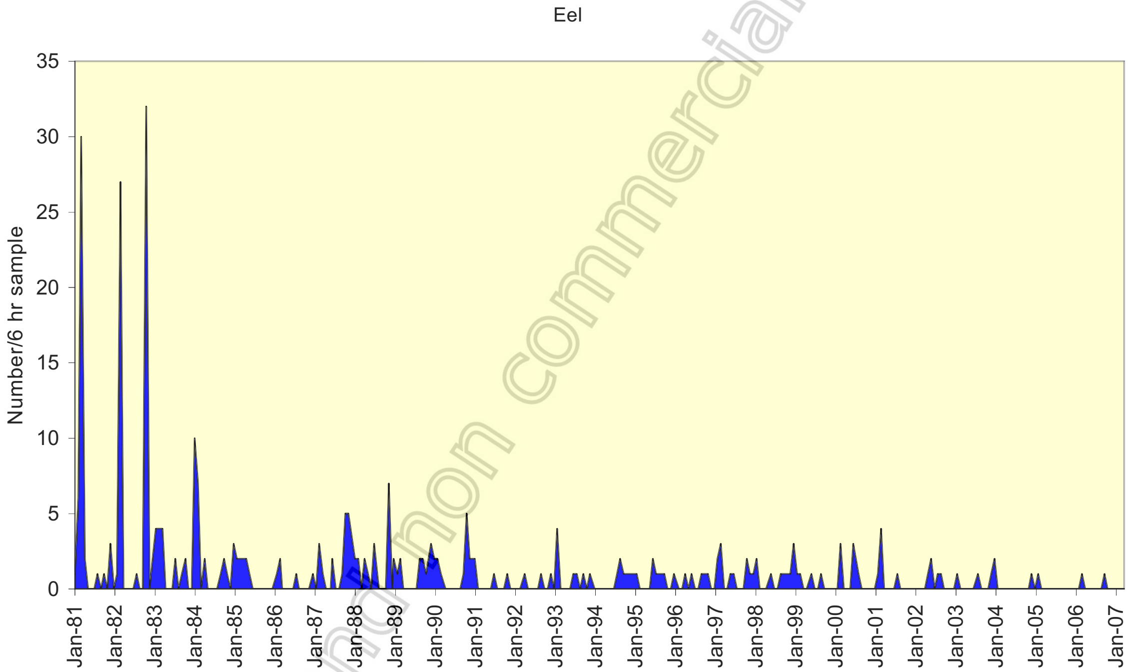
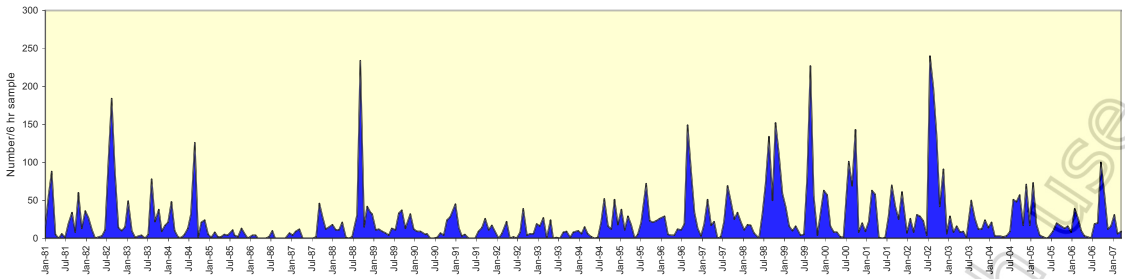
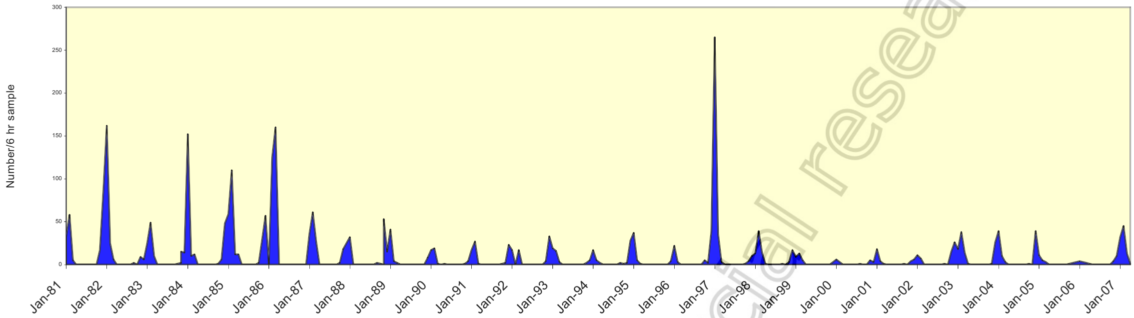


Figure 4: Bottom-living fish

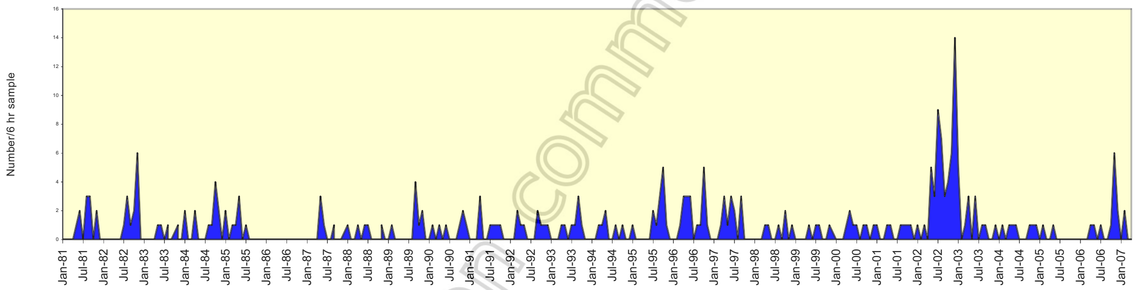
Sand Goby



Sea Snail



Conger eel



V bearded Rockling

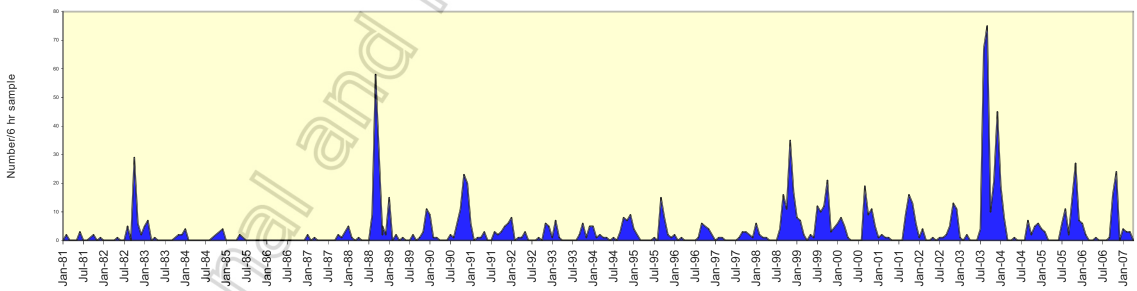
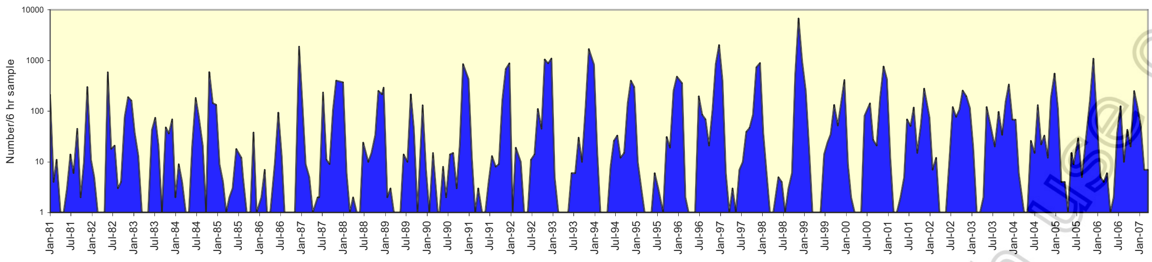
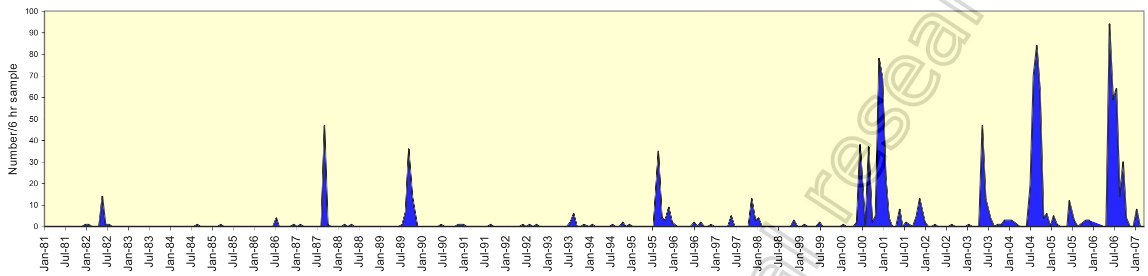


Figure 5: Pelagic fish

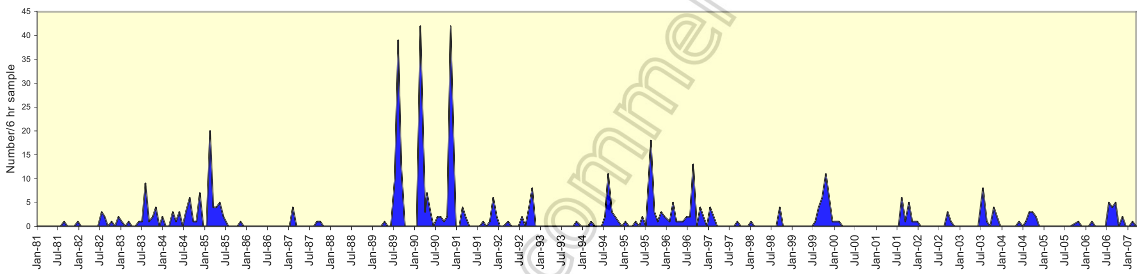
Sprat



Herring



Twaite shad



Transparent goby

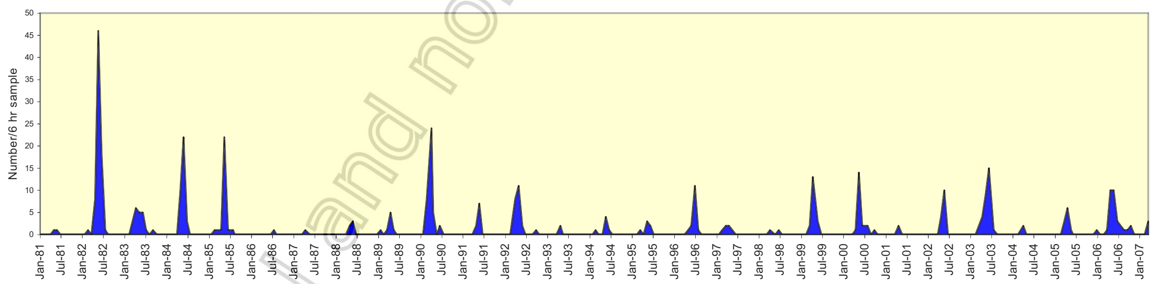


Figure 6: The flatfish

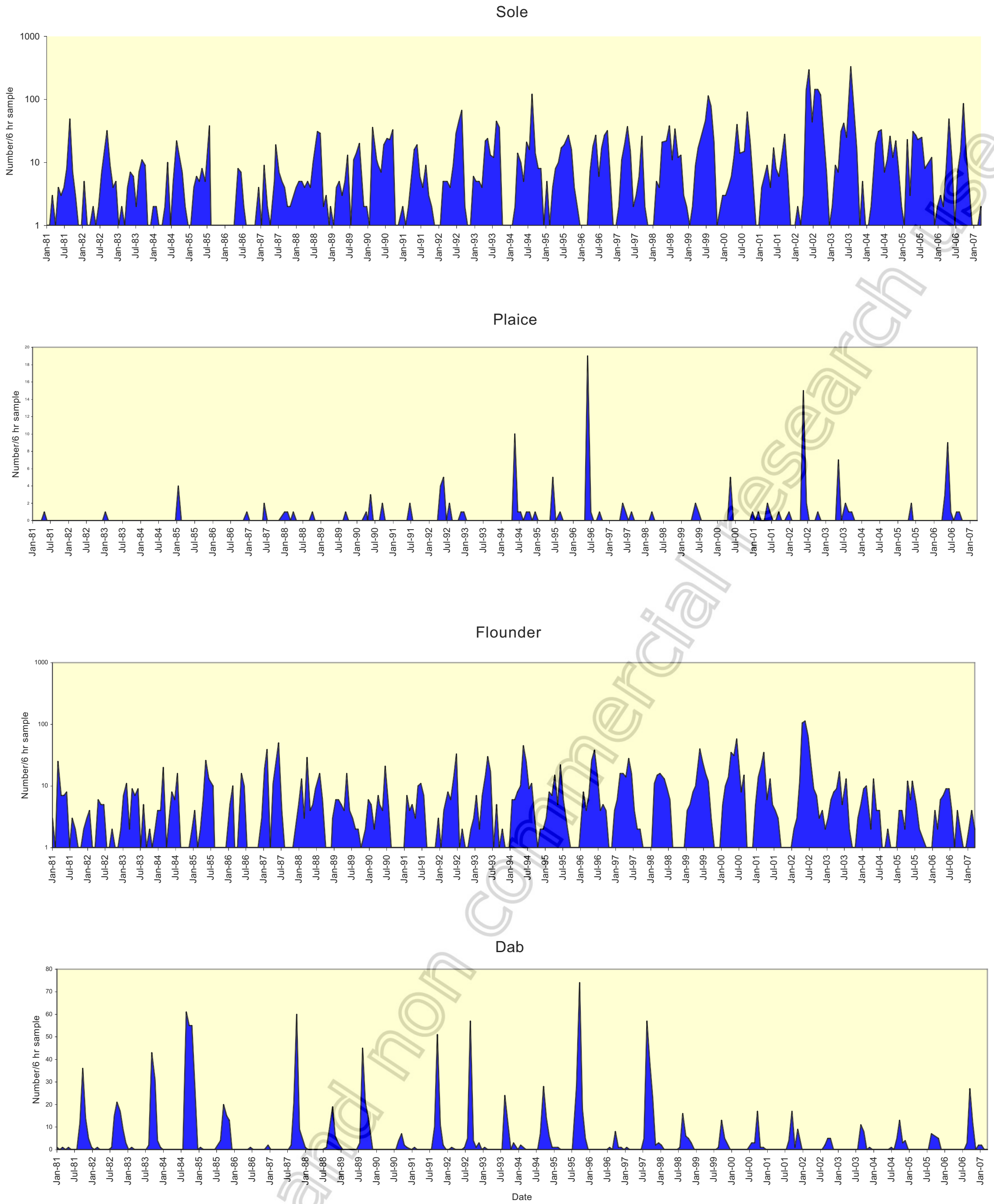


Figure 7: Common crustaceans