FISH AND CRUSTACEAN CAPTURES AT HINKLEY POINT B NUCLEAR POWER STATION: REPORT FOR THE YEAR APRIL 2005 TO MARCH 2006.

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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 2005 to March 2006 are presented together with an analysis of long-term trends in animal abundance. After almost 10 years when annual increases in fish and crustacean abundance have been the norm 2005/6 marked a return to long-term average abundance levels. No new species were recorded over the last year and no new records for species numbers were recorded. The summer of 2005 was notable for the warmest seawater temperatures since our study started in 1980. Temperatures of 22 ºC or more were recorded for 3 consecutive months. As shrimps and some fish seem to avoid shallow waters when temperature exceed 20 ºC, this could, at least in part, explain the recent small decline in total captures.

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 to 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 2005 to March 2006 11 samples were successfully collected, using the established methodology (Henderson & Holmes, 1991). The sample in October 2005 was not collected because of a station shutdown. 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)

2005/2006 was another warm year with July, August and September recording water temperatures at or above 22 ºC. These are the warmest summer temperatures since recording began in 1980. The winter minimum was 6.5 ºC, an average winter only notable for an unusually cold spell in March 2006. .

3.2 Salinity (Fig 1b)

Salinities in Bridgwater Bay showed a marked decline since 2003 reflecting the recent low levels of rainfall. The long-term trend, also shown on Fig 1b shows no significant change.

4. OBSERVATIONS ON FISH ABUNDANCE

In this section data collected over the period April 2005 to March 2006 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 2005/2006.

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 has been declining. This trend was reversed in 2005 with evidence of the best recruitment since 2000.

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.

4.4 *Poor cod* ***Trisopterus minutus*** *(Fig2)*

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 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.

4.7 *Pollack* ***Pollachius pollachius***

This species is never abundant but continues to be caught in low numbers. 3 were caught in 2005/6.

4.8 *Norway pout* ***Trisopterus esmarkii***

A typical catch of 6 individual 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. However, the long term trend for number s to increase has continued.

4.10 *Common eel* ***Anguilla anguilla*** *(Fig 3)*

The long-term decline in the rate of capture of this species has continued during 2005/06 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, *if the decline of this species continues, conservation measures will be needed*. The present data indicates that we may be witnessing the loss of eel from Bristol Channel rivers. The indifference shown to this disaster is saddening.

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

Thin-lipped mullet have continued to be caught in small numbers. No golden-grey were caught in 2005/6.

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 2005/06 was higher than 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 2005.

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 and only a single individual was caught in 2005/6.

4.15 Lumpsucker Cyclopterus lumpus

No lumpsucker were recorded in 2005/06.

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 2005/6 were exceptionally low.

4.17 Sand goby Pomatoschistus minutus (Fig 4)

Abundance in 2004/05 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. Only 2 juveniles were captured in 2005/6, the lowest total since 1981. 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 a effect is known to influence salmon.

4.19 Transparent goby ***Aphia minuta*** *(Fig 5)*

Abundance in 2005/06 was close to the long-term average.

4.20 Herring ***Clupea harengus*** *(Fig 5)*

Herring abundance in 2005/6 was lower than in a number of recent years. However, recruitment changes greatly and this reduction may be a reflection of normal variability.

4.21 Sprat ***Sprattus sprattus*** *(Fig 5)*

Sprat abundance during the 2005/2006 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 2005/6 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 2005/6; 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 2005/6 was low and similar to that observed since 2003.

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 12^{th} 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)*

Two plaice were recorded in 2005/6. 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. None were recorded in 2005/6.

4.27 *Grey gurnard* ***Eutrigla gurnardus***

This species has become a regular seasonal visitor, 12 individuals were caught in 2005/6.

4.28 *Hooknose* ***Agonus cataphractus***

Only a single individual was caught in 2005, which is one of the lowest annual captures since 1980. 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***

This species is an occasional visitor, but none were captured in 2005. However, over the last year 3 greater pipefish, *Sygnathus acus* were caught.

4.30 *Thornback ray* ***Raja clavata***

This species became more abundant in Bridgwater Bay in the mid 1980s, when mean water temperatures were lower. Two were captured in 2006, it will be interesting to observe abundance over the next 3 years as the North Atlantic Oscillation enters a different phase.

5. CRUSTACEAN ABUNDANCE

5.1 *New species observations*

No new crustacean was recorded.

5.2 *Trends in abundance*

The numbers of common crustaceans captured per month are presented in Fig 7. During 2005/6 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 close to the long-term average abundance in 2005. The large edible prawn *Palaemon serratus* has showing a clear trend of increasing abundance within the estuary (Fig 6). 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 2005/6 but the period of exponential growth is clearly over. This species can now be caught in all months of the year.

6. GENERAL OBSERVATIONS

The general trend of increasing water temperature observed within the Bristol Channel, which may be related to large-scale climatic trends, is producing a gradual change in fish and crustacean abundance in Bridgwater Bay. The previously noted long-term trend of increasing species richness is mostly due to the more frequent capture of warmer water species (bass, mullets, gurnards, trigger fish etc). However, while species that are close to the southern limit of their range in the Bristol Channel such as dab, northern rockling and sea snail have declined in abundance they are still present. Over the last year there has been a further decline in overall fish abundance. The North Atlantic Oscillation has now changed phase so it is more likely that we will experience some colder winters. It is therefore possible that the community is now reverting to a structure with similarities to that observed in the 1980s. However, unlike the 1980s water temperatures have remained unusually high. The three months at or above 22 ºC observed in summer 2005 are particularly notable as the warmest summer we have observed since records began in 1980. These high temperatures may have had an impact on fish and crustacean abundance in Bridgwater Bay. There are indications at some fish and, most importantly, *Crangon crangon* avoid such warm shallow waters. It is quite possible that recent decline in the total number of fish captured were linked to a summer movement away from warm, inshore waters.

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Figure 1

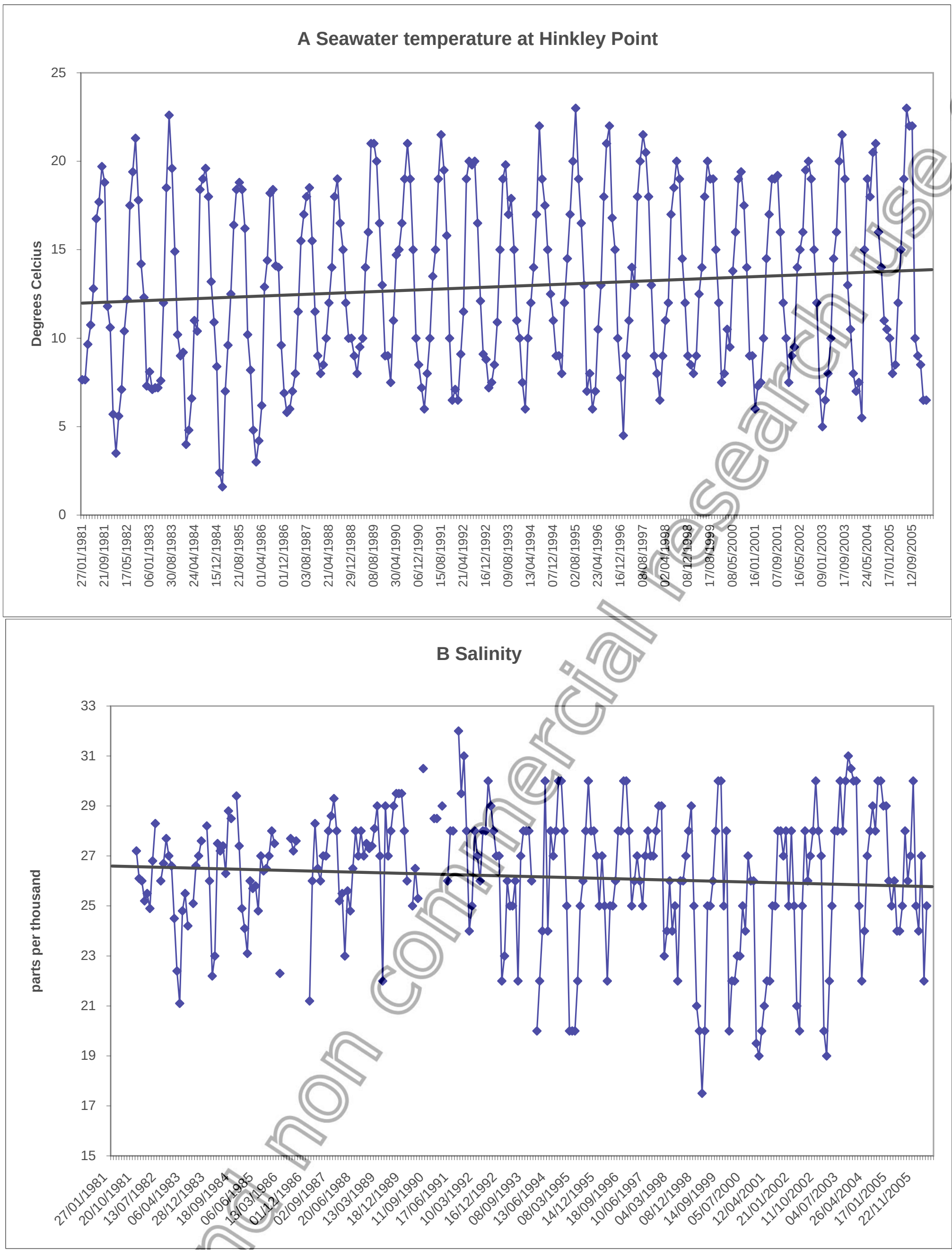

A Seawater temperature at Hinkley Point
Degrees Celcius
25
20
15
10
5
0
B Salinity
parts per thousand
33
31
29
27
25
23
21
19
17
15

Figure 2 The gadoids

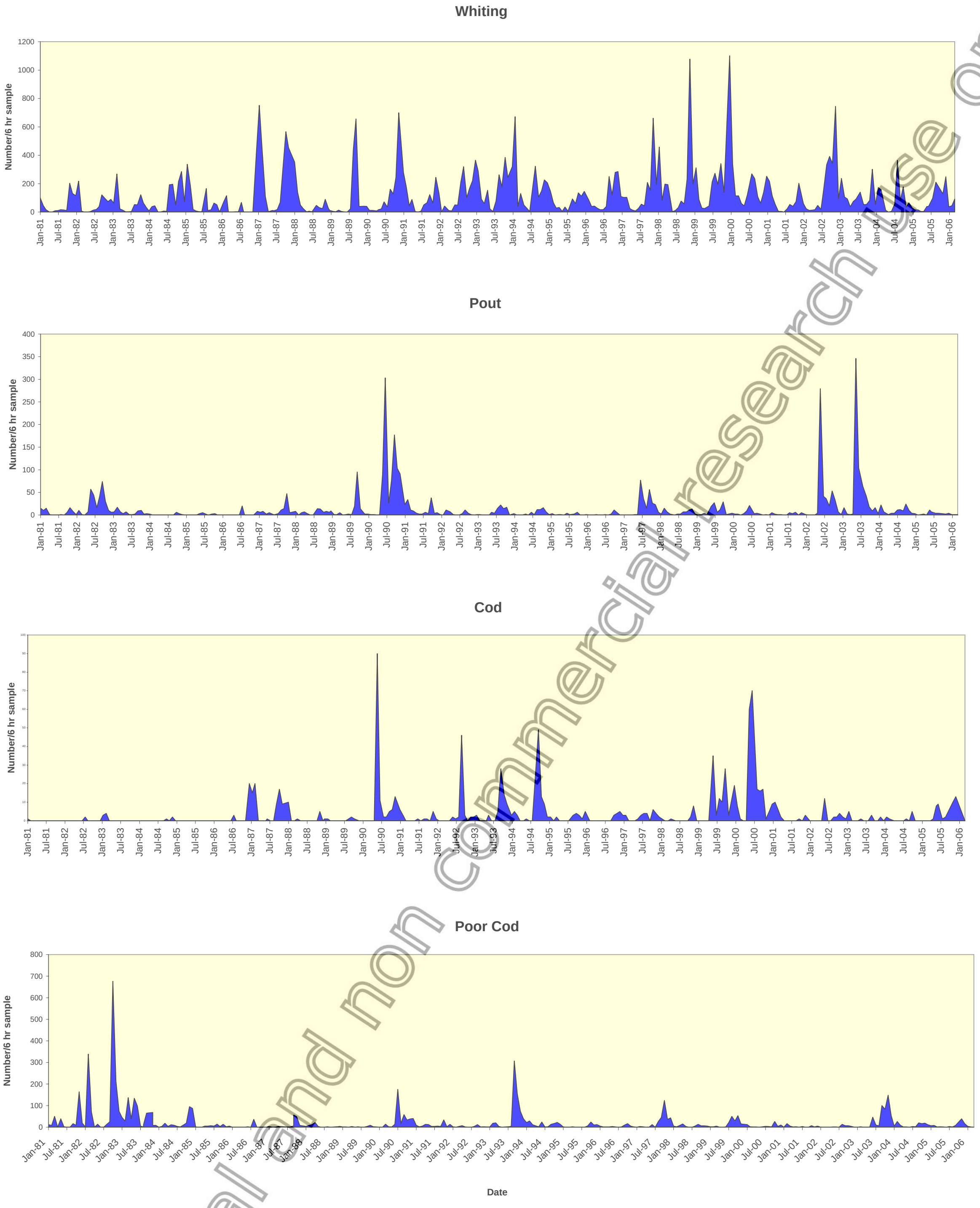
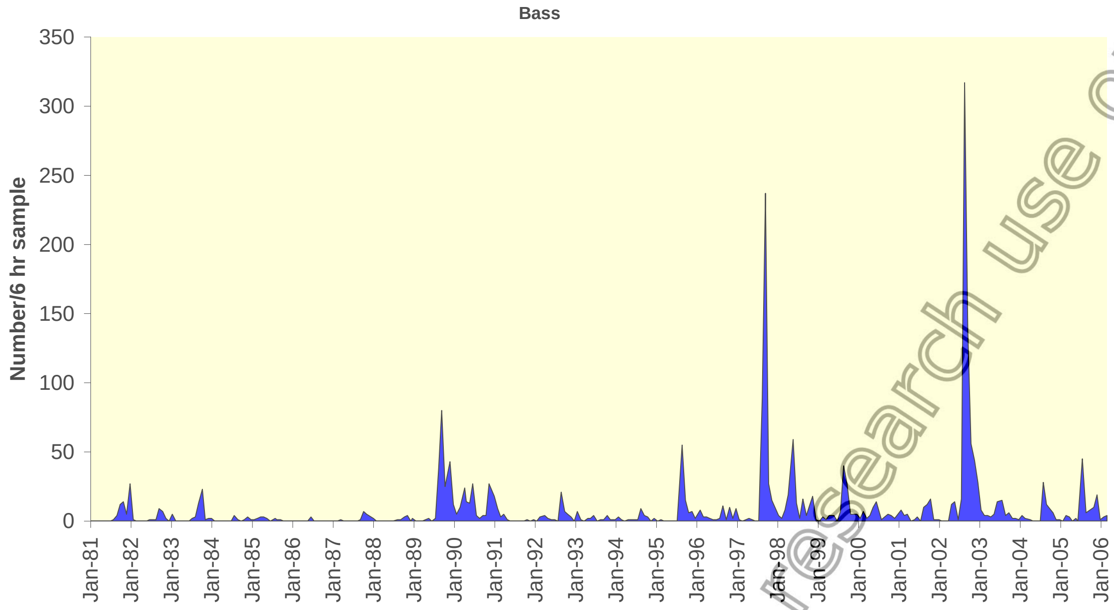


Figure 3 Bass and eel abundance



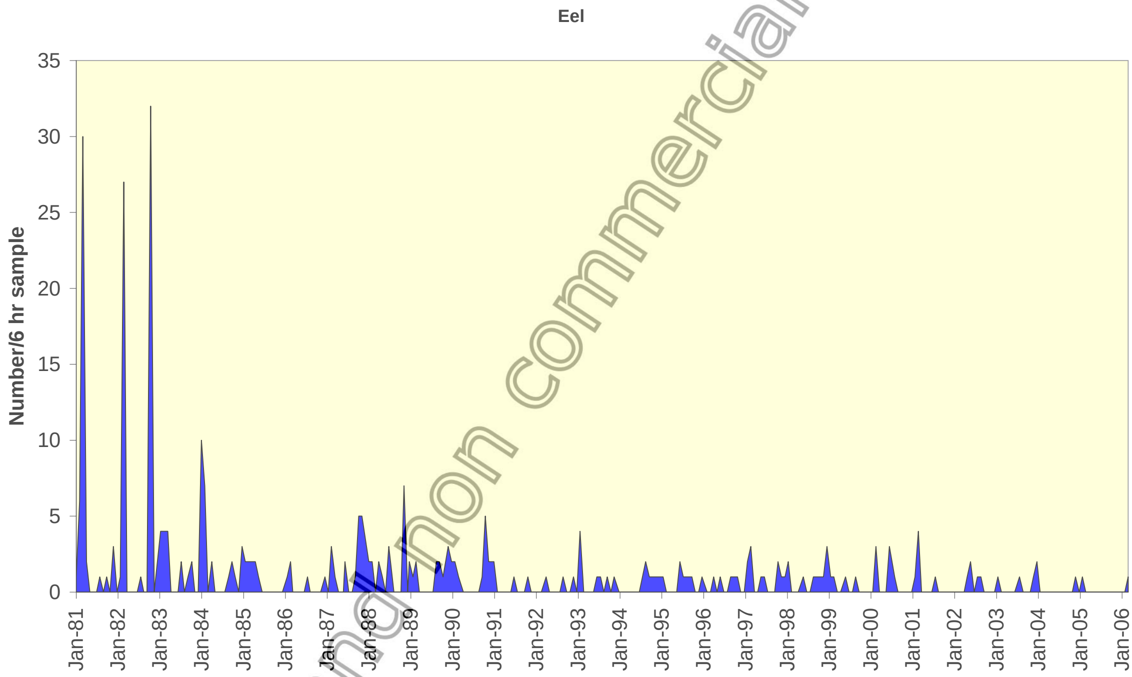


Figure 4 Sand goby, sea snail conger and rockling abundance

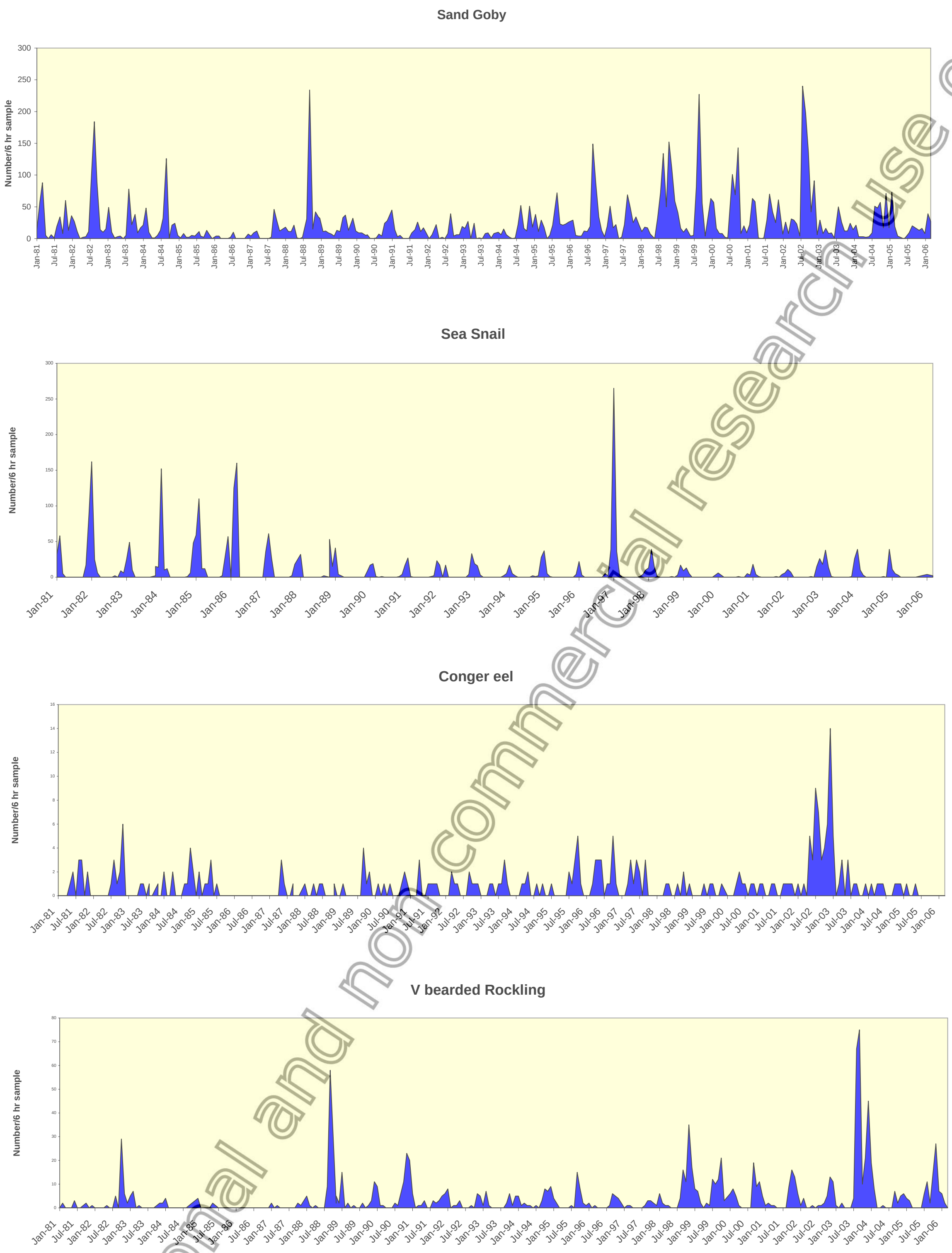


Figure 5 pelagic fish abundance

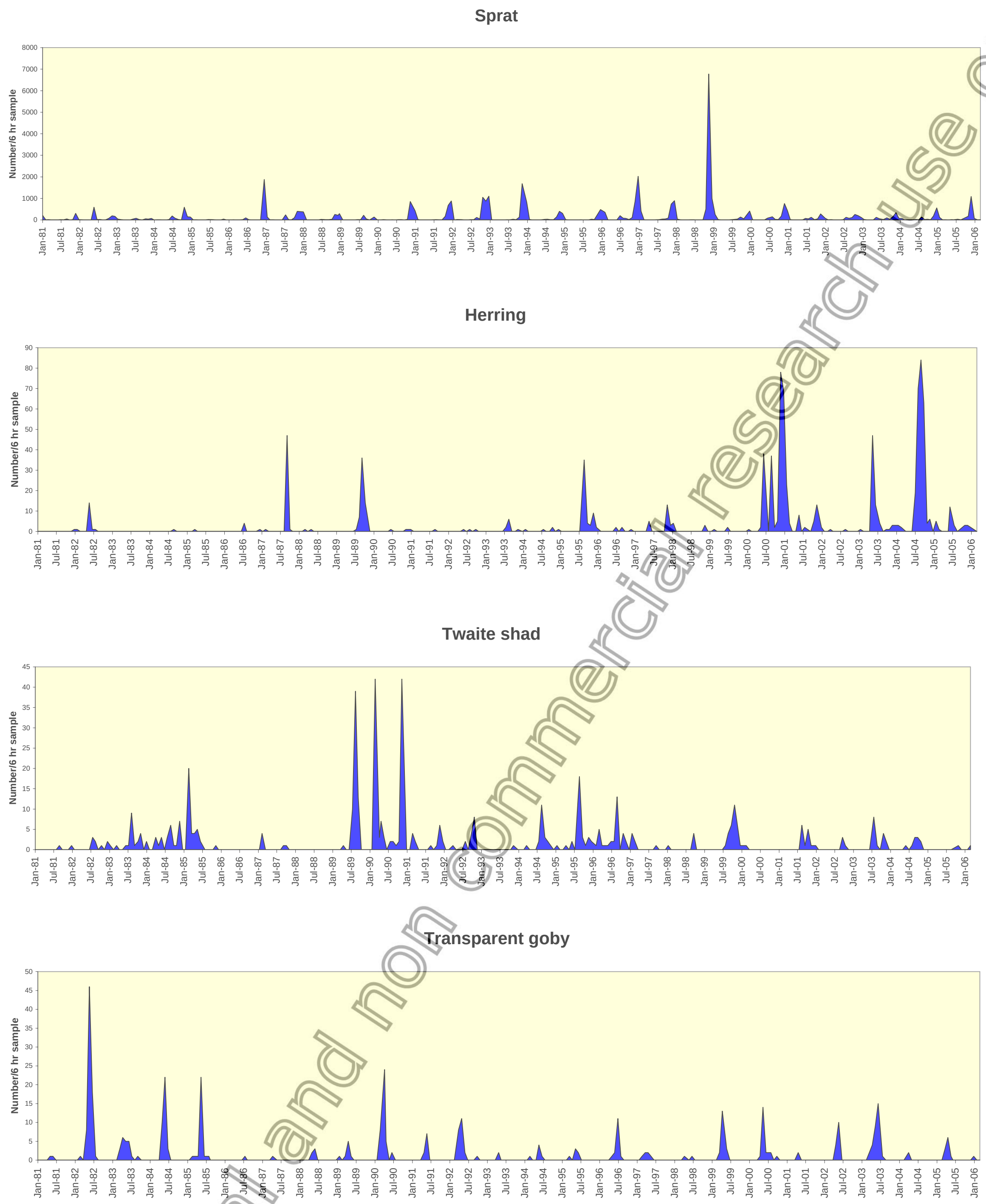


Figure 6 The flatfish

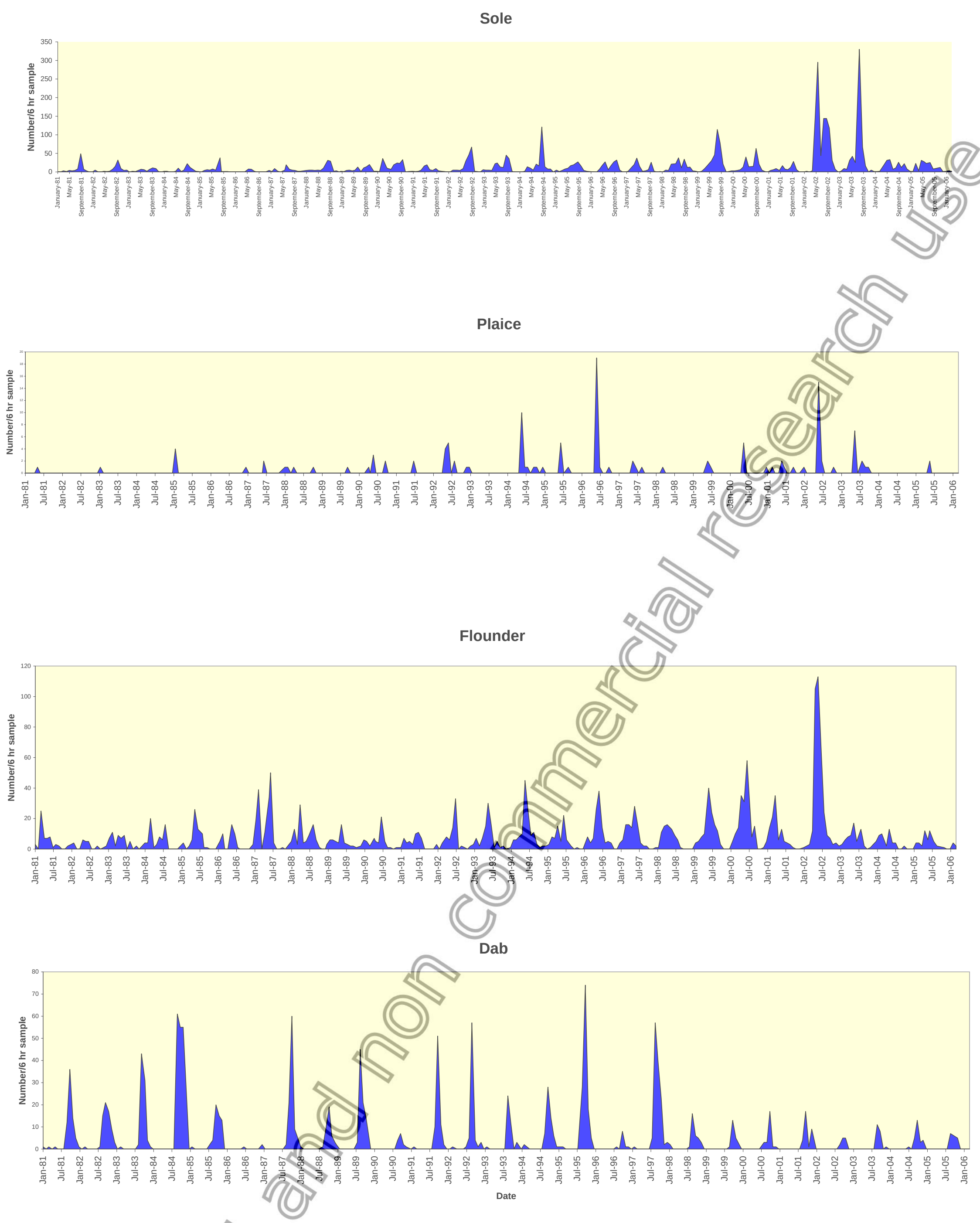


Figure 7 Common crustaceans