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**MEDWAY ESTUARY FISHERIES
SURVEY 2000**
(Incorporating the Report for 1997 to 2000)



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1. ABSTRACT

As part of a Medway Estuary Project funded by the Environment Agency's Water Resources function, a biennial programme of sampling has surveyed the fish fauna at 5 locations within the tidal Medway. Species characteristic of estuarine conditions have been identified at all 5 sites (e.g. bass, smelt, flounder, goby) and freshwater species have been identified at the two sites in the upper part of the estuary.

Bass, sprat, herring and smelt have been identified as suitable indicators of water quality because they are common, comparatively sensitive and occur at sites in the middle reaches of the estuary defined within the tidal excursion range; an area where pollutants would concentrate as a consequence of the tidal regime.

The surveys for 2000 identified bass, smelt and sprat at the mid-reach sites (Wouldham and M2 Bridge/ Borstal). In this respect, the estuary met its' environmental quality standard for fish in the year 2000.

Floods in June followed by major flooding in October had the effect of extending the range of freshwater fish species down the tideway in the first instance and probably extended displacement and loss of these species within the outer estuary during the autumn event. Elevated freshwater discharges during 2000 maintained the estuary with above average dissolved oxygen levels. This ensured fish survival and overall productivity within the nursery areas.

No evidence was found of any juvenile shad or shad recruitment within the estuary. Whilst no salmon or sea trout were taken by the survey net, reports were received of some adult migratory fish within the tideway and in the main river Medway upstream of Allington Lock at the normal tidal limit.

This report includes an additional report upon the findings of the four years of study and recommendations for future work and investigations.

2. INTRODUCTION

The following is a report on the fourth biennial Tidal Medway Survey which includes an examination of the surveys carried out for the period 1997 – 2000.

The primary purpose of the report is to identify the fish species present and their distribution within the tidal region of the River Medway and to determine any seasonal patterns.

The specific distribution of bass (*Dicentrarchus labrax*), herring (*Clupea harengus*), sprat (*Clupea sprattus*) and smelt (*Osmerus eperlanus*) is considered to be important because of the comparative sensitivities of these species and because they are commonly found within East Coast estuaries.

This medium term programme of sampling may also determine the importance of the Medway estuary as a spawning and nursery ground for commercially important species and the extent of these populations. Concurrently, the status of protected species and species of conservation concern (i.e. allis and twaite shad, salmon, sea trout and smelt) is being examined. The Environment Agency has a long-term objective of re-establishing the migratory salmon and sea trout fisheries of the Medway and other English and Welsh estuaries and both species of shad are included in the UK Biodiversity Action Plan Steering Group (BAPSG) list of priority species.

The Water Quality Monitoring Review has identified a revised format for the classification of estuaries. This includes dissolved oxygen levels, aesthetic pollution from polluting inputs and biological quality including the passage of migratory fish, the resident fish population, the benthic community, resident wildlife and bioaccumulation of pollutants in live tissues.

A new project (UK LIFE Rivers Project) funded by the European Union and supported by the Environment Agency and other conservation organisations, aims to develop conservation strategies and monitoring protocols for use on SAC rivers. The project seeks to address the definition of 'favourable conservation status' for the allis and twaite shads, both at specific sites and across their geographic range in the UK.

This Medway Estuary Fisheries study is presently funded by the Environment Agency's Water Resources function as a part of the Medway Estuary Project which is examining the quantity and quality of freshwater required to be released from the River Medway to ensure a quality environment within the estuary. Fresh water is abstracted from the river for agricultural, domestic and industrial consumption. Abstractions are controlled by a system of licensing which is coming under review. Information from the fisheries study will constitute an important part of the considerations given to the Catchment Abstraction Management Strategy (CAMS) and the licensing review process for the River Medway, which is being developed. The principal funding for this project expires in March 2001 but an extension of the work is anticipated.

Industrial discharge consents are being reviewed by the Agency's Integrated Pollution Prevention & Control function (IPPC) and fisheries monitoring is likely to be required. Developments within the EU Habitats and Frameworks Directives are also likely to include a need for up to date knowledge of estuarine fish stocks.

Additional interest has been expressed by the Thames Estuary Research Forum (TERF) which includes representatives from the National Resources Institute (NRI) based at Chatham and the University of Greenwich. TERF includes Environment Agency fisheries' representation from the Thames region which samples the Thames estuary in similar fashion to this study. The Swale Medway Estuary Partnership is operating to a similar brief locally.

English Nature has an interest relative to the BAPS fish species and the availability of fish fry for terms within the Medway SAC/ Ramsar site. The study is cooperating with the Ministry of Agriculture, Fisheries & Food in gathering sticklebacks from estuarine environments for examination of organic pollutants and associated oestrogenic effects.

3. METHOD

3.1. Seine netting

The method of seine netting followed that used in previous years. A 5mm micro-mesh seine net (35m x 2.5m) was deployed three times at each of the 5 sites. This was carried out at slack water, allowing the net to be worked easily and efficiently without resistance from tidal movement. The low slack period was used at all sites other than at Grain, where the high slack was used. The net was deployed from a dinghy with one end being held by two staff in dry suits who had waded out as far as safely possible. The net was fed out in the direction of any residual current. The dinghy completed an arc returning to the shore where the two staff in the dinghy landed and the net was then pulled in. Two members of staff worked on each of the lead and float lines at each end of the net to ensure the netting was as efficient as possible. A dinghy was not used at Allington because the water was shallow and permitted the deployment of the net on foot.



3.2. Fish Processing

Fish caught were transferred to a bin until netting operations were complete. Nettings were carried out concurrently to minimise stress to the fish. The fish from the second and third nettings were transferred to the bin and no attempt was made to separate the catches as population size was not calculated.

When the three sweeps of the net had been completed, the captured fish were identified and measured. All fish were returned alive to the estuary.

3.3. Species Identification

Where possible, fish were identified in the field using identification keys. Small specimens and fry were taken back to the laboratory for more detailed analysis and accurate identification. No effort was made to differentiate between the sand goby, *Pomatoschistus minutus*, and the common goby, *Pomatoschistus microps*.

3.4. Data Processing

Information collected in the field was processed using Microsoft Excel version 5.0. A full analysis for each site and survey is to be found within the Appendix commencing from the head of the tide at Allington to the most seaward site at Grain Tower. Each analysis describes the site, the fish species found, the population composition and size distribution plus a length frequency histogram for each species caught. A temporal and physical density index has been included for the first time for comparison with this years', and future, results.

3.5. Sampling Sites

To obtain a representative sample of fish from within the estuary, the 5 sites formally used were again considered to provide suitable diversity and coverage of the tidal reach of the river. Access difficulties to the Grain Tower site resulted in a minor revision in the site situation to a position adjacent to the Cockleshell Hard Pier. This change in location is considered to be minor resulting in no noticeable change in the topography of the foreshore and unlikely to affect a major change in the number or constituents of the catch. The use of the same sites enables a direct comparison between seasonal and annual patterns in fish populations and ensures continuity within the study.

4. RESULTS

A total of 16 different species were recorded in this survey compared with 17 in 1999 and 30 during the 1997-1998 survey programme. Graphic expressions of the results are to be found in *Appendix A* in the following site order.

4.1. Allington

4.1.1. Summer

The Allington site is located at the upper limit of the tidal Medway. During the summer survey a total of 7 species of fish were found to be present. They were principally freshwater species including one predator, a pike. The one exclusion was of 5 flounder, a euryhaline species which is characteristically found from the marine zone into freshwater. There was obvious recruitment to the gudgeon, bleak, dace and roach stocks. It is likely that the freshwater fish had been displaced from the freshwater river by floods in June. A large salmonid fish hit the net but escaped downstream and evaded capture. Timbers, boulders and general rubbish on the river bed at this site adversely influenced the netting efficiency.

4.1.2. Autumn

An autumn survey was not possible because of early spates which opened the automatic sluices upstream of the site. Further attempts at surveying within the autumn (September/October) period were negated by the heaviest rains and autumn floods since 1846 which left the river bed ultimately strewn with the aftermath jetsum of sunken boats, broken caravans and washed down timbers.

4.2. Wouldham

4.2.1. Summer

Freshwater species become less common with increasing salinity further down the estuary. Only one of the 8 species captured at this site, the bleak, was a freshwater species. The 17 individuals captured were of a greater size than those captured at the Allington site. Bleak dominated the catch followed by bass. The presence of juvenile smelt, sprat and bass ensured that the site met its' environmental quality standard.

4.2.2. Autumn

The autumn survey featured 2 freshwater fish species – roach and dace in the 100mm to 300mm length range. This is consistent with the improved summer freshwater flows down the river and the possible downstream displacement of coarse fish by summer floods. The growth of the smelt and bass fry is readily apparent relative to the summer survey and their presence indicates that the site met its environmental quality standard. The quantity of fish caught was 30% higher than that taken during the summer survey. The showing of smelt in number was encouraging.

The results indicate that the Wouldham site is the most upstream site, of the 5 examined, for the survival of the marine fry species.

4.3. Borstal

4.3.1. Summer

The results of the summer survey at Borstal showed that a total of 8 fish species were captured. None were truly freshwater species – sticklebacks and eels are comfortable in estuary and freshwater conditions. No one species truly dominated the catch although bass and sand goby constituted half of it. The presence of juvenile smelt, sprat and bass ensured that the site met its environmental quality standard.

4.3.2. Autumn

Seven species were caught in the autumn survey. Sprat were noticeably absent. Sand goby and bass truly dominated the catch. The bass and smelt were naturally of a larger size than those captured in the summer. There was an element of net fouling at the site caused by large stone and scrap iron on the bed which will have adversely impacted upon the total number of fish taken.

4.4. Lower Upnor

4.4.1. Summer

Five species of fish were taken in relatively small number dominated by sprat which constituted 55% of the catch. Both bass and sprat exhibited a larger size range than their fry which were found at Borstal and Wouldham at this time of year.

4.4.2. Autumn

Six species of fish were caught in the autumn survey. Sand smelt dominated the catch (60%). 3 quality fish were caught – a bass of 610mm (about 3Kgs), a bass of 265mm and a mullet of 425mm in length.



4.5. Grain Tower

4.5.1. Summer

Eight species were caught totally dominated by over 300 sprat constituting 90% of the catch. Even more small sprat escaped through the mesh of the net. Per the Upnor site, the bass stock consisted of fish older than this years fry. A strong cucumber smell was reported at the site. This usually accompanies the presence of smelt, however, none were taken in the net.

4.5.2. Autumn

The autumn survey showed a reduction in the species richness with a total of 5 species present. Again sprat dominated the catch (84%), and the length frequency histogram shows a clear shift in growth compared with the same survey in June. The length frequency histogram for bass indicates three possible year classes. Sand smelt were represented by two year classes. An anchovy was also found; the first time this species has been caught during these surveys but common in the outer Thames estuary during the summer and autumn (Wheeler pers. comm.)

4.6 Environmental status

The surveys for 2000 identified bass, smelt and sprat at the mid-reach sites (Wouldham and M2 Bridge/Borstal). In this respect, the estuary met its environmental quality standard for fish in the year 2000.

Table A shows the distribution of these indicator species. Obviously the Allington site was not suited to their needs – a likely reflection of the influence of freshwater and the coarse fish species dominance at the site. The bass is both a marine and estuarine species. The smelt appears to be principally an estuarine species with an element of seaward displacement in the autumn perhaps precipitated by higher than average freshwater flows during the summer. Similarly the sprat may have been displaced seawards by the same phenomenon because none were found at the Wouldham or Borstal sites in the autumn.

Table A. Measure of the status of water quality in the Medway Estuary using the main indicator species.

Site	Bass		Smelt		Herring		Sprat	
	Summer	Autumn	Summer	Autumn	Summer	Autumn	Summer	Autumn
Allington								
Wouldham								
Borstal								
Lower Upnor								
Isle of Grain								

(A greyed out square indicates the presence of that species)

Most of the fish taken in the micromesh seine net are juvenile fish principally those which have hatched during the current year. This applies mostly to bass, smelt, herring and sprat. Often juvenile fish are more sensitive to environmental influences compared with adult fish. "Infant" mortality is naturally high but easily influenced by changes in water quality and, to a lesser extent, predation by other fish, crustaceans and birds.

5. REPORT FOR THE YEARS 1997 TO 2000

5.1. General factors

Distribution of juvenile fish within the estuary is related to a number of factors principally

- salinity

Some species are fully marine and will tolerate little if any dilution of neat seawater

Some species are freshwater and will tolerate little if any salt water

Some species are euryhaline, that is they can live in brackish waters and their range may well extend into the freshwater and marine zones

- water quality

Dissolved oxygen levels of 50% saturation and higher seem to support most if not all the fish species within the estuary. Levels less than 30% DO may result in fish mortalities particularly in relation to the more sensitive species and especially to juveniles of those species.

Ammonia levels in the upper estuary, particularly, may result in mortalities. Mortalities are less likely within the outer estuary where greater dilution and seawater tidal dilution is regularly available.

Thermal differences. Salmon and seatrout will migrate through estuaries up to temperatures of 20 deg C to 25 Deg C. Bass and bass fry favour elevated water temperatures particularly adjacent to the powerstation outfalls within the outer estuary. This phenomenon has been recognised and a "no fishing" box has been created in these areas to protect the juvenile stocks from exploitation.

- stock recruitment in the year of sampling .

Bass spawn in the North Sea and the fry move inshore to the estuary nursery areas from an early age. Similarly herring spawn on the Eagle Bank and off Whitstable within the Thames estuary and the fry migrate inshore. Conversely, smelt probably spawn in the upper Medway estuary and the fry spread downstream into the intertidal zone. Any adverse environmental conditions, excessive predation or limit upon the number of spawning adults will have an impact upon the availability of juvenile fish within the estuary.

Within the estuary, the distribution of fishes on the day of sampling has been affected by these factors. In the absence of any mortalities or a lack of recruitment, distribution will have been determined by the water quality situation before sampling including the salinity which will have been influenced by the volumes of freshwater discharged from the river.

The following analysis relates to surveys carried out on the dates at the sites listed in **Table B** below.

Medway Estuary Survey Dates & Sites								
Year	1997	1997	1998	1998	1999	1999	2000	2000
Site	Summer	Autumn	Summer	Autumn	Summer	Autumn	Summer	Autumn
Allington	8.7	17.10	16.7		5.7	13.9	7.7	-
Wouldham	24.6	18.9	14.6	10.9	7.7	19.10	25.7	19.9
Borstal	26.6	6.10	18.6	11.9	6.7	14.9	21.7	20.9
Upnor	27.6	5.9	29.6	12.10	8.7	20.9	23.6	21.9
Grain	10.7	20.10	15.7	13.10	11.6	7.9	29.6	12.9

5.2 Estuary Flows

Freshwater river flows from the Teston gauge near Maidstone were examined for the years 1997 to 2000. The information analysed related to the months of June & July and September & October each year and consisted of mean daily flows. It is considered that the freshwater flow discharging to the estuary at Allington is about 10% greater than that measured at Teston due to additional inflows downstream of the gauge. The information is listed in **Table C** below.

Medway Estuary Study

Teston Flows

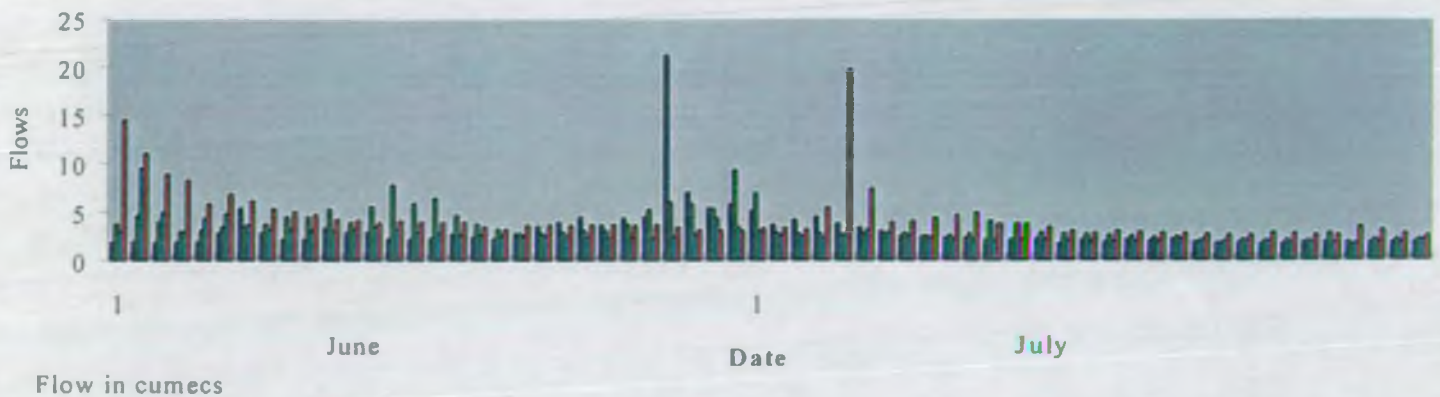
	June/July 97	Sept/Oct 97	June/July 98	Sept/Oct 98	June/July 99	Sept/Oct 99	June/July 00	Sept/Oct 00
Max	21.25	8.36	9.31	24.71	9.47	22.59	19.81	231.78
Min	1.75	1.64	1.69	2.09	1.78	1.74	2.58	1.98
Av	3.14	2.58	3.58	5.82	2.74	3.97	4.48	28.63
STD	2.64	1.49	1.55	5.16	1.13	4.04	2.89	51.43

Flows in cumecs.

It is very apparent that the autumn flows in 2000 were much greater than any others seen within the reviewed periods. The hydrographs for 1997-2000 indicate that the summer flows were punctuated by relatively few small spates >10 cumecs. (4 recorded to a maximum of 21 cumecs) (**Chart D**) whilst the autumn series recorded 37 instances >10cumecs to a maximum of 240 cumecs) (**Chart E**).

1997-2000

Chart D



1997-2000

Chart E



The likelihood of downstream displacement of some freshwater and marine species may be more likely during extreme autumn flood events.

5.3 Changes in water quality

Water quality was examined at or near the 5 sampling sites in low water conditions for the years 1997 to 2000. The samples were taken monthly and related to chloride ion concentration (Cl), % solution of dissolved oxygen (DO) and ammoniacal nitrogen levels (N) in mg/l.

The fisheries survey dates did not exactly correspond to the dates or the exact sites where these samples were taken. However, in broad terms, the greatest changes in concentration were seen in chloride levels (representing salinity) Table F below.

Site	Normal range	Lowest reading
Allington	50 - 120	<20
Wouldham	300 - 2700	54
Borstal	1200 - 8600	29
Upnor	8000 - 13000	3000
Grain	16000 - 18000	12700

Generally the DO was recorded at >70% ranging from a low of 29% to supersaturated (>100%) condition. N levels varied from <0.01 mg/l. to 0.86 mg/l. but were normally <0.3 mg/l. The higher levels were found in the confined reaches of the estuary in contrast to the Grain site in the open estuary situation.

None of these determinands suggested any risk to fish stocks although the influence of salinity could influence the distribution of the fish within the estuary. It is much more likely that episodic events are responsible for changes in the fish stocks and their distribution. Water quality monitoring for these determinands on a regular basis may not reflect environmental quality as well as fish and invertebrate studies which are directly affected by any changes not detected on the due dates.

5.4 Changes at the sites

5.4.1 Species changes

The Allington site is directly influenced by freshwater discharges from the river, hence most fish caught are freshwater varieties which may have been washed down river and over Allington sluices. Observations of fish trying to ascend the sluices in the autumn of 1999 clearly identified them as roach.

Conversely, the Grain site is a marine site exposed to full strength seawater. Consequently no freshwater fish are found at this site and catches of large numbers of sprat/herring are not unusual. The conductivity only reduces at this site when the river experiences extreme flood conditions (normally 15500 to 18400 mg/l chloride but this dropped to 12700 mg/l chloride in November 2000 following the major flood event).

The Upnor and Borstal sites normally experience similar water conductivity and quality conditions and support a range of marine and euryhaline species. Whilst no freshwater species were taken during the surveys, a commercial netsman reported catching two large live carp at Upnor in his nets in the autumn and a rod fisherman reported catching chub at Borstal.

The Wouldham site is the most dynamic of the 5 sites containing a full range of marine, euryhaline and freshwater species depending upon conditions.

The changes in the fish species composition on a biannual basis is illustrated in Table H.

The appearance of freshwater species (dace, bleak & roach) at the Allington and Wouldham sites can be clearly seen during the study period. Roach appeared in the autumn 2000 survey perhaps displaced by the summer floods.

Juvenile herring disappeared from the estuary from the autumn of 1998 onwards. Whilst sprat have been recovered since there may have been an element of mis-identification during earlier surveys, albeit sprat were recovered from the Borstal site in autumn 1997.

Bass and goby have been found throughout the tidal range.

Distribution of Selected Fish Species within the Medway Estuary 1997-2000

Table H

Site	Year							
	1997	1997	1998	1998	1999	1999	2000	2000
	Summer	Autumn	Summer	Autumn	Summer	Autumn	Summer	Autumn
Allington	Bl, Ro, Da	Ro,Bl,Go,Da,Ba	Ro, Bl, Da	No sample	Ro,Da	Ro,Bl,Ba,Da,Go	Ro,Da,Bl	No sample
Wouldham	Bl,Ba,Sm,Go	Go,Ba	He,Ba,Bl,Go,S	Ba,Go,Sm	Go,Ba,Sp,Da	Go,Ba,Da	Bl,Ba,Sm,Go,Sp	Go,Sm,Ba,Ro,Da
Borstal	Go,Sm,Ba,He	Ba,Go,Sp	He,Sm,Go	Go,Ba	Go,Sp,Ba	Ba,Go,Sp	Ba,Go,Sm,Sp	Go,Ba,Sm
Upnor	He,Go,Sm	He,Ba,Sm,Go	He,Ba,Go	Go,Sp,Ba	Sp,Go	Sp,Ba,Go	Sp,Ba	Ba,Sp,Go,Sm
Grain	He,Go,DS	Ba,Go	He,Go,Ba,	Go,Ba,So	Sp,Sm	Sp,Ba,Go	Sp,Ba,Go	Sp,Go,Ba

Key

Bleak	Sprat
Dace	Herring
Roach	Goby
Smelt	Sole
Bass	Dover Sole

Abundant/ Important	Emboldened
Present	Normal

Smelt stocks have featured every year of the survey although the 1999 catch consisted of a single second season fish taken during the summer survey at Grain. The catches of juvenile smelt in 2000 were exceptional and may attest to an excellent spawning in the river that spring. In respect of the abundance of smelt stock, the adage of "seven years fat and seven years lean" may apply. This phenomenon is being investigated in 2001. Brush mats will be placed in the historic smelt shoots between Snodland and Cuxton during the spring smelt spawning period. It is hoped that the experiment will confirm smelt spawning in that region and provide some indication of the availability of fertilised ova. The certainty that smelt spawn within this section of the tidal excursion would reinforce the quality aspect of river water quality and environmental condition considering that the fish spawn upon clean gravels.

Table G: List of fish species recorded in the Medway estuary seine net surveys

Common Name	Scientific Name
Anchovy	<i>Engraulis encrasicolus</i>
Bass	<i>Dicentrarchus labrax</i>
Bleak	<i>Alburnus alburnus</i>
Bream	<i>Abramis brama</i>
Chub	<i>Leuciscus cephalus</i>
Dace	<i>Leuciscus leuciscus</i>
Dover Sole	<i>Solea solea</i>
Eel	<i>Anguilla anguilla</i>
Flounder	<i>Platichthys flesus</i>
Gudgeon	<i>Gobio gobio</i>
Gurnard	<i>Eutrigla gurnardus</i>
Herring	<i>Clupea harengus</i>
Hooknose	<i>Agonus cataphractus</i>
Ling	<i>Molva molva</i>
Mullet (Thick & thin lipped)	<i>Crenimugil labrosus & Liza ramada</i>
Perch	<i>Perca fluviatilis</i>
Pike	<i>Esox lucius</i>
Pipefish	<i>Syngnathus spp.</i>
Plaice	<i>Pleuronectes platessa</i>
Roach	<i>Rutilus rutilus</i>
Ruffe	<i>Gymnocephalus cernua</i>
Salmon	<i>Salmo salar</i>
Sand goby	<i>Pomatoschistus minutus</i>
Sand smelt	<i>Atherina boyeri</i>
Smelt	<i>Osmerus eperlanus</i>
Sole	<i>Solea solea</i>
3-Spined Stickleback	<i>Gasterosteus aculeatus</i>
10-Spined Stickleback	<i>Pungitius pungitius</i>
Sprat	<i>Sprattus sprattus</i>
Turbot	<i>Scophthalmus maximus</i>

A cursory examination of the water quality and flow data in 5.4 in relation to the spread of freshwater fish species from the Allington to the Wouldham and Borstal sites, paying attention to the range of flows available to the estuary for several weeks in advance of the surveys, met with a 60-75% success level of prediction that freshwater fish were displaced by elevated flows and reduced salinities.

5.4.2 PRIMER analysis

The data gathered during the 1997 – 2000 period was subjected to analysis using the computer based PRIMER program (**Appendix B**). The data was split to; the number of each species caught; for each site; for each period (viz. summer & autumn); for each year and subjected to two types of analysis: the Bray Curtis similarity cluster analysis and a multi-dimensional ordination analysis (MDS).

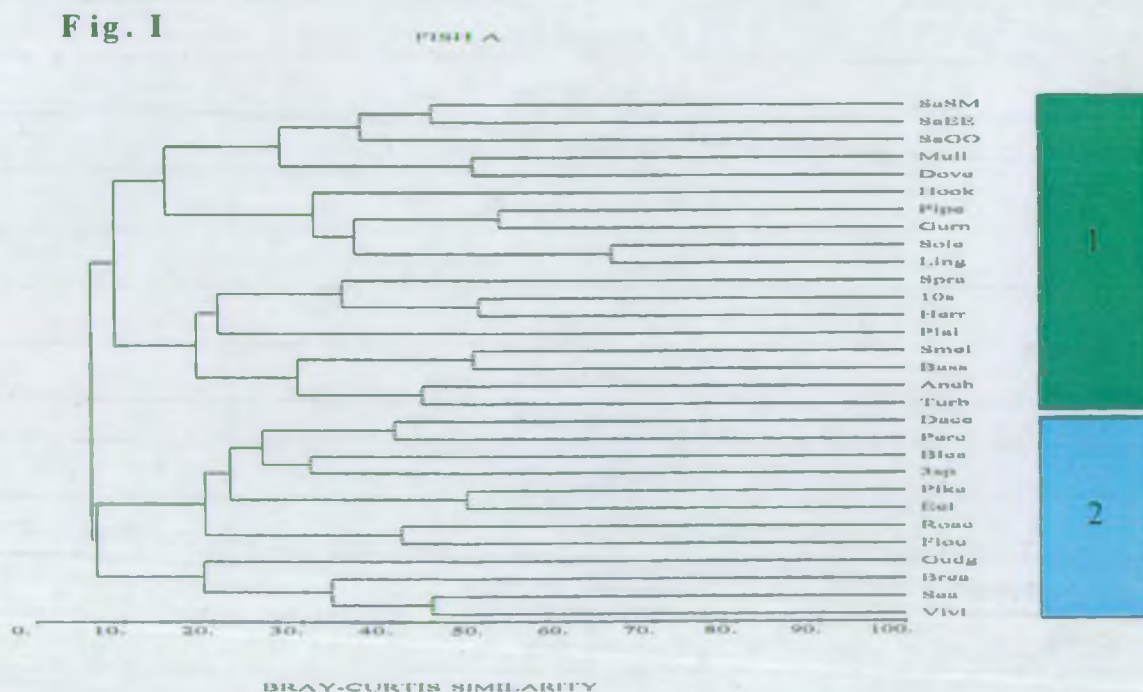
(1) The Bray Curtis similarity cluster analysis produces a dendrogram. Turned on its side, the dendrogram could be considered to be a mobile with each of the species “fingers” able to rotate freely about the axes above it.

(2) The multi-dimensional ordination analysis produces a two dimensional separation of the species.

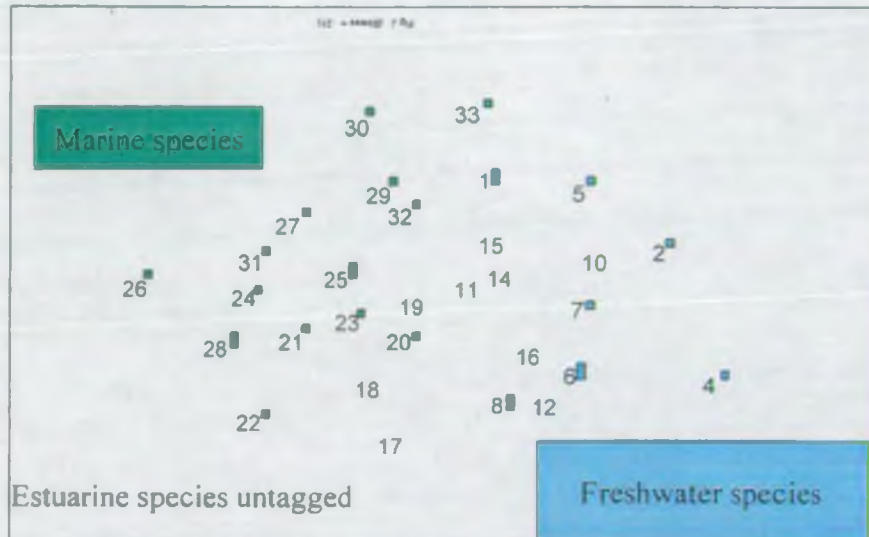
These methods were employed to:

- (a) Examine the relationships between the different species of fish
- (b) Examine the relationships between each site, for each period, for each year

(1a) An examination of (**Fig. I**) Fish A shows that most of the freshwater species are found in Block 1 and most of the marine species are found in Block 2.



(2a) Each species has been identified by a number (**Fig.J**) and separation clearly shows the marine species to the right hand side of the page and the freshwater species to the left hand side of the page.



(1b) Within the dendrogram (**Fig K**), Wouldham, Borstal & Grain showed some semblance of grouping albeit differently grouped. Allington & Upnor showed no particular patterns.

Key to finger labels:

Site then

Year then

Season

e.g. W0S =

Wouldham

2000

Summer

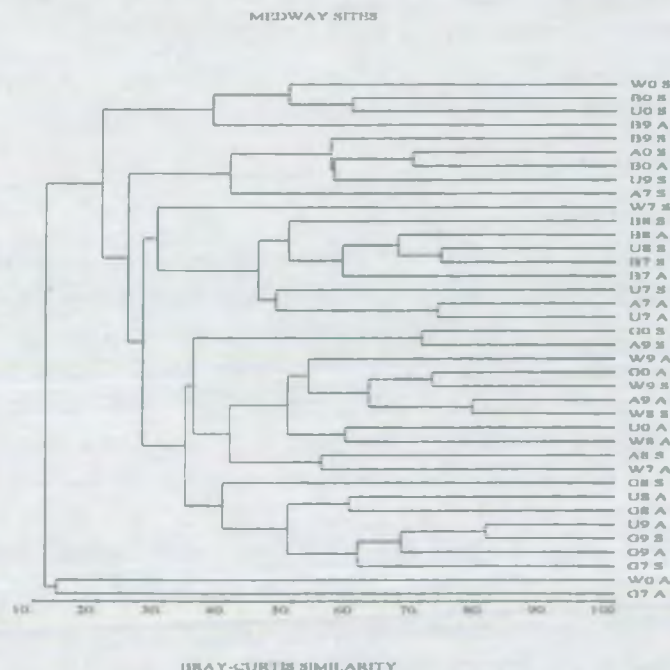
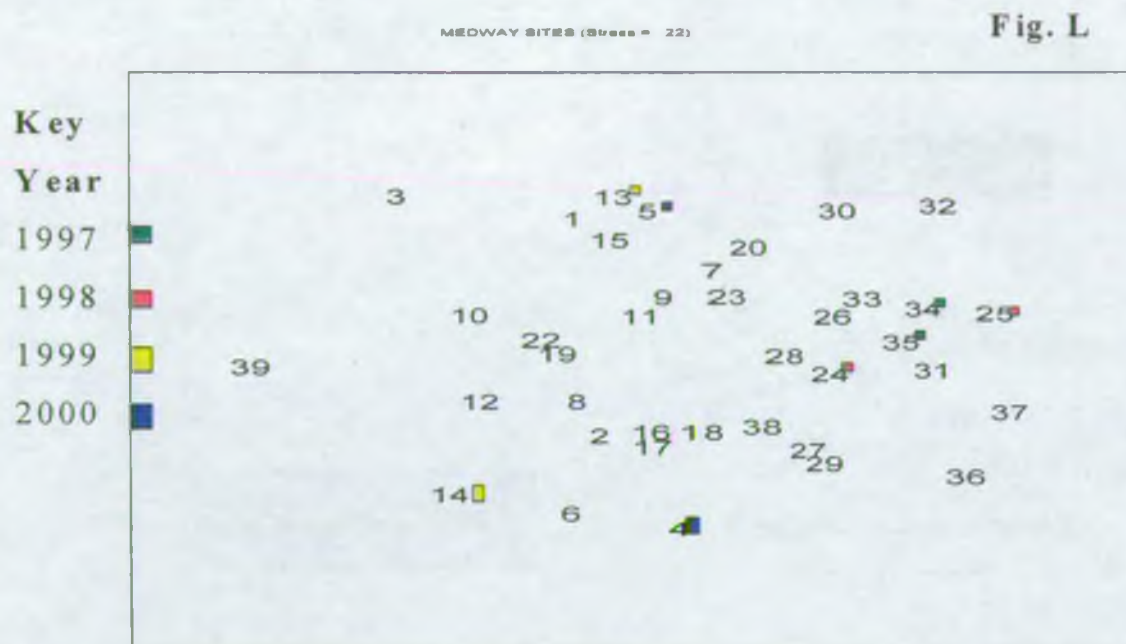


Fig K

(2b) The two dimensional analysis (Fig. L) generally showed a shift from the right hand side to the left hand side of the chart in subsequent years. This analysis can "wrap around"; hence it is quite possible that points on the extreme left of the page could equally appear on the extreme left hand side. No reason has been ascribed to this change in distribution.



Borstal site shown as an example

A Windows based version of PRIMER is just being released which will be much more user friendly. Further analyses will be attempted when this program is commissioned.

5.5 Additional observations

5.5.1 From CEFAS

The Centre for Environment, Fisheries & Aquaculture Science (CEFAS) is an Executive Agency of M.A.F.F. CEFAS regularly surveys inshore fisheries (Rogers, Millner & Mead 1998). Information regarding trawl surveys carried out by CEFAS in the Thames estuary including the Medway estuary and Swale has been summarised in Appendix D for completeness of this report. The surveys were carried out by a locally hired fishing vessel which towed a pair of Bristol trawls each covering a ground track of approximately 12m. in width. Two trawls were made off Kingsnorth Power Station within the bass box (M.A.F.F. 1990), two trawls were made off Grain Tower and 4/5 trawls were made in the Swale and into the Thames estuary during autumn 1999 and 2000. The trawl data has been amalgamated for each site to produce the Reports in Appendix C. In general terms, the density of fish caught in the trawls is much less than that taken within our micro-mesh beach seine at the shore based sites. However, the trawl takes larger fish and additional fish species including bib, dab, whiting, cod, poor cod, brill and plaice.

6. PROPOSALS FOR ADDITIONAL RESEARCH WITHIN THIS STUDY

The following have been identified:

Increasing man generated encroachment leading to increased water velocities and displacement of spawning and nursery areas

Loss of floodplain and open tributaries providing shelter for adults and juvenile fish from flood events

Review of the literature with regard to the water quality requirements of estuarine fish fry - especially likely indicator species such as smelt, bass, herring & sprat

Control of land use (ploughing by farmers, run off from roads, railways, urban areas) to reduce silt discharges to estuaries which might blanket spawning beds/ nursery areas. Reduce estuarine dredging and hence silt discharges to the sea which could result in eutrophication, algal blooms, loss of fish stocks.

Impacts of above plus climate change upon sea fisheries and commercial production.

Re-open salt marshes via managed retreat where possible. Requires a map study to first establish likely areas. Man made sea defences have converted most marshes to landlocked brackish or freshwater drains. Salt marsh drains are probably important as nursery areas for some marine fish fry. The change may provide a greater recruitment to marine fish stocks with the potential for a greater commercial take.

Opening up saltmarsh drains may also favour oyster & mussel culture with socio-economic benefit.

Satellite or aerial photo plot extent of saltmarshes to monitor encroachments over time and to assist above.

Identify long term benefits to the community of less silt & eutrophication to the North Sea/ English Channel especially in relation to climate change and the deposition of organics/ heavy metal toxins in the long term.

7. RECOMMENDATIONS

That the existing biannual monitoring study be continued to accommodate the needs of those groups showing an interest, with the proviso that, if insufficient financial support can be attracted, the less complex successful smelt spawning study mentioned in 5.4.1 be substituted to continue to indicate quality water conditions within the tidal excursion.

It is important that there be immediate co-ordination of the fish surveying efforts in the Thames and Medway tide-ways by EA Thames & Southern (Kent) Regions plus the Environment Agency's National Maritime Surveys and CEFAS surveys.

The recently reported National Fisheries Legislative Review has acknowledged the importance of estuary studies. It would be appropriate if EA Regions with major river estuaries who are already carrying out fisheries studies were to co-ordinate their efforts (i.e. cross fertilise and agree co-ordination of Thames, Medway, Mersey, Humber, Tyne etc.) by appointing a joint group on estuary management.

Extension of this principle (if EC Directives can be interpreted to encompass the study and funds attracted), to include other EU estuaries – e.g. Rhine, Seine, Rhone, Tagus

The benefits of co-ordinated study are ecological, relate to commercial fish stock recruitment and shellfish development. There are also implications for maritime bird populations and other BAP species.

The element relating to commercial fish stock recruitment may be very important following the recent closure of 25% of the North Sea for 12 weeks commencing 14 February 2001 to protect spawning cod. Whilst not necessarily forwarding a major haven for cod, the Medway estuary as a spawning and nursery area for some species may assume greater importance in the maintenance of sea fish stocks and the national sea fishing industry.

8. REFERENCES

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Appendix A

Fisheries Survey Results 2000

MEDWAY ESTUARY SURVEY DATES 2000						JUNE	
Low waters (LW) except where noted for Grain Tower							
Based on Sheerness & Corrected for BST/GMT							
Day	Date	Corrected tim	HW	LW	Place	Actual survey time	Height in m.
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
M	12	1006	X				
T	13	1105	X				
W	14	1156	X				
TH	15	1240	X				
F	16	1319	X				
	17						
	18						
	19						
	20						
	21						
TH	22	1026		X			
F	23	1103		X	Lower Upnor	1100	"-1.72
	24						
	25						
M	26	1340		X			
T	27	1452		X			
W	28	1005	X				
T	29	1107	X		Grain	1030	2.53
F	30	1204	X				
	31						

MEDWAY ESTUARY SURVEY DATES 2000

JULY

Low waters (LW) except where noted for Grain Tower

Based on Sheerness & Corrected for BST/GMT

Da	Date	Corrected ti	HW	LW	Place	Actual survey time	Height in m.
	1						
	2						
M	3	1435	X				
	4						
W	5		1001	X			
TH	6		1046	X			
F	7		1131	X	Allington Lock	1129	"-1.96
	8						
	9						
M	10		1411	X			
	11						
W	12	1027	X				
TH	13	1125	X				
F	14	1214	X				
	15						
	16						
M	17	1410	X				
	18						
	19						
	20						
F	21		1011	X	Borstal	1015	"-1.98
	22						
	23						
M	24		1202	X			
T	25		1255	X	Wouldham	1350	"-1.56
W	26		1404	X			
	27						
	28						
	29						
	30						
	31						

MEDWAY ESTUARY SURVEY DATES 2000

SEPTEMBER

Low waters (LW) except where noted for Grain Tower

Based on Sheerness & Corrected for BST/GMT

Day	Date	Corrected tim	HW	LW	Place
	1				
	2				
	3				
M	4	1107		X	
T	5	1138		X	
W	6	1220		X	
TH	7	1323		X	
	8				
	9				
	10				
M	11	1204		X	
T	12	1245		X	Grain Tower
W	13	1323		X	
TH	14	1358		X	
F	15	1432		X	
	16				
	17				
M	18	1001		X	
T	19	1032		X	Wouldham
W	20	1108		X	Borstal
TH	21	1159		X	Upnor
F	22	1313		X	
	23				
	24				
M	25	1115		X	
T	26	1216		X	
W	27	1304		X	
TH	28	1347		X	
F	29	1426		X	
	30				
	31				

Actual survey time Height in m.

1145 2.57

1205 "-1.95

1200 "-1.82

1214 "-1.67

MEDWAY ESTUARY SURVEY DATES 2000

OCTOBER

Low waters (LW) except where noted for Grain Tower

Based on Sheerness & Corrected for BST/GMT

Day	Date	Corrected time	HW	LW	Place
	1				
M	2	1006		X	
TH	3	1033		X	
W	4	1058		X	
TH	5	1132		X	
F	6	1228		X	
	7				
	8				
M	9	1029		X	
T	10	1126		X	
W	11	1210		X	
TH	12	1249		X	
F	13	1327		X	
	14				
	15				
	16				
	17				
W	18	1018		X	
TH	19	1100		X	
F	20	1155		X	
	21				
	22				
	23				
TH	24	1057		X	
W	25	1155		X	
TH	26	1242		X	
F	27	1323		X	
	28				
	29				
	30				
	31				

Actual
survey time

Height
in m.

RIVER	Medway
SITE NAME	Allington
SITE CODE	199
LOCATION	Immediately D/S of sluice
NGR	TQ 745 581
METHOD	35m x 2.5m micro mesh seine net
TIDAL STATE	Low
WIDTH AT LOW WATER (M)	Approximately 30m
DEPTH (M)	0.3 to 0.7m
SUBSTRATE	Gravel and some large stones/rocks with a heavy silt covering. Timbers and obstructions foul netting ops.
AQUATIC VEGETATION	None
BANKSIDE VEGETATION	None, flood defence wall. Despite this some vegetation growing on the wooden piling
ADJACENT LAND USE	Left bank Lock keepers house and private garden. Right bank Public footpath.



Fisheries Survey Results

River/Lake: Medway Estuary
 Site: d/s Allington Lock

Date: 7.7.00
 Surveyed length (m): 43
 Surveyed width (m): 35
 Area (m²): 1505

National Grid Ref: TQ 745 581 To

Start Time: 1129
 Finish Time: 1205
 Minutes: 22

Total No. of fish observed: 24
 No. of species: 7
 Total Fish / m²: 0.02
 Total Fish / min: 1.09

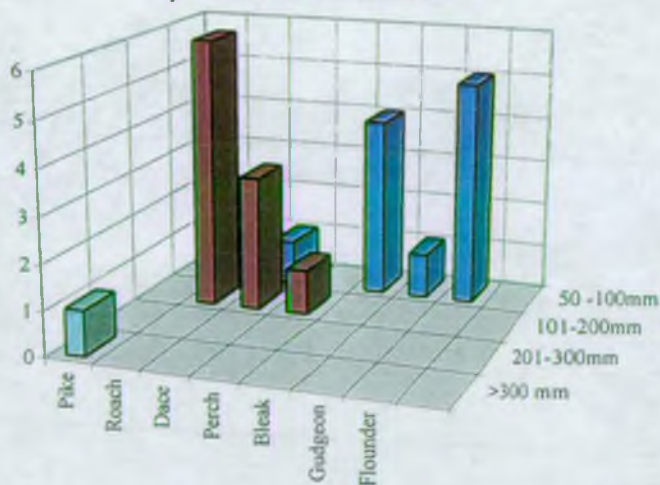
note ; 3 nettings took 22 mins.

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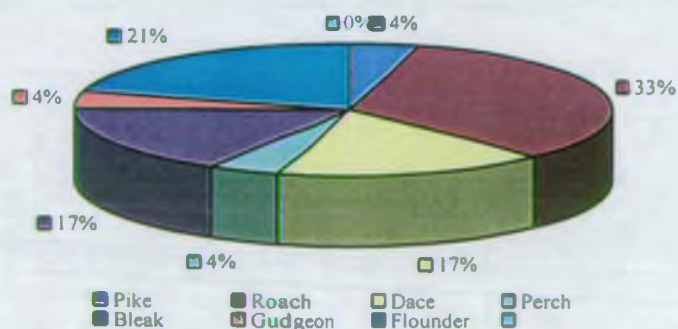
Raw Data

Species	50 -100mm	101-200mm	201-300mm	>300 mm	No. Caught	Fish / m ²	Fish / min.	% of Tot.
Pike				1	1	0.00	0.05	4
Roach	2	6			8	0.01	0.36	33
Dace	1	3			4	0.00	0.18	17
Perch		1			1	0.00	0.05	4
Bleak	4				4	0.00	0.18	17
Gudgeon	1				1	0.00	0.05	4
Flounder	5				5	0.00	0.23	21
					0	0.00	0.00	0

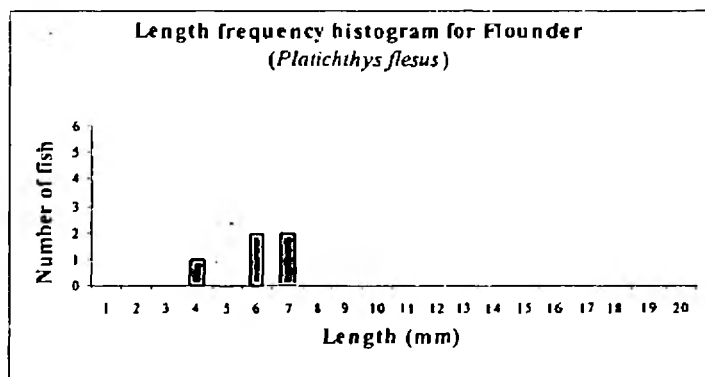
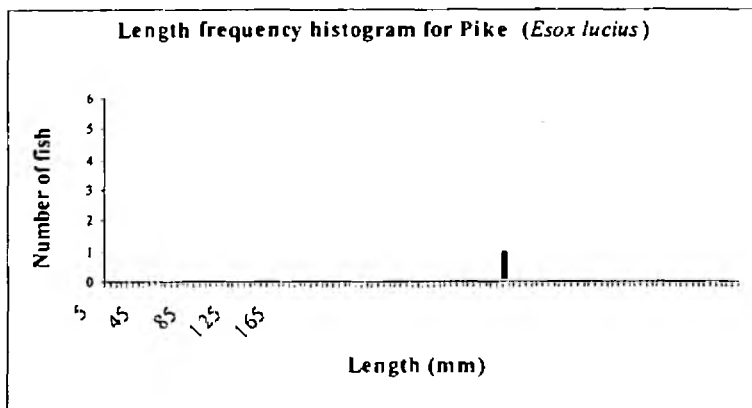
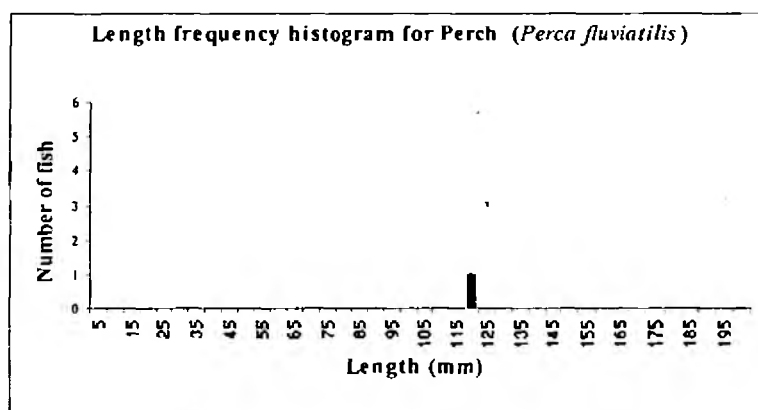
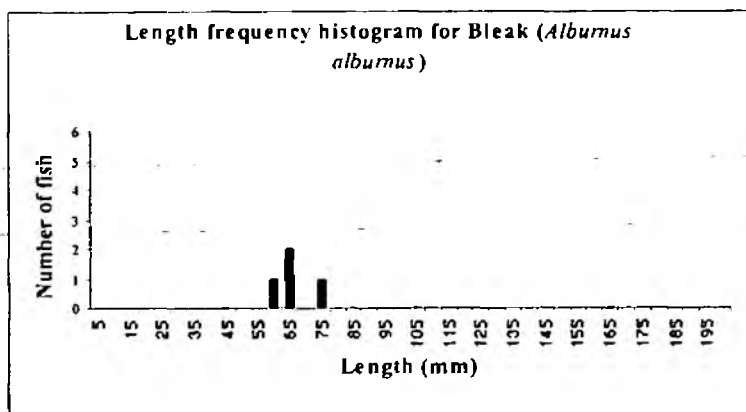
Species and Size Distribution

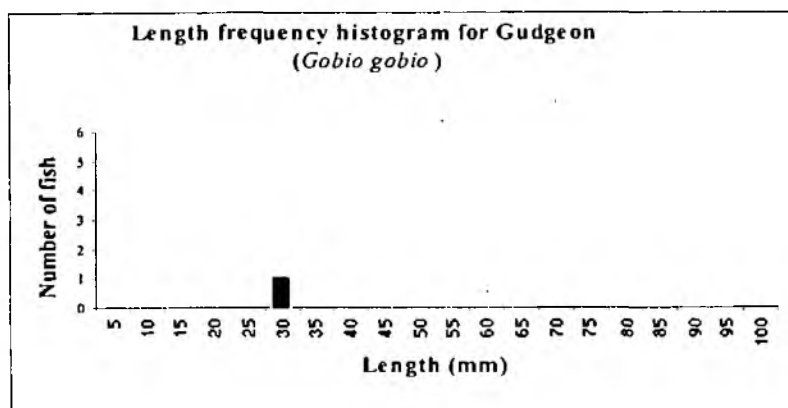
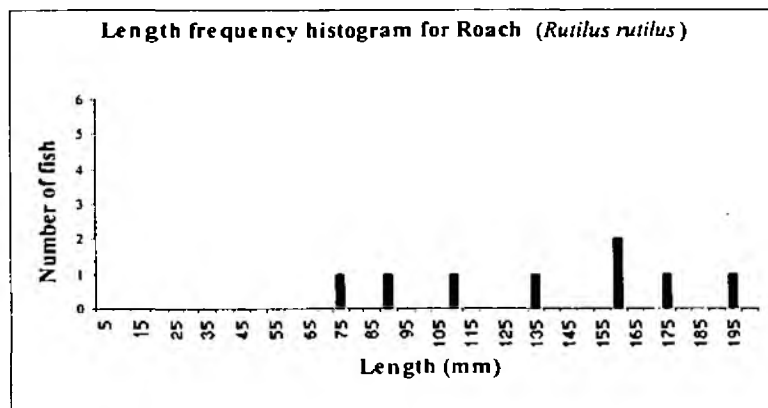
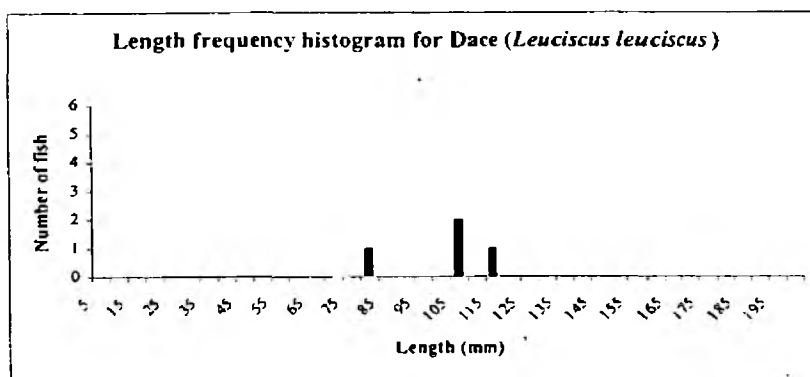


Population Composition (frequency)



Notes: 1 large salmonid hit the net; 1 live & 2 dead mitten crabs; 1 prawn





RIVER	Medway	
SITE NAME	Wouldham	
SITE CODE	249	
LOCATION	Right bank next to church	
NGR	TQ 712 644	
METHOD	35m x 2.5m micro mesh seine net	
TIDAL STATE	Low	
WIDTH AT LOW WATER (M)	Approximately 6m	
DEPTH (M)	0.3 to 2m. Shallow drop off	
SUBSTRATE	Gravel sand and silt, some stones and rocks	
AQUATIC VEGETATION	None	
BANKSIDE VEGETATION	Left bank	Common club reed
	Right bank	None
ADJACENT LAND USE	Left bank	Marshland
	Right bank	Housing estate



Fisheries Survey Results

River/Lake: Medway Estuary
 Site: Wouldham

Date: 25.07.00
 Surveyed length (m): 105
 Surveyed width (m): 24
 Area (m²): 2520

National Grid Ref: TQ 712 644 To

Start Time: 1350
 Finish Time: 1430
 Minutes: 25

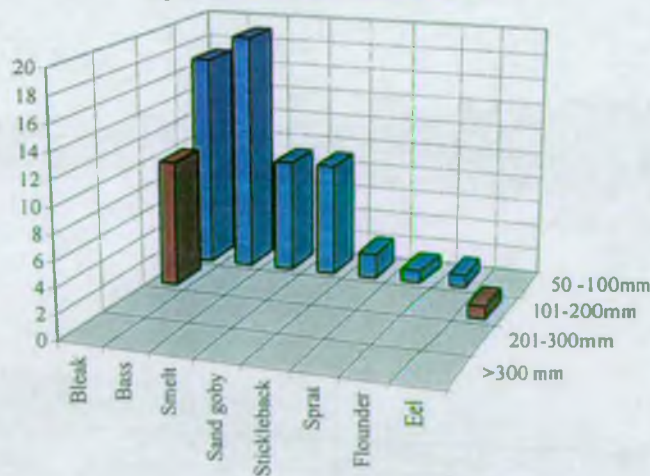
Total No. of fish observed: 69
 No. of species: 8
 Total Fish / m²: 0.03
 Total Fish / min: 2.76

Note: 3 nettings done
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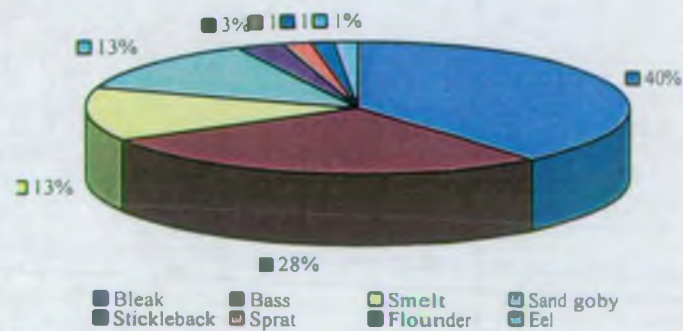
Raw Data

Species	50 -100mm	101-200mm	201-300mm	>300 mm	No. Caught	Fish / m ²	Fish / min.	% of Tot.
Bleak	17	10			27	0.01	1.08	39
Bass	19				19	0.01	0.76	28
Smelt	9				9	0.00	0.36	13
Sand goby	9				9	0.00	0.36	13
Stickleback	2				2	0.00	0.08	3
Sprat	1				1	0.00	0.04	1
Flounder	1				1	0.00	0.04	1
Eel		1			1	0.00	0.04	1

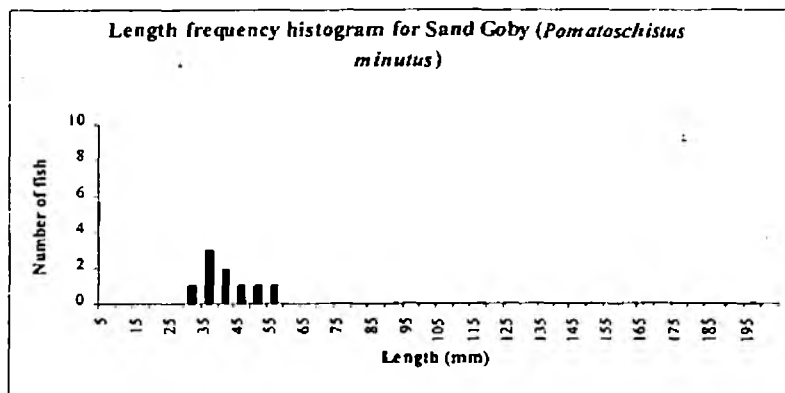
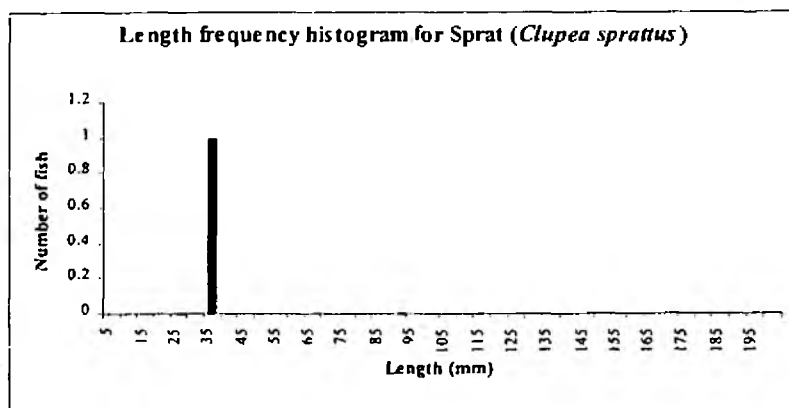
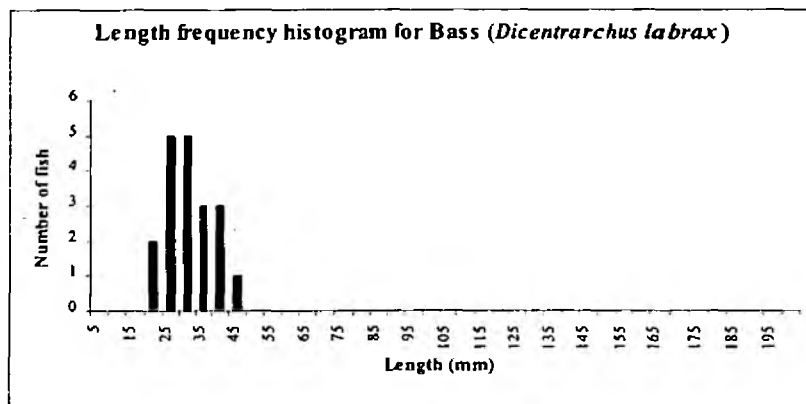
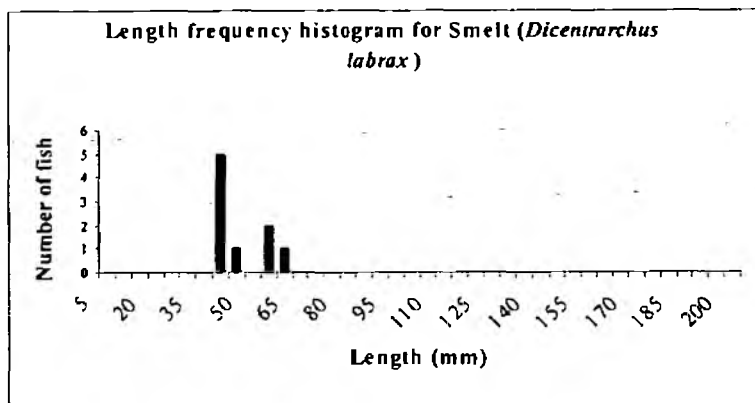
Species and Size Distribution

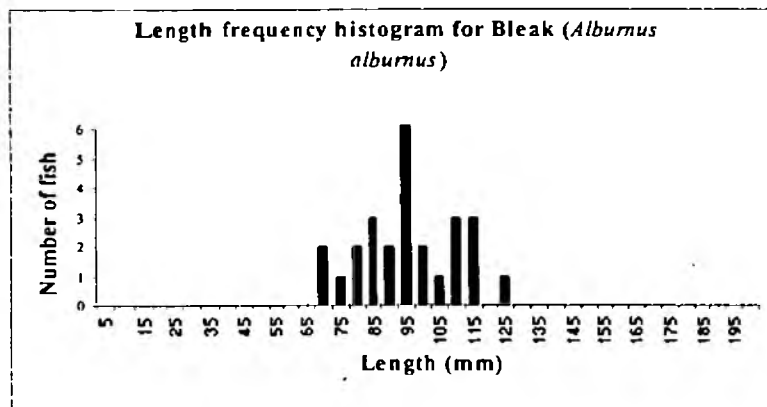
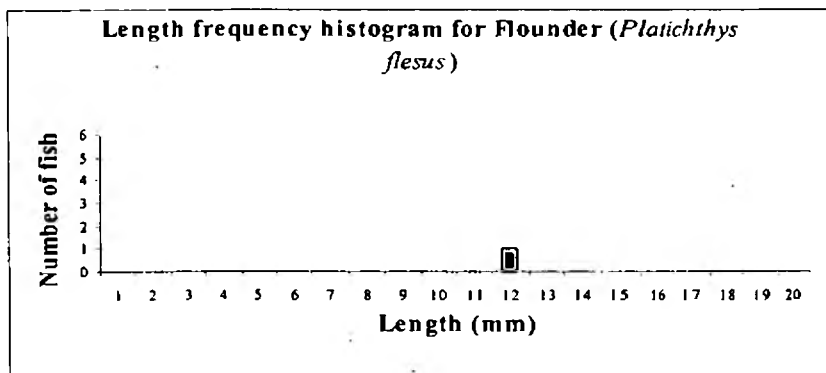
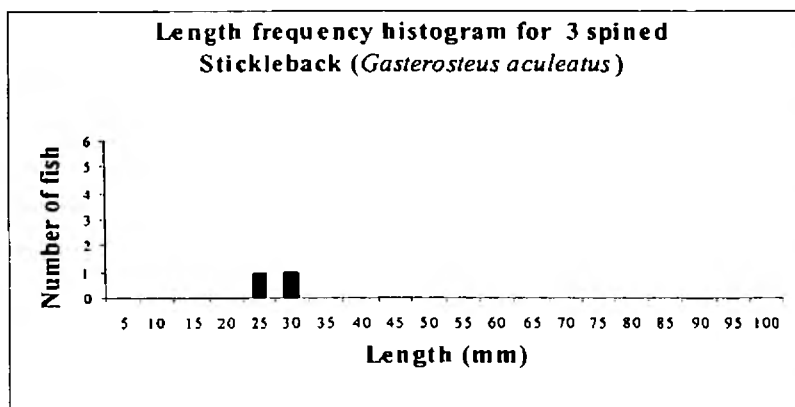
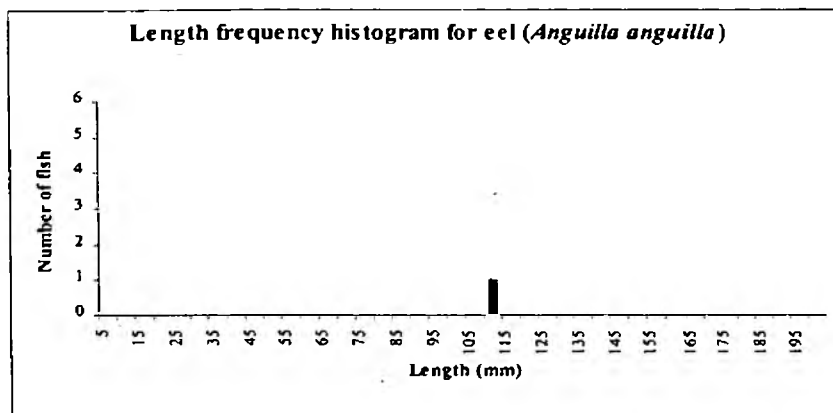


Population Composition (frequency)



Notes:





Fisheries Survey Results

River/Lake: Medway Estuary
 Site: Wouldham

Date: 19.09.00
 Surveyed length (m): 105
 Surveyed width (m): 24
 Area (m²): 2520

National Grid Ref: TQ 712 644 To

Start Time: 1205
 Finish Time: 1230
 Minutes: 19

Total No. of fish observed: 102
 No. of species: 9
 Total Fish / m²: 0.04
 Total Fish / min: 5.42

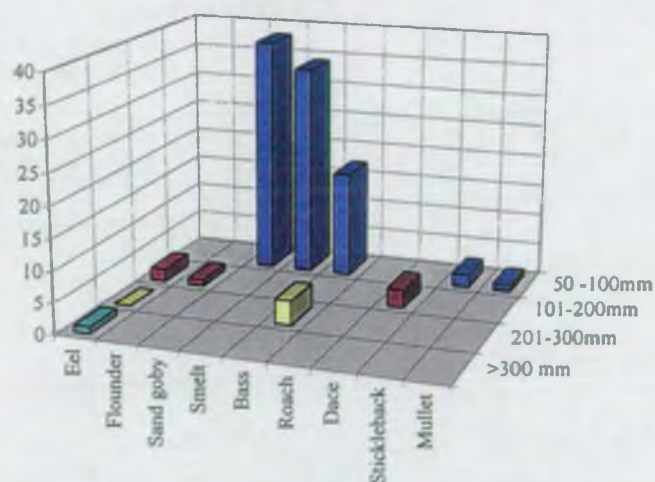
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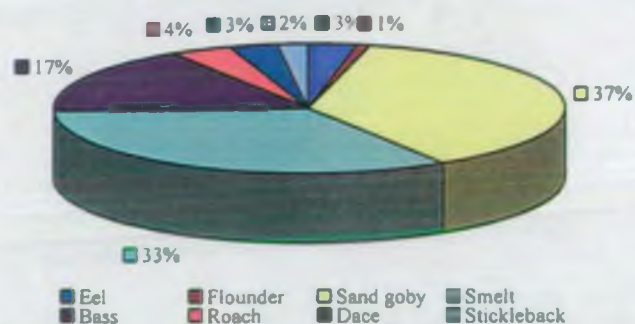
Raw Data

Species	50 - 100mm	101 - 200mm	201 - 300mm	>300 mm	No. Caught	Fish / m ²	Fish / min.	% of Tot.
Eel		2		1	3	0.00	0.16	3
Flounder		1			1	0.00	0.05	1
Sand goby	38				38	0.02	2.00	37
Smelt	34				34	0.01	1.79	33
Bass	17				17	0.01	0.89	17
Roach			4		4	0.00	0.21	4
Dace		3			3	0.00	0.16	3
Stickleback	2				2	0.00	0.11	2
Mullet	1				1	0.00	0.05	1

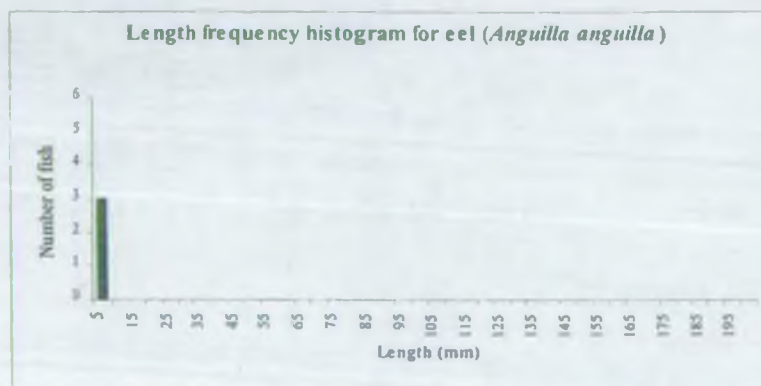
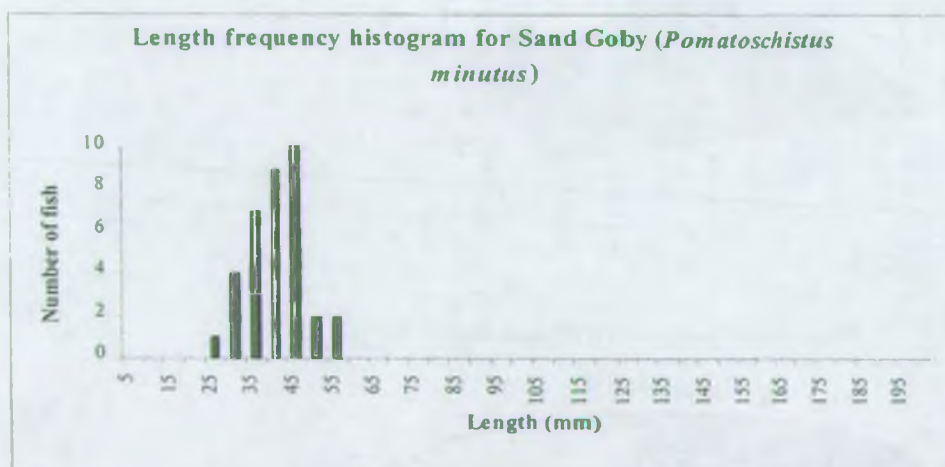
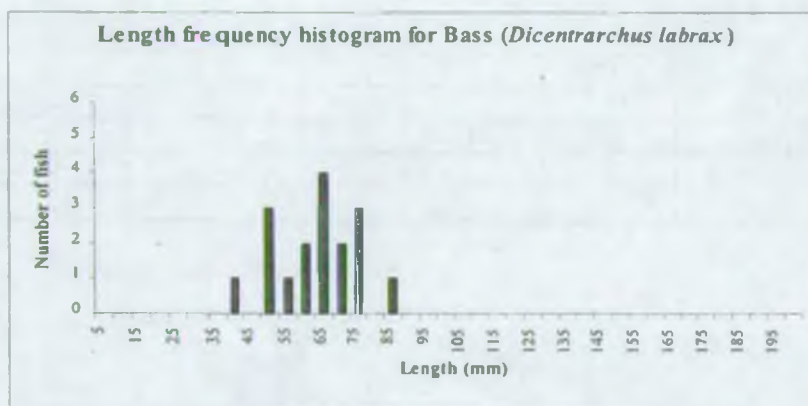
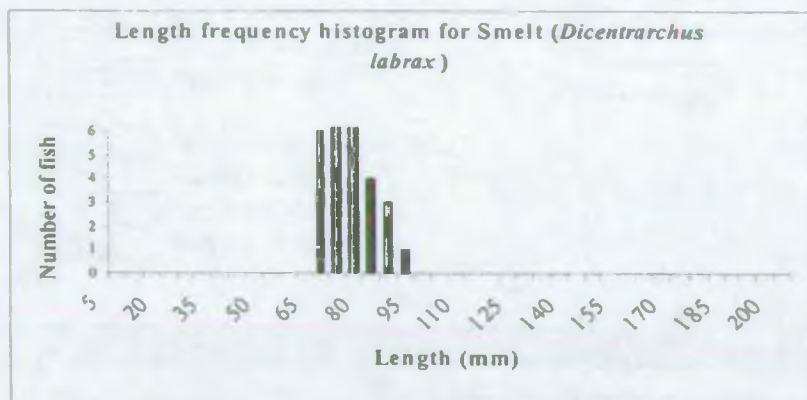
Species and Size Distribution

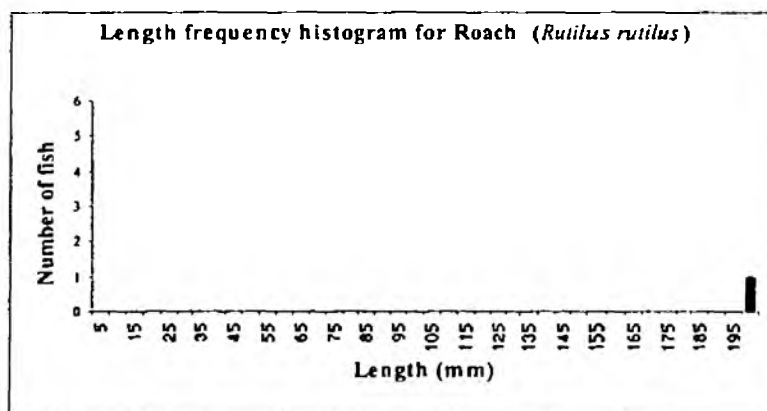
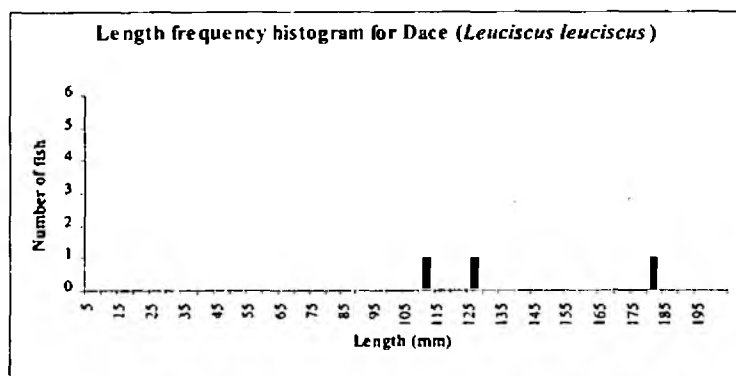
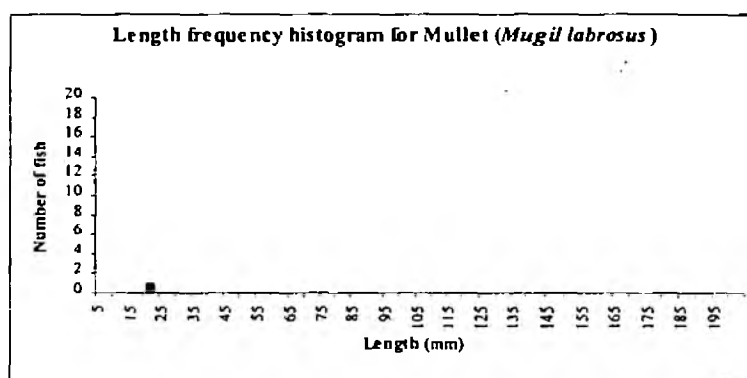
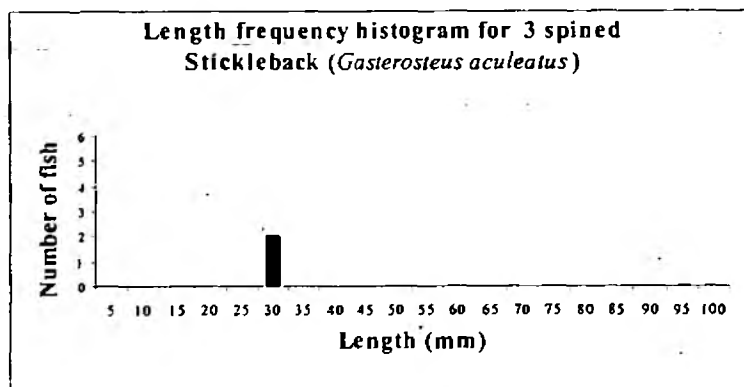


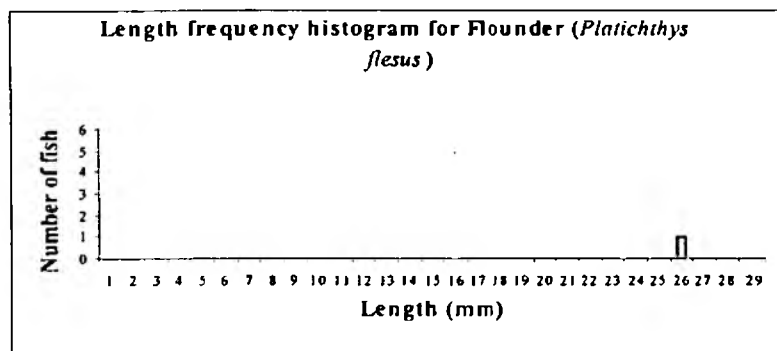
Population Composition (frequency)

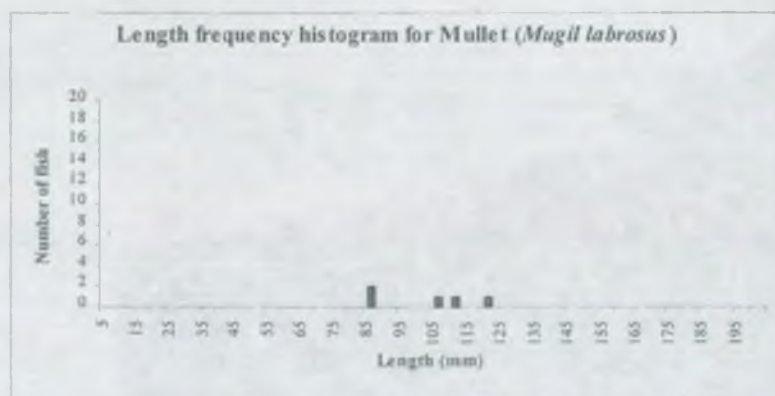
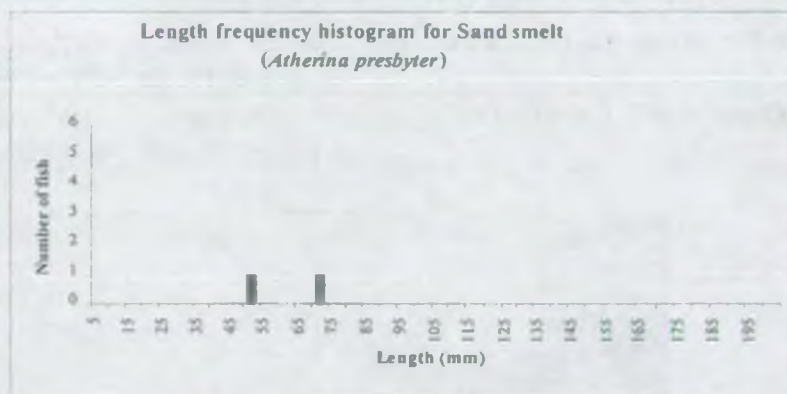
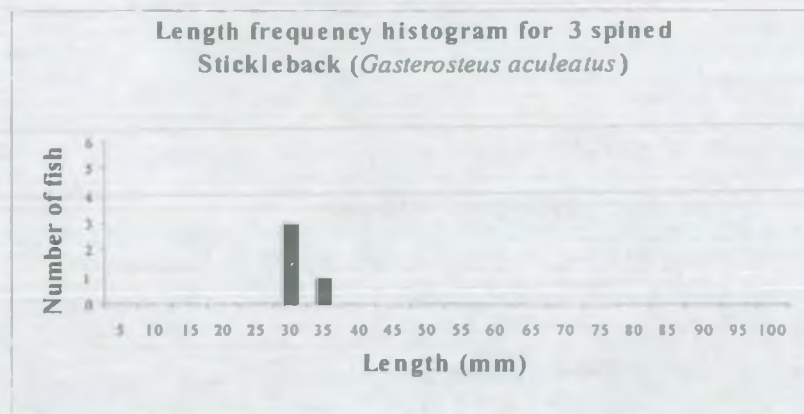


Notes: 3 spined sticklebacks only









RIVER	Medway	
SITE NAME	Lower Upnor	
SITE CODE	256	
LOCATION	Left bank. 400m D/S of Marina	
NGR	TQ 770 712	
METHOD	35m x 2.5m micro mesh seine net	
TIDAL STATE	Low	
WIDTH AT LOW WATER (M)	Approximately 300m	
DEPTH (M)	0 to 2+m. Steep drop off	
SUBSTRATE	Pebbles and silt, some small stones/rocks	
AQUATIC VEGETATION	None	
BANKSIDE VEGETATION	Left bank	Common club reed
	Right bank	Beach and woodland, deciduous
ADJACENT LAND USE	Left bank	Public access boat moorings (not fixed)
	Right bank	Marshland, horse grazing



Fisheries Survey Results

River/Lake: Medway Estuary
 Site: Lower Upnor

Date: 23.06.00
 Surveyed length (m): 110
 Surveyed width (m): 50
 Area (m²): 5500

National Grid Ref: TQ 770 712 To

Start Time: 1100
 Finish Time: 1137
 Minutes: 28

Total No. of fish observed: 33
 No. of species: 5
 Total Fish / m²: 0.01
 Total Fish / min: 1.18

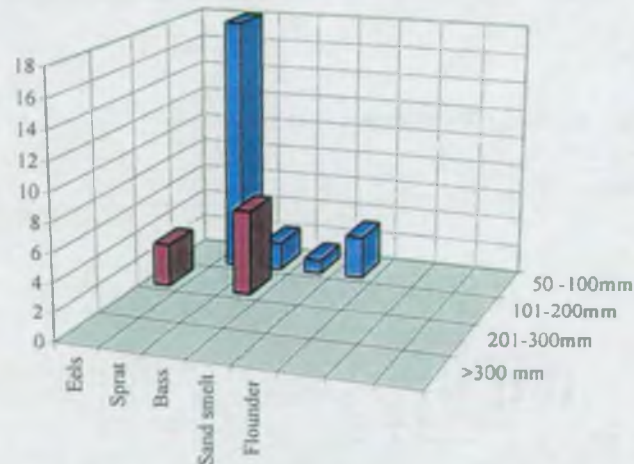
note: 3 nettings

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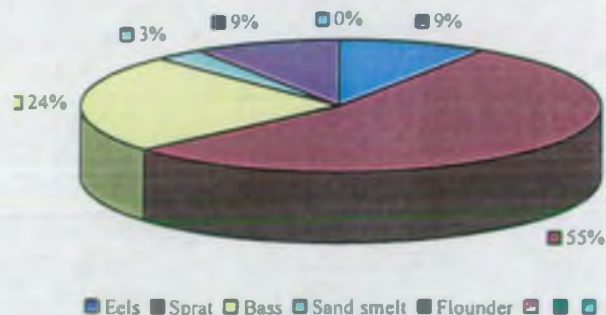
Raw Data

Species	50 -100mm	101-200mm	201-300mm	>300 mm	No. Caught	Fish / m ²	Fish / min.	% of Tot.
Eels		3			3	0.00	0.11	9
Sprat	18				18	0.00	0.64	55
Bass	2	6			8	0.00	0.29	24
Sand smelt	1				1	0.00	0.04	3
Flounder	3				3	0.00	0.11	9
					0	0.00	0.00	0
					0	0.00	0.00	0
					0	0.00	0.00	0

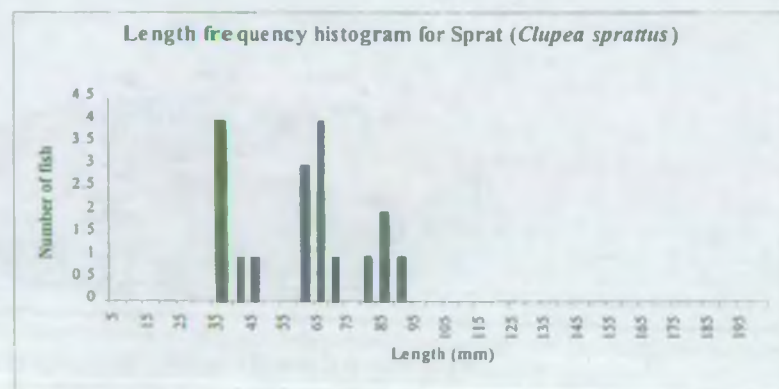
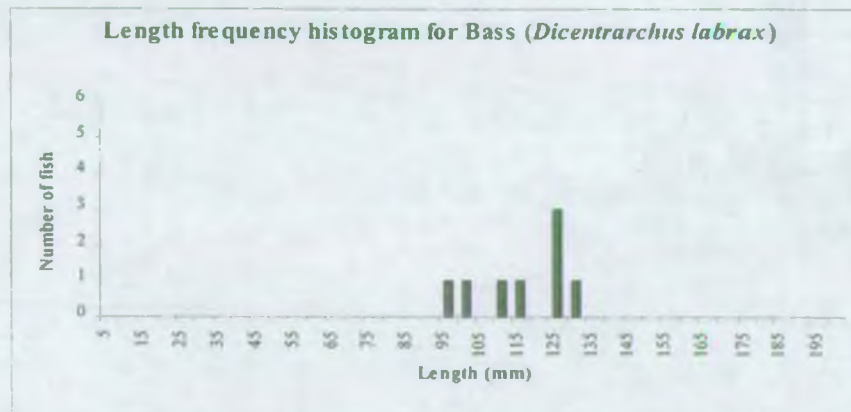
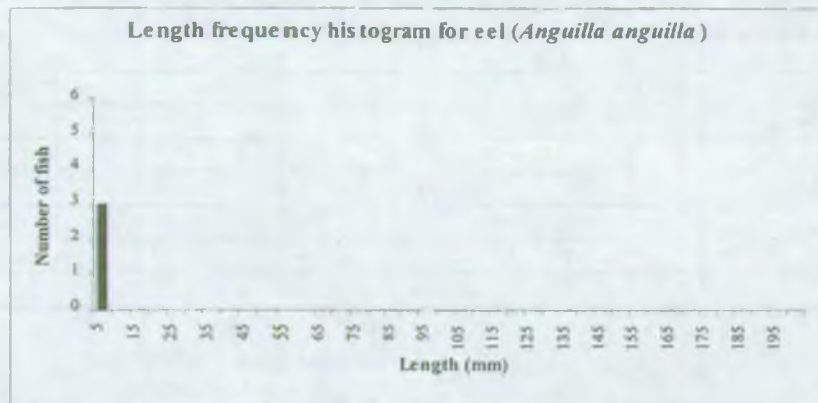
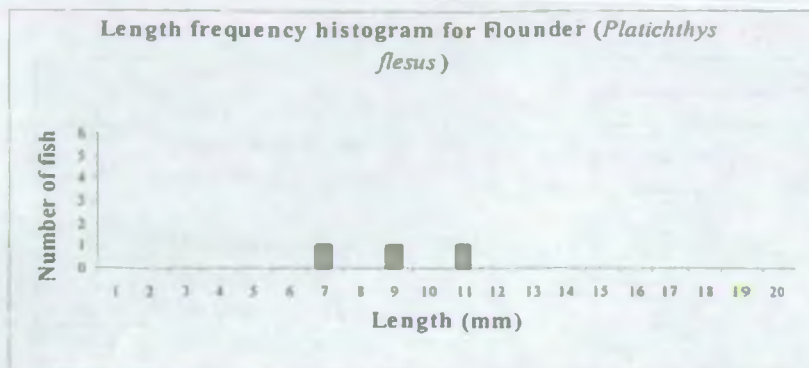
Species and Size Distribution

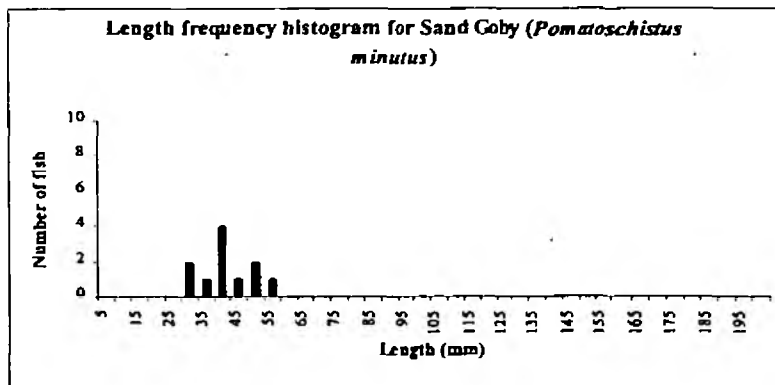
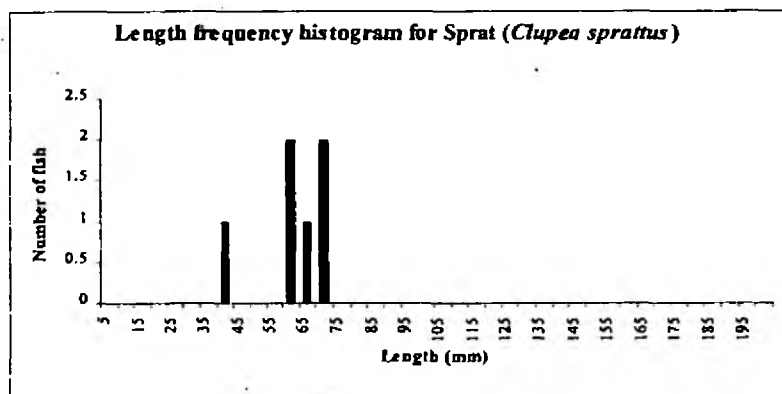
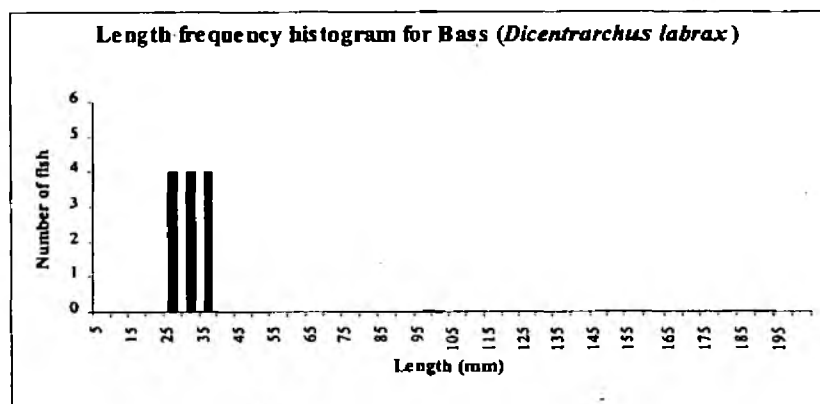
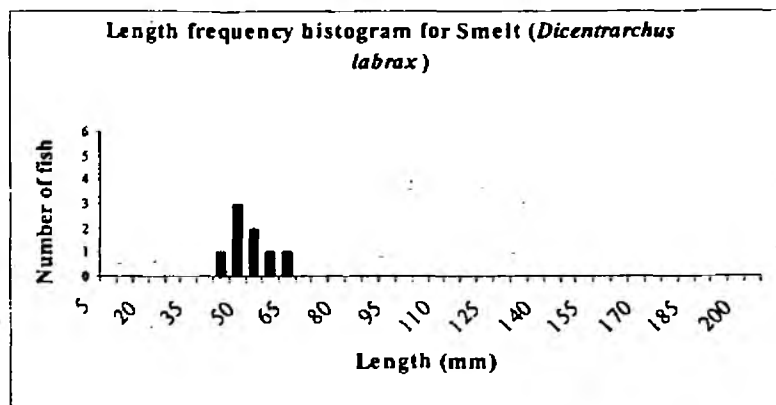


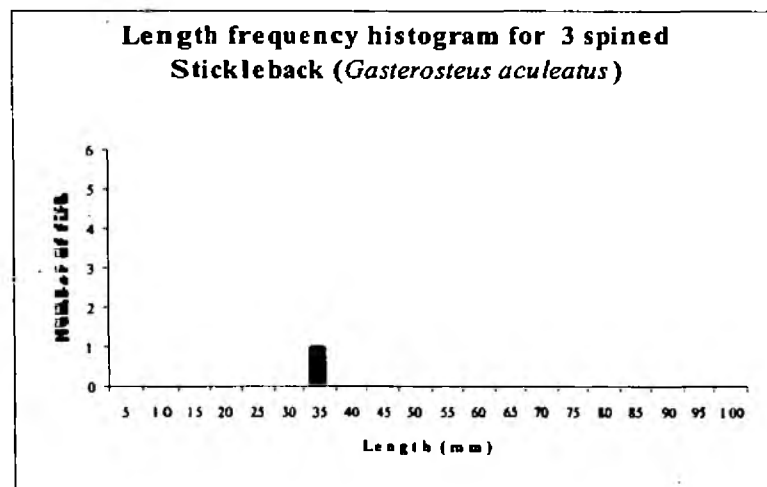
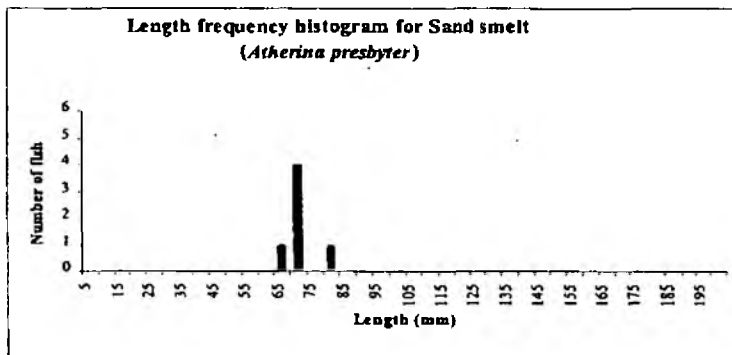
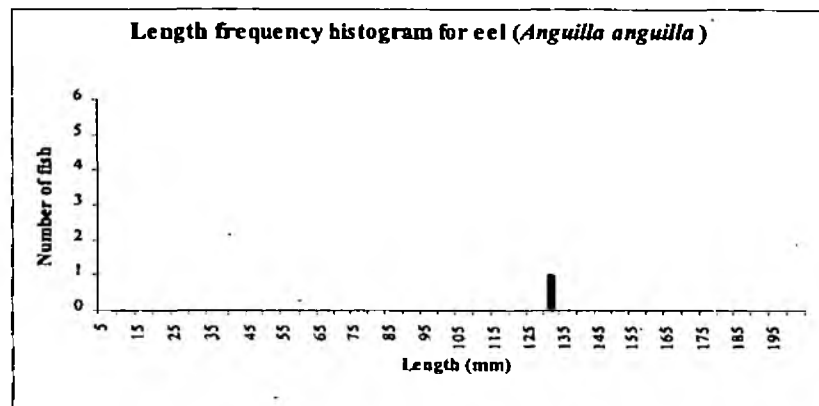
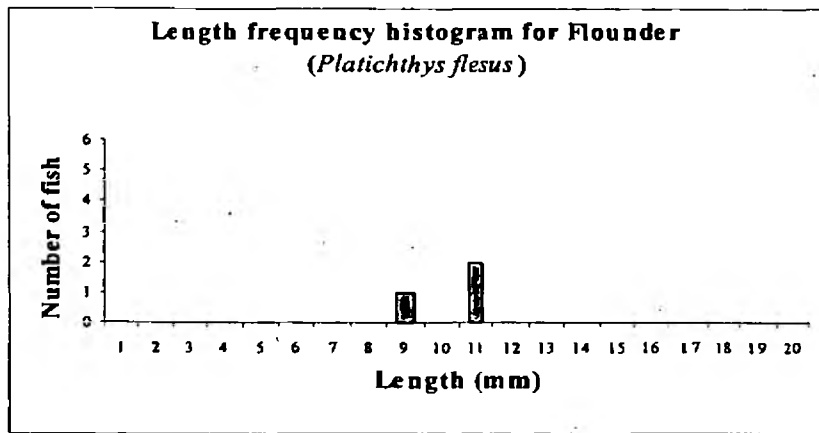
Population Composition (frequency)

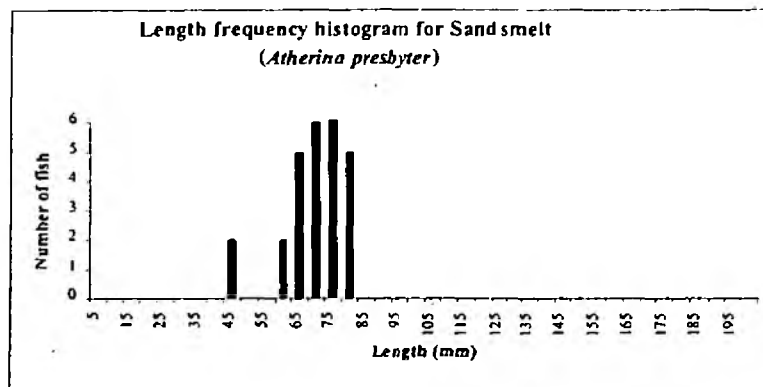
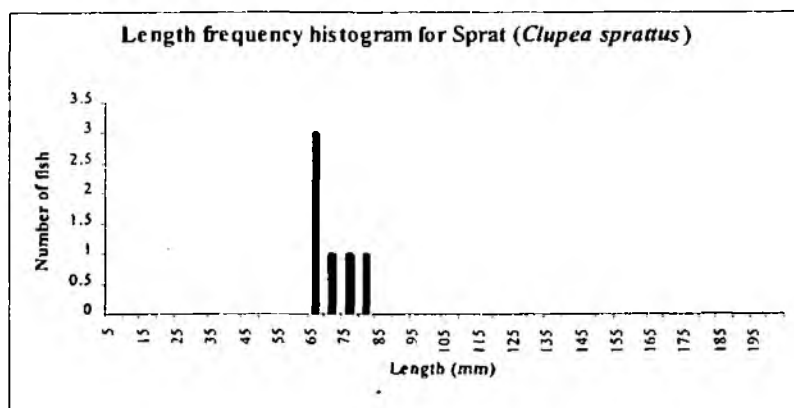
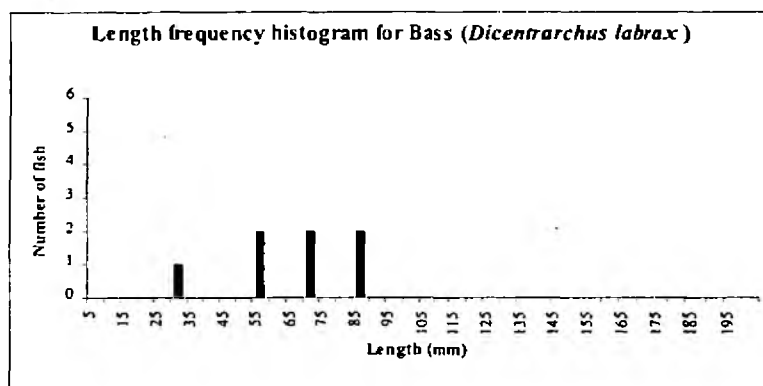
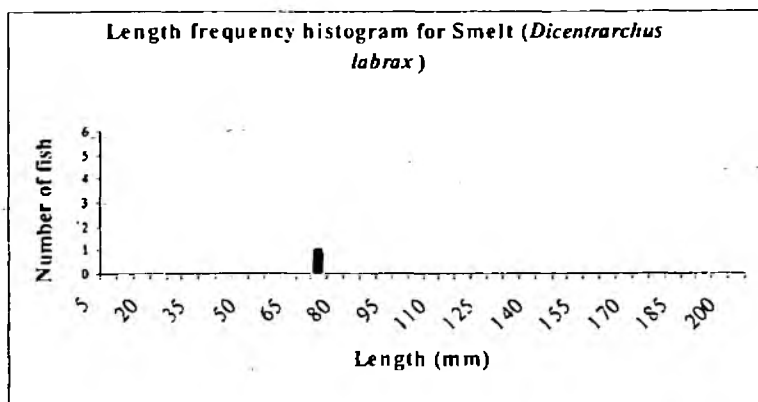


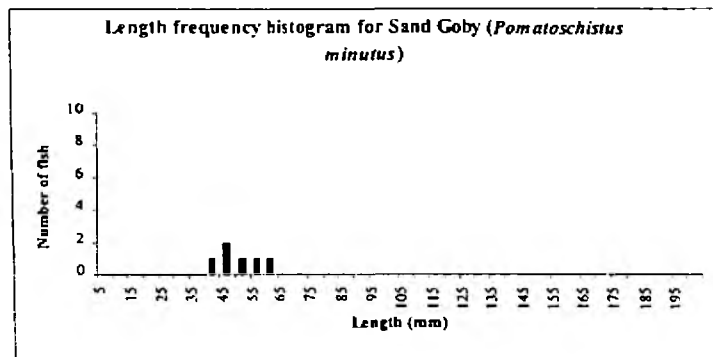
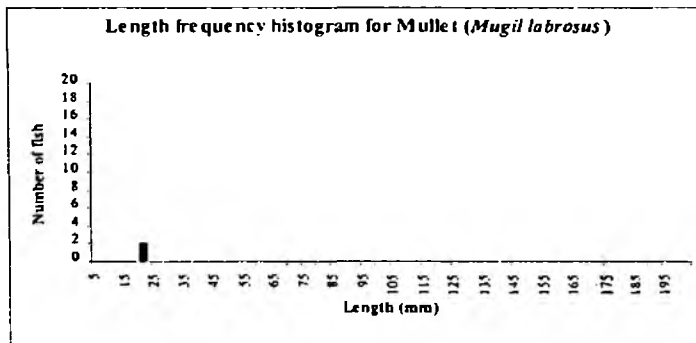
Notes: Brown shrimp & prawns present

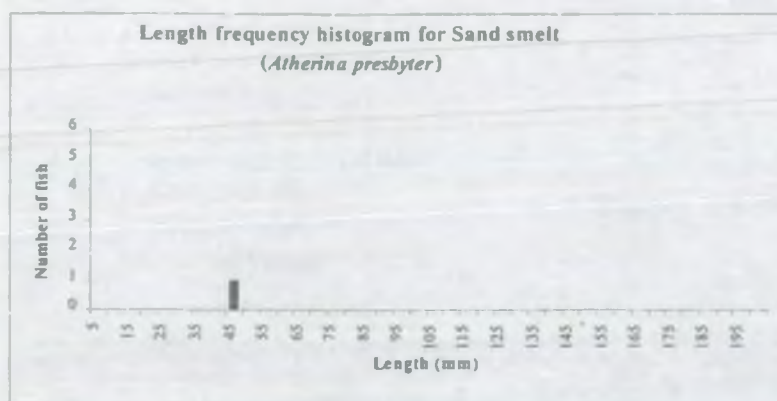












Fisheries Survey Results

River/Lake: Medway Estuary
 Site: Lower Upnor

Date: 21.09.00
 Surveyed length (m): 110
 Surveyed width (m): 50
 Area (m²): 5500

National Grid Ref: TQ 770 712 To

Start Time: 1214
 Finish Time: 1255
 Minutes: 18

Total No. of fish observed: 63
 No. of species: 6
 Total Fish / m²: 0.01
 Total Fish / min: 3.50

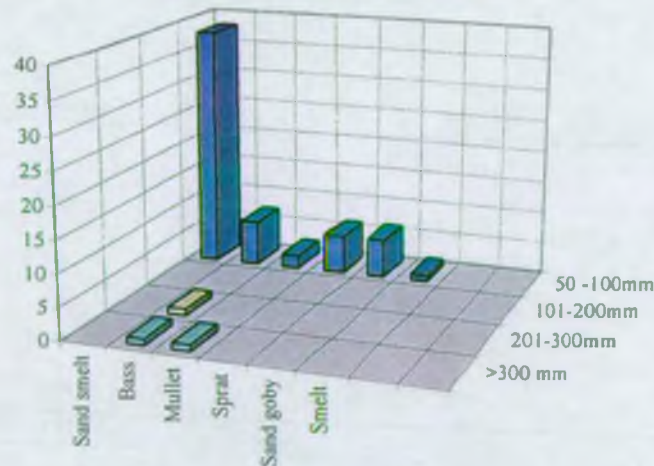
note: 3 nettings

(computer file:) mdw2109.256

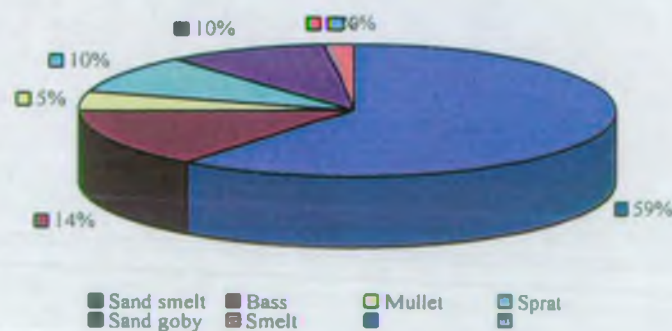
Raw Data

Species	50 -100mm	101-200mm	201-300mm	>300 mm	No. Caught	Fish / m ²	Fish / min.	% of Tot.
Sand smelt	38				38	0.01	2.11	60
Bass	7		1	1	9	0.00	0.50	14
Mullet	2			1	3	0.00	0.17	5
Sprat	6				6	0.00	0.33	10
Sand goby	6				6	0.00	0.33	10
Smelt	1				1	0.00	0.06	2
					0	0.00	0.00	0
					0	0.00	0.00	0

Species and Size Distribution



Population Composition (frequency)



Notes: Bass 610mm c 3Kgs & 265 mm; Mullet 425 mm

RIVER	Medway	
SITE NAME	Grain Tower	
SITE CODE	372	
LOCATION	Left bank, next to power station inlet/outlet channel	
NGR	TQ 888 744	
METHOD	35m x 2.5m micro mesh seine net	
TIDAL STATE	High water	
WIDTH AT LOW WATER (M)	500 – 1000m	
DEPTH (M)	Not ascertainable, but gentle slope	
SUBSTRATE	Mud and silt at low tide. Sand and single further upshore	
AQUATIC VEGETATION	None	
BANKSIDE VEGETATION	Left bank	None
	Right bank	None
ADJACENT LAND USE	Left bank	Sandy, shingle shore and flood defence embankments
	Right bank	N/A



Fisheries Survey Results

River/Lake: Medway Estuary
 Site: Grain Tower (Cockleshell Hard Pier)

Date: 29.06.00
 Surveyed length (m): 110
 Surveyed width (m): 50
 Area (m²): 5500

National Grid Ref: TQ 888 744 To

Start Time: 1030
 Finish Time: 1103
 Minutes: 31.5

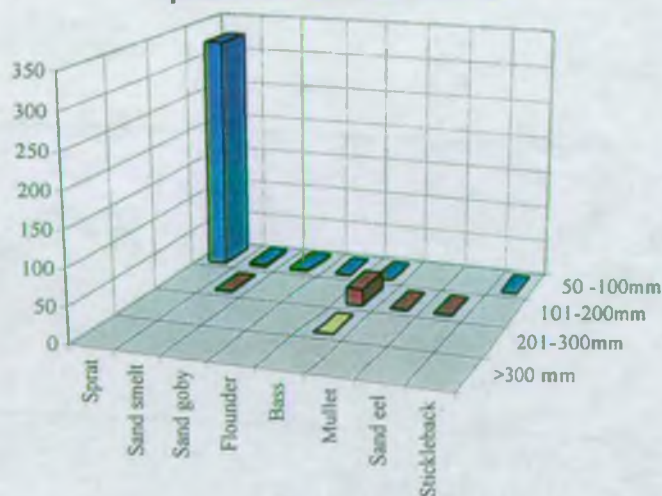
Total No. of fish observed: 362
 No. of species: 8
 Total Fish / m²: 0.07
 Total Fish / min: 11.49

(computer file:) note: 3 nettins
 mdw2906.372

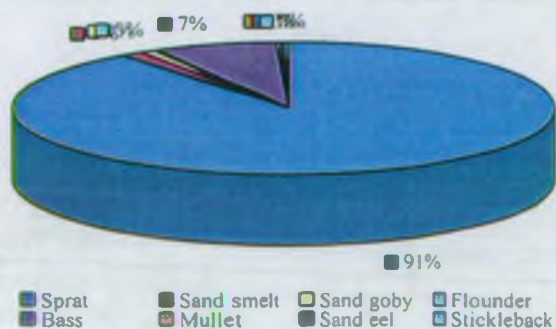
Raw Data

Species	50 -100mm	101-200mm	201-300mm	>300 mm	No. Caught	Fish / m ²	Fish / min.	% of Tot.
Sprat	325				325	0.06	10.32	90
Sand smelt	4	1			5	0.00	0.16	1
Sand goby	3				3	0.00	0.10	1
Flounder	1				1	0.00	0.03	0
Bass	1	23	1		25	0.00	0.79	7
Mullet		1			1	0.00	0.03	0
Sand eel		1			1	0.00	0.03	0
Stickleback	1				1	0.00	0.03	0

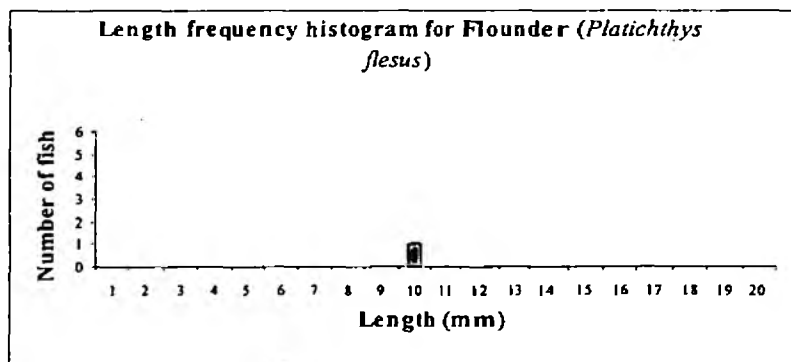
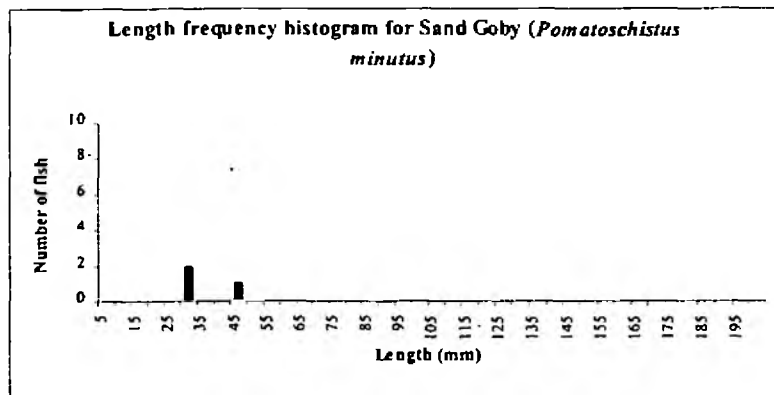
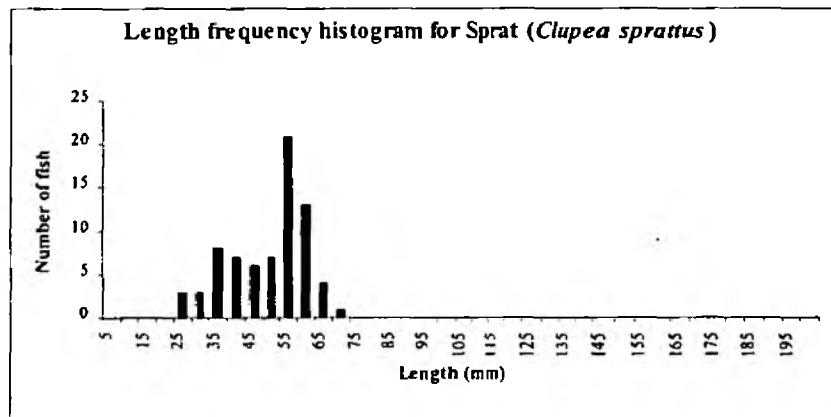
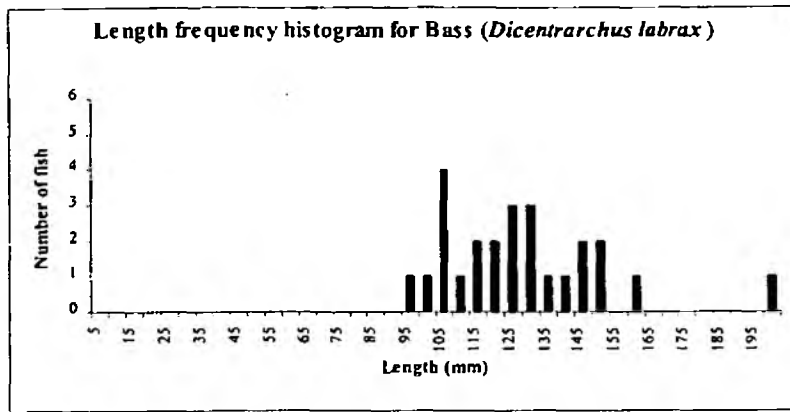
Species and Size Distribution

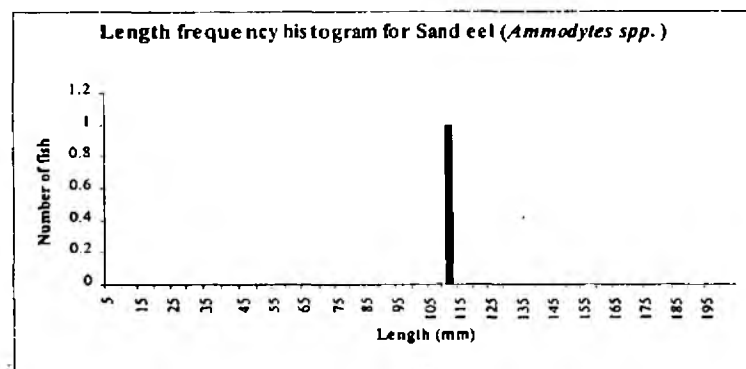
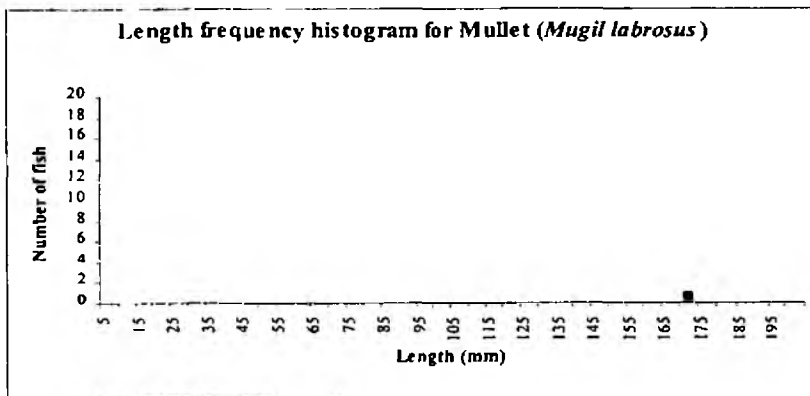
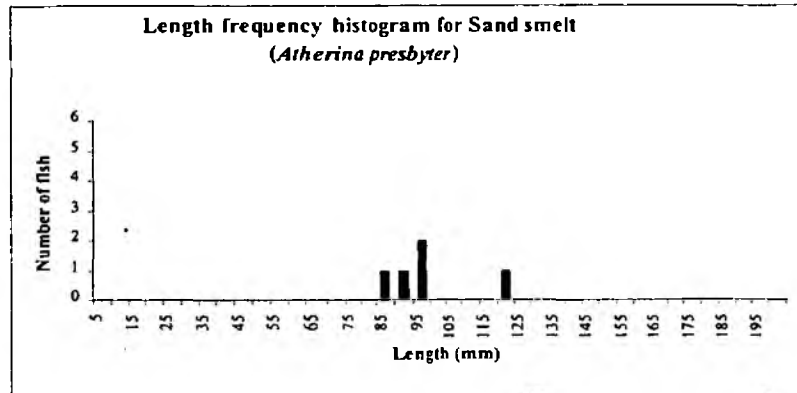
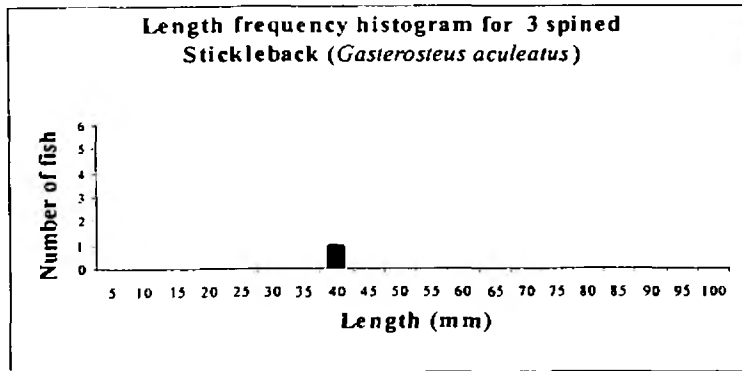


Population Composition (frequency)



Notes: Large nos. small sprat escaped thru' mesh. Strong cucumber smell to the site.





Fisheries Survey Results

River/Lake: Medway Estuary
 Site: Grain Tower

Date: 12.09.00
 Surveyed length (m): 110
 Surveyed width (m): 50
 Area (m²): 5500

National Grid Ref: TQ888744 To

Start Time: 1145
 Finish Time: 1215
 Minutes: 15

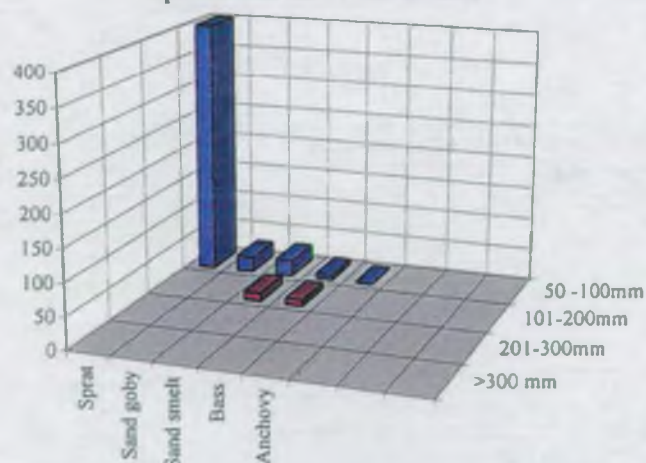
Total No. of fish observed: 480
 No. of species: 5
 Total Fish / m²: 0.09
 Total Fish / min: 32.00

Note: 3 separate seine nettings
 (computer file:) mdw0912.372

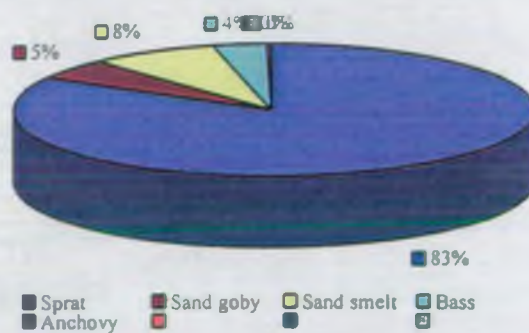
Raw Data

Species	50 - 100mm	101-200mm	201-300mm	>300 mm	No. Caught	Fish / m ²	Fish / min.	% of Tot.
Sprat	400				400	0.07	26.67	83
Sand goby	24				24	0.00	1.60	5
Sand smelt	25	13			38	0.01	2.53	8
Bass	8	9			17	0.00	1.13	4
Anchovy	1				1	0.00	0.07	0
					0	0.00	0.00	0
					0	0.00	0.00	0
					0	0.00	0.00	0

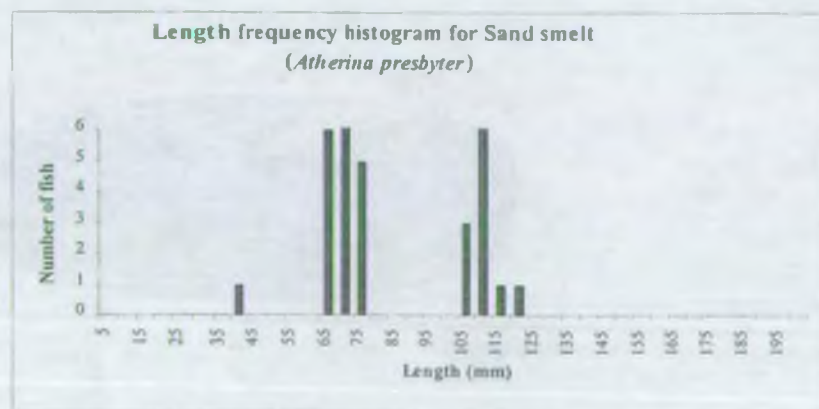
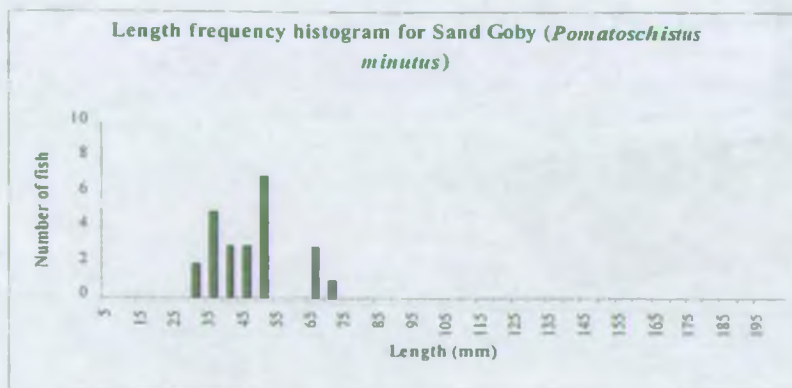
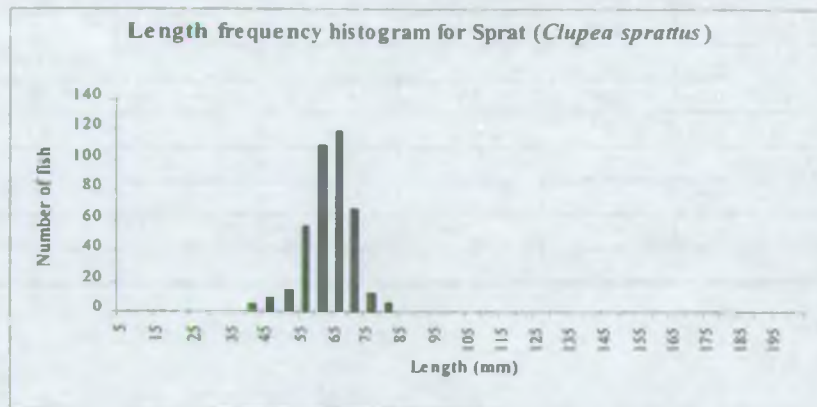
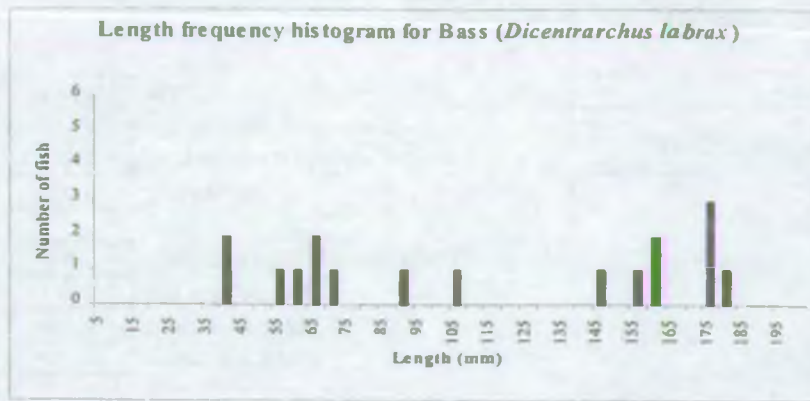
Species and Size Distribution



Population Composition (frequency)



Notes:



Appendix B.

PRIMER - Plymouth Routines in Multivariate Ecological Research

This is a suite of programs developed by Plymouth Marine Laboratories that is commonly used by marine and freshwater ecologists to aid analysis of their data. The programme suite contains packages that manipulate data, generate a range of univariate statistics including diversity indices and abundance - biomass k-dominance plots and multivariate techniques such as Cluster, MDS, principal component analysis (PCA). There are also programs that link environmental variables to the ordination analysis and tests of significance for pre-determined sample groups.

Bray and Curtis similarity coefficient.

A common feature of ecological data especially large marine surveys with a large total species list, is that many species are absent from most samples. So any coefficient of similarity that uses all the information in the matrix will often group unrelated samples on the basis of their joint absences. The Bray and Curtis similarity coefficient (1957) does not fall into this trap, although it gives more weight to abundant rather than rare species. This balance between rare and dominant species can be adjusted using transformations, the more severe the transformation, the greater the contribution that rare species has upon the similarity coefficient. Analysis of a data matrix using the Bray and Curtis coefficient creates a triangular matrix of similarities.

Cluster analysis.

This process uses the similarity matrix using group average sorting to produce a dendrogram. This links two groups of samples together at the average level of similarity between the members of one group and those of another. However, Field *et al.* (1982) lists four disadvantages with dendrograms: -

Hierarchy is irreversible,

Dendrograms only show inter-group relationships, the level of similarity indicated is only the average inter-group average.

Adjacent samples are not necessarily the most similar.

Dendrograms may force a true graded series into discrete classes.

In view of these disadvantages, it is good practice to use another technique to test whether the clusters generated by Cluster analysis are consistent with the results of the new analysis method. Ordination methods are probably the most widely used alternative methods to Cluster analysis.

Ordination analysis.

The method used to analyse the Medway data was non-metric multidimensional scaling (MDS) (Kruskal & Wish 1978). The process begins with a random ordering of the samples. The dissimilarities are regressed using a non-linear regression against the interpoint distances. A stress value is calculated that is a measure of the distortion involved in 'compressing' the data to a small number of dimensions. The original sample order is changed slightly and the above process is repeated until a configuration is arrived at that has least stress. This process has the disadvantage that the ordination will finish at local minimum of stress not the global minimum that best fits the samples. To overcome this, the entire process is repeated, usually six times, starting each time with a random ordering of the samples (Field *et al* 1982). The run that arrives at the lowest stress values is taken as the final configuration and plotted usually in two dimensions although the data to create three dimensional plots is available in the output file created using the PRIMER package.

Appendix C

CEFAS Trawl Survey Results

October 1999

**Medway Estuary
Kingsnorth
Grain**

The Swale

Fisheries Survey Results

River/Lake: The Swale
 Site: 13, 14, 15 & 16

Date: 25.11.99
 Surveyed length (m): 5700
 Surveyed width (m): 24
 Area (m²): 136800

National Grid Ref: TR 040667 To

Start Time:
 Finish Time:
 Minutes: 114

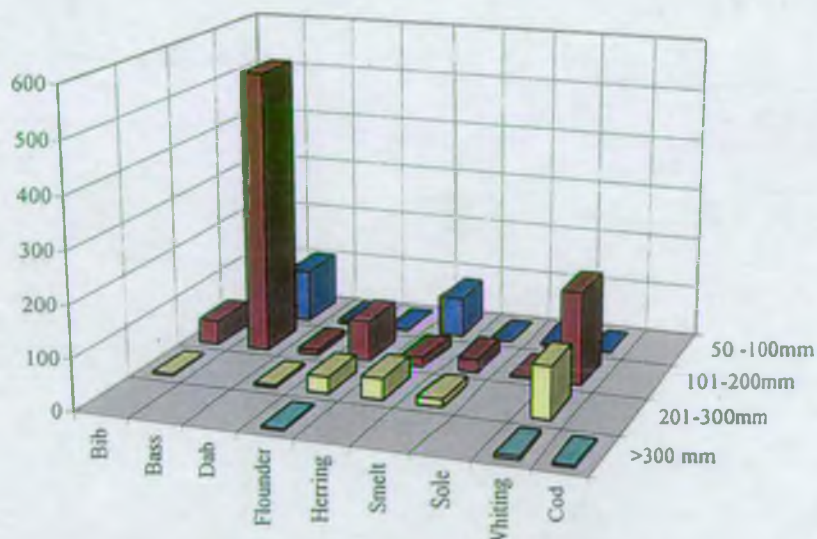
Total No. of fish observed: 1327
 No. of species: 9
 Total Fish / m²: 0.01
 Total Fish / min: 11.64

(computer file:) swl2511.380

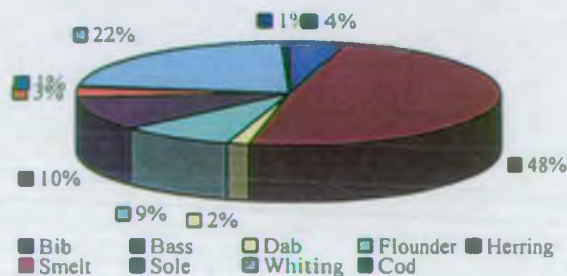
Raw Data

Species	50-100mm	101-200mm	201-300mm	>300 mm	No. Caught	Fish / m ²	Fish / min.	% of Tot.
Bib		47	3		50	0.00	0.44	4
Bass	103	550			653	0.00	5.73	49
Dab	7	10	5		22	0.00	0.19	2
Flounder	2	79	33	3	117	0.00	1.03	9
Herring	78	18	42		138	0.00	1.21	10
Smelt	1	26	15		42	0.00	0.37	3
Sole	4	3			7	0.00	0.06	1
Whiting	1	180	102	7	290	0.00	2.54	22
Cod		4		4	8	0.00	0.07	1

Species and Size Distribution



Population Composition (frequency)



Notes: CEFAS Trawl surveys

Fisheries Survey Results

River/Lake: Medway Estuary, Grain
 Site: 19 & 20

Date: 25.11.99
 Surveyed length (m): 1600
 Surveyed width (m): 24
 Area (m²): 38400

National Grid Ref: TQ 900755 To

Start Time: 1350
 Finish Time:
 Minutes: 30

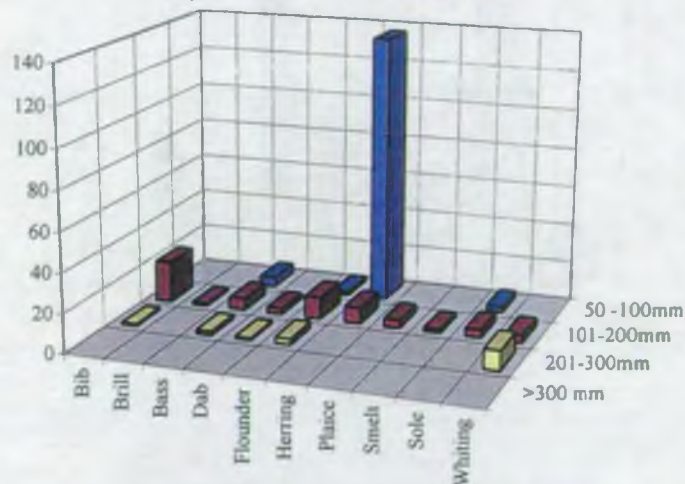
Total No. of fish observed: 227
 No. of species: 10
 Total Fish / m²: 0.01
 Total Fish / min: 7.57

(computer file:) mdw2511.372

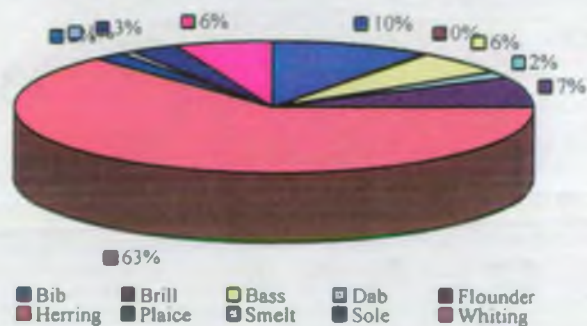
Raw Data

Species	50-100mm	101-200mm	201-300mm	>300 mm	No. Caught	Fish / m ²	Fish / min.	% of Tot.
Bib		21	1		22	0.00	0.73	10
Brill		1			1	0.00	0.03	0
Bass	5	6	2		13	0.00	0.43	6
Dab		3	1		4	0.00	0.13	2
Flounder	2	11	3		16	0.00	0.53	7
Herring	136	8			144	0.00	4.80	63
Plaice		4			4	0.00	0.13	2
Smelt		2			2	0.00	0.07	1
Sole	3	4			7	0.00	0.23	3
Whiting		4	10		14	0.00	0.47	6

Species and Size Distribution



Population Composition (frequency)



Notes: CEFAS trawl surveys

Fisheries Survey Results

River/Lake: Medway Estuary, Kingsnorth
 Site: 17 & 18

Date: 25.11.99
 Surveyed length (m): 1600
 Surveyed width (m): 24
 Area (m²): 38400

National Grid Ref: TQ 813 713 To

Start Time: 1233
 Finish Time:
 Minutes: 31

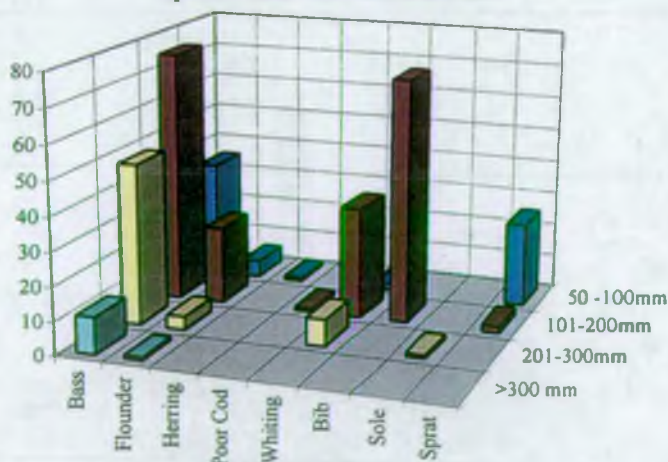
Total No. of fish observed: 347
 No. of species: 8
 Total Fish / m²: 0.01
 Total Fish / min: 11.19

(computer file:) mdw2511.033

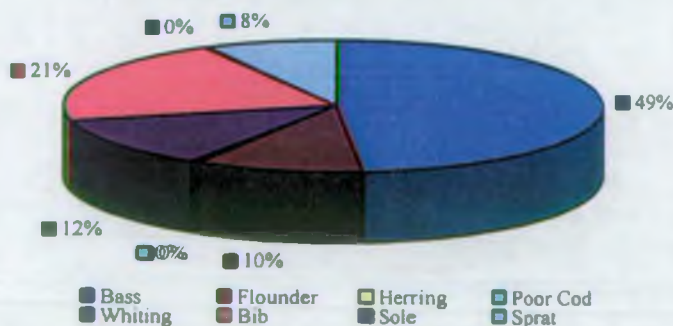
Raw Data

Species	50 -100mm	101-200mm	201-300mm	>300 mm	No. Caught	Fish / m ²	Fish / min.	% of Tot.
Bass	35	75	48	11	169	0.00	5.45	49
Flounder	5	23	4	1	33	0.00	1.06	10
Herring	1				1	0.00	0.03	0
Poor Cod		1			1	0.00	0.03	0
Whiting	2	33	8		43	0.00	1.39	12
Bib		72			72	0.00	2.32	21
Sole			1		1	0.00	0.03	0
Sprat	25	2			27	0.00	0.87	8

Species and Size Distribution



Population Composition (frequency)



Notes: CEFAS trawl surveys

