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SEA TROUT WORKSHOP - 28 FEBRUARY 1992

FOOTNOTE: This document represents a comprehensive report of the workshop proceedings including the discussions and comments. The opinions expressed reflect the knowledge and experience of each delegate and as such must not be considered as the views of the respective organisations. The report is confidential to the delegates and is for restricted circulation within the NRA.

A summary document will be produced for release to the Regional Fisheries Advisory Committee.

NRA SOUTH WEST REGION

Sea Trout Workshop - Friday 28th February 1992

10.30 a.m. - 4.00 p.m.

Attendees

Professor Clive Kennedy	University of Exeter and RFAC Member
Dr. Ken Whelan	Salmon Research Agency, Farran Laboratory, Ireland
Dr. Teigwyn Harris	Dept. of Biological Sciences, University of Exeter
Professor Alan Southward	Marine Bioligical Association
Dr. Eve Southward	Marine Biological Association
Mr Dennis Mitchell	NRA SW Regional Chairman
Mr Gordan Bielby	NRA SW Regional General Manager
Mrs Anne Voss-Bark	NRA SW RFAC Chairman
Lt. Col. Pat Badham	RFAC Member, Chairman Eastern F.C.
Mr Stuart Bray	NRA SW Fisheries Controller
Mr Hugh Sambrook	NRA SW Fishery Scientist
Mr David Jordan	NRA Head Office, Sea Trout National Project Leader
Dr. Andy Moore	MAFF Lowestoft
Dr. Gerald Boalch	Marine Biological Association
Mr John Waldon	RSPB

NRA SOUTH WEST

SEA TROUT WORKSHOP - 28 FEBRUARY 1992

AGENDA

1. WELCOME

Mrs A Voss-Bark, Chairman of the Regional Fisheries Advisory Committee.

2. INTRODUCTION

Professor Clive Kennedy, Exeter University.

3. SEA TROUT IN THE SOUTH WEST REGION

E S Bray, Fisheries, Recreation and Conservation Controller, NRA South West.

4. SEA TROUT IN ENGLAND AND WALES

Dr D Jordan, Fisheries Officer, NRA Head Office Bristol.

5. SEA TROUT IN IRELAND

Dr K Whelan - Salmon Research Agency.

6. DISCUSSION

To be led by Professor Clive Kennedy.

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1. WELCOME

Mrs A Voss-Bark opened the meeting by welcoming the delegates and introducing the Chairperson, Professor C Kennedy. She stated her role and concern. Both as Chairperson of the Regional Fisheries Advisory Committee and a keen angler, she had been aware of the recent decline in sea trout stocks. Many similarities existed between the decline and the reported poor condition of the sea trout in the South West when compared with the dramatic crash recorded on the West Coast of Ireland. Further concern was highlighted following a recent report to the RFAC regarding the lack of breeding success among certain species of marine sea birds and the inference of a possible marine problem. (Ref. Miss Joan Edwards, Devon Wildlife Trust). The NRA have extensive knowledge of the freshwater issues affecting the life cycle of sea trout but she welcomed the opportunity to discuss the problem with marine specialists and to "pool ideas".

2. INTRODUCTION

Professor Kennedy stated that he considered the workshop as a medium for the exchange of information and informal interpretation. In order to appreciate the nature of the South West problem there was a need to understand the sea trout issue in a broader context. This foundation would be outlined in the three main papers, progressing from the regional perspective to the national scene in England and Wales and overlaid by the renowned Irish problem. In addition comments were invited from the floor regarding sea trout in Scotland. It was hoped that these papers would act as a catalyst to stimulate responses from the multi-functional specialists and in part enable the interface of topics relating to marine invertebrates, climate, marine environment, sea birds etc. Ultimately there was a need to document what is known and to detail any actions to remedy the problem.

Professor Kennedy explained that two sand eel specialists had been invited but ironically both were unable to attend. (Ref: Joan Edwards, Devon Wildlife Trust and Peter Reay, Polytechnic South West).

3. SEA TROUT IN THE SOUTH WEST REGION - E S BRAY

Stuart Bray structured the paper to include five discrete sections:-

a. Life History of Sea Trout in the South West

Main features:-

i. Spawning November/December.
ii. Freshwater Phase : 1 - 5 years (average 3 years)
iii. Smolts range in size 15-20cm. Migrate to sea in April/May period (occasional autumn migration).

iv. Marine phase, depending on life strategy this phase can vary between 6 weeks to 3 years for maiden fish. Food source can be diverse but most fish are opportunistic. Migration patterns are presumed to be in inshore coastal waters.

v. Spawning migrations comprise mixed stocks of various sizes and ages. Three main categories which include school peal, maiden fish (1 year and older) and previous spawners. Post-spawning mortality is significantly lower than that recorded for salmon.

vi. Periods of migration. Two main peaks are recorded, with the larger fish entering the river between April-June and the school peal in July. The proportion of sea trout entering in the autumn varies annually.

vii. Size of sea trout. Majority of sea trout are school peal, 12-14oz with the larger fish comprised of 2-4lb fish. Sea trout up to 15lb have been recorded.

b. Historic Catches

Statutory rod and net returns form the basis of the knowledge of sea trout stocks across the region. The limitations of such data are known but were not considered in detail. Catch statistics are often considered in a time series eg. 1951-1990 (Figure A1).

Examples:-

i. Taw/Torridge Nets, Figure A2. The joint estuary of the Taw and Torridge supports the most significant sea trout fishery in the region. Annual catches range from 2000-6000 fish. Interpretation of any trends is made more complicated due to a "net reduction" (1981 : 36 to 22 nets and 1987 : 22 to 14 nets) and the "buy-out" (1988/89 partial and 1990 total).

ii. Taw Rods - Figure A3. Peak catches in mid 60's followed by a steady decline and the influence of UDN. Low catches usually coincided with low flows in drought years ie. 1975, 1976, 1984, 1985, 1989 and 1990.

iii. Torridge Rods - Figure A4. Similar pattern to Taw rods with peak in mid 60's and low spots in 1976, 1984, 1989 and 1990.

The performance of the salmon and sea trout fisheries on both the Taw and Torridge has suffered in recent years due to environmental degradation directly attributed to farm drainage and deterioration in water quality. Similar problems exist in other catchments include Otter, Axe and Tamar.

Comparison of sea trout catches from "cleaner rivers" were presented:-

iv. Teign rods - Figure A5. Peak catches in mid 60's and collapse between 1968-1971 (UDN). Low spot recorded in 1976, 1980 and 1984 with severe crash in 1989 and 1990.
v. Teign nets - Figure A6. Again, peak catches in mid 60's. Collapses recorded in 1968-1972, 1976/77 and 1984/85. Downward trend in 1990 but not as marked as for the rods.
vi. Fowey Rods - Figure A7. Peak catches in mid 60's and 1976. Collapse in 1968-1972 period, 1984 and 1989/90.

In general there was a similar underlying pattern to both rod and net catches:-

i. Peak catch in the mid 60's.
ii. Collapse in catch 1968-1972.
111. Status-quo maintained within bounds of acceptable annual variation until 1989.
iv. Decline in stock in 1989 and 1990.
v. Decline most noticeable among the rods.

c. <u>Period 1989 - 1991</u>

Observations recorded in:-

i. <u>1989 Drought Year</u>. The year registered the first significant decline in catches, primarily among the school peal. Smaller school peal were reported. Deaths of fresh run adult sea trout were recorded in several rivers, possibly related to river temperatures eg. River Fowey 19°c. Spawning was reasonable.
ii. <u>1990 - Drought Year</u>. The smolts were later leaving the river and in lower numbers. Returning school peal numbers were dramatically low. Reports of smaller school peal were noted and their condition was reasonable. Again spawning was reasonable.
iii. <u>1991 - Average to Wet Year</u>. Many rivers showed signs of recovery but there was much variation in stock size recorded. eg. Dart nets reported larger sea trout. School peal numbers had improved in most rivers. Catches by individual anglers were good. Many fresh sea trout reported entering the rivers after the angling season eg. Fowey, Plym and Lynher. Spawning considered good in many rivers, even excellent in specific tributaries.

d. <u>Sea Trout Questionnaire - Autumn 1990</u>

2000 questionnaire distributed to anglers but only 90 returns logged. Insufficient response to consider each river separately and general comments include:-

i. smolt run - migration smaller and delayed,
ii. school peal - small runs and later. Decline in run of 1989 by 40% and 1990 by 60%-80%.
iii. larger sea trout, migration pattern unchanged but size of runs reduced.
iv. Condition of fish ie. emaciated fish - 10% and pale flesh-14%. Irish problem not noted re. sea lice infestation and poor condition.

e. Causes of Decline

i. Environmental degradation in freshwater, specifically water quality and siltation.
ii. Low flow, high temperature and associated water quality problems resulting from the droughts of 1989 and 1990. These factors had both direct and indirect effects on migration patterns (size and timing), production, and mortality rates of juvenile and adult sea trout.
iii. Possible changes in the marine environment, compounded by unfavourable conditions experienced at the freshwater/marine interface.

Stuart Bray considered that the recent decline was not directly associated with the 'Irish problem'. It was accepted that the overall sea trout numbers were declining since a peak in the mid 60's. The fact that 1991 indicated a recovery on the sea trout stocks it was suggested that the 'crashes' in 1989 and 1990 were associated with the drought conditions.

4. SEA TROUT IN ENGLAND AND WALES : D JORDAN

David Jordan, Fisheries Officer - NRA Head Office, is involved in the Sea Trout R & D Programme as Topic Leader.

David Jordan acknowledged that the main data sources available to the NRA for the effective management of sea trout stocks were statutory rod and net returns. The value of all data for management of sea trout is compounded by the complex life history strategies of the species. The problems associated with catch statistics were summarized and as usual standard questions were asked of the data:-

i. How accurate are the catch data?
ii. What is the relationship between catch and stock?
iii. The importance of effort data?

All catch statistics relate to in-season catch and can be influenced by patterns and timing of migrations, environmental conditions, angling conditions, (both real and perceived). The NRA have the powers to request the recording of effort data and to set a byelaw, if necessary.

David Jordan proceeded to set the scene regarding sea trout stocks in England and Wales. This gross overview was based on catch records compiled by Ian Russell, MAFF.

David Jordan presented a series of data, in tabular and graphical format, for sea trout catches in each of the NRA regions. (See Tables B1 & B2 and Figures B1 - B12). Data for 1990 and 1991 were compared with 5-year averages for various time series.

Catches in 1990 and 1991 for the South West showed a marked decline when compared to the previous five-year mean. Net catches were reduced by 58% and 61% in each year and similar figures for the rods showed a reduction of 60% and 54% respectively.

Comparison of the histograms for each region revealed the overall decline throughout the 1980's. Peak catches in the late 70's represented a recovery from a trough in the late 60's and early 70's. The previous peak had been in the early-mid 60's. Variations on this general theme were evident in the various regions, eg. a dramatic decline in Southern and Wessex and a less marked reduction in rod catches in Wales. The trend in sea trout catches for the North East showed a reversal in the general trend which was attributed to the recovery of many of the rivers in Northumbria and Yorkshire.

Accepting that the 1991 rod statistics were very provisional it appeared that the net catches for England and Wales showed a decline in 1991, while the rods showed an increase, fuelling speculation of a recovery.

David Jordan was asked to comment briefly on sea trout in Scotland. He made reference to recent works undertaken by Andy Walker (SOAFI) which was summarised in Table B3 and Figure B13. The region identified as "North West" was the problem area in Scotland. Various reasons were considered but the low catches might be a result of an "Irish type problem". Sea trout exhibited the same visual damage associated with sea lice infestations. This aspect will receive additional study in 1992.

5. SEA TROUT IN IRELAND : K WHELAN

Ken Whelan tabled a copy of the STAG 1991 Report which formed the basis of the paper.

Ken Whelan began by introducing the background to the Irish problem by describing salient features of the Irish sea trout. The majority of sea trout waters are derived from specific geological formations which result in natural acid waters pH 5.5 - 6.5. Various types of fisheries exist of which many are loch fisheries. Smolt ages varied between 2 and 5 years. Among the rod fisheries, 60% of the sea trout caught are finnock and the remainder ranged in size from 1.25-3.0lb. Exploitation rates for sea trout can be up to 25%.

The problem of the decline in sea trout catches appeared in 1988, when concern was stated. The immediate questions were "What is known and what are the causes? Initially, many catchment management based issues were promoted as the primary cause, eg. forestry, land drainage. With time, greater emphasis was targeted at the marine environment. In autumn 1988 studies commenced on the River Eriff but this was short lived and funding was removed in the spring 1989. In May 1989, post smolts and kelts returned to freshwater showing massive sea lice damage. The condition of the fish, in particular the older fish, was poor. Among the multiple spawners the gonads were poorly developed. Major concern was stated due to the magnitude of the problem and the unprecedented loss of the spawning population.

The sea trout decline was recorded throughout Ireland but the Eastern area showed signs of recovery in 1991. By far the greatest damage to the stock was recorded in Galway and South Mayo in the Western area. The scale of the decline was emphasised in the rod catches for the Connemara District : 1974 - 1991 (See Figure C1).

Consultation with many concerned parties result in the compilation of numerous theories to explain the 'crash' (See Table C1). All issues contained in this diverse array were addressed.

In autumn 1988, the Sea Trout Action Group (STAG) was established to tackle the problem. Members of STAG represented both regional and Government organisations. A research programme was formulated for 1989 based on the experience and knowledge of a specialist team of scientists The main elements of this research programme were:-

i. Survey marine sites for feeding trout (adjacent to and remote from aquaculture sites.
ii. Tagging kelts and smolts.
iii. Examine samples for: length, age, sex, growth, parasites, disease.
iv. Look at food organisms in sea trout stomachs.
v. Look at availability of food at sea.
vi. Data collection range of fisheries.
vii. Range of enhancement programmes.

Ken Whelan proceeded by presenting selected data generated as a result of this programme. Using the extensive time series of quality data produced at Burrishoole it was shown how the survival rate of finnock and older sea trout were affected (Figures C2 and C3). The low spot was recorded in 1989 with some recovery in 1990 and 1991. Smolt migrations were studied in relation to rainfall and temperatures from 1969 to 1991. Figure C4 show the two specific years, 1990 and 1991. Common factors recorded were:-

i. Rate of temperature increase was staggered and not a steady increase. Water temperatures were high. There was some indication that temperatures greater than 13°c inhibited smolt migration.

ii. Low flow during the smolt migration (April/May) changed the pattern of behaviour.
iii. Less silver fish, and hence smolts less keen to migrate, were recorded in greater numbers.

(Sambrook documented the importance of temperatures and flow regimes in 1980 and emphasised the link with sea trout stocks following the dramatic crash in stocks of 1980. Migration patterns of smolts and adults were studied on the River Fowey over the period 1977 - 1981. The "1980 crash" was also recorded in Ireland, ref. E Fahey).

Ken Whelan showed a short video of the extent of sea lice damage experienced in the Delphy Fishery, Connemara. Extensive damage to the skin resulted from massive infestations of juvenile lice (up to 400 juvenile and 40 adult sea lice per fish) were recorded. Such infestations will result in a major imbalance in the fish due to physiological changes. These sites were prone to secondary infections and subsequent death. The poor condition of maiden and previous spawners was also emphasised.

Ken Whelan recognised that the decline in sea trout stocks during the 1980's could be attributed to environmental factors, but these factors alone were not the 'link' with the "collapse" in Ireland. Greater emphasis was placed on the 'explosion' in the sea lice populations in association with the expansion of sea cages and sea farms (Figure C5 and Tables C2-4). Predictive models were designed which showed that a minimum 94% of sea lice were potentially derived from sea farms. This established a link between cage rearing and wild sea trout stocks. (Note: Not a proven case).

The effect of sea lice on the physiology of smolts and sea trout and the adaption to salt water will be studied in 1992, following much development of the technology in 1991.

The possibility of disease underlying the collapse was studied. Samples were studied at 3 laboratories for bacteriology, virology and histology. With the exception of Furunculosis, no other diseases were recorded.

In summary, the impact of high temperatures and low flow levels in 1989 and 1990 would have been sufficient to cause an increase in mortality rates and hence a reduction in sea trout numbers. As a coincidence, the already depleted stocks were significantly affected by the massive infestations of sea lice. The impact was further compounded by the decline in all age categories of sea trout in 1989. Hence the benefits of a life history strategy based on "divided migration and return" were nullified. Those fisheries in the mid-West of Ireland suffered a dramatic reduction in the spawning stocks and as a result will take longer to recover.

6. DISCUSSION

Professor Kennedy invited Andy Moore (MAFF) to comment on any matters following the CFRD Working Group on Sea Trout - Edinburgh 1992. Data presented suggested that the reasons for the decline in England and Wales were not directly comparable with the Irish problem. The case for a link between reductions in Ireland and North-West Scotland wasto be proven. Differences in the performances of sea trout stocks on a region and river basis in 1989 and 1990 were mainly attributed to low flow and drought conditions. It was recognised that the first 100 days of smolt life was vital and as a result many research areas were identified. Andy Moore emphasised that communication and collaboration between the NRA (Head Office) and all external organisations including MAFF was essential.

Professor Kennedy thanked the main speakers and summarised the general findings in relation to fish. He emphasised that no single cause should ever be assumed. Often the causes can be diverse and complex resulting in an overall imbalance to the equilibrium. Professor Kennedy broadened the field of interest and invited John Waldon (RSPB) to comment on any aspect of bird life which showed similarities to the sea trout problem.

John Waldon explained that there were limited data available but there were some similarities with certain sea birds. The importance of understanding the long term cycles associated with the marine environment was stressed and that the sea must not be considered as a single habitat but extremely complex. John Waldon continued with references to sea bird populations in the Shetlands and the decline in sand eels as a primary food source. Certain bird species also crashed which resulted in the closure of the commercial fishery. The link of the recovery of sea bird populations with the fishery was only tentative, since subsequently it was evident that many other factors were contributory. These factors included changes in sea temperatures and current patterns. There were suggestions that overall changes to frontal weather systems were affecting the food chain of both primary and secondary producers.

With specific reference to the South West, it was noted that the breeding birds declined dramatically in 1930 - 1940's period. Unfortunately there had been no recovery. Why? The impact of the inshore fishing industry and the increased use of monofilament nets was mentioned. The inshore bird species of importance include the terns (Roseate, Sandwich and Little, of which the former has declined dramatically, being of national concern due to 50 pairs in U.K.) and auks (Guillemots and Razorbills).

Gerald Boalch (MBA), was asked to comment on any relevant aspects of the marine environment. The immediate retort was "What do sea trout feed on"? Answering this specific question should enable a better link with the marine specialists. Gerald Boalch emphasised that in terms of marine studies, where long data sets were required, this decline in sea trout numbers was little more than a 'blip'.

Studies in recent years of the proliferation of fish farms around the world have recorded major changes in phyto plankton cycles, increased frequency of occurrence of "red-tides" and in the development of anaerobic zones adjacent to the farms. The type of farms studied included a range from mussel to salmon farms.

In relation to the decline in sea trout numbers in the late sixties, reference was made to major dino-flagellate blooms recorded in South West and Irish waters.

Andy Moore commented that phyto-plankton records were to be studied in relation to the timing of smolt migrations and early sea feeding.

Teigwyn Harris (University of Exeter) was invited to comment on aspects of marine biology, specifically invertebrates. The question of "What do sea trout feed on"? was restated. Overall there has been no significant change in the littoral fauna in the South West, certainly in recent years. Reference was made to the fact that the shore invertebrate populations of the Torridge estuary were exceptionally dense and diverse in the mud shoals but that the sand banks were considered azoic. The factor that invertebrate species and communities were also complex and as such may be of significance to sea trout.

Over the past 3 years the number of sand eels reported as a 'by-catch' to the invertebrate sampling has increased in the Exe and Torbay area. This evidence was not scientific but anecdotal and noticeable. It was considered that this could reflect the recovery of the sand eel populations following the Gyrodinium bloom of the mid eighties. (Note: A bloom of Phaeocystis was recorded in Irish waters in 1990 but this species does not produce toxins).

A reduction in the number of prawns caught in the South West inshore was recorded in 1991, with populations showing early signs of recovery in 1992.

Professor Kennedy pursued the interest in the marine issues by inviting Professor Alan Southward (MBA) to contribute on matters relating to climate and long-term changes.

Professor Southward initial comment was that any changes in sea trout stocks were not linked with patterns recorded for marine invertebrates and marine fish.

Professor Southward continued by presenting a comprehensive array of data to emphasise the complex interrelationships between biota and environmental factors and to restate the importance of comparable long time series of data.

The figures and tables detailed in the Appendix D are those presented at the workshop. The following notes represent the salient points:-

i. Atmospheric carbon dioxide levels continue to rise.

ii. Global mean air temperature continue to increase, with only a slight depression during the 1960's.

iii. Sea surface temperatures for Biscay peaked in the 1950's, reached a low in the late 1970's with a marked increase in recent years. This pattern is lagging behind global predictions.

iv. Changes in sea temperatures reflect the changes in abundance of cold and warm water species eg. Sagetta elegans and Calanus.

v. Changes of 'zoo-fish' catches in spring and summer samples showed slightly different patterns but the overall trend was a peak from 1960 onwards.

vi. The distribution and range for cold and warm water species was emphasised by comparing herring/pilchard and haddock/red mullet.

vii. When small zoo-and phytplankton dominate the pilchard benefit but when large plankton species dominate herring benefit. The recruitment of these species is interlinked with the plankton species but not discrete.

viii. Comparison of catch ratios of the herring and pilchard eggs reflect the changes in sea temperatures.

ix. The numbers of pelagic species has increased in the fish trawls. Cold water species dominated in years 1976 - 1979, with warm water species returning since 1989.

x. Cold sea temperatures in 1970's resulted in changes to plankton and fish species but this was not linked to sea trout decline.

xi. Sun-spot shape and greenhouse effect compounded the effects in 1989 and 1990.

xii. Global warming and climatic change could result in predicted changes of 1.5°c, which could significantly affect sea trout and salmon stocks in Southern Europe.

[LUNCH 13.00 - 14.00 hours]

Professor Kennedy set the scene for the afternoon session by targeting specific areas of concern associated with the decline of sea trout. Topic issues, included both the marine and freshwater factors affecting the life cycle, climate and long term trends, genetics as a factor contributing to regional differences and analogous changes to other species.

Comments were invited on aspects of the freshwater phase, with reference to smoltification and changes to migration patterns. Wild stocks were coming under greater pressure due to environmental degradation, land use changes, etc. Stuart Bray stated that due to increased pollution problems brown trout stocks were declining. In South West rivers probably 95% of the trout stocks were derived from the migratory component. The proportion of adult trout remain as resident brown trout was small and predominantly male. Increased mortality in freshwater could directly affect the sex ratio of the spawning adults.

Ken Whelan stated that on the River Eriff brown trout populations located upstream of impenetrable barriers remained stable. Trout stocks downstream of these barriers were reduced but were replaced by salmon. On the River Eriff and at Burrishoole there was a decline in autumn migrants in 1991. In Ireland the lake and loch habitats offer an additional buffer to the trout populations while many rivers rely solely on the sea for the spawning stocks. Research undertaken on the juvenile stocks in 1992 will aid the understanding and the interrelationship of brown trout/sea trout stocks.

Burrishoole data illustrated the delicate balance between catchment management and the effective management of fish stocks. Ken Whelan emphasised the need to protect sea trout habitat in small streams. Such streams represent significant spawning and recruitment grounds and are small in area relative to the loch complexes.

David Jordan announced that the NRA were commissioning 3 main projects associated with smoltification and factors controlling the successful transition of smolts from freshwater to the sea.

Andy Moore referred to a project undertaken by the Game Conservancy which showed that brown trout stocks were declining. Reference was also made to a study on Pacific Salmon which linked acidification and metal levels to the effect on smolt adaption. It was acknowledged that stocks in the South West were adapted to naturally low pH levels. It should be noted that such impacts may not necessarily be dramatic but may be insidious. Any changes which could result on the smolt being less adapted will result in grater mortality (eg. Norwegian stocks).

Stuart Bray returned to the topic of acidification and acid rain, making reference to the North West region. Research had shown that background pH levels were of concern to sea trout but no direct 'cause and effect' link had been established. Ken Whelan reiterated that many of these issues were complex and were overlaid by specific regional factors. Individual trout populations have evolved and adapted to a diverse range of environmental factors such as extremes in pH levels.

Pat Badham was invited to relate experience gained as a keen angler in the Taw for over 25 years. Paramount to the decline was the increased siltation of redds throughout the catchment. Changes in smolt behaviour and the size of smolt runs were noted. Stuart Bray agreed with much of the anecdotal evidence presented by Pat Badham but factors affecting the Taw were not responsible for the decline in sea trout recorded in rivers such as the Teign and Fowey.

Andy Moore stated that sedimentation and increased intergravel mortality of the early life stages was important. Currently a study was underway in the River Test and methods of cleaning gravels were being investigated. Similar measures had already been introduced in the South West.

Teigwyn Harris asked what the state of knowledge was relating to factors influencing and controlling the physiology and osmo regulatory mechanisms of smolts. Ken Whelan stated that such studies were in hand but it was imperative that research was undertaken on migratory fish. There was a need to link the internal physiological responses to external factors associated with the known transition period of March - April and sea lice damage to mucous layers. Knowledge on the adaption of smolts migrating through the estuary on an "osmo regulatory pathway" is essential.

Professor Kennedy progressed the discussion to cover the genetic identity of sea trout stocks. David Jordan stated that recent studies had shown that sea trout stocks were unique. Differences in migration patterns were evident among different stocks. Irish sea trout undergo short migrations and were small fish. Conversely sea trout from the North East Coast rivers underwent long migrations and were larger fish. Sambrook provided evidence promoting accurate homing among sea trout, and made reference to studies on the River Fowey, period 1977 - 1982.

David Piggins also considered that homing of sea trout could be as precise as salmon, but during feeding migration the fish will cross boundaries. Although sea trout are well adapted to physiological change and saline gradients and enable migrations in and out of estuaries, the majority of fish spawn in their natal waters.

Ken Whelan commented on the fact that to date no evidence was available to suggest that brown trout and sea trout stocks in a single river were genetically different. Andy Ferguson will be repeating specific studies on trout stocks to check historic results using new DNA probes. Ken Whelan also referred to work undertaken at Burrishoole using introduct eggs from fast growing sea trout stocks. The resulting progeny showed similar growth rates, size and behaviour to the slow growing and genetically different West Coast stocks.

Professor Kennedy raised the question of 'what do sea trout feed on in the sea? Research in Scotland had been less than fruitful when considering the time and effort involved in sampling and the numbers of sea trout caught.

Andy Moore and David Jordan referred to data presented at Edinburgh where sea trout caught in sea lochs had been feeding on Atlantic Herring, diptera, amphipod and sand eels. MAFF will be undertaking feeding studies on sea trout migrating off East Anglia during 1992..

Ken Whelan successfully sampled sea trout in shallow inshore water (depth 1 - 1.5m; 100 - 200m off shore; sample period: dusk to darkness; sampling area: sandy shore). Food include zooia, sprat, sand eel and diptera.

Teigwyn Harris stated the need to understand the detail behaviour of sea trout at sea. Food sources will be affected by the diurnal migration patterns and vary between surface, pelagic and benthic zones. Selective feeding would complicate the issue further. Adequate sampling in each specific time period and discrete feeding zone was essential Andy Moore exemplified this point by stating that smolts migrate on the surface during the hours of darkness and on the bottom during the day. As a result previous feeding studies may be unrepresentative of the types of food sources utilised throughout the sea phase.

Professor Kennedy introduced his own specialist topic of parasitology as a possible means of studying food sources. Sea trout stocks from Norway, Russia and Ireland and the South West were studied. The internal parasite fauna were different to those found in salmon. No flukes or nematodes were recorded in sea trout. Tapeworms were recorded in both species, with salmon supporting large mature tapeworms and conversely sea trout supporting small immature tapeworms. The only host involved in the life cycle is a marine copepod. This evidence would suggest that sea trout are planktonic feeders and that the parasite is picked up in coastal waters. Using parasites as a 'natural tag' could indirectly link the sea trout and its food source, via the host.

Ken Whelan commented on the difference in behaviour exhibited by smolts leaving freshwater. Catches of post smolts were restricted to sea trout only, no salmon. A possible explanation would be that salmon exhibit a more positive behaviour moving quickly away from inshore waters while sea trout move outside the influence of the river but mill around in the inshore coastal reaches.

Professor Kennedy invited comments on any other issues relating to sea trout.

David Jordan emphasised that the type of data required to monitor changes in stock level should be more comprehensive. Current catch statistics should be treated with caution, even though the decline in 1989 -1990 was real. Sambrook emphasised this point in 1989 while studying the Tamar rod catches and trapping records at the head of tide. Rod data reflected a marked decline while the reverse trend was recorded in the trap catches. The few trap installations such as Burrishoole provide better data but are often considered biased to an individual river. David Jordan promoted the need for a number of index rivers to be studied in detail.

The use of private historic catch records should be considered to compliment statutory catch returns. This could overcome the problem of the current short term data sets. David Jordan confirmed that the NRA were commissioning a £200,00 study related solely to catch statistics. Some work has already been undertaken on sea trout catches, (Ref: Malcolm Elliott, IFE).

Professor Southward reiterated that there was no clear link between the open sea marine data and sea trout decline. It was suggested that greater emphasis should be put on collection and collation of physical and biological data from inshore waters.

Returning to the topic of climatic changes and the response of biota to warm and cold waters, Professor Southward considered that while adiverse array of warm water species had been recorded in recent years that a change was occurring among barnacles, with the return of the cold water species. Most marine phases are linked to a 45 year cycle but at present there is no clear indication which way the pendulum is likely to swing.

Ken Whelan re-emphasised that greater knowledge was required relating to the patterns of smolt migration and the changes caused by environmental factors and time. The 'window' linking the transition from freshwater to the marine environments must be the focal point of such research.
Professor Kennedy brought the workshop to a close by summing up:-

a. The 3 main talks set the scene in a broad prospective.
b. The majority of stocks showed a decline throughout the 1980's. The low flows and drought conditions exaggerated the decline in 1989 and 1990. In Ireland (mid-West) these trends were compounded by a 'Factor X' which resulted in a catastrophic crash.
c. Many local issues could be related to the steady decline.
d. There is no correlation between the long term marine trends and the sea trout data.
e. There is a need to improve data collection and establish long term data series. The importance of such long term data sets are fundamental to managing catchments and resources effectively. Such studies are neither political high profile or considered "sexy science" but must be categorised just essential. Fundings must be provided.
f. Greater collaboration between national organisations in relation to research and management of sea trout stocks.
g. Areas of concern include deterioration in the freshwater environment, problems with smoltification and the limited knowledge regarding inshore ecology.
h. Sea trout must receive equal priority to salmon in terms of fisheries management and R & D.

Professor Kennedy thanked all the delegates for participating and contributing, greatly increasing the knowledge and awareness of the issues involved.

Mrs A Voss-Bark finally thanked Professor Kennedy for Chairing the workshop.

[Workshops closed at 16.00 hours].

Hugh Sambrook
Fisheries Scientist

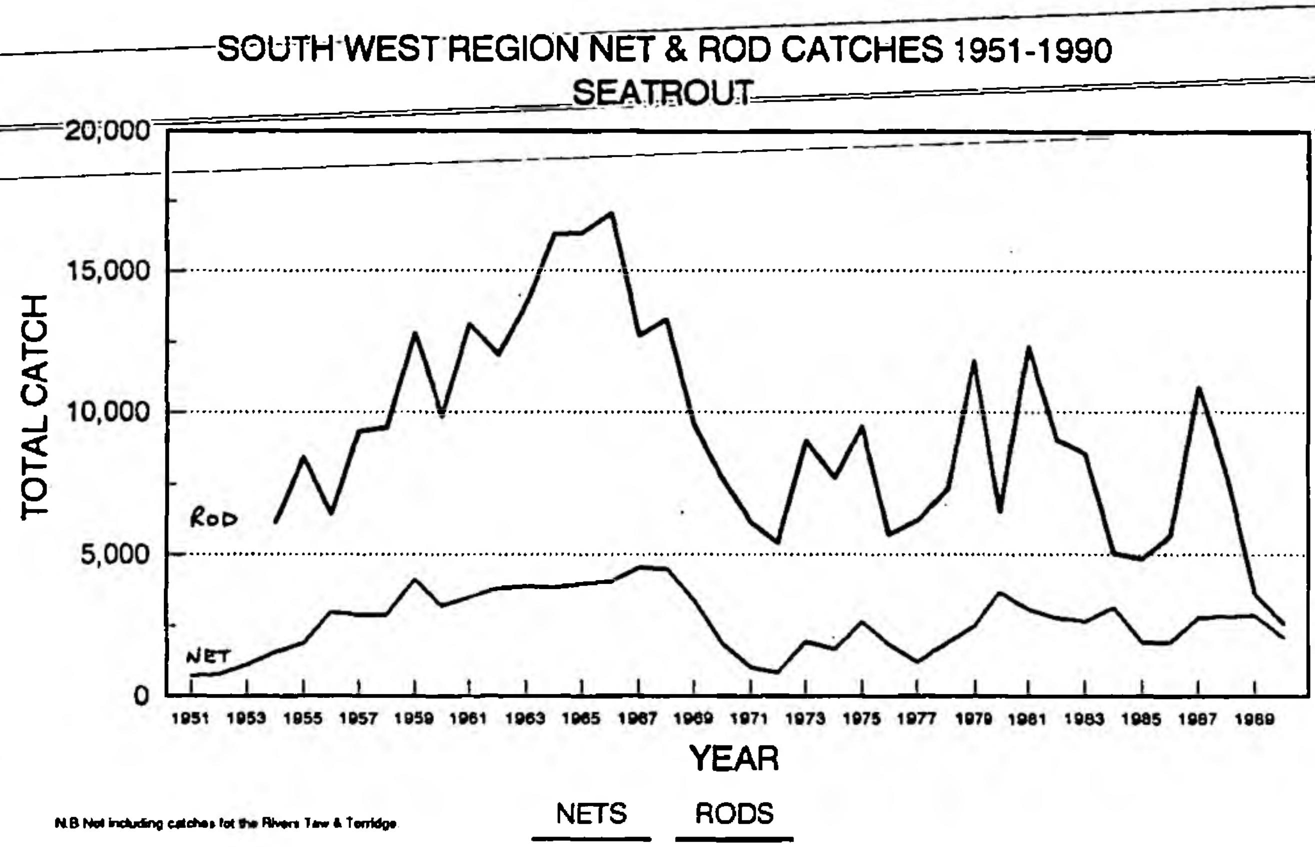
HS/JD/10.3.92.

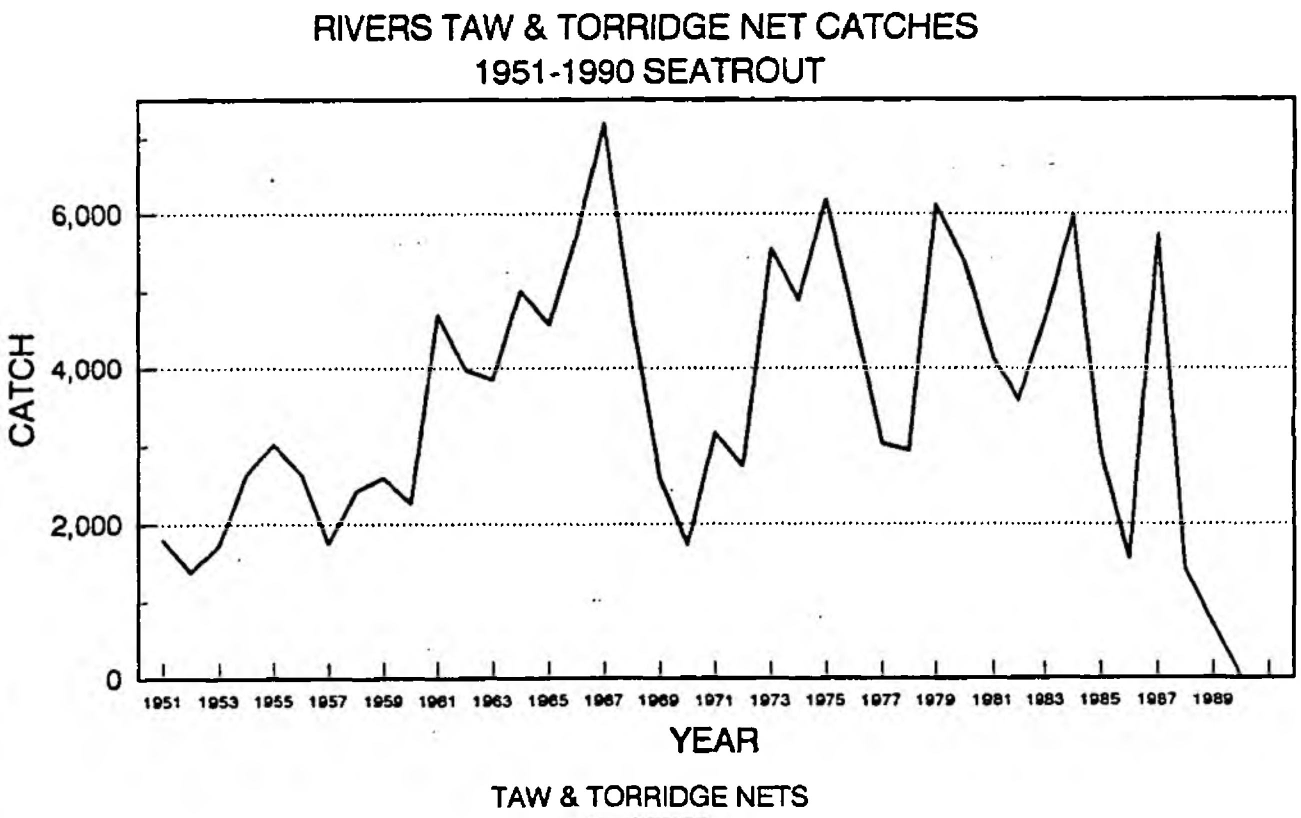
APPENDIX : A

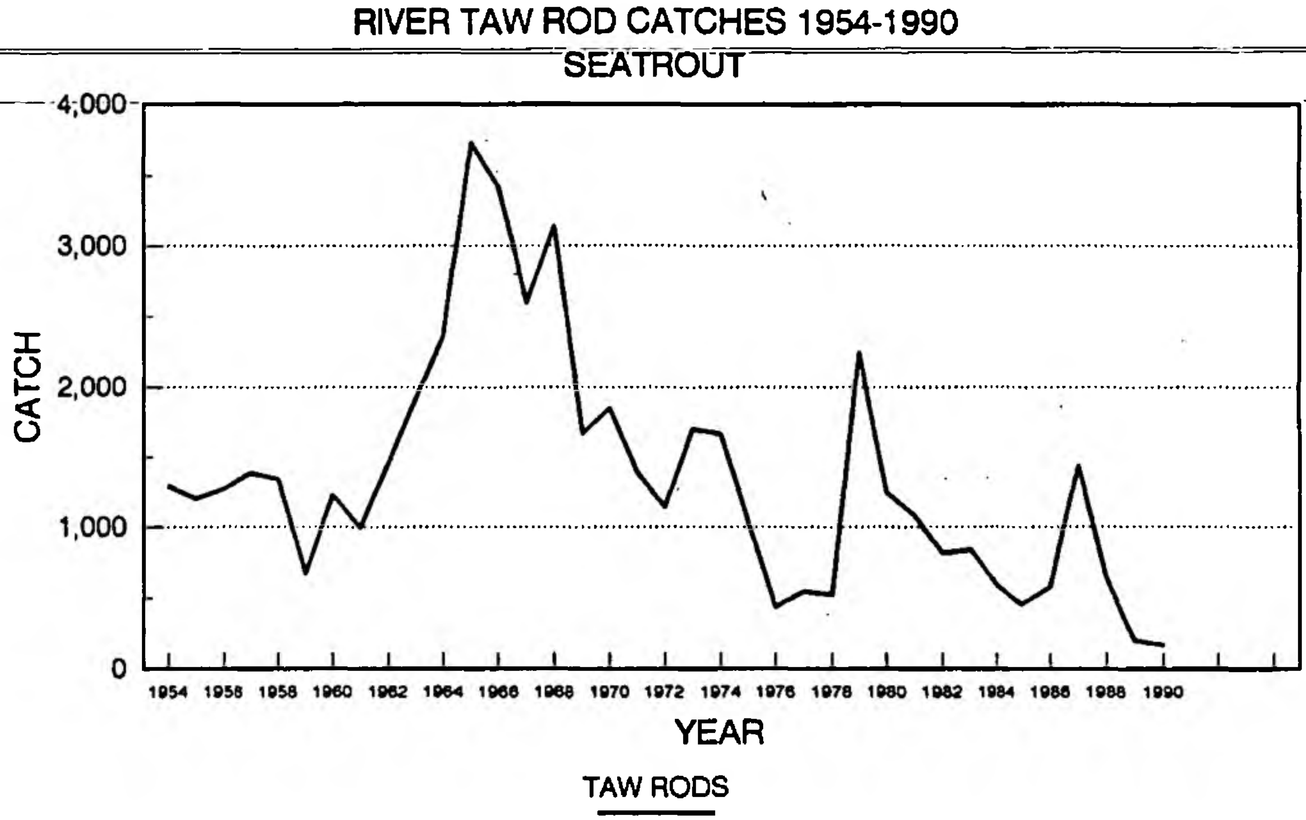
SEA TROUT IN THE SOUTH WEST REGION

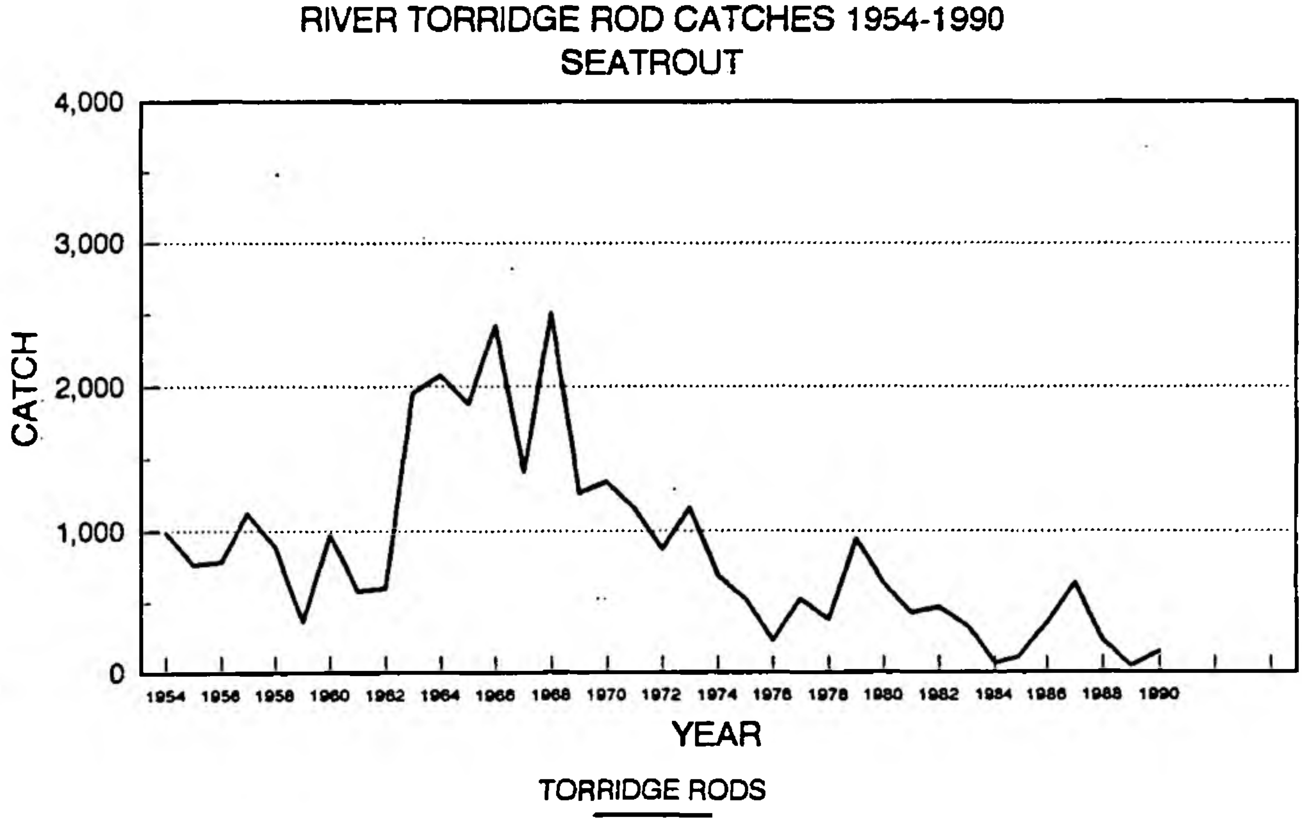
E S BRAY

Figures A1&A2



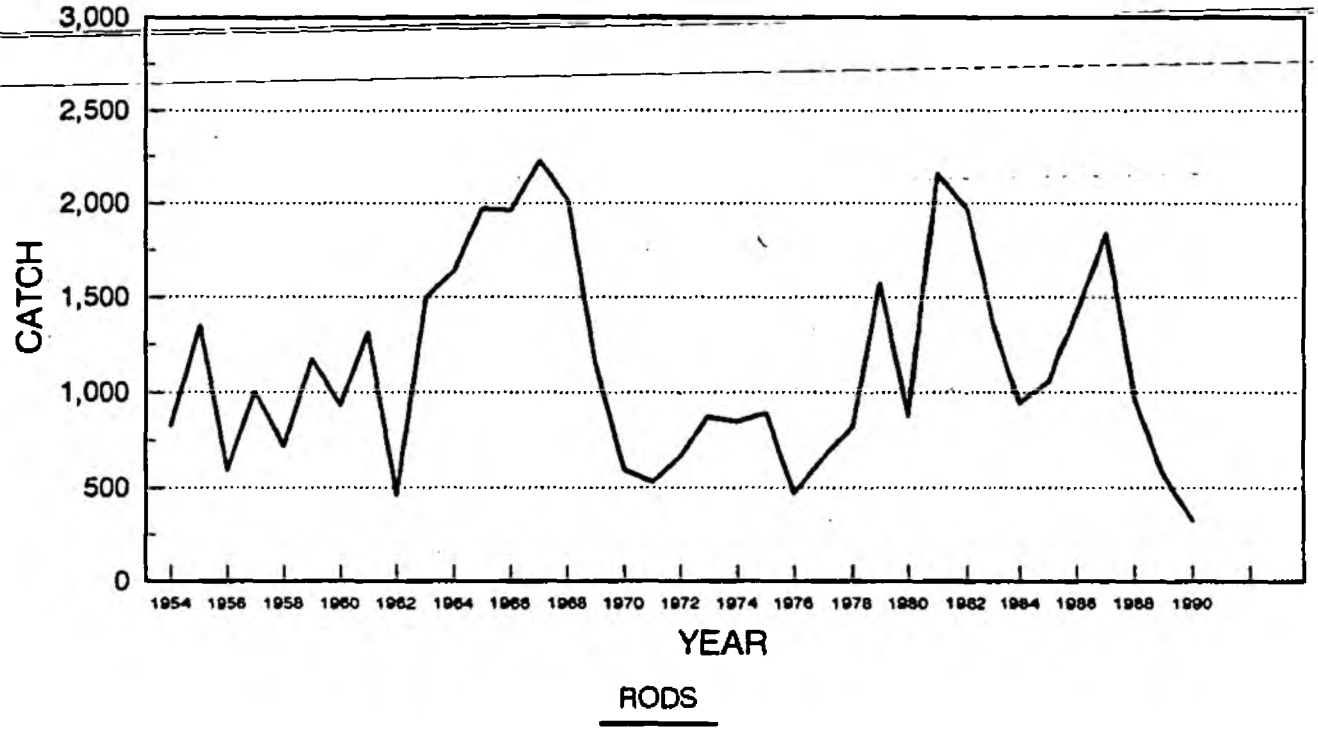



RIVER TAW ROD CATCHES 1954-1990
SEATROUT
4,000
3,000
2,000
1,000
0
CATCH
1954 1956 1958 1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990
YEAR
TAW RODS


RIVER TORRIDGE ROD CATCHES 1954-1990
SEATROUT
4,000
3,000
2,000
1,000
0
CATCH
1954 1956 1958 1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990
YEAR
TORRIDGE RODS

Figures A5&A6

RIVER TEIGN ROD CATCH 1954-1990
SEATROUT



RIVER TEIGN NET CATCH 1951-1990
SEATROUT

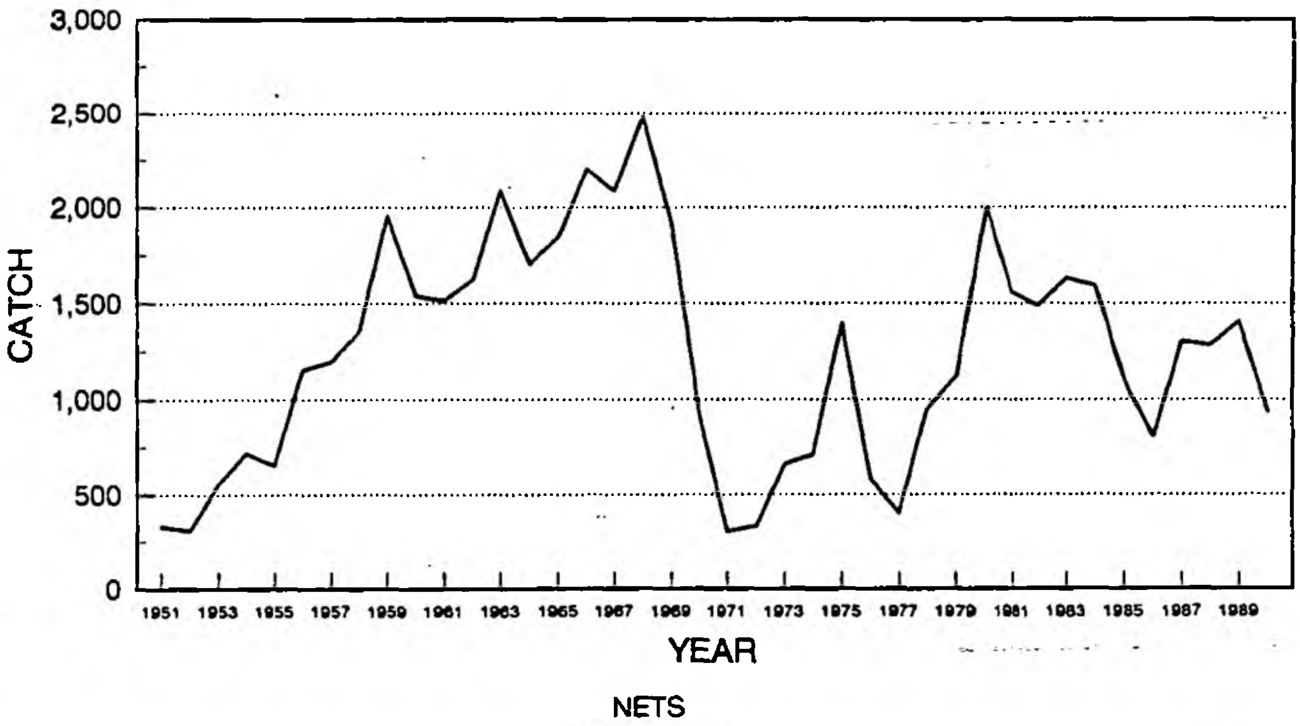
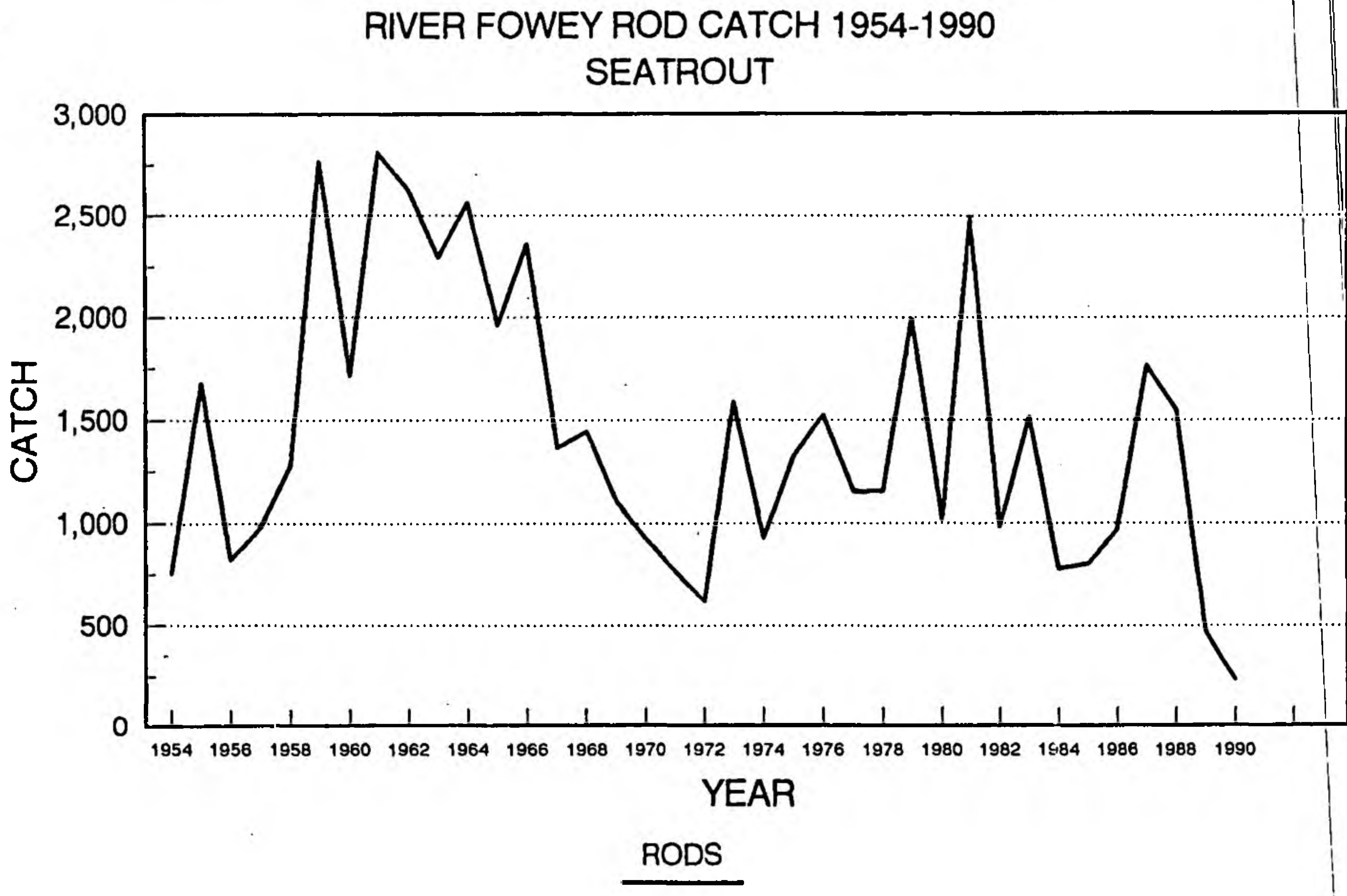


Figure 7


RIVER FOWEY ROD CATCH 1954-1990
SEATROUT
3,000
2,500
2,000
1,500
1,000
500
0
CATCH
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
YEAR
RODS

APPENDIX : B

SEA TROUT IN ENGLAND AND WALES

D JORDAN

Table 1. Summary of regional migratory trout commercial catches, 1985-91.

NRA Region	1985	1986	1987	1988	1989	5-Year Mean (1985-89)	1990	1991 (provisional)	% Change '90 on 5-yr mean	% Change '91 on 5-yr mean
	Numbers of fish									
Northumbria	29619	24610	30345	32711	48626	33182	28560	24869	-14	-25
Yorkshire	21160	23107	18994	21574	22743	21516	15857	11399	-26	-47
Southern	496	163	327	232	170	278	50	55	-82	-80
Wessex	384	359	410	505	365	405	484	311	+20	-23
South West	4907	3482	8570	4364	3591	4983	2071	1950	-58	-61
Welsh	5097	5098	4878	6591	6440	5621	3588	2661	-36	-53
North West	6467	5633	6032	7207	5737	6215	3271	2845	-47	-54
Total	68130	62452	69556	73184	87672	72199	53881	44090	-25	-39

Note: Excludes data for the Anglian region, which was not available before 1989.

Table 2. Summary of regional migratory trout rod catches, 1985-91.

NRA Region	1985	1986	1987	1988	1989	5-Year Mean (1985-89)	1990	1991 (provisional)	% Change '90 on 5-yr mean	% Change '91 on 5-yr mean
	Numbers of fish									
Northumbria	675	1256	2237	2778	1640	1717	1543	1192	-10	-31
Yorkshire	209	130	299	279	97	203	162	86	-20	-58
Southern (a)	124	2517	56	1073	437	841	100	51	-88	-94
Wessex	1668	2274	1447	837	402	1326	101	140	-92	-89
South West	4838	5656	10898	7755	3645	6558	2596	3000	-60	-54
Welsh	20868	21308	35727	30681	13203	24357	10030	14000	-59	-43
North West	3993	3739	5195	6215	3481	4525	2499	3022	-45	-33
Total	32375	36880	55859	49618	22905	39527	17031	21491	-57	-46

Key: (a) Migratory trout returns are unreliable in the NRA Southern region. In addition data for 1986 and 1988 are believed to include significant numbers of under-sized fish which were returned to the water.

Figure 1. Total declared net and fixed engine catch of sea trout for England & Wales, 1978 - 1991.

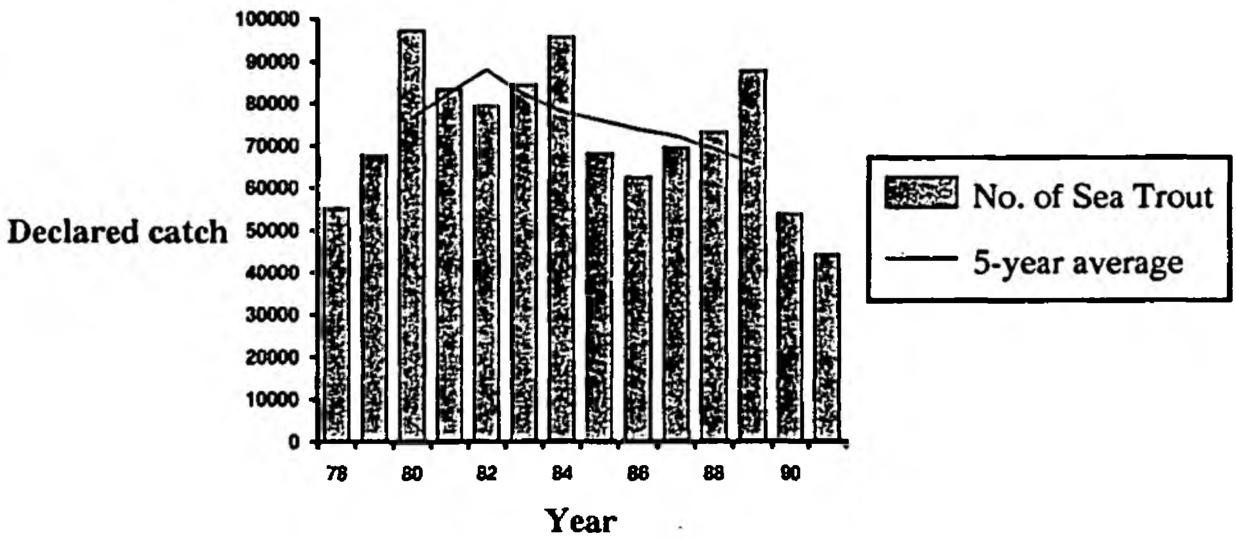


Figure 2. Total declared rod catch of sea trout for England & Wales, 1976 - 1991.

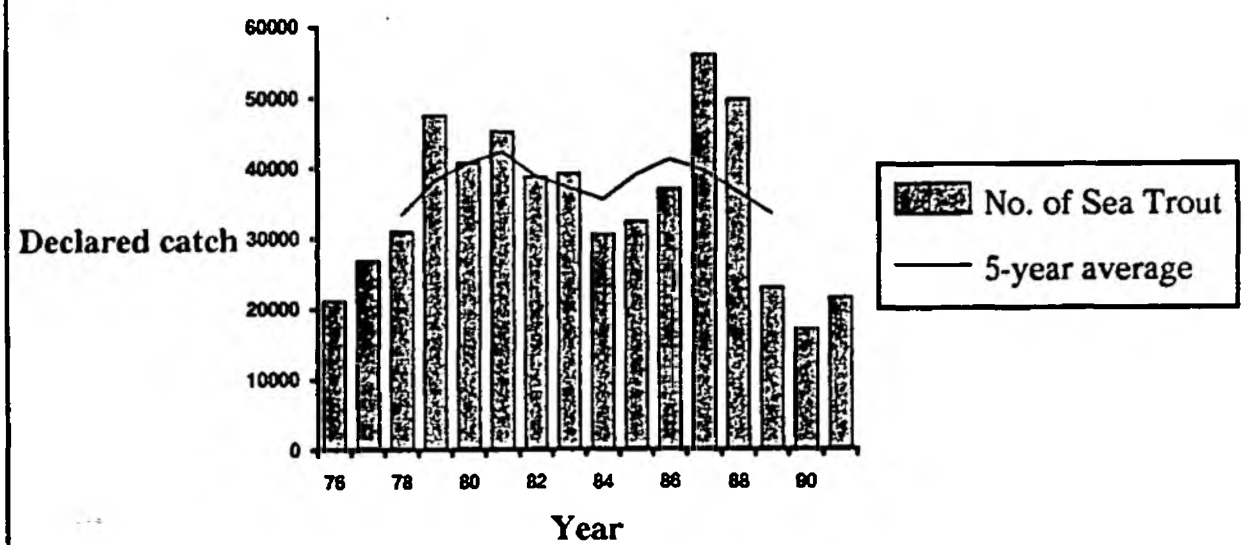


Figure 3. Total declared net catch of sea trout for north-east England (Northumbria + Yorkshire), 1951 - 1991.

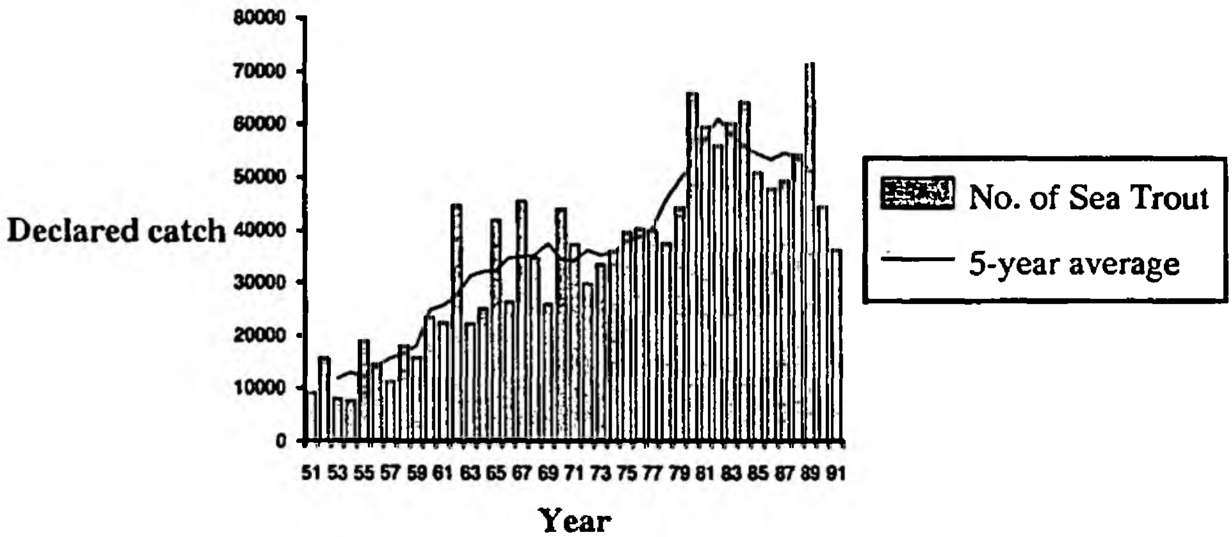


Figure 4. Total declared rod catch of sea trout for north-east England (Northumbria + Yorkshire), 1952 - 1991.

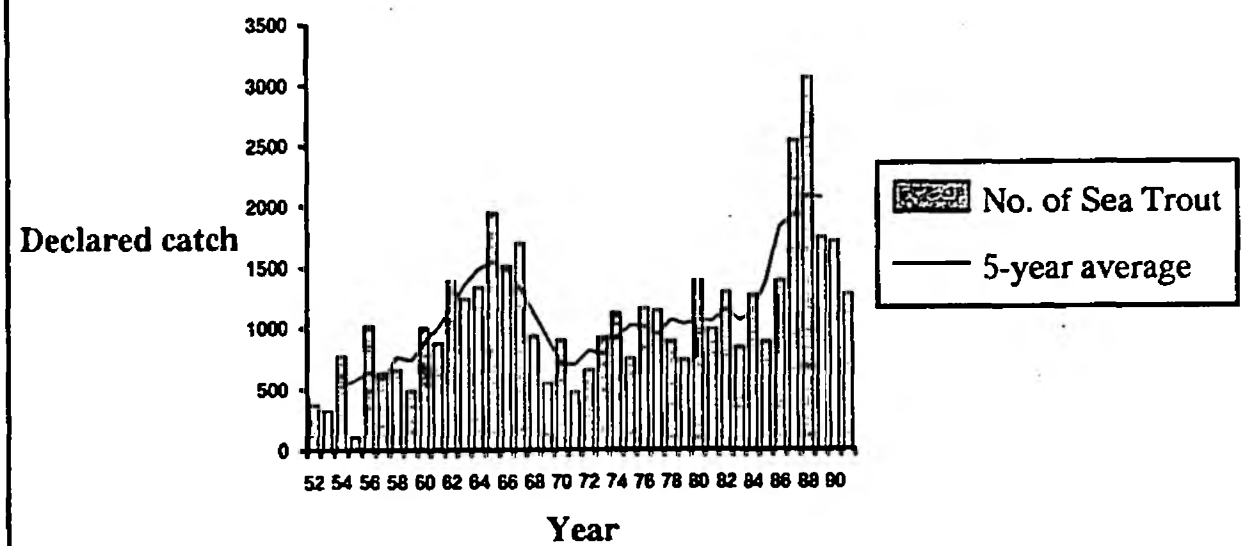


Figure 5. Total declared net catch of sea trout for southern England (Southern + Wessex). 1951 - 1991.

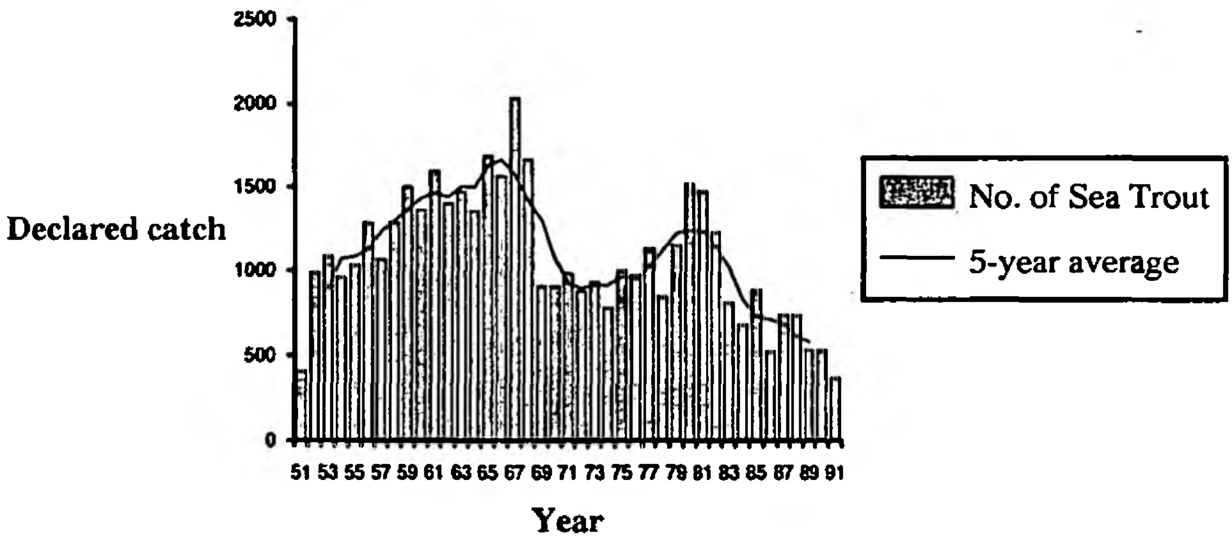
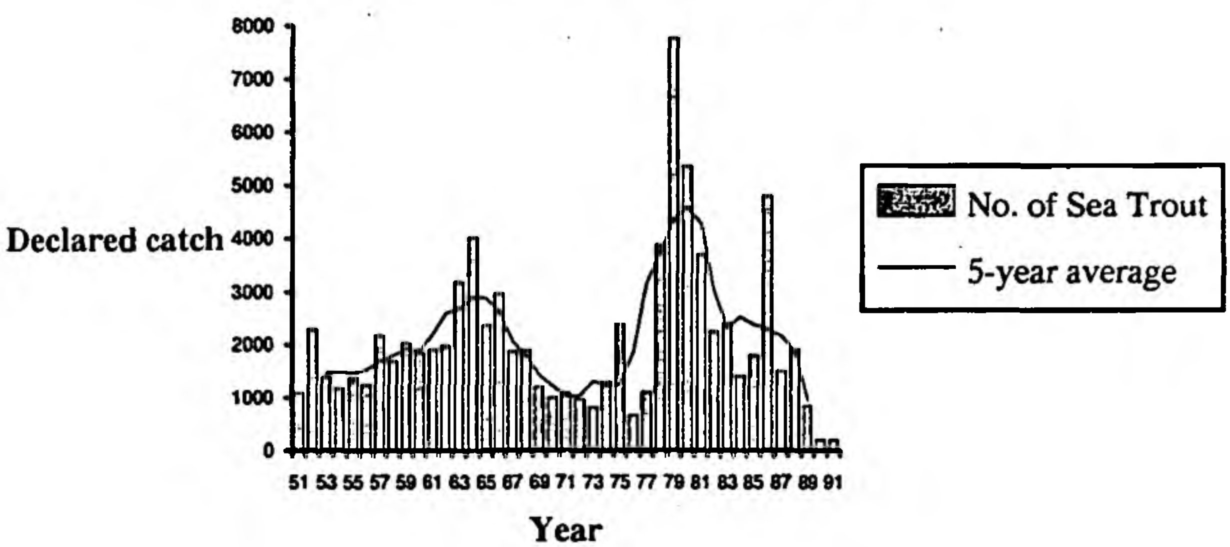


Figure 6. Total declared rod catch of sea trout for southern England (Southern + Wessex). 1951 - 1991.



Figures B7&B8

Figure 7. Total declared net and fixed engine catch of sea trout for south-west England. 1951 - 1991.

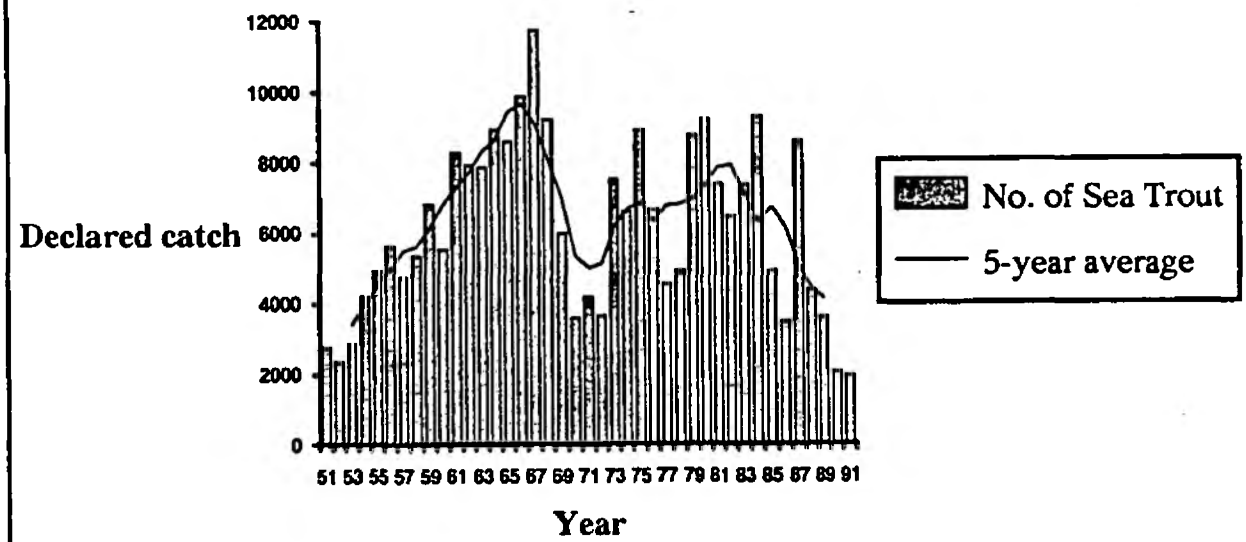


Figure 8. Total declared rod catch of sea trout for south-west England. 1951 - 1991.

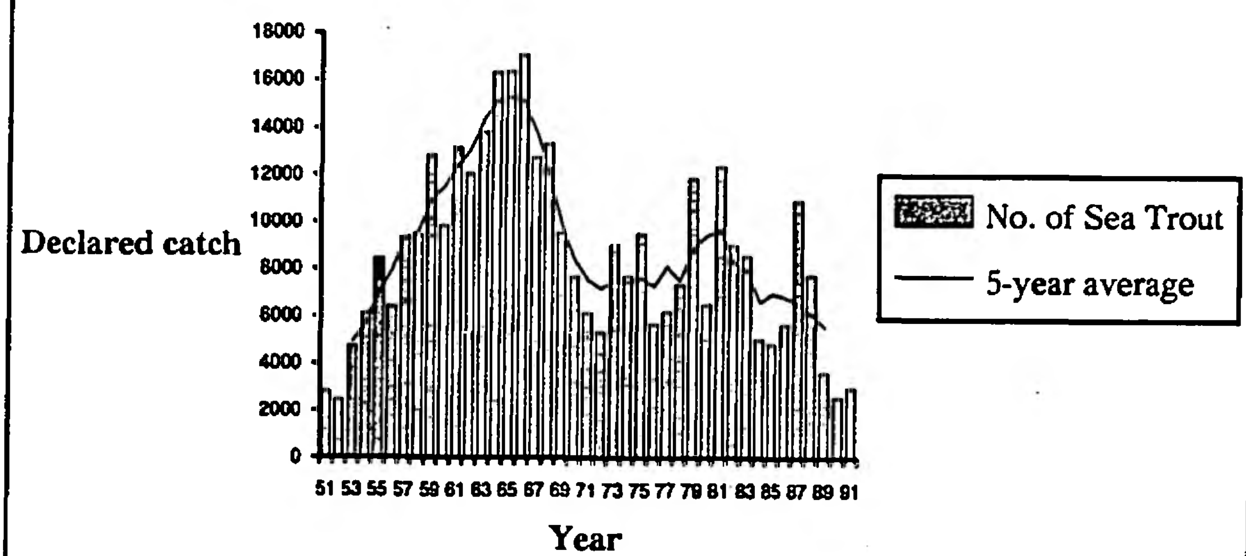


Figure 9. Total declared net and fixed engine catch of sea trout for Wales, 1956 - 1991.

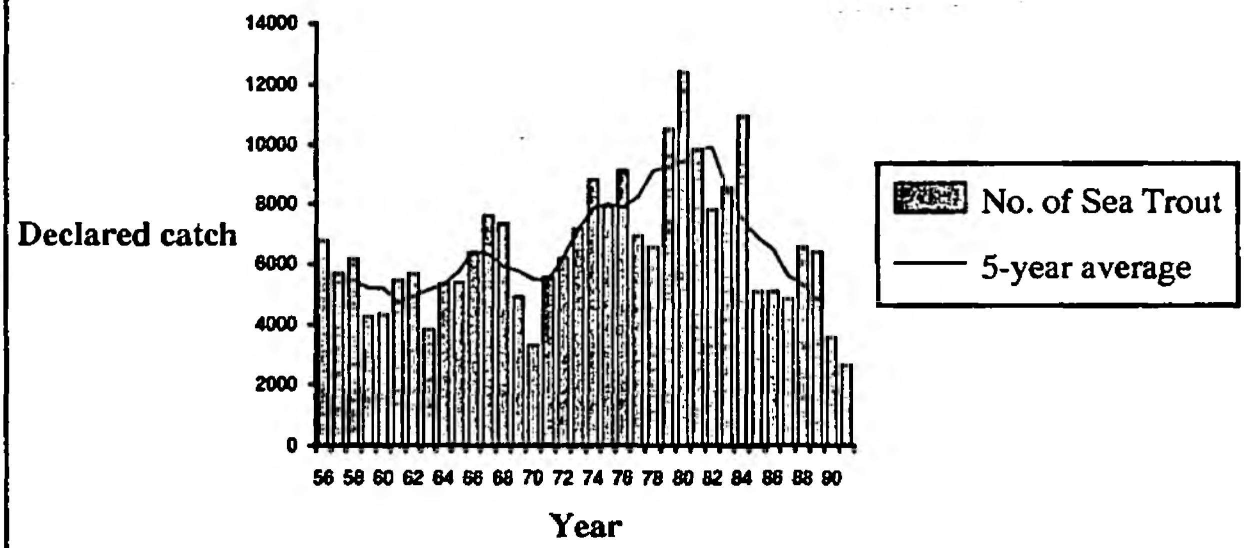


Figure 10. Total declared rod catch of sea trout for Wales, 1952 - 1991.

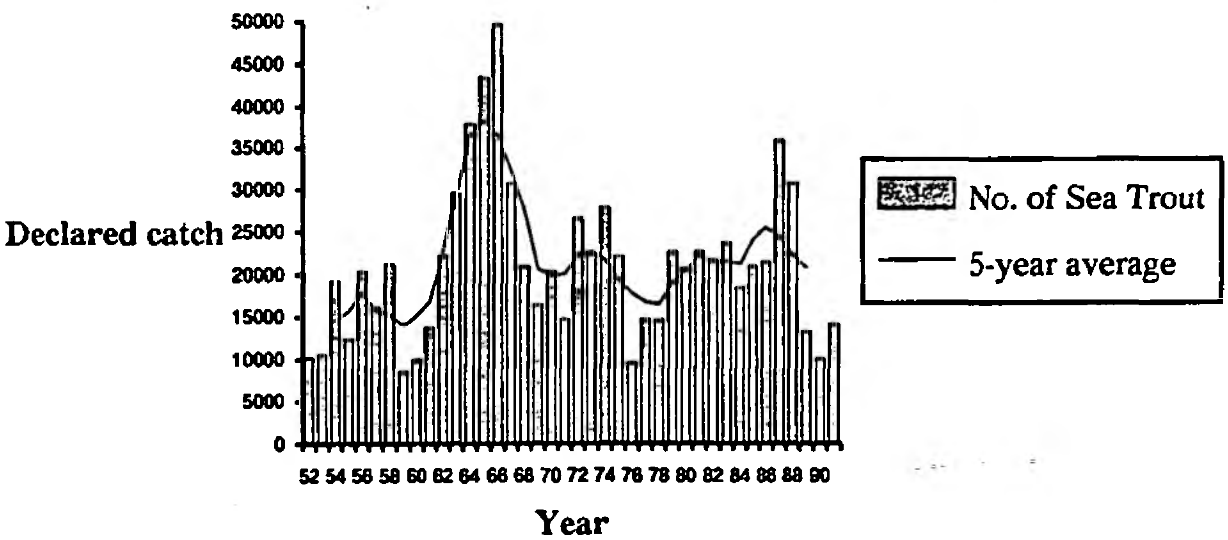


Figure 11. Total declared net and fixed engine catch of sea trout for north-west England, 1978 - 1991.

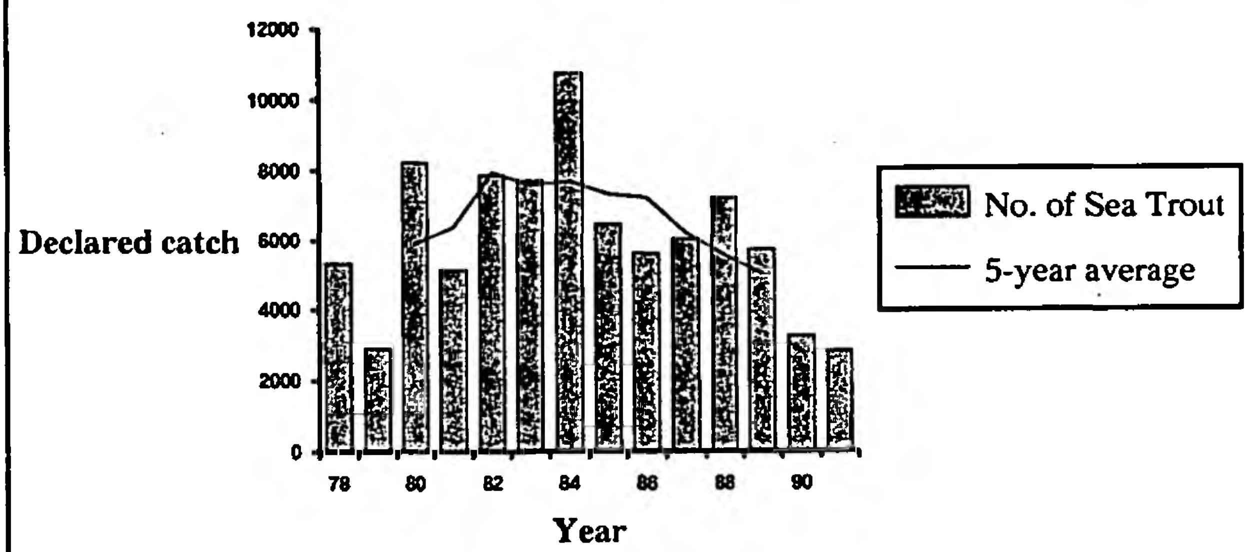


Figure 12. Total declared rod catch of sea trout for north-west England, 1976 - 1991.

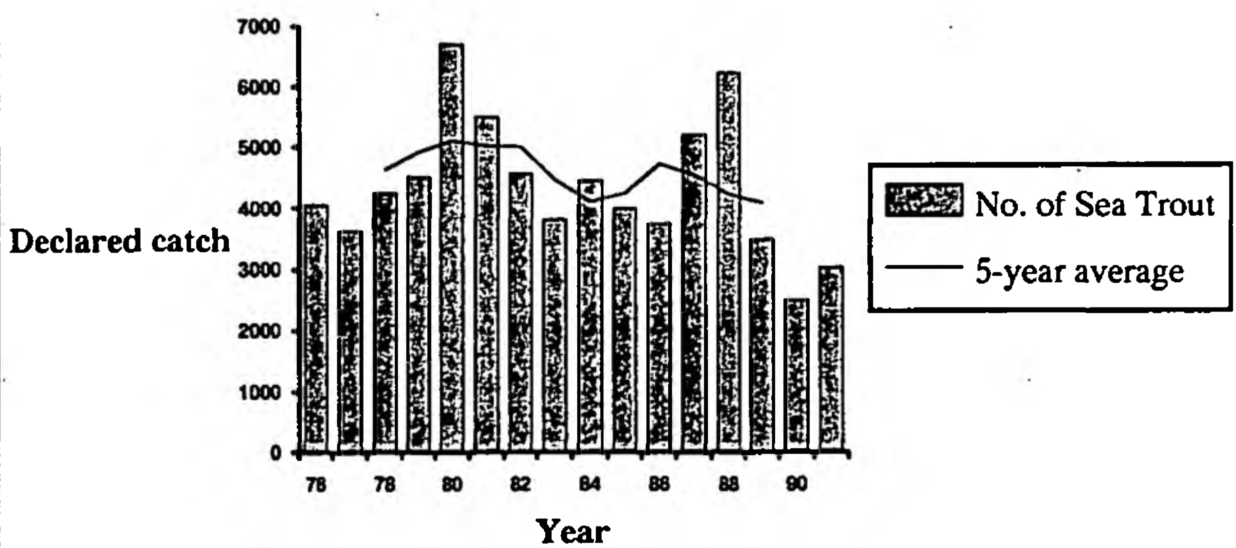


Table B3

SCOTLAND

(work by Andy Walker, SOAFD)

PERCEIVED DECLINE IN ANGLER CATCHES SINCE 1988

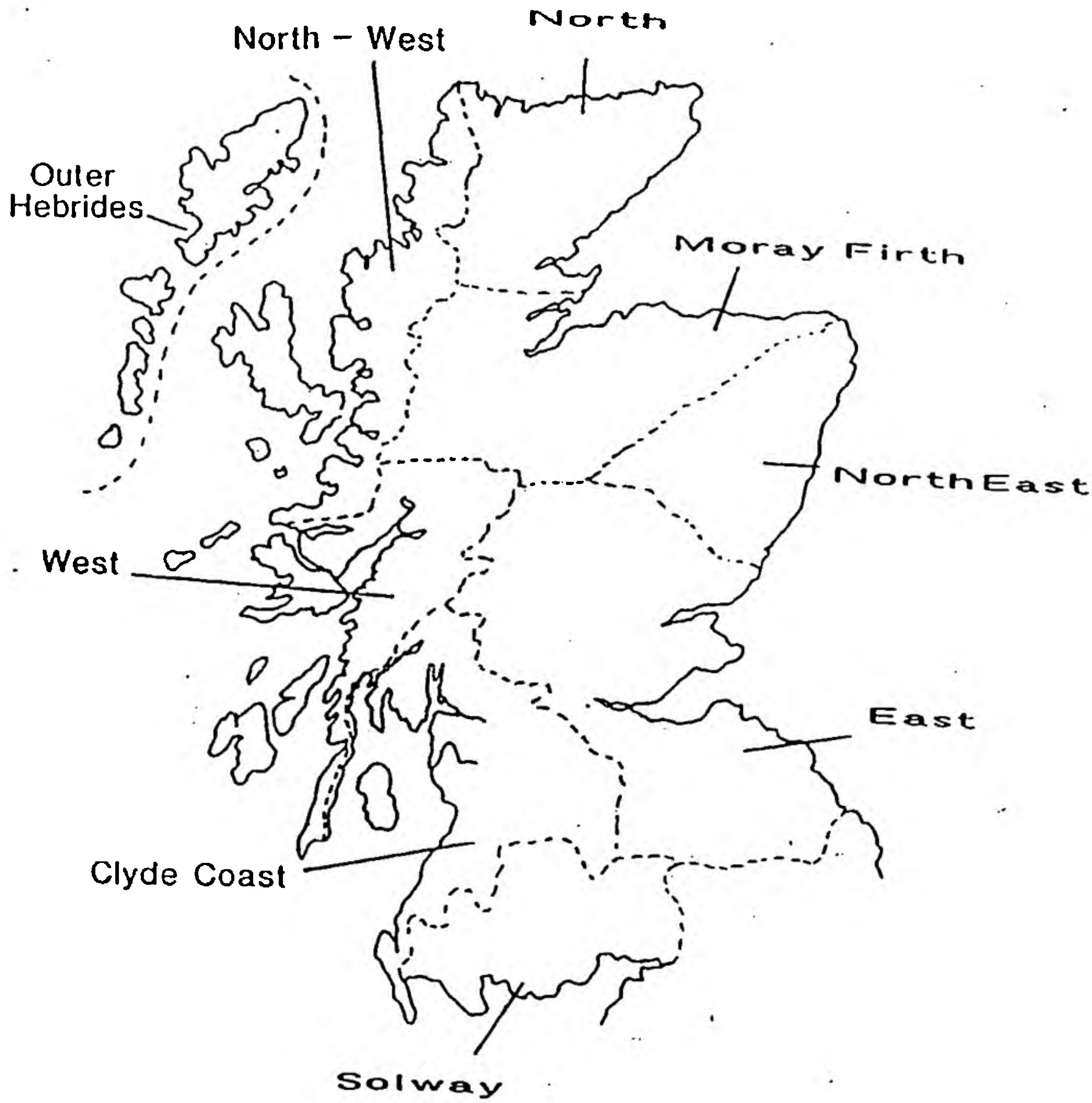
ANGLER CATCHES 1952 - 1990 AGGREGATED BY REGION

EAST, NORTH EAST, SOLWAY:	NO SIGNIFICANT REDUCTION
MORAY FIRTH:	RECENT CATCHES LOW RELATIVE TO LAST DECADE BUT NO EVIDENCE OF LONG-TERM EFFECT
CLYDE:	NO SIGNIFICANT SHORT-TERM EFFECT BUT RECENT CATCHES LOW RELATIVE TO LONG-TERM
NORTH & OUTER HEBRIDES:	SIGNIFICANTLY LOW RECENT CATCHES cf LONG-TERM
NORTH WEST & WEST:	LOW RECENT CATCHES cf SHORT AND LONG-TERM

IN NORTH WEST, CATCHES CONSISTENTLY LOWER THAN EVER BEFORE IN THE SERIES.

CATCHES IN MOST REGIONS HAVE BEEN AT SIMILAR LOW LEVELS (NOTABLY IN 1970s) BUT IN NORTH WEST CATCHES ARE AT UNPRECEDENTED LOW LEVELS.

Figure B13


North - West
North
Outer Hebrides
Moray Firth
North East
West
East
Clyde Coast
Solway

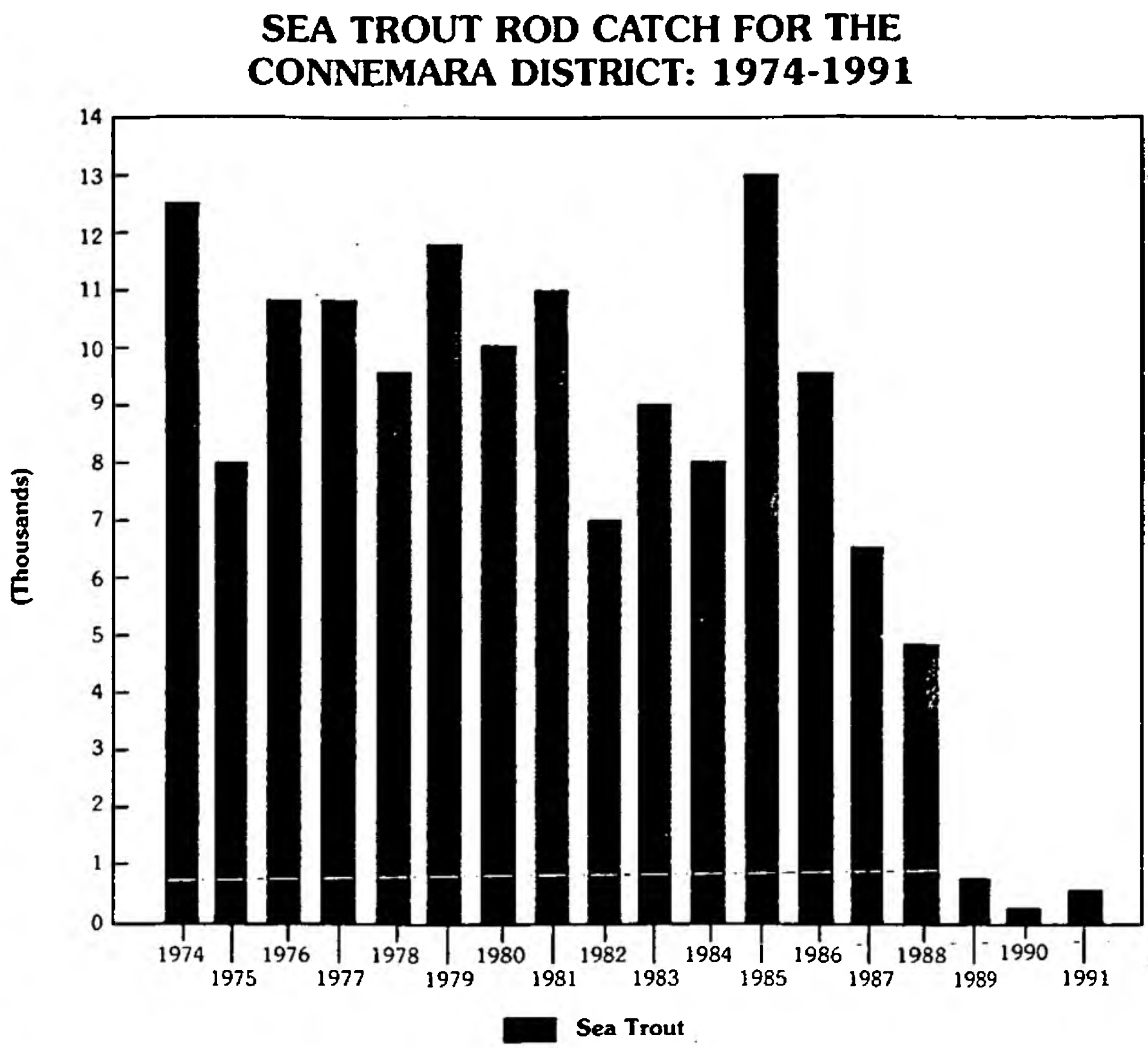
APPENDIX : C

SEA TROUT IN IRELAND

K WHELAN

FIGURE C1

Fig. 2

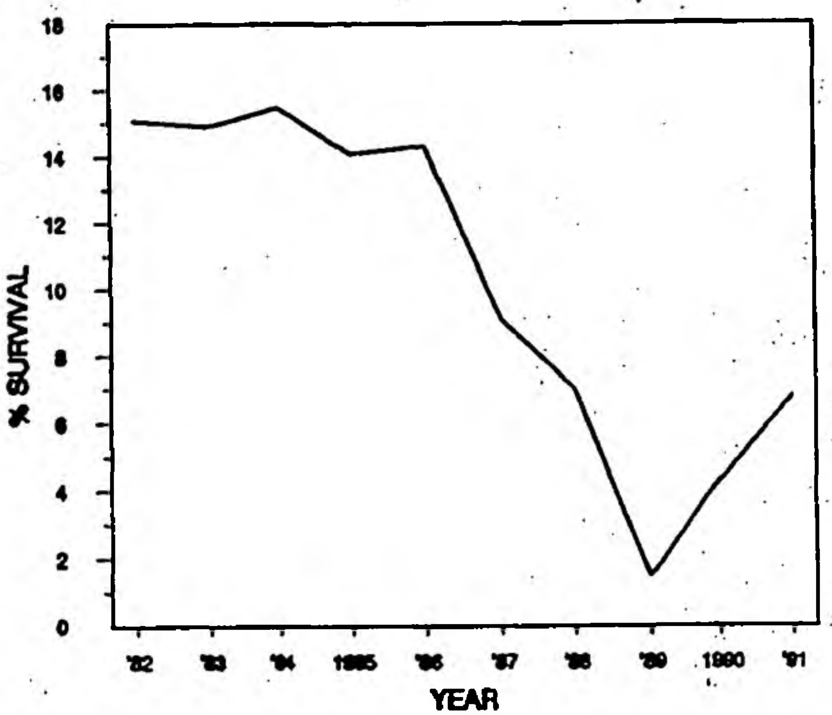


- 1990 AND 1991 TOTALS BASED ON "CATCH AND RELEASE" ESTIMATES, AND REDUCED FISHING EFFORT IN SOME FISHERIES.
- THE CONNEMARA DISTRICT IS ONE OF THREE DISTRICTS MAKING UP THE WESTERN FISHERY REGION. IT EXTENDS FROM SLYNE HEAD, SOUTH OF CLIFDEN, TO A POINT ON THE NORTH SHORE OF GALWAY BAY. THE GALWAY AND BALLINAKILL DISTRICTS COMPLETE THE REGION.

Figure C2

Figure 8. FINNOCK SURVIVAL

Survival from Total Juvenile Recruitment



PERCENTAGE SURVIVAL TO FINNOCK FROM SMOLT

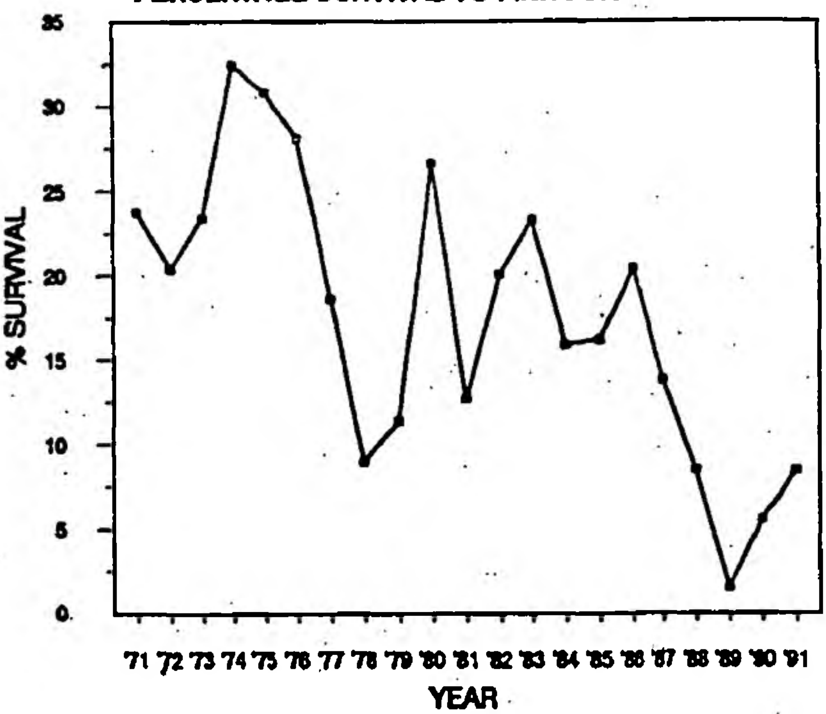
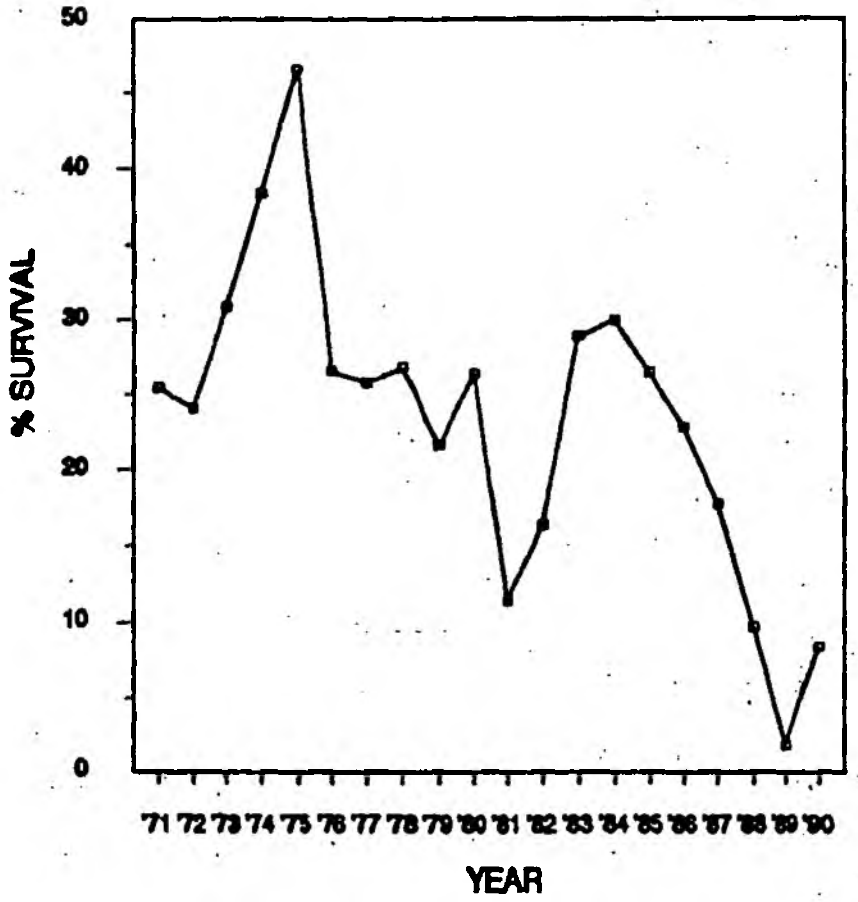


Figure C3

Figure 9. MARINE SURVIVAL

BURRISHOOLE SEA TROUT



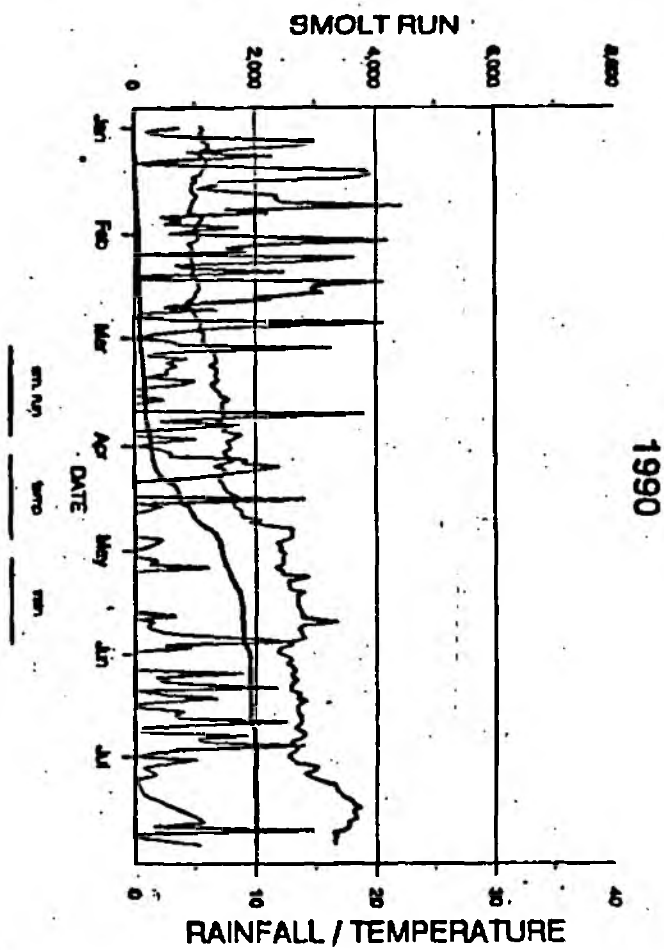

SMOLT RUN
0
2,000
4,000
6,000
8,000
Jan
Feb
Mar
Apr
May
Jun
Jul
DATE
sm.run
temp
rain
0
10
20
30
40
RAINFALL / TEMPERATURE
1990

Figure C4

Figure 10.

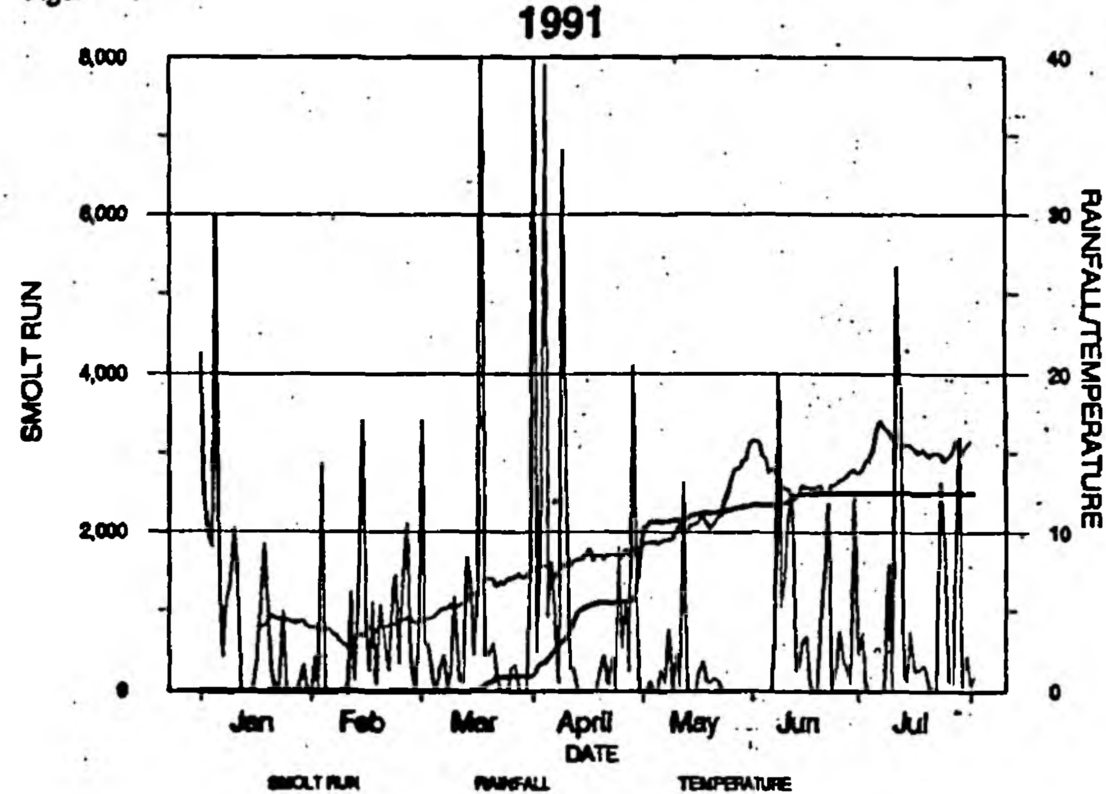
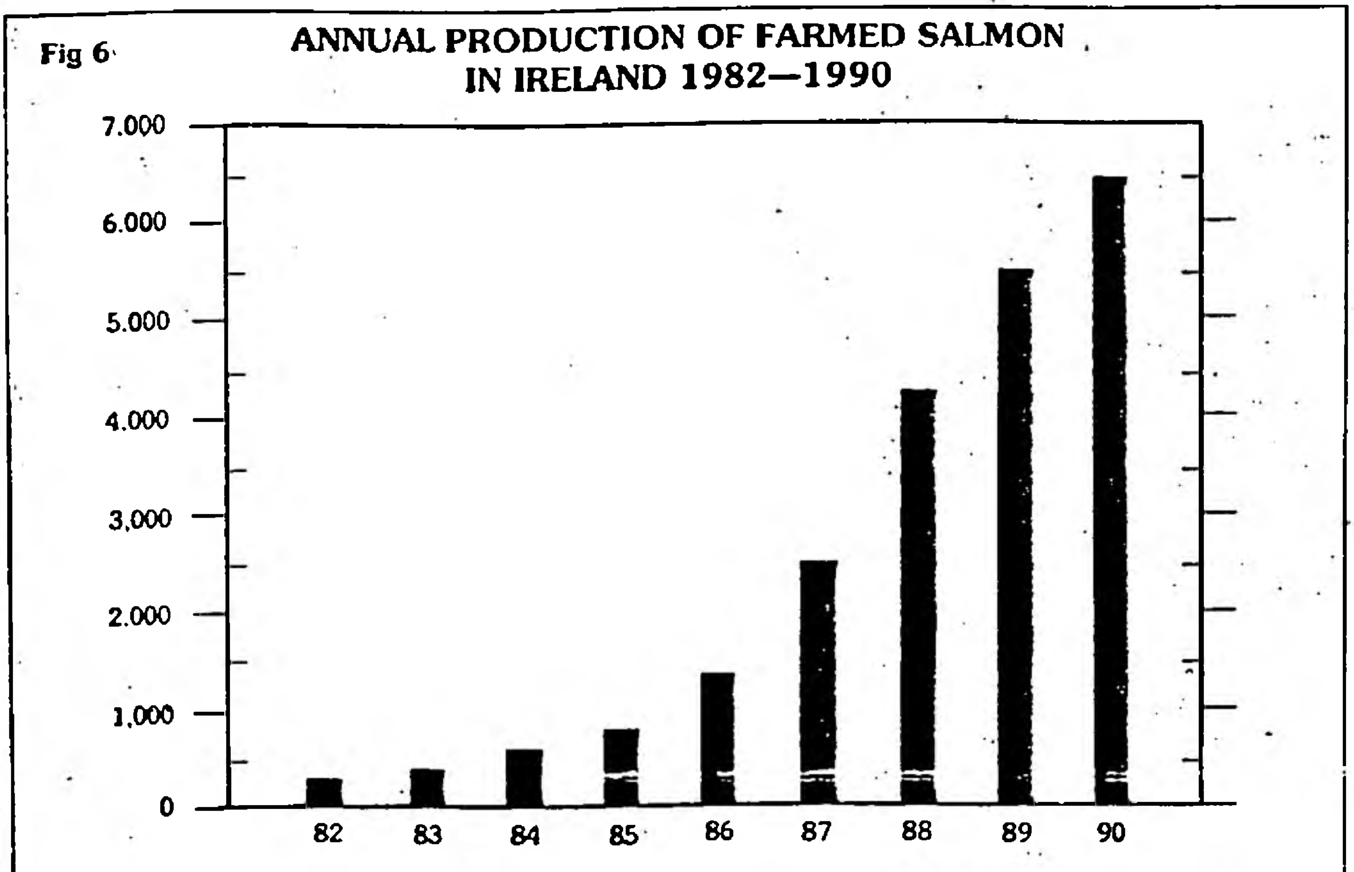


Figure C5



Source: Landhill Mills Associates (1990). Report for B.I.M., Dublin.

Table C1

WHITE TROUT - RED HERRINGS

The Theories

Feeding at the Sea Cages
Predators at the Sea Cages
Disease or Virus
Chemicals, ie Nuvan, TBT,
Collapse in Elver Numbers
Explosion in Sea Lice Numbers
Shoals of Herring with sea lice and eating all the food
Tapeworm epidemic, possibly due to cormorants
Sea or freshwater global warming
Food chain collapse
Overfishing by drift nets/Spanish trawlers
Seals
Forestry

Pink mackerel/pollack
Sea Lice on bathers in Connemara/flatfish

Table C2

ANNUAL PRODUCTION OF FARMED SALMON & CATCH OF WILD SALMON

('000 tonnes)

YEAR	FARMED SALMON ('000)	WILD SALMON CATCH ('000)
1980	4.8	10.1
1981	10.2	9.9
1982	12.8	8.7
1983	20.3	8.7
1984	27.6	6.9
1985	38.9	8.1
1986	61.8	9.3
1987	69.4	8.1
1988	112.3	7.7
1989	170.0	5.9
1990	242.8	4.6

Table C3

IRISH SALMON CATCHES BY METHOD OF CAPTURE

YEAR	DRIFT NET	DRAFT NET	ROD & LINE	OTHERS	CATCH IN TONNES
1960	19.8%	52.72%	14.75%	12.73%	710
1970	49.31%	35.92%	3.90%	10.87%	1,596
1980	71.73%	19.22%	4.47%	4.58%	896
1990	68.42%	28.12%	6.84%	1.58%	740

Table C4

IRISH SALMON CATCHES
(TONNES)

YEAR	WEIGHT
1950	856
1955	775
1960	710
1965	1,445
1970	1,596
1975	2,188
1980	895
1985	1,466
1990	740
1991	600

APPENDIX : D

CLIMATIC CHANGES & THE MARINE ENVIRONMENT

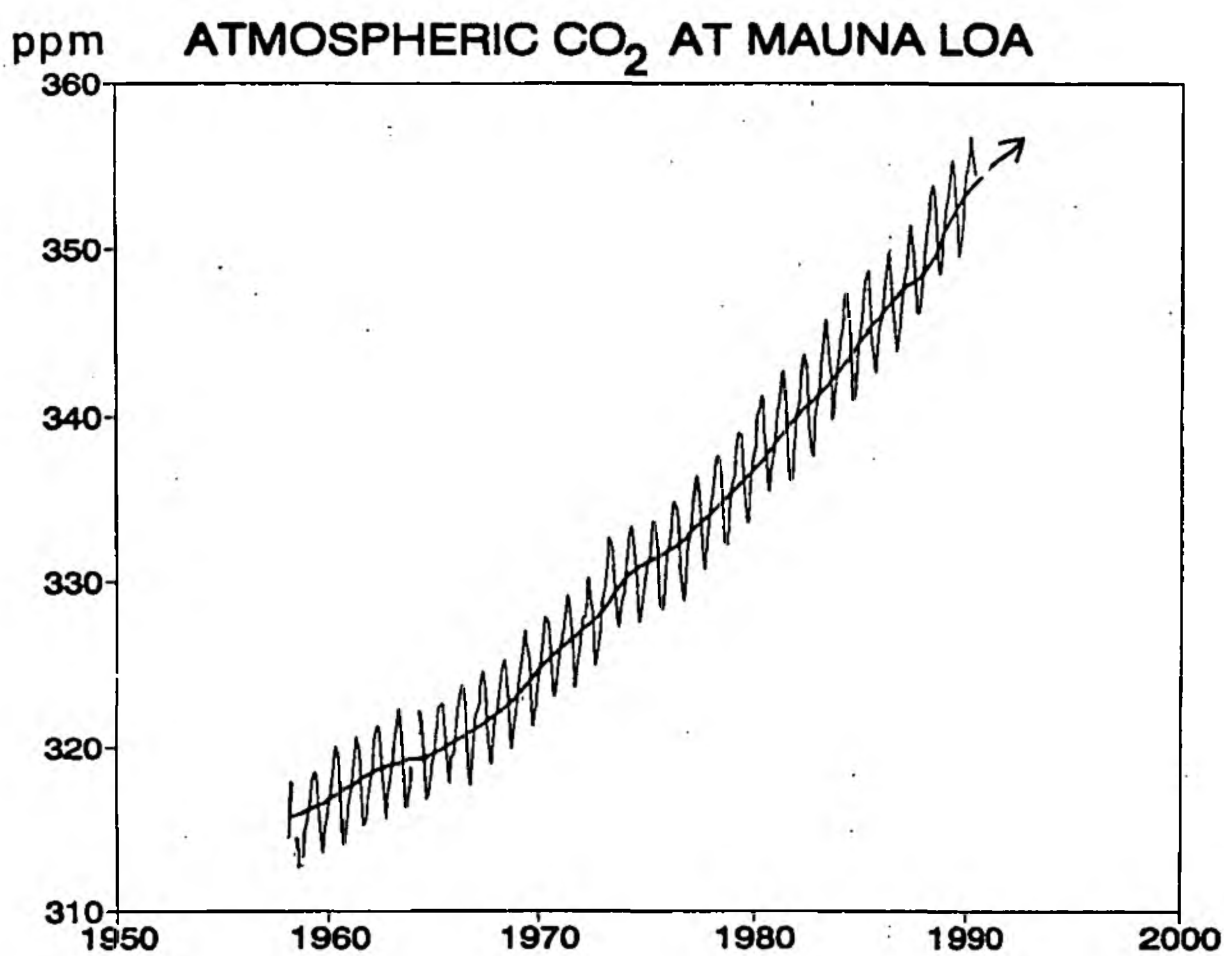
PROFESSOR SOUTHWARD

D1

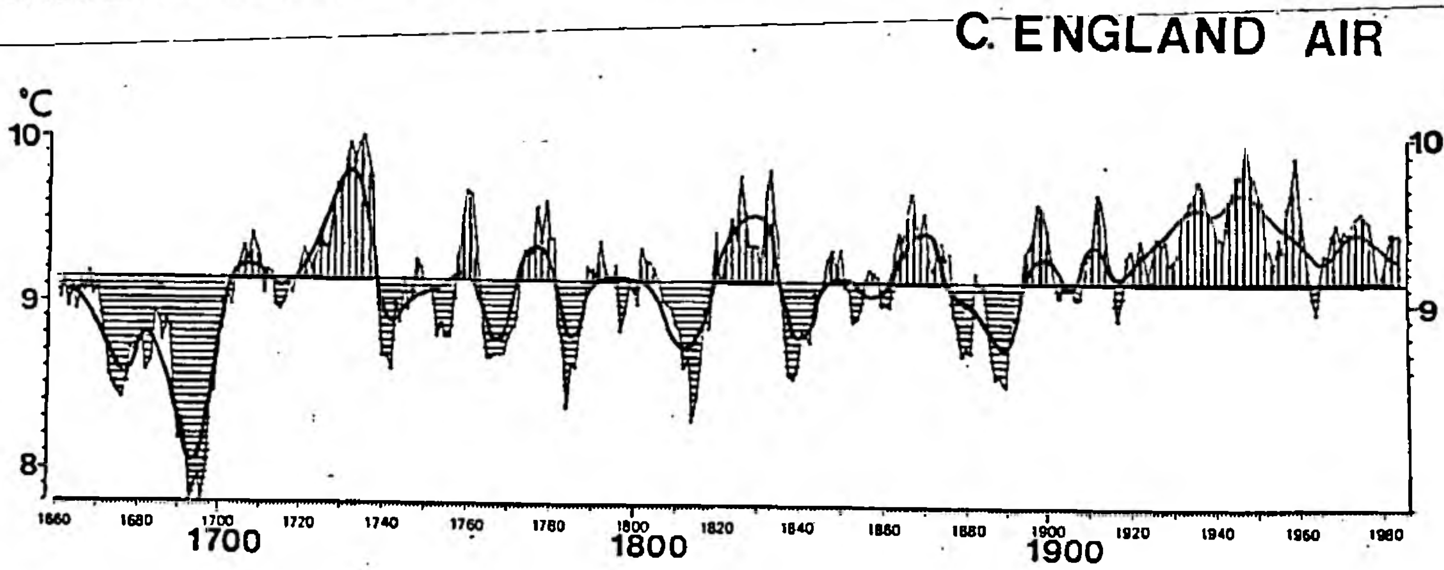
THE PLYMOUTH TIME SERIES

TEMPERATURE & SALINITY	FROM	1902
INORGANIC NUTRIENTS	FROM	1921
DISSOLVED ORGANICS	FROM	1964
NET PHYTOPLANKTON	FROM	1903
ZOOPLANKTON	FROM	1903
PLANKTONIC STAGES OF FISH	FROM	1924
FISH		1913, 1920's, 1950's, 1970's
INTERTIDAL BARNACLES	FROM	1950

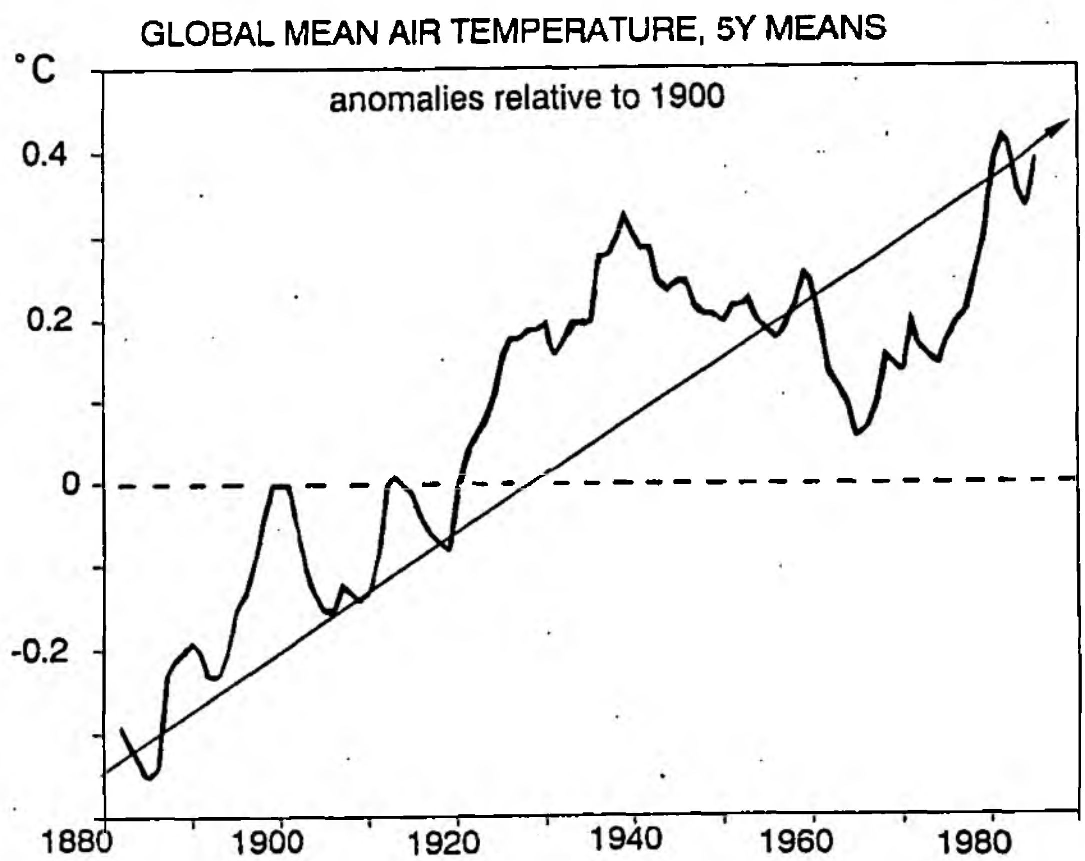
D2



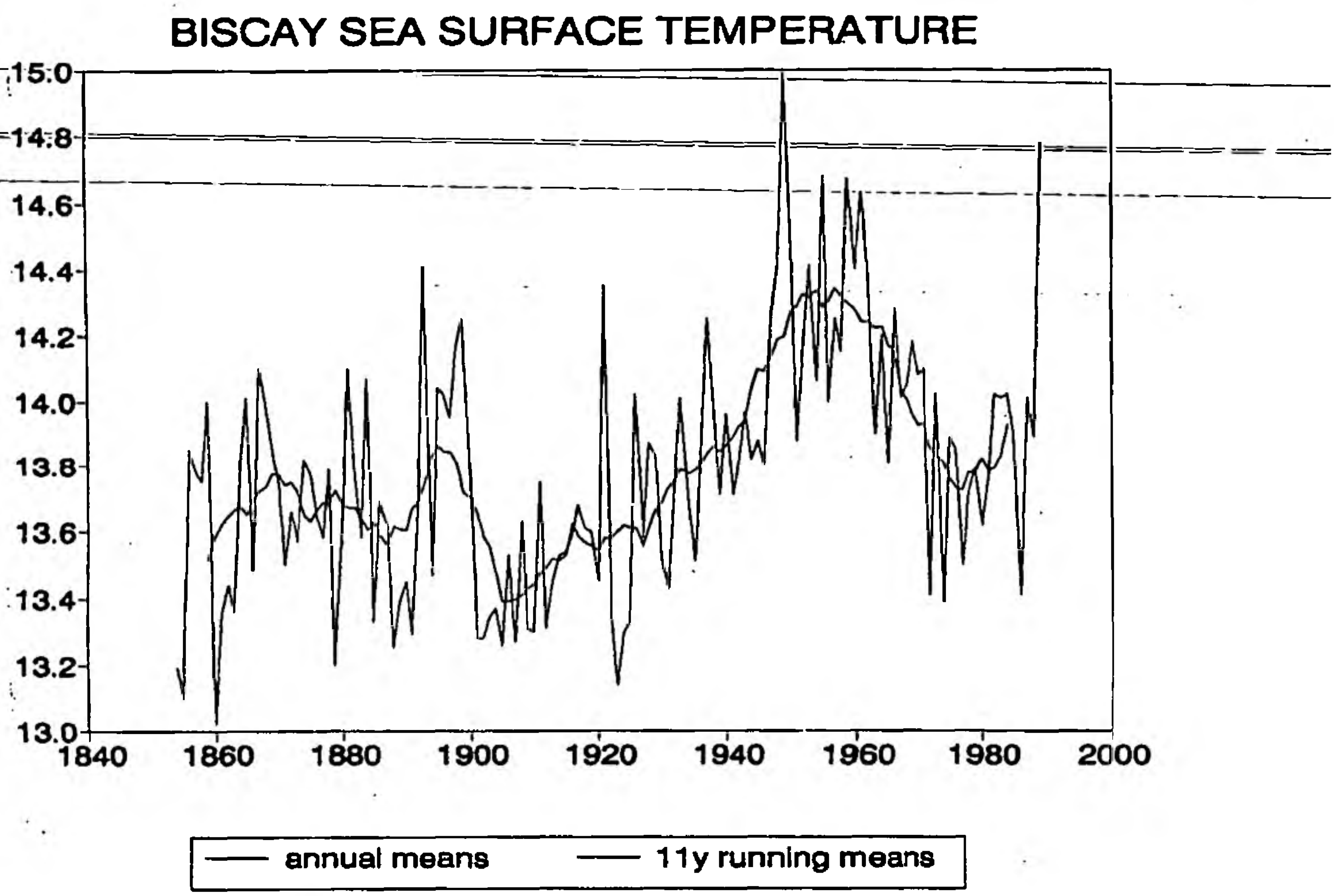
D3


C. ENGLAND AIR
°C
10
9
8
10
9
1700
1800
1900

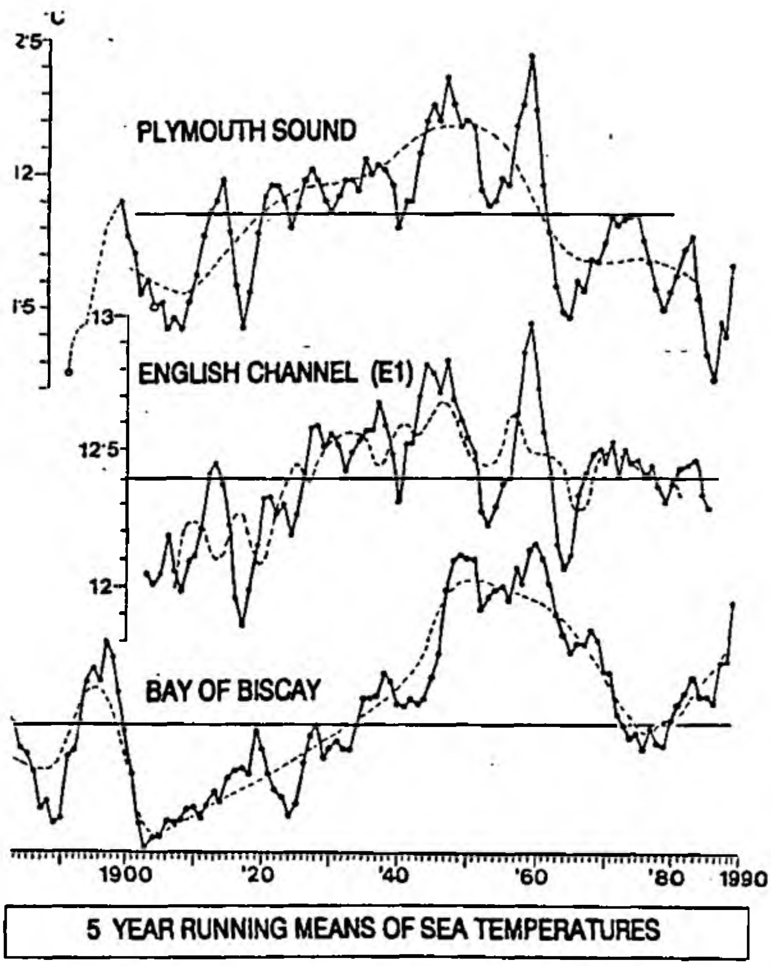
D4


GLOBAL MEAN AIR TEMPERATURE, 5Y MEANS
anomalies relative to 1900
°C
0.4
0.2
0
-0.2
1880
1900
1920
1940
1960
1980

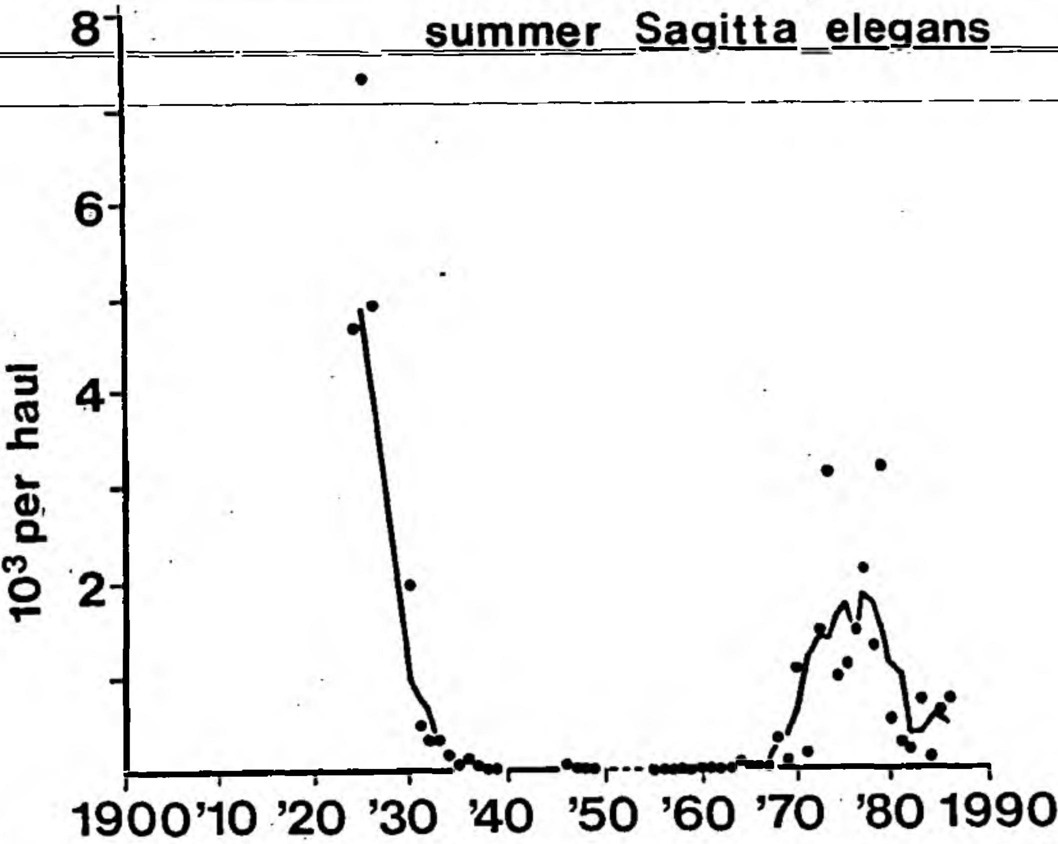
D5


BISCAY SEA SURFACE TEMPERATURE
15.0
14.8
14.6
14.4
14.2
14.0
13.8
13.6
13.4
13.2
13.0
1840
1860
1880
1900
1920
1940
1960
1980
2000
annual means
11y running means

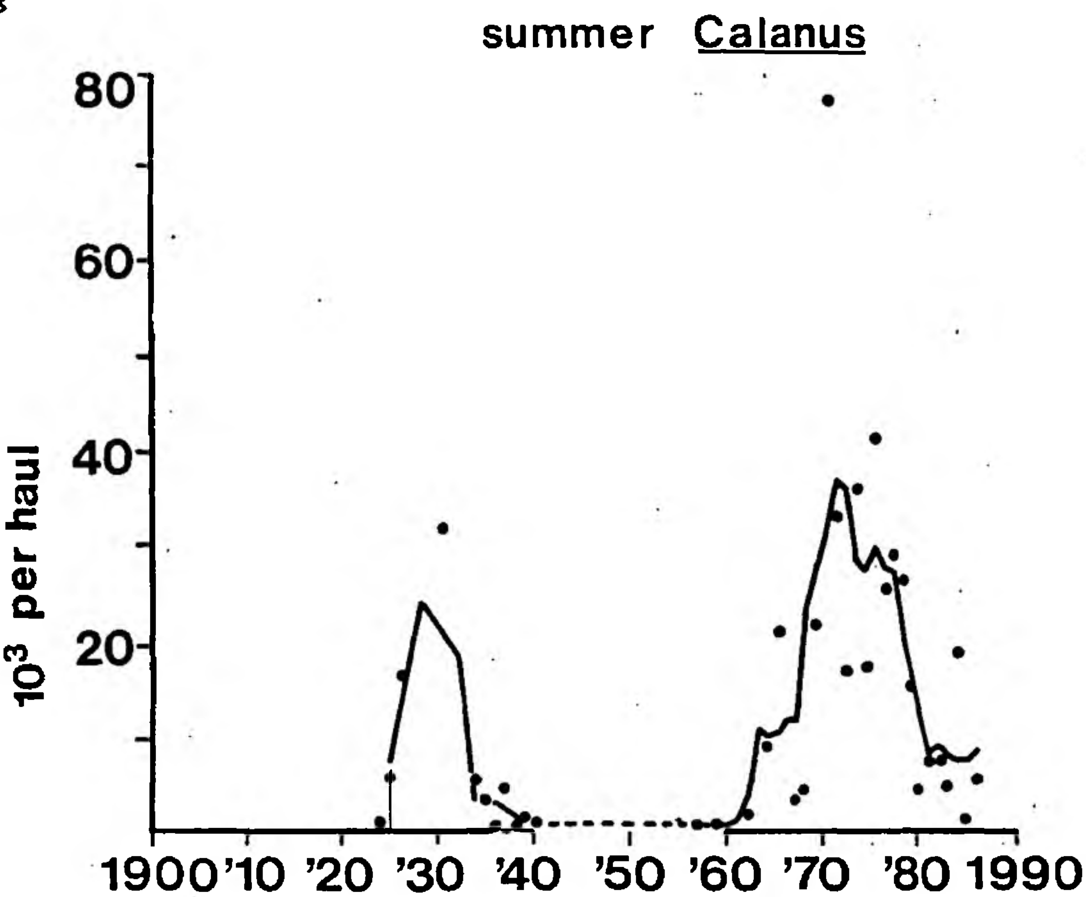
D6


PLYMOUTH SOUND
ENGLISH CHANNEL (E1)
BAY OF BISCAY
12
13
12·5
12
1900
'20
'40
'60
'80
1990
5 YEAR RUNNING MEANS OF SEA TEMPERATURES

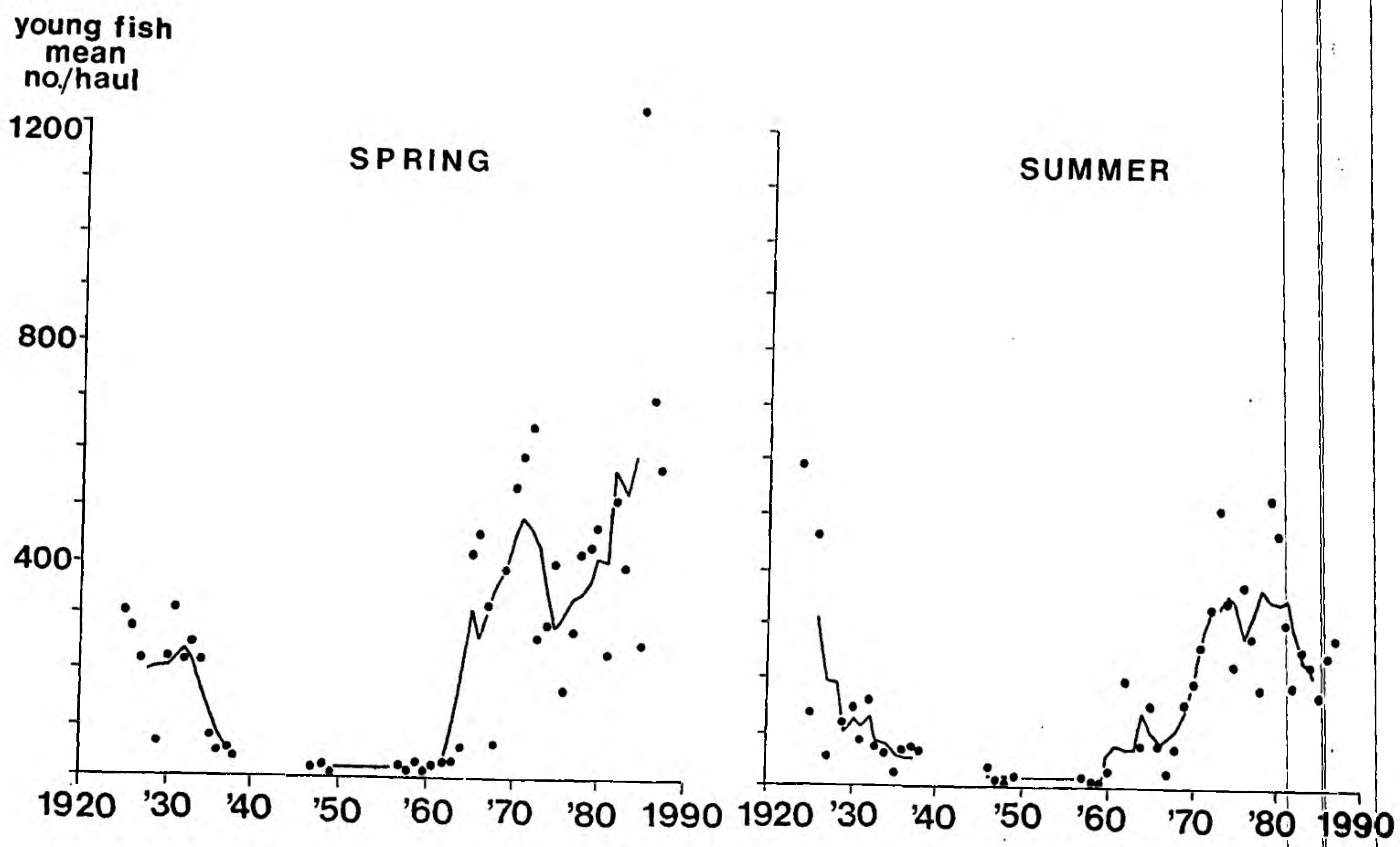
D7


summer Sagitta elegans
8
6
4
2
10^3 per haul
1900 '10 '20 '30 '40 '50 '60 '70 '80 1990

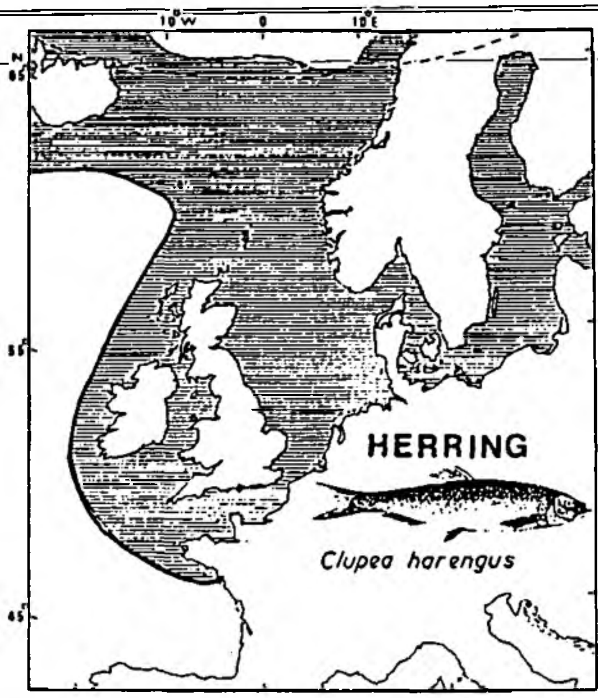
D8

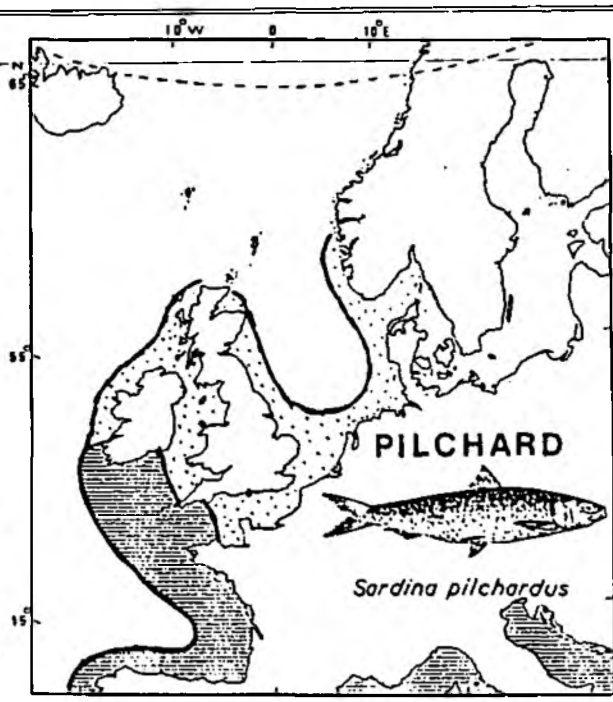

summer Calanus
80
60
40
20
10^3 per haul
1900 '10 '20 '30 '40 '50 '60 '70 '80 1990

D9

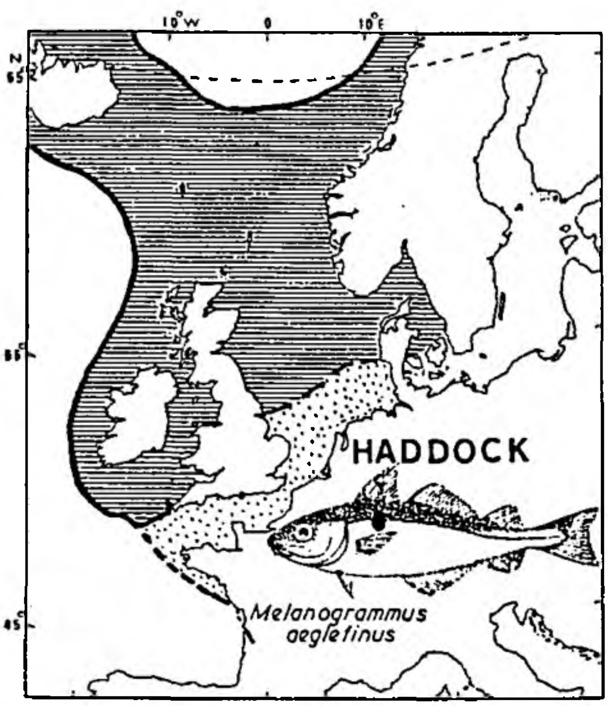

young fish
mean
no./haul
1200
800
400
SPRING
SUMMER
1920 '30 '40 '50 '60 '70 '80 1990
1920 '30 '40 '50 '60 '70 '80 1990

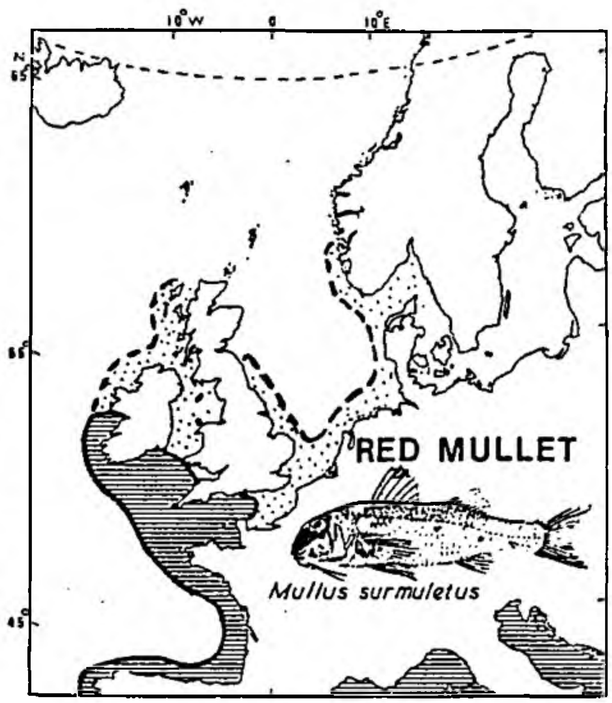
D10


HERRING
Clupea harengus


PILCHARD
Sardina pilchardus

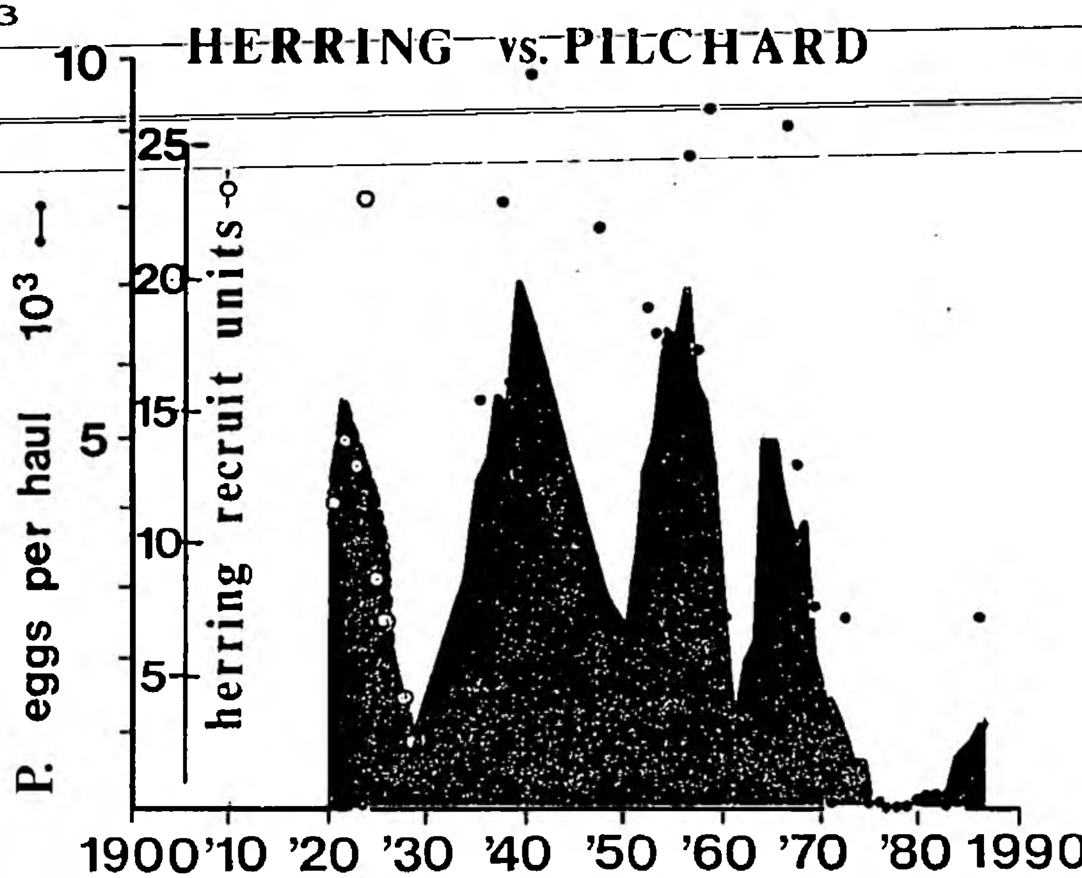
D11


HADDOCK
Melanogrammus aeglefinus

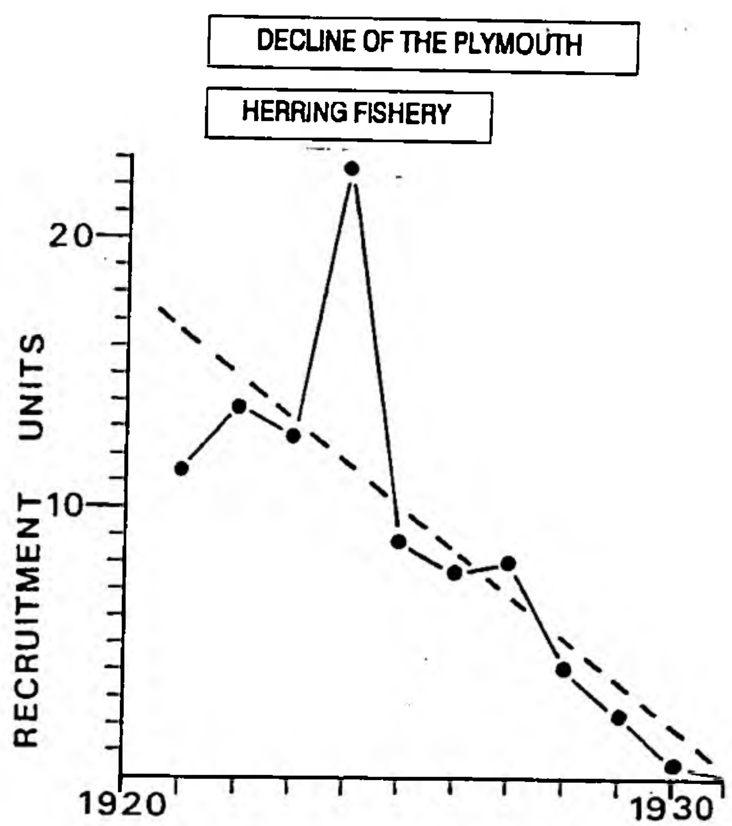

RED MULLET
Mullus surmuletus

TYPE OF CHANGE	SPECIES	number of fish per hour's fishing 1919-22	1950-52	1976-79
DECREASING SINCE 1920's OR 1930's; EFFECT OF FISHING	Scyliorhinus caniculus	21.37	12.73	14.49
	Squalus acanthias	23.47	0.03	0.01
	Raia species	8.66	6.73	4.24
	Trigloporus lastoviza	2.58	0.80	0.11
	Scophthalmus maximus	0.36	0.11	0.10
	Arnoglossus species	13.52	14.16	0.14
RECENT INCREASES	Trisopterus luscus	4.47	3.63	15.20
	Trisopterus minutus	53.54	55.15	80.14
INCREASING SINCE 1920's; CHANGE IN ECOSYSTEM OR GEAR IMPROVEMENTS	Trachurus trachurus	0.01	2.73	47.95
	Cepola rubescens	0.01	0.65	0.69
	Platichthys flesus	0.06	0.11	1.09
	Lophius piscatorius	0.86	1.71	2.01
LITTLE OR NO CHANGE	Aspitrigla cuculus	41.07	42.58	44.74
	Callionymus lyra	83.97	97.42	77.16
WARM WATER SPECIES THAT INCREASED AND THEN DECREASED IN PHASE WITH CLIMATE CHANGE	Scyliorhinus stellaris	0.15	0.28	0.15
	Conger conger	0.24	0.57	0.08
	Merluccius merluccius	0.15	8.99	1.50
	Mullus surmuletus	0.06	1.19	0.10
	Pagellus bogaraveo	NIL	0.79	0.03
	Scophthalmus rhombus	0.16	1.12	0.10
COLD WATER SPECIES THAT DECREASED AND THEN INCREASED IN PHASE WITH CLIMATE CHANGE	Merlangius merlangus	63.37	16.03	51.11
	Gadus morrhua	0.27	0.14	0.86
	Melanogrammus aeglefinus	0.03	NIL	0.01
	Molva molva	0.16	NIL	0.82
	Eutrigla gurnardus	46.62	0.84	1.46
	Limanda limanda	8.85	2.71	9.30
	Pleuronectes platessa	1.52	1.38	2.56
	Microstomus kitt	1.92	1.54	3.36
WARM WATER SPECIES OUT OF PHASE WITH CLIMATE	Zeus faber	7.28	2.20	8.14
	Solea solea	1.58	1.01	1.23
TOTAL PELAGIC FISH, INCLUDING HERRING, SPRAT PILCHARD, MACKEREL AND HORSE MACKEREL		2.14	3.39	94.84
TOTAL ALL FISH		394.10	280.78	394.07

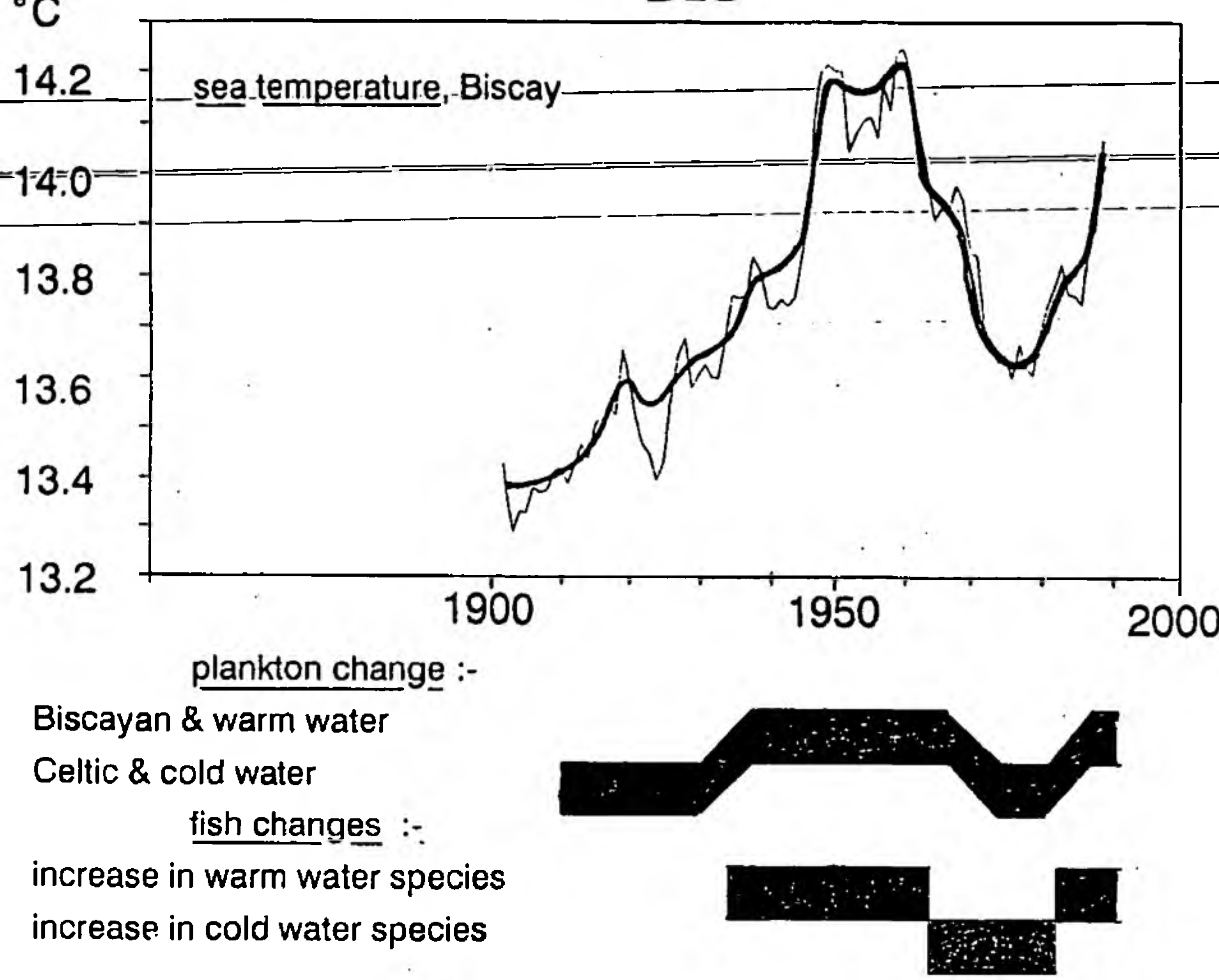
D13


HERRING vs. PILCHARD
10
5
P. eggs per haul 10^3
25
20
15
10
5
herring recruit units
1900 '10 '20 '30 '40 '50 '60 '70 '80 1990

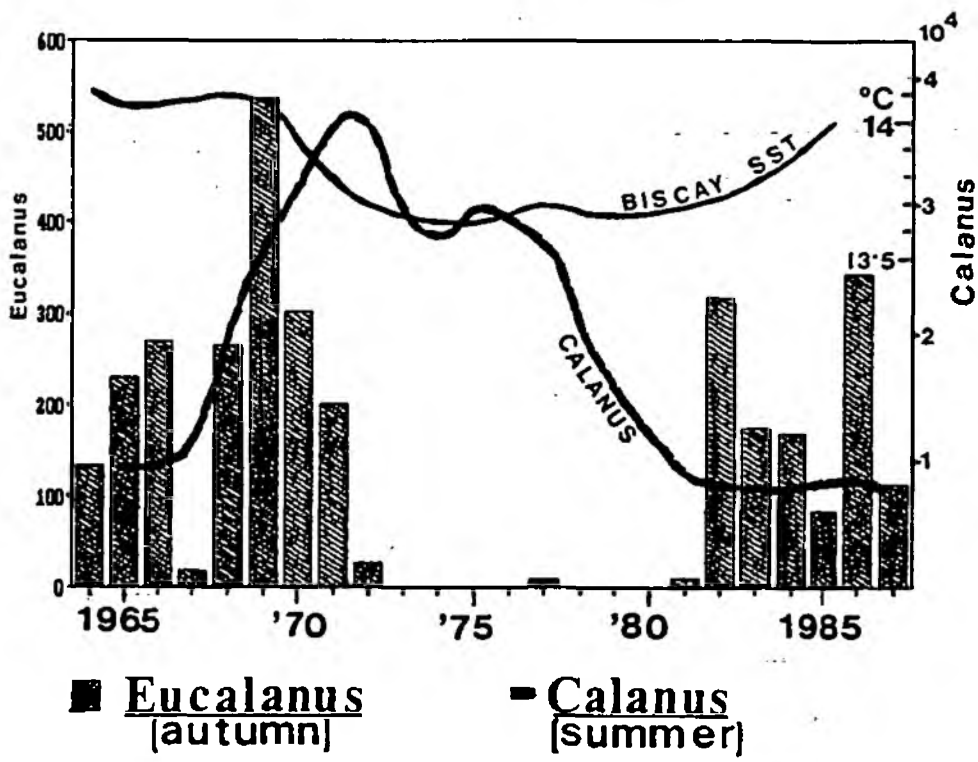
D14


DECLINE OF THE PLYMOUTH
HERRING FISHERY
20
10
RECRUITMENT UNITS
1920
1930

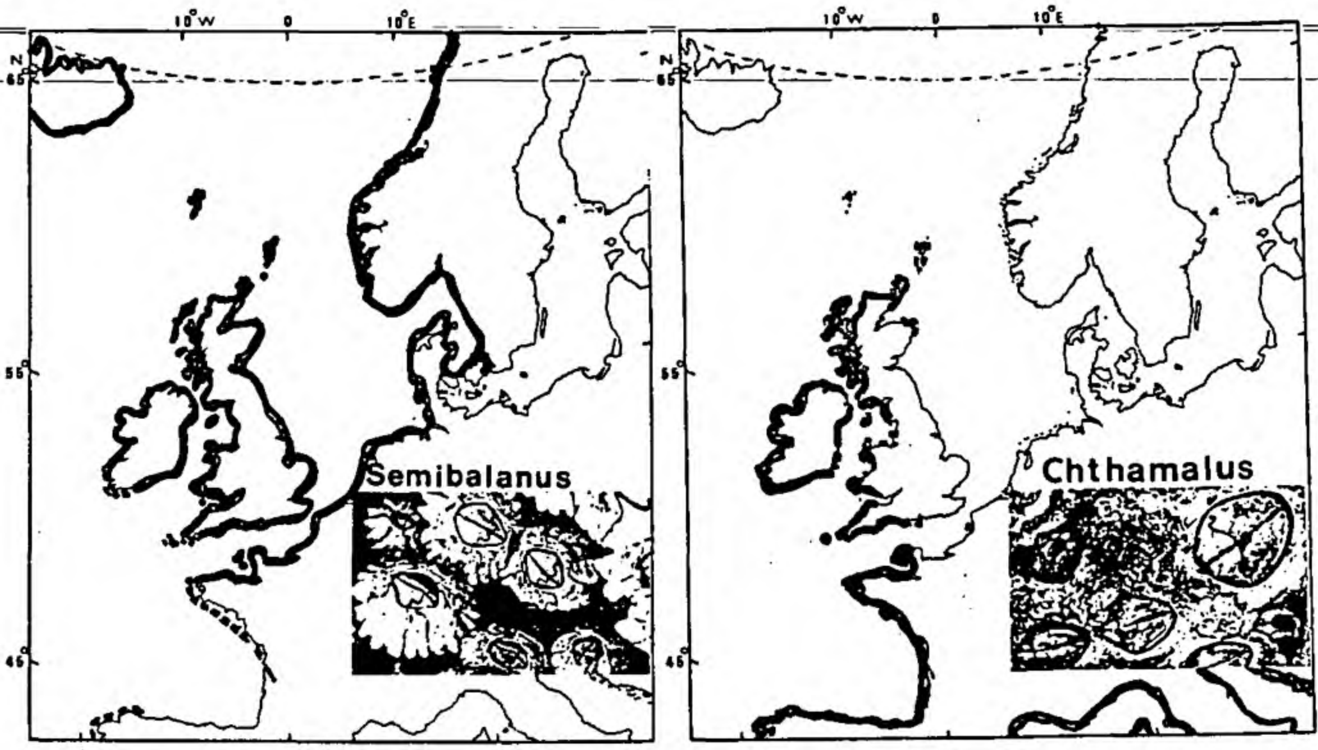
D15


°C
14.2
14.0
13.8
13.6
13.4
13.2
sea temperature, Biscay
1900
1950
2000
plankton change :-
Biscayan & warm water
Celtic & cold water
fish changes :-
increase in warm water species
increase in cold water species

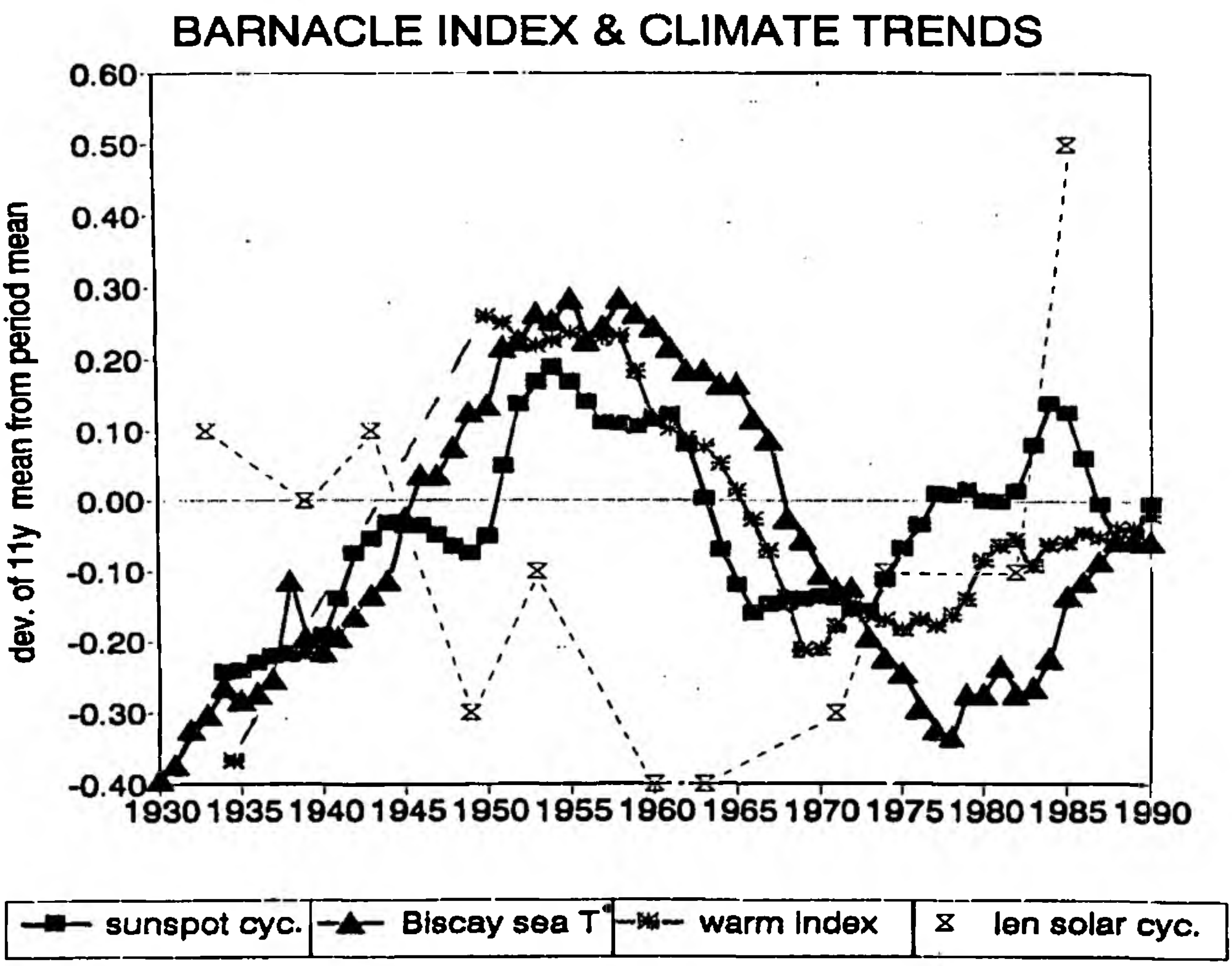
D16


600
500
400
300
200
100
0
Eucalanus
10^4
°C
14
13·5
4
3
2
1
Calanus
BISCAY SST
CALANUS
1965
'70
'75
'80
1985
Eucalanus
(autumn)
Calanus
(summer)

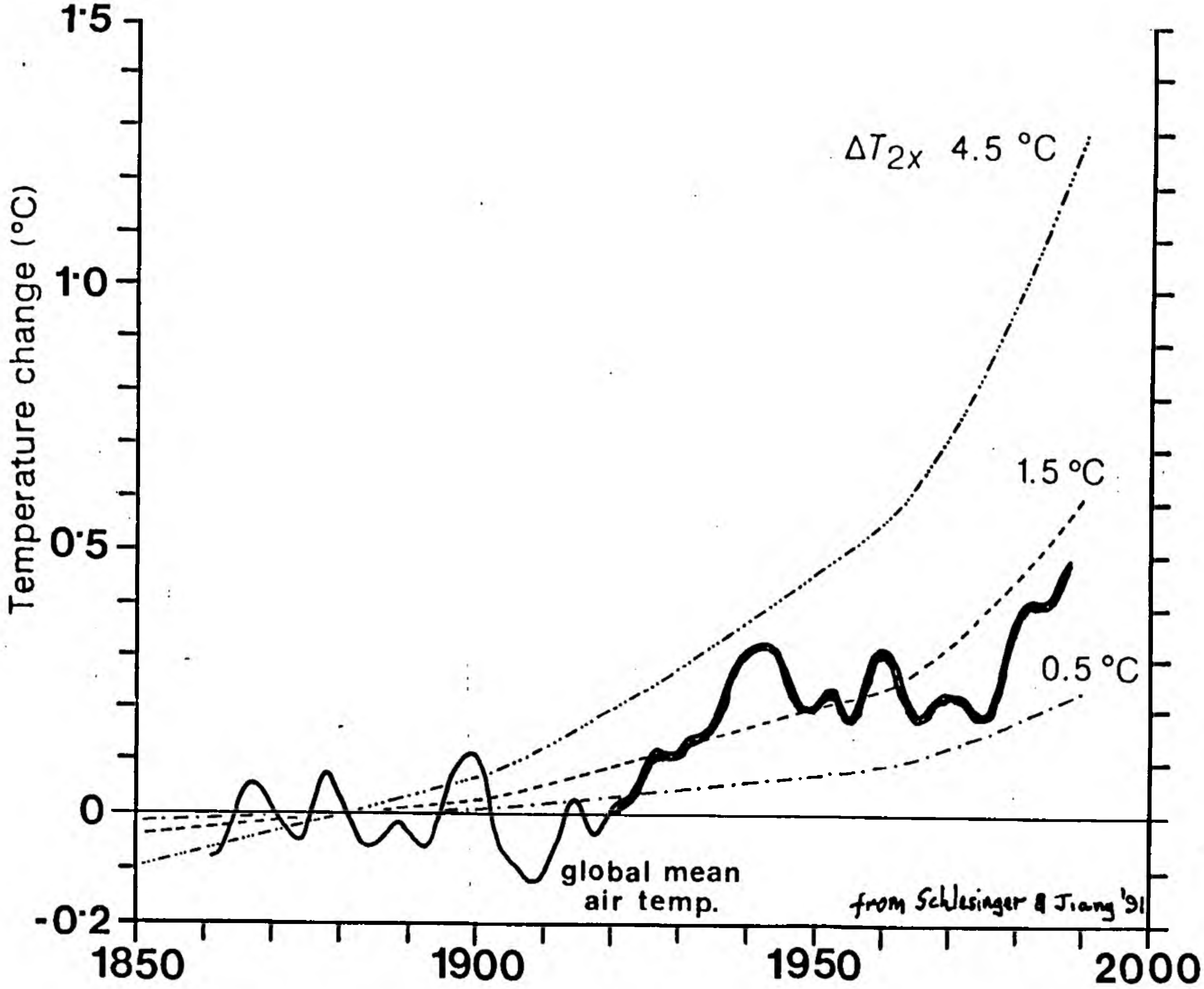
D17


10°W
0
10°E
N 65°
55°
45°
Semibalanus
Chthamalus

D18


BARNACLE INDEX & CLIMATE TRENDS
dev. of 11y mean from period mean
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990
sunspot cyc.
Biscay sea T°
warm index
len solar cyc.

D19



1·5
1·0
0·5
0
-0·2
Temperature change (°C)
ΔT_{2x} 4.5 °C
1.5 °C
0.5 °C
global mean
air temp.
from Schlesinger & Jiang '91
1850
1900
1950
2000