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THE FISH AND FISHERY OF STOCKS RESERVOIR, LANCASHIRE.

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by
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<u>VOLUME I</u>

The Text and Bibliography.

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Abstract

The Fish and Fishery of Stocks Reservoir, Lancashire.

This study of the fish and fishery of Stocks Reservoir, Lancashire, is the result of contract work undertaken by the researcher for North West Water (NWW). In an attempt to describe the location of the study, relevant information covering the catchment, local geology, reservoir construction and flora and fauna is included.

The Authority's remit suggested a study of three facets of the catchment, namely, a study of the native fish populations, a monitoring of the recently opened fishery and an analysis of operational filter plate impingement.

Tributary stream fish population survey

In order to minimise disturbance of the sport fishery, native fish population work was necessarily limited to the reservoir's three major afferent streams, the River Hodder, Hasgill Beck and Bottoms Beck.

As a preliminary measure of tributary stream status, a simple invertebrate site study was undertaken by the researcher in 1985.

Fish population work based on catch per unit effort (CPUE) was pursued in the spring, summer and winter of 1985, 1986 and 1987 at 8 sites, employing D.C. electric fishing equipment, whilst Carle and Strub's (1978) MWL Method was adopted for population estimations . The validity of the electric fishing survey and age determination are discussed in

the text.

The native species of brown trout, bullhead, stone loach and minnow were encountered, as was the introduced rainbow trout. Species densities and the population structure of the native brown trout were examined in detail for each survey site. The River Hodder was revealed to be the least populous tributary, whilst Hasgill Beck exhibited the greatest fish densities. Spawning migrations of native brown trout were evident, with fry recruitment at its optimum at site 4 on Hasgill Beck and site 8 on Bottoms Beck. The waterfall on Bottoms Beck might well have precluded upstream access to the head waters of this tributary. Observed mean brown trout length for age data were similar to those recorded by authors researching other upland stream locations.

The Fishery

The history of Stocks Reservoir as a sport fishery is outlined prior to the present leaseholder's opening of the reservoir as a day ticket fly fishery for the 1985 season. The water was stocked predominantly with rainbow trout, together with some brook trout and brown trout before fishing commenced.

The present study covering the seasons 1985 to 1987 was based primarily on data abstracted from catch return forms, which displayed a notably high rate of submission, and stocking consent data provided by NWW. The validity of return form data is discussed.

Over the three seasons studied, angler patronage was observed to decline by 16%, whilst the number of fish caught and taken also declined by 34.8% and 20.5% respectively. Angler success was similarly observed to decline in accord with the decrease in patronage and catches. Interestingly, there was an increased reliance on introductions of rainbow trout over the period, including larger fish, and by 1987 a cessation in the stocking of other trout species.

From correlations observed between environmental parameters and angler patronage, anglers appeared to prefer fishing in dry, sunny conditions, but decreases in angler success occurred during periods of increased water turbidity. Such declines in success also displayed congruity with decreases in angler patronage.

From a comparison undertaken with a cross-section of English and Welsh stillwater trout fisheries, Stocks Reservoir was judged to rate poorly, returning the lowest performance data in the upland stocked category.

An examination of the stomach and hind gut contents of 127 rainbow trout, 7 brook trout and 8 brown trout caught by anglers, was undertaken in the 1985 and 1986 seasons, and was compared with the reservoir fauna data of Mills, M.L. (1971).

<u>Operational filter plate impingement</u>

A description of the water treatment plant and its operation is delineated, and a pertinent collection of fish impingement and screening literature is included.

Impingement data were collated from 1st March 1985 to 31st December 1987 from routine and emergency cleaning of the filter plates. After storage in a freezer, the thawed fish were examined chronologically, identified, measured and weighed. During the examinations a random sample of stomach and hind guts was procured, and scales from brown trout were removed for possible future reference.

The total annual impingement was observed to vary considerably, although brown trout habitually exhibited the greatest losses, comprising 71%, 64% and 89% of fish impinged annually. Of the introduced species, rainbow trout and brook trout, brook trout were the more susceptible to impingement, but remarkably few rainbow trout were lost considering the number stocked.

Rainbow trout and brook trout of medium (150mm to 300mm) and large ($>$300mm) length classes were impinged, whereas many smaller ($<$ 150mm) brown trout were lost, a phenomenon concurrent with the recruitment of juvenile stream fish to the reservoir population.

Brown trout in particular exhibited an annual dissimilarity in rates of impingement, probably suggesting that seasonal migration was not causative of their increased impingement.

Impingement of rainbow trout showed limited correlation with environmental parameters. In 1985 and 1986, increased impingement of both brown trout and brook trout was significantly correlated with low reservoir levels, and to some extent might be linked to rising values of water turbidity.

The collecting of stomach and hind gut samples from impinged fish was discontinued after 1985 because of problems in collection associated with delays in sampling and probable regurgitation of stomach contents. The problem of eye fluke infestation in impinged fish was noted and enumerated as sampling progressed.

A brief discussion of further routes of operational fish loss from the reservoir is included.

Chapter I Stocks Reservoir

Description of the reservoir and catchment

Located at an altitude of 180 metres above mean sea level, in the upper reaches of the Hodder Valley, the reservoir is situated approximately 14 kilometres due north of the Lancashire market town of Clitheroe (Figure 1). At maximum capacity, it covers an expanse of 139 hectares with a shoreline of 10 kilometres and a maximum depth of 30.18 metres at the foot of the valve tower. A small island is situated at the northern end of the reservoir, in an area of shallow water which often dries out in the summer months (Figure 3).

Excluding the reservoir itself, the catchment extends to 3667 hectares and rises to an altitude of 543 metres. This upland region has an approximate annual rainfall of 1500 millimetres and a consequent mean daily run-off of around 112 megalitres. Three major tributary streams drain the catchment, namely the River Hodder, Hasgill Beck and Bottoms Beck. Together these streams constitute almost three quarters of the run-off. Peat-moss moorland, rough pasture and coniferous forestry plantations predominate on the nutrient-poor gritstone and shales of the locality, which accounts for the truly oligotrophic status, neutral pH, and high hazen values associated with Stocks. Two thirds of the catchment is worked by four farms named Catlow, Lamb Hill, Lower Halsteads and Higher Clough. Sheep farming predominates on the fells whilst cattle are more numerous on the lower slopes; cultivation of arable crops is negligible. The final third of the catchment, concentrated to the north-east of the reservoir, is planted with Sitka spruce (*Picea sitchensis*) and managed by the Forestry Commission. These plantations, known collectively as the Gisburn Forest, encroach on the edge of the reservoir east of the River Hodder and Hasgill Beck. It should be borne in mind that the acidic nature of such plantations, and possible silt deposition in the catchment's streams resulting from tree felling and clearing may locally prove deleterious to water quality. However, as part of the Commission's replanting policy, more broadleafed species are being planted in the cleared areas which might ameliorate this problem.

The geology of the region

To the west of the Pennines lies a region of broad folds trending towards the south-west, which gives rise to a tract of elevated land split from east to west by Ribblesdale. The high area north of the Ribble, known collectively as the Lancaster Fells or the Forest of Bowland, is a moorland area consisting of peat-moss and gritstone type topography. By contrast, Ribblesdale presents shale and limestone topography diversified by reef-knolls. South of the Ribble a further high area of typical coalfield ground giving place to gritstone topography constitutes the Rossendale Hills. A coastal plain of rich arable land flanks the region to the west, the northerly region of which is known as the Lancashire Fylde, whilst the broad sweep of the Cheshire Plain is to the south. (Figure 2).

Stocks Reservoir is situated to the north of Ribblesdale in the upper reaches of the Hodder Valley, in the area referred to as the Forest of Bowland. Lithologically, this locality consists of well-bedded, laminated, black shales interbedded with thin marine bands. The latter consist of agrillaceous limestone or bullions of an iron-calcium carbonate rock interbedded with limy shales. Known as the Bowland Shales they are lithologically idivisible; however an arbitrary subdivision of approximately 120 metres known as the Upper Bowland Shales is defined as lying between two such marine bands. A persistent band of argillaceous limestone marks the limit of the Upper Bowland Shales, whilst sandy shales and shaly sandstones overlie the limestone, which in turn are overlayered by massive sandstone often referred to as gritstone or millstone grit (Edwards and Trotter, 1954). The agrillaceous limestone which divides the Bowland Shales from the sandstone is known as a passage or transition series, as it separates two distinct sedimentary rocks formed in contrasting environments (Whitton and Brooks, 1982).

The millstone grit and interbedded shales of this upland region are relatively imnpervious, and the thick mantle of peat moss moorland effectively retains much of the precipitation. The result is an ideal location for water collection, initially utilised in the development of the Lancashire cotton industry, and more recently for the construction of a number of water supply reservoirs.

The construction of the reservoir

The construction of a dam impounding the headwaters of the River Hodder was proposed in the Fylde Water Board Act of 1912. The ensuing reservoir was to be named Stocks Reservoir, after the village of Stocks in Bowland which would be flooded as a consequence of the work.

Concurrent with the building of Stocks Reservoir, two smaller service reservoirs were to be constructed in the Fylde region, at Warbreck and Westby respectively. The planning of such a system of reservoirs was necessary because of the rapid expansion of Blackpool, Lythan St. Annes, Thornton-Cleveleys and Fleetwood, which resulted in a greatly increased demand for water.

However, due to the First World War of 1914-1918 the Fylde Water Board Act of 1912 was not implemented until 1923, when the excavation of Stocks' main embankment trench was finally undertaken. During construction the height of the main embankment was raised, thereby increasing the potential capacity of the reservoir; such a modification to the initial design had the advantage of eliminating the necessity to build the two further reservoirs, provided for in the Act.

In the course of building, the road through the village of Stocks in Bowland was re-routed to run along the eastern shore of the reservoir. The village of Stocks in Bowland was razed; some re-dressed stone from the site was incorporated in the construction of the Board House situated at the western end of the dam. Upon completion, Stocks was flooded in the spring of 1933, following an inauguration ceremony on July 5th 1932, attended by H.R.H. The Prince George K.G. Although initially built for the Fylde Water Board, Stocks Reservoir and catchment has been managed by the North West Water Authority (NWWA) since the Water Authorities Act of 1974. For reasons of safety the embankment overspill was lowered in 1972, thus reducing the top water level by 1.2 metres.

Reservoir catchment, flora and fauna

The overall oligotrophic nature of the reservoir and catchment attributable to the nutrient-poor millstone grit and shales of the area, is to some degree moderated by the outcropping of thin shaly beds of limestone. Additionally, despite Water Authority control, farm effluent and land improvement may have contributed to further marginal enrichment of the reservoir. Certainly this is suggested by the presence of some algal genera in the reservoir and in the catchment's streams.

Lund (1959) whilst working for the Fylde Water Board, undertook a reservoir survey which concentrated on growth responses of the diatom Asterionella to nutrient addition. The conclusions drawn suggest that although reservoir enrichment is undesirable, there is no case for a total ban on the application of fertilisers to land within the catchment. Further work by Dussart (1980), describes the algal community in greater detail. He concludes that although genera habitually found in oligotrophic waters are present (i.e. Acnanthes, Asterionella, Hydrurus and Tabellaria) so too are diatoms associated with enriched conditions, notably Gomphonema, Navicula, Nitzschia and Synedra.

The dominant zooplankton of the reservoir comprises the genera Daphnia, Bosmina and Cyclops, comparable with oligotrophic waters in the English Lake District such as Hawester and Wastwater; whilst the benthos is dominated by the family Chironomidae, the subclasses Oligochaeta and Hirudinea, and the genera *Pisidium* and *Lymnaea*.

Native fish species present in the catchment include brown trout (*Salmo trutta* L.), minnow (*Phoxinus phoxinus* (L.)), stone loach (*Noemacheilus barbatulus* (L.)) and the bullhead (*Cottus gobio* L.). Prior to impoundment, the upper reaches of the Hodder were annually populated with spawning Atlantic salmon (*Salmo salar* L.) and sea trout (*Salmo trutta* L.). Such was the quality of this salmonid migration, that when Stocks Reservoir was initially proposed in the Fylde Water board Act of 1912, provision was made for the development of a fish farm at Dunsop Bridge, situated 7 kilometres downstream of Slaidburn village as compensation for the lost spawning grounds (Nott, 1984). The construction of the dam embankment similarly affected the natural eel (*Anguilla anguilla* (L.)) population. Downstream of Stocks in the vicinity of the Hodder, eels are very common. However, within the reservoir catchment they have become scarce. In addition to the reservoir's native fish species two further species have been introduced in the interests of angling, namely rainbow trout (*Salmo gairdneri* Rich.) and American brook trout (*Salvelinus fontinalis* (Mitch.)). There is at present no indication that these introduced species have successfully reproduced in the catchment.

The 'intertidal' zone, caused by reservoir drawdown, is a notable British site for numerous rare Bryophytes. Species of this phylum have colonised areas of the shoreline where repeated drying and reflooding is common (NWWA internal communication).

Stocks Reservoir and catchment attracts numerous bird species. The upland catchment of heather moorland is particularly suited to the Red Grouse (Lagopus lagopus scoticus L.), whilst many species including the Crossbill (Loxia curvirostra L.) are attracted to the coniferous and broadleafed woodlands (NWWA internal communication). The reservoir itself is home to a large breeding colony of Black-headed Gulls (Larus ridibundus L.), which frequent the island; a resident population of Canada Geese (Branta canadensis L.) and numerous species of duck. Passage waders inhabit the reservoir margins in the spring and autumn months, and migratory wildfowl are common visitors in the winter. As a direct consequence of these populations, the northern shore of the reservoir is now a designated conservation area with access to anglers prohibited.

Chapter II Tributary stream fish population survey

Introduction

The aim of the survey was to gain a fuller understanding of the catchment's native fish populations, known to include bullhead (Cottus gobio), stone loach (Neomachilus barbatulus), minnow (Phoxinus phoxinus) and brown trout (Salmo trutta). Emphasis was placed on the brown trout population as a result of its importance as the catchment's only native angler quarry species.

Many papers cover work related to these species, although none concerns Stocks Reservoir and catchment. Ideally, a survey covering all aspects of the native fish populations would have included both the reservoir and tributary streams. After consultation with both North West Water (NWW) and the Fishery leaseholder, however, it became apparent that population work within the reservoir would have run into technical difficulty and possible conflict. A mark-recapture exercise was initially proposed, although due to the large water area and irregular shape and depth of the reservoir, technical difficulties were anticipated; such problems are well documented (Cormack, 1968; Cross, 1972a). The major concern involved interference with the fishery's large stock of rainbow trout (Salmo gairdneri), brook trout (Salvelinus fontinalis) and brown trout, which would inevitably result as a consequence of repeated sampling. The use of anglers' catch as a sampling technique was ruled out due to the nature of the fishery, and the anglers' selective pursuit of the larger stock fish by their choice of technique (Cowx et al., 1986). The smaller, native brown trout proved less susceptible to such methods and played only a minor role in the sport fishery. Cooper and Wheatley (1981), suggest that selective fishing by anglers for larger, more desirable fish, may often invalidate 'Creel census' data.

For these reasons, native fish population work concentrated on the catchment's three major tributaries. These included the River Hodder, Hasgill Beck and Bottoms Beck, which between them drain almost three quarters of the catchment. By virtue of these streams holding resident fish populations, and providing spawning sites for the native reservoir brown trout, it was felt that an adequate evaluation of the wild fish population status could be made. Survey work was undertaken in the spring, summer and winter of each year from 1985 to 1987, such that site population stability and structure could be assessed over time. Portable, electric fishing equipment, supplied by NWW, was considered the most appropriate sampling technique. Eight survey sites of easy year-round access were selected, each representative of a particular length of stream. The two longer tributaries, namely the River Hodder and Bottoms Beck, were sampled at three locations respectively, whilst the final two sites were on Hasgill Beck, the shortest tributary. Ideally, a greater number of sites would have been preferable, but this was precluded by the constraints of Authority manpower and equipment.

In addition to electric fishing, detailed site measurements were taken in order to assess stream area, and enable accurate site sketches to be drawn. Simple invertebrate surveys were also undertaken in the autumn of 1985, as a further measure of stream status.

Methodology

Electric fishing

The history of electric fishing spans a period in excess of 50 years, although its use only became widespread in the 1960's (Boccardy and Cooper, 1963). Two distinct forms of equipment have developed over this period utilising Alternating Current (A.C.) or Direct Current (D.C.).

Alternating current as its name implies, alternates the direction of electrical flow between the electrodes, at a usual rate of 50 times a second. A fish subject to the required level of electrical field will suffer immobilisation or electronarcosis, whilst a fish in contact with a weaker field will swim away (Vibert et al., 1960; Bain et al., 1985).

Direct current flows from a positive electrode known as the anode, to a negative electrode or cathode. A fish subject to the resulting electric field is drawn involuntarily towards the positive anode. Most D.C. equipment does not pass a smooth current, but what is often referred to as 'pulsed D.C.' or more correctly uni-directional quarter sinewave pulses (Moore, 1968; Williams, 1984). The frequency of these pulses may be controlled by adjustment of the equipment; Burnet (1959) states that the most efficient pulse rate for trout is between 50 and 100 hertz. A control box must be used to convert the generators' A.C. current into the pulsed D.C. form, and extreme caution must be exercised at all times when in use (Lippett, 1978).

Guidelines for safety in electric fishing operations have been produced by the National Joint Health and Safety Committee for the Water Service (NJHSCWS), and all equipment should conform to British Standards (BS 5240) regarding electrical protection in the presence of water (Williams, 1984; Hickley, 1985).

Weiss (1975) and Layher and Maughan (1984) both indicate a preference for pulsed D.C. as opposed to A.C. equipment particularly in stream locations, where the compulsive attraction of the fish to the anode (positive electrode) facilities capture by overcoming the current. Such equipment, therefore, was particularly well suited for population survey work in the small, upland streams encountered in this survey. Consequently, portable pulsed D.C. equipment was used, operated by the researcher and a team of four Water Authority bailiffs experienced in similar survey work. Hartley (1967) and Weiss (1972) amongst others discuss further suitable generators and equipment for effective electric fishing.

As electric fishing has grown in popularity, it has become widely used in the estimation of population size by either mark-recapture (Petersen, 1896; cited by Cormack, 1968), or depletion methods (Leslie and Davis, 1939 ; DeLury, 1947). Both methods require the efficiency of capture to remain constant; for this reason Cross (1976) emphasises the use of the same equipment in all comparable surveys.

The apparatus used in the present survey comprised a portable, petrol-driven generator (Honda EM300), a sealed control box, anodes, each with 50m of insulated cable, and cathode wires. The control box was equipped with indicator lights for the input and output circuits, and an emergency 'stop' button as suggested by Williams (1984). The hand-held anodes were similar in design to those described by Weiss and Cross (1974), mounted on 2m long, hollow fibre glass poles, threaded at one end to accept an alloy or copper anode ring of 40cm diameter. For safety reasons, a waterproof micro-switch or 'dead man's button' was placed mid-way down the pole to operate an electrically isolated, low voltage relay circuit, designed to disconnect the current from the anode ring. The complete anode assembly was connected to the control box via a 50m cable and plastic plug of robust and waterproof design. Some anodes described in the literature are equipped with a semi-rigid basket mounted within the ring for fish removal; however, such a system was considered impractical in a confined stream situation where small insolated, aquarium nets proved invaluable. The apparatus' cathode comprised two braided, copper cables, the final two metres of which were uninsulated. This created a large surface area at the water-cathode interface, which minimised electrical resistance as the current returned to the generator. In waters of high conductivity this two metre length may be reduced to one metre.

Field operation

Population studies for the sites sampled were undertaken using a removal method, based on catch per unit effort (CPUE). Standard Water Authority practice required only two catches to arrive at an estimation of population by Seber and LeCrens' (1967) formula (Clough, 1983). However, generally more reliable formulae by Zippin (1956) and Carle and Strub (1978) were finally used, both requiring a minimum of three catches.

On arrival at the sampling location and prior to the commencement of fishing, small meshed seine nets were set across the stream to delimit the site. In order to avoid the lead-lines lifting in the swift current, stones were often necessary to give further anchorage. The generator and control box were conveniently placed to facilitate runout of the anode cable, and the short cathode cables were laid on the stream bed downstream of the bottom stop-net. For safety and practical reasons, studded, leak-free rubber thigh boots or chest waders were worn by all team members, whilst one man was positioned at the control box in order to switch off the flow of electricity in the event of a mishap. As the efficiency of electric fishing equipment falls with increasing water area and stream width (Kennedy and Strange, 1981; Penczak, 1985), two anodes were considered necessary for the majority of sites. However, sites 1, 4 and 5 were of such width that a single anode proved sufficient and safer in operation. It should be noted that when two anodes were in use, the micro-switch on both units had to be pressed simultaneously in order for the current to flow.

Electric fishing commenced at the bottom of the site, care being taken to avoid the cathode cables with the hand-held anodes. Each anode operator carried a net, and by working together upstream, water discoloured whilst wading was displaced by the current. The whole site area was fished, with particular attention given to likely lies at the head of pools, round large boulders and under tree roots. A team member in close attendance carried a receptacle for the captured fish, and was able to help in the extraction of stunned fish lodged between stones or under tree roots. In deeper water the technique was to sweep the anode in proximity to the stream bed before drawing it to the surface where attracted fish could be seen and netted. In such situations, extreme care was necessary to avoid injury to the fish in the proximity of the anode ring

Once the site had been fished through, the generator was turned off and the anode cables recoiled prior to the next run. A 15 minute interval was allowed to elapse between each of the three runs, giving time for the water to clear and the uncaught fish to recover. For each consecutive run the number of fish of each species was recorded, and a measuring board used to determine forklength to the nearest millimetre (Lagler, 1978). The fish were not weighed as they were generally rather small, and accurate readings proved difficult to obtain under field conditions; further, as the fish were to be returned unharmed additional handling was undesirable.

A number of scales were collected from a representative sample of the brown trout caught, for the purpose of age determination at a later date (Mann, 1971). Each sample was taken from the side of the fish by gentle scraping with a scalpel blade. The aim was to remove approximately 20 scales from each fish, as a high percentage were unsuitable for the determination of age. This unsuitability was attributable to variability in scale size and morphology (Alvord, 1954), and to the large number of regenerate scales present in the samples (Carlander, 1974). This phenomenon is very common in older brown trout, where Bagenal and Tesch (1978) note over 70% of scales may be regenerate. Upon removal each scale sample was placed in a small paper envelope on which was recorded the relevant information. Unfortunately, when dry, mucus removed with some of the earlier samples led to adhesion between the scales and the envelope. This was remedied in further samples by the insertion of a fold of smooth paper, similar to the cellophane insert advocated by Bagenal and Tesch (1978).

<u>The estimation of fish populations</u>

As stated by Zalewski (1983), the determination of fish populations has long been a weak point in fish research, whilst Bayley (1985) notes that accurate estimation of fish populations is perhaps one of the most elusive goals in fishery science, partly due to the limited development of the methods. Although the basic concepts of such estimations are relatively simple, the formulae involved are often complex, and care must be exercised if one is not to lose sight of the basic assumptions and limitations of the methods. It should be remembered that the use of a particularly sophisticated technique will not overcome the bias caused by failure to observe a basic principle (Cross, 1972a).

Over the years the methods and formulae associated with population estimation have been refined and developed to a considerable extent, resulting in a plethora of useful techniques available to the researcher. In order to place the adopted techniques developed by Zippin (1956) and Carle and Strub (1978) in perspective, a brief chronological review of the associated methods was undertaken. These methods generally fall into two categories, known as mark-recapture techniques and catch-effort or depletion techniques (Seber and LeCren, 1967).

Mark-recapture techniques. Experiments in mark-recapture techniques have been used for many years in the estimation of animal populations. The method was first applied to the estimation of fish populations by Petersen in 1896 (cited by Cormack, 1968). His method referred to as the Petersen or single census method involved the catching, marking and liberation of a sample of fish from the population under study, and then at a later date, sampling the population again in order to determine the ratio of marked to unmarked fish. From these data an estimation of population size may be obtained, using the following relationship:

$$\text{if} \quad \frac{M}{N} = \frac{R}{C}$$

$$\text{then} \quad N = C \times \frac{M}{R}$$

Using standard notation:

N = Population size at time of marking.

M = Number of fish marked.

C = Number of marked and unmarked fish recaught.

R = Number of marked fish recaught.

(Cormack, 1968; Cross, 1972a; Ricker, 1975).

However, for the above expression to apply, a number of assumptions are made, namely:

(i) Marked and unmarked fish are equally liable to capture.

(ii) The distribution of marked and unmarked fish is random prior to the commencement of the second fishing.

(iii) Either the population is entirely closed, or recruitment and immigration is zero whilst emigration and mortality affects equally marked and unmarked fish.

(iv) Fish do not lose their marks.

(v) Sampled fish are correctly classified as marked or unmarked.

Such assumptions suggest that only rarely is an accurate estimate of population achieved. Further, if narrow confidence limits are to be obtained, then due to the mathematics involved, the number of fish initially marked and the size of the second sample must be large in relation to the total population (Cross, 1972c).

Faced with these problems, researchers in the nineteenthirties developed methods of population estimation in which the population under study was sampled on a number of occasions, overcoming the problems associated with obtaining a large single sample. Schnabel's published work of 1938 discusses the basic theory and application of this model, generally referred to as the multiple census method. The assumptions of Petersen's single census method apply, with the additional limitation that the population size must remain constant throughout the period of marking and recapture. This in effect means that recruitment, mortality and migration are assumed to be zero; a severe limitation with respect to some mark-recapture techniques. Jackson (1940) overcame this limitation in his work on the estimation of tsetse fly densities, which resulted in a model which takes into account such limitations. Further developments by Fisher and Ford (1947) and Dowdeswell et al. (1949) culminated in Bailey's (1951) Triple Catch Method, whereby mark-recapture techniques were applied to truly 'open' populations. As the title suggests, the population is sampled on three successive occasions. On the first occasion the fish are marked; on the second marked fish are recorded and returned, whilst unmarked fish are given a different mark; finally, on the third occasion the marks of both categories are recorded (Ricker, 1975). With these data an estimation of population at the time of the second fishing may be calculated from Bailey's formula, along with the standard error.

Estimation of population at second fishing:

$$N_2 = \frac{M_2(C_2 + 1)(R_{13})}{(R_{12} + 1)(R_{23} + 1)}$$

$$SE(N_2) = \sqrt{\left(N_2^2 - \frac{M_2^2(C_2+1)(C_2+2)R_{13}(R_{13}-1)}{(R_{12}+1)(R_{12}+2)(R_{23}+1)(R_{23}+2)}\right)}$$

suffixes to standard notation:

Fishing occasions:	1	2	3
Fish newly marked	M_1	M_2	-
Fish examined for marks	-	C_2	C_3
Recaptures from first marking	-	R_{12}	R_{13}
Recaptures from second marking	-	-	R_{23}

(Bailey, 1951; Cross 1972a and 1972b; Ricker, 1975).

Cormack (1968) and Ricker (1975) explain in further detail methods of mark-recapture, although the significant developments have been discussed. If it had been possible in this study to undertake population work within the reservoir itself, then it is probable that a multiple census method of mark-recapture would have been adopted as being most suitable.

Catch-effort or depletion methods. In the estimation of fish populations it has been suggested that methods of mark-recapture are perhaps the most accepted technique (Cowx , 1983). However, an alternative approach for estimating population size is the use of the catch-effort or depletion method. Catch-effort techniques are based on the rationale that for a closed population, catch per unit effort (CPUE) is proportional to the population available for capture. A series of catches therefore, should show a decline in CPUE, which is directly related to the population and number of fish removed.

The mathematical theory of the catch-effort method has been understood for a considerable time, an early example being Leslie and Davis' paper of 1939. That paper deals with the estimation of the rat population of a typical residential area of Freetown, Sierra Leone. By the nightly trapping of rats (Rattus rattus, Rattus norvegicus, Mus muscalus) in the buildings and compounds of the area, it was discovered that when the total rat catches were plotted as a function of time, then a gentle curve resulted. Further work resulted in the development of a regression technique which involved the plotting of CPUE against cumulative catch over a period of time. Similar independent work by DeLury (1947) concentrated on the lobster fishery of Prince Edward Island, Canada, and the records of a speckled trout pond fishery. The resulting model, based on the theory of maximum likelihood, requires a logarithmic plot of CPUE against cumulative effort. Both regression techniques described by Seber (1973) and Ricker (1975), are limited by the following conditions which apply to all catch-effort techniques:

(i) A closed population is assumed.

(ii) All fish are equally liable to capture, i.e., catchability remains constant.

(iii) A constant effort is applied to each sampling and is spread evenly over the study area.

(iv) The CPUE significantly reduces the population size.

(v) The population is not so large that the catching of one individual interferes with the catching of another.

(Leslie and Davis, 1939; DeLury, 1947).

However, one drawback associated with the method of regression analysis is that the data points do not always show a trend towards a straight line. This may result in poor correlation values and subsequent difficulties of interpretation.

The Leslie and Davis model of 1939 was later improved by Moran (1951), who provided a statistically superior model based on asymptotic maximum likelihood theory. This has the advantge of being shorter and provides easily calculable estimates of standard error. Although Moran may be regarded as the pioneer, it was Zippin in his papers of 1956 and 1958 who simplified and developed the technique. The mathematics may be complex, but Zippin's graphical technique removes much work thereby facilitating calculation. The basic calculation is as follows and relies on two sets of graphs to estimate $(1-q^k)$ and p for various values of k.

A ratio (R), specific for each set of sample catches, must initially be calculated in order to enter the graphs:

$$R = \frac{\sum_{i=1}^{k} (i-1)c_i}{T}$$

The graphs for estimating $(1-q^k)$ and p circumvent the following equation:

$$R = \frac{q}{p} = \frac{kq^k}{(1-q^k)}$$

The population estimation is calculated from:

$$N_o = \frac{T}{(1-q^k)}$$

Standard error:

$$SE\ (N_o) = \sqrt{\frac{N_o(N_o - T)T}{T^2 - N_o(N_o - T)([kp]^2/[1-p])}}$$

<u>Standard notation for catch effort methods</u>:

N_o = Original population size.

T = Total number of fish caught in all samples.

k = Number of samples.

ci = Number of fish caught in ith sample.

p = Catchability.

q = (1-p) proportion of remaining fish after sample has been taken.

(Zippin, 1956 and 1958; Cowx 1983).

For this method to provide reliable estimates, Zippin (1956) shows that a significant proportion of the population must be caught. Similarly, Seber and LeCren (1967) produced an extremely concise formula, again based on maximum likelihood theory, which this time relied on just two catches. Their formula was developed for use in small river surveys where electrofishing techniques made it possible generally to catch a significant proportion of the fish population. Seber and LeCren's (1967) formula as modified by Robson and Reiger (1968) is as follows:

$$N_o = \frac{C_1^2 - C_2}{C_1 - C_2}$$

Standard error:

$$SE(N_o) = \frac{C_1 - C_2}{(C_1 - C_2)^2} \sqrt{(C_1 + C_2)}$$

where: C_1 = first catch

C_2 = second catch

(Seber and LeCren, 1967; Robson and Reiger, 1968; Cowx, 1983).

If the two catches comprise only a small proportion of the population, then the estimates of variance become unacceptably large for the population estimate to be of any value. However, due to the simplicity of the calculation and the need for only two fishings, Seber and LeCren's (1967) method has become justifiably popular with Water Authorities. Although it is still useful, this method is only recommended for use when resources dictate a maximum of two successive fishings, as the technique is greatly inferior to the more complex Zippin (1956) method.

With recent advances in the development and availability of micro-computers, an opportunity for an increased use of the more complex models of population estimation has become possible. Higgins (1985), has presented an interactive BASIC computer programme designed to estimate population size using Zippin's (1956) removal method. This programme, now used by the Thames Water Authority and the Freshwater Fisheries Laboratory, Pitlochry, was initially judged ideal for the native fish population estimation work undertaken in the tributaries of Stocks Reservoir. Once the model was in operation however, it became apparent that on numerous occasions the programme failed, or the confidence limits were such that the estimate was invalid. Generally, it was found that Zippin's (1956) model performed adequately if there was a proportionate decline in catch; however, if there was marked variability in the proportion of the population caught, then the model was liable to fail. Zippin (1956) discussed this problem, and Cowx (1983) listed it as a major disadvantage, whilst Carle and Strub (1978) explained that the model is particularly limited when estimating several species populations simultaneously, because the number of fish of any one species is likely to be small within a given sample. Further, if was suggested that problems might be magnified if the catchability of some species is particularly low. These problems were evident during population estimation in the Stocks' catchment, for the small benthic fish, stoneloach and bullhead, appeared less susceptible to capture than the generally larger, more agile brown trout.

Since Higgins' (1985) programme of Zippin's (1956) removal method was initially used in the study, a corrected copy of his programme is included with a worked example in Appendix 1a. (The researcher found line 400 of the programme to be incorrect due to a typing error).

As it became evident that Zippin's (1956) removal method often failed to provide valid estimates of population size, a more suitable model was sought. A literature search revealed a relatively new model, possibly more suited to the Stocks' catchment data, which was developed and described by Carle and Strub (1978). This method known as the Maximum Weighted Likelihood Method (MWL) is claimed to be a more 'robust' technique, overcoming some of the difficulties associated with fluctuations in catches and the sampling of a large proportion of the population (Cowx, 1983; Bayley, 1985). One weakness in the technique however, is the trial and error procedure required in order to determine the population estimation. Using standard notation (p.25) the basic calculation is as follows:

$$\left(\frac{N_o + 1}{N_o - T + 1}\right)\left(\frac{kN_o - M - T + 0.5k}{kN_o - M + 1 + 1 + 0.5k}\right)^k \leq 1$$

where: $$M = \sum_{i=1}^{k} (k-i)\, ci$$

Standard error:

$$SE(N_o) = \sqrt{\frac{N_o(N_o - T)T}{T^2 - (N_o(N_o - T)(kp^2/1-p))}}$$

where probability of capture (p):

$$p = \frac{T}{kN_o - M}$$

(Zippin, 1956; Carle and Strub, 1978; Cowx, 1983).

As may be imagined the longhand working of this formula is tedious. Therefore a BASIC computer programme was written for the present study, in order to facilitate calculation of the many population estimates. The programme was designed to accept data, and to display the results in a format similar to Higgins' (1985) programme of Zippin's (1956) removal method. A maximum of ten sample catches was accommodated, and estimates of catchability and density were incorporated along with the population estimate and 95% confidence intervals. A copy of the programme with a worked example may be found in Appendix 1b.

In use the MWL model proved to be of great value, as it generally gave realistic population estimates for the Stocks' catchment data. However, under one set of conditions the model was inevitably found to fail. If fish were caught in the first sample catch, whilst subsequent catches were zero, then the model understandably failed. In that situation it is reasonable to assume that the minimum population should be regarded as the total fish caught on the first catch. The programme was designed in order to inform the operator of this, and to assume the first catch as the minimum population estimate. The normal conditions and limitations for catch-effort methods apply, requiring careful site selection and informed implementation of the field techniques.

Age determination

The determination of the age of fish has a long history covering more than two centuries. The first reliable account was written in 1759 by a Swedish clergyman, Hans Hederström, who determined the age of pike (Esox lucius) and other species from the rings on their vertebrae (Hederström, 1759). Most recently, age has been determined from marking experiments, length frequency distributions, and by the interpretation of rings or circuli on the various hard structures of fish i.e., vertebrae, opercular bones, fin rays, otoliths and scales (Carlander, 1974).

Estimation of age and growth from marking or tagging experiments is sometimes undertaken, although it is imperative in such work to determine the effects of handling and marking on the subsequent growth rate. Length frequency distribution, often referred to as the Petersen method (Ricker, 1975), is a common technique, although it is only applicable in climates where fish species spawn annually. If the offspring grow at reasonably uniform rates, then a length frequency distribution will exhibit a pronounced mode for each age group. Such distributions are generally clearer for younger fish where large numbers may be sampled, and there is little overlap in the sizes from adjacent age groups. Perhaps the most frequently used method of age determination is the counting of annual growth zones known as checks or annuli, present on the hard structures of fish. These annuli are formed during alternate periods of faster and slower growth which bear a definite relationship to the warm and cold seasons of the year (Swift, 1961). Generally, greater fluctuations in seasonal temperature differences lead to clearer annual marks, which often precludes this technique from use in tropical areas where seasonal fluctuations may be small (Hopson, 1965).

Due to their ease of procurement and analysis, otoliths from the inner ears of fish, and scales are probably the most useful hard structures for age determination. As an accurate means of age determination otoliths are superior, as they form earlier in the fishes' life (Williams and Bedford, 1974) and do not suffer from erosion or regeneration which facilitate age determination in older fish (Mann, 1973). On the other hand, brown trout scales start to form when the fish is 30 to 40 millimetres in length (Skurdal and Andersen, 1985). However, they are extremely useful as the fish may be released unharmed after a number of scales have been removed. This latter rationale was instrumental in the choice of scales, as the method of age determination in the native brown trout populations of the catchment. Further, in a study of the validity of age determination from brown trout scales, Sych (1967) suggests that scales may give an accurate estimation of age in over 90% of cases; similar conclusions were drawn by Hellawell (1974).

In accord with numerous modern authors, rigorous cleaning of the scale samples was not found necessary, as a little distilled water and medium-grade filterpaper removed much of the unwanted detritus. However, Graham (1929) advises the use of peroxide solution and sodium sulphate solution to remove pigmented dermal tissue, whilst Mann (1973) suggests cleaning stubborn scales with 8% sodium hydroxide before washing in distilled water.

Once clean, there are primarily two means by which scales may be usefully viewed. The first and oldest method involves the mounting of scales in glycerin jelly or dry between two taped glass slides, in preparation for viewing through a microscope (Duff, 1929; Mann, 1973). The second method involves some form of projection, whereby the scale image is thrown onto a screen. This results in a large, clear image which as Bagenal and Tesch (1978) suggest, facilitates consultation and discussion. Two approaches are feasible; first a standard slide projector and lens may be used, the scales sandwiched between two taped glass plates of the correct size (generally 50mm x 50mm). Banks and Irvine (1969) consider this an excellent method particularly for lecturing purposes. The second more sophisticated technique utilises a micro-projector designed for reading micro-film. Such equipment if fitted with a 50x lens (Walker, 1984), will provide sufficient magnification for the majority of scales, giving good images if the scales are placed concave side down on the film carriage. In the present study, both projection methods were utilised for age determination depending upon the availability of the equipment.

Brown trout scales are cycloid in shape, composed on the upper surface of a myriad concentric ridges known as circuli or striae (Utrecht, 1973), radiating out from a central focus. It is the spacing of these striae, determined by seasonal growth, which gives rise to the annuli important for age determination. Alvord (1954) notes that in brown trout, the annuli are particularly pronounced on the scale's anterior radius which is normally overlapped by adjacent scales. For accurate age determination it is imperative that all annuli are recognised and counted, whilst false checks are disregarded. Carlander (1974) suggests that interpretative errors may be minimised by careful definition of the criteria used for annuli recognition. Thus the following criteria, adopted in part by many authors including Linfield (1974) and Bagenal and Tesch (1978), were selected for the recognition of annuli in this study:

(1) Alternate zones of closely-spaced and widely-spaced striae compose a scale's upper surface. Where appropriate an annulus was considered to be located at the outer border of the closely-spaced striae.

(2) On occasions an annulus was apparent as one or two striae cut over several others. This occurred predominantly in the dorsolateral and ventrolateral fields.

(3) An annulus was traced right round the scale where possible, although difficulty was often experienced in the posterior field.

(4) As far as possible, a particular annulus was identified on all perfect scales sampled from an individual fish.

A certain amount of discretion was necessary, however, as many fish species including brown trout are liable to form 'false checks' on their bony structures, which may exhibit one or more of the above criteria. Conversely, many authors, including Bhatia (1931), Bucholz and Carlander (1963) and Carlander (1974), suggest that, particularly in temperate latitudes, limited growth associated with cool summers may lead to poor check formation, with the consequence that annuli may be overlooked.

Further sources of error are associated with establishing the position of the first annulus, and interpretation of the closely-spaced annuli often present on scales from older fish. Mann (1976), notes that great care is necessary if one is to avoid overlooking the first annulus which may form near the scale focus. Similarly, Linfield (1974) suggests that the position of the first annulus may often vary between year classes, but is usually constant for individuals within a year class. It is suggested by Skurdal and Andersen (1985) that this variation may result from summer temperature differences influencing the rate of circuli formation. Therefore, if the position of the first annulus can be established, then errors associated with the ageing of young fish should be infrequent. Many authors, however, note that in older fish scale annuli may become less pronounced beyond the third year. Alvord (1954) notes that the close proximity of such annuli may complicate interpretation, whilst Linfield (1974) suggests that annuli may in fact become superimposed. Work by Frost (1978) and Barbour and Einarsson (1987) on char corroborates such conclusions, whilst erosion and reabsorption of the scale edge may further compound the problems.

Such complications may result in an overall underestimation of longevity; fortunately as Carlander (1974) states this may not be of great significance from a management point of view as few fish ever attain maximum age. Harris (1973) notes that, in the British Isles, few brown trout of more than 12 years of age have been recorded, possibly as a direct consequence of such errors in age determination.

It should be noted that although Ricker (1975) states that no researcher could ever claim that his age determinations are infallibly accurate, it has been argued by Easton and Morgan (1974) that, despite the associated problems, reasonably accurate estimates of age are obtainable even by persons with limited experience of scale interpretation. For the determination of age of very small trout however, where no scale samples were taken the Petersen method of length-frequency distribution was adopted (Ricker, 1975), using Minitab stem and leaf plots (Ryan et al., 1985).

Having determined the criteria for the recognition of annuli and the problems encountered, a consistent system of age designation was required. Standard practice accepted by many authors including Bagenal and Tesch (1978), defines age in terms of the number of annuli present on the hard structures, as the exact age of a fish is usually unknown. Therefore, in the first season of growth when no annulus was present a fish belonged to age group O. Similarly, in the second season it belonged to age group I, and in the third season to age group II and so on. Hellawell (1974), however, notes that the time of annulus formation often varies between individual fish, which may cause complications. To avoid possible confusion, a proposal by Hile (1950) was adopted in which January 1st was observed as the date on which a fish moved up an age group, regardless of whether an annulus was yet recognisable. In accord with numerous authors including Alvord (1954), Carlander (1974) and Mann (1973), Roman numerals were used to designate age, whilst the adoption of a '+' sign to denote growth beyond the final annulus was regarded as superfluous (Bagenal and Tesch, 1978).

Results

The survey sites

Tables I, II and III present general details of each of the three tributary streams surveyed, namely the River Hodder, Hasgill Beck and Bottoms Beck, with specific data for the survey sites located on each tributary.

These sites, surveyed regularly with electric fishing equipment between March 1985 and December 1987, are depicted on a map of the reservoir and catchment, along with their national grid references (Figure 3). Detailed diagrams of the survey sites, drawn to a scale of 1:250 are given in Figure 4.

A photographic record of the sites is similarly included, taken in the summer months during periods of low flow (Plates 1 to 8). Plates 9 and 10 depict a two-tier water fall situated between sites 7 and 8 on Bottoms Beck, which may act as an effective barrier to upstream migration.

Invertebrate surveys undertaken with a 20 cm x 20 cm Surben sampler.

... depicted graphically in Figure 5.

The surveys

The electric fishing surveys were undertaken three times a year from 1985 to 1987 during the spring, summer and autumn months. For reasons of continuity, every effort was made to ensure that subsequent surveys in successive years were undertaken during the corresponding months. Unfortunately, this was not always feasible due to inclement weather, spate conditions, and Water Authority manpower constraints. Table V gives the dates on which each site was surveyed over the three year period.

As both Zippin's (1956) removal method, and Carle and Strubs (1978) MWL method are techniques based on CPUE, it was necessary to fish each site by applying constant effort on three successive occasions, in order to achieve results from which to estimate fish populations. At each site, the catch on successive runs and the total were tabulated for each species. Tables VI, VII and VIII record these data for the 1985, 1986 and 1987 surveys respectively. Raw length data for the surveys may be found for native fish and rainbow trout in Appendix 2.

Although minnows were at times encountered at sites 2, 3, 5 and 8, no attempt was made to estimate their numbers. This decision was judged necessary because their abundance and subsequent capture would have militated against the capture of other less numerous species, thereby invalidating a condition basic to all CPUE techniques; namely that the catching of one individual does not interfere with the catching of another (Leslie and Davis, 1939; DeLury, 1947).

<u>The fish populations</u>

After careful study of the available methods of population estimation based on CPUE data, Zippin's (1956) removal method was initially selected. However, over the survey period, and excluding the 32 cases when a catch was made on the first run alone, the method failed on 14.5% of occasions. This failure resulted in the adoption of Carle and Strub's (1978) MWL method, which succeeded in providing a population estimate on all occasions.

A corrected copy of Higgins' (1985) BASIC programme of Zippin's (1956) removal method may be found in Appendix la, whilst in Appendix lb may be found the researcher's own BASIC programme of Carle and Strub's (1978) MWL method, expressly written for the study. Accompanying these programmes are worked examples based on data from the Afon Dulas (Cowx, 1983). These are included as checks to the correct operation of the programmes.

Tables of estimated populations with 95% confidence limits for all survey sites and species excluding minnows, are included for the spring, summer and winter periods of 1985, 1986 and 1987 respectively. Annual Tables IX, X and XI record population estimates initially calculated using Zippin's removal method; whilst Tables XII, XIII and XIV present Carle and Strub's MWL method population estimates. Although Carle and Strub's MWL method was adopted throughout the study, it was felt necessary to include the estimates derived from Zippin's removal method for reasons of comparison. To this end, Table XV sets out the native fish population estimates calculated from Carle and Strub's MWL method as percentages of those calculated using Zippin's method, whilst Figure 6 illustrates these data in the form of species frequency histograms.

The BASIC programme devised to estimate population using Carle and Strub's MWL method, also gave catchability (P) values. Such values, which were defined by Ricker (1975) as the fraction of the fish stock caught by a defined unit of fishing effort, are presented in their entirety in Table XVI. Table XVII summarises these values giving the range, mean, and 95% confidence limits for the native species caught during the spring, summer and winter surveys. The combined catchability data suggest that brown trout exhibit the highest level of catchability and smallest confidence limits, whilst stone loach display the lowest catchability and largest confidence limits.

From the estimates of population displayed in Tables XII to XIV, values for percentage species composition were calculated. These data, displayed in Table XVIII, were instrumental in the drawing of a bar chart which depicts percentage species composition at each survey site. Divided into three pages, each representing the survey sites on one tributary, the chart illustrates clearly the diversity of species composition between the sites and seasons (Figure 7). Further, the presence of minnow during a survey is also recorded.

As the BASIC programme for Carle and Strub's MWL method made provision for the insertion of survey site area, the programme provided estimates of species density (m^{-2}) with 95% confidence limits. In order to achieve greater clarity, these data recorded in Tables XIX to XXI are recorded as estimates 100m^{-2}. Figure 8 is a graphical interpretation of these data and also indicates, where appropriate, the presence of minnow. Again Figure 8 extends for three pages, the histograms on each page corresponding with the sites on each of the three tributaries surveyed.

A summary of native species densities may also be found in Table XXII, which gives the range and mean densities for the spring, summer and winter survey periods for each site.

Although the emphasis of the survey was placed on the native brown trout populations of the tributaries, an analysis of bullhead and stone loach length frequency data was undertaken. Tables XXIII and XXIV record combined length frequency data for each survey site for these species. These data, based on the fish length data included in Appendix 2, are depicted graphically in Figures 9 and 10 for bullhead and stone loach respectively. It may be noted that these two benthic species were represented at all survey sites excluding the highest site on the River Hodder (Site 1).

Once an attempt at ageing the brown trout had been made from interpretation of the scale samples, it was then possible to assess age group density estimates. If appropriate, perhaps the best method of achieving this involves splitting the successive catches into age groups or size classes, and estimating abundance for each group or class (Mahon, 1980). Although this effectively eliminates problems of differential catchability associated with fish size, it does require large samples. If because of small sample sizes this technique is not feasible (Bohlin, et al. 1989), then an estimate of age group abundance may be made by the calculation of age group proportions from the total catch, which may then be applied to the estimated total population. Although not an ideal technique, as it assumes constant catchability irrespective of fish size, it does provide a useful method of analysis. This latter technique was adopted in the present study as a consequence of the varied and generally small sample sizes. The brown trout age group proportions of the total catch, expressed as percentages, are recorded in Tables XXV, XXVI and XXVII, whilst the resulting estimated age group densities ($100m^{-2}$) are displayed in Tables XXVIII, XXIX and XXX. A graphical interpretation of the age group density estimates for all surveys undertaken at each site, are illustrated in Figure 11, with a separate page used to display the sites on each tributary. Two further figures dwell on recruitment to the brown trout populations, with Figure 12 summarising the summer fry density estimated for each site, and Figure 13 expressing the 0 group density estimates as a percentage of the total brown trout population estimates for both the summer and winter surveys, for 1985 to 1987 respectively.

Table XXXI, which may be regarded as a summary of Tables XXVIII, XXIX and XXX, displays the estimated age group densities divided into 0 group brown trout and older. Although such data manipulation is useful in its own right for purposes of interpretation, it is included primarily as a means of comparison with other authors, namely; Crisp et al. (1974) and Crisp and Cubby (1978) who produced population density data for upland tributaries of the Tees and Eden (Table XXXII).

In addition to brown trout age group density, observed mean length for age was assessed with 95% confidence limits where appropriate. Length values were calculated to the nearest millimetre whilst confidence limits, which required the use of t-tables due to the small sample sizes, were taken to one decimal place. As scale reading proved problematic for a number of larger fish, these age estimates are placed in parenthesis to indicate possible error. The observed length for age data for brown trout is shown in Tables XXXIII, XXXIV and XXXV for all survey sites on the River Hodder, Hasgill Beck and Bottoms Beck. These data, combined for each site, are plotted separately resulting in mean curves of length for age over the survey period (Carpenter, 1982). Due to the uncertainty associated with the ageing of some of the older fish, these values are omitted from the curves illustrated in Figures 14 to 21. For purposes of comparison, Figures 22 and 23 depict curves of length for age for a number of similar upland locations plotted from data recorded by Thomas (1964), Crisp et al. (1974; 1975), Crisp and Cubby (1978), Milner et al. (1978) and Turnpenny (1985). Further work associated with length for age data involved the use of cohort analysis over the three year survey period.

Unfortunately, because of the fragmentary nature of the ensuing results, the work is not included in the present study.

In an attempt to illustrate the diversity of fish scale morphology, both between age groups and for individual fish, scales from brown trout of age groups I, II and III respectively are depicted in Plates 11 to 13.

Discussion

The three major tributaries of the catchment, which carry almost three quarters of the run-off, were covered by eight survey sites; three on each of the larger tributaries the River Hodder and Bottoms Beck, and the final two sites on Hasgill Beck. Ideally a greater number of sites would have been chosen, but the study was limited to eight as a consequence of constraints imposed by the Water Authority.

Care was essential in the choice of the sites, such that they were representative of each stretch of stream. However, a compromise had, at times, to be sought in order to make allowance for year-round vehicular access. Consequently no direct attempt was made to extrapolate from site level to stock level, but site population density and structure were taken as indicative of the particular stretch of stream. It may be seen from a consultation of Figure 3, that the sites were chosen to cover the lengths of the tributaries. An exception is sites 6, 7 and 8 on Bottoms Beck which are rather close together, due to access problems upstream of the bridge at the head of site 6. Reference to Tables I, II and III will give further physical details for the tributaries and sites for the River Hodder, Hasgill Beck and Bottoms Beck, whilst Figure 4 and Plates 1 to 8 illustrate the sites diagramatically and photographically.

The invertebrate survey

River Hodder. Sites 1, 2 and 3. Estimated invertebrate numbers were low at all three sites reaching a maximum of $350m^{-2}$, although an increase in diversity was apparent as one moved down stream from site 1 to site 3 (Table IV). Plecoptera, Diptera and Trichoptera were the only orders present at site 1 with Plecoptera dominant, primarily represented by the family Perlodidae. At sites 2 and 3, Diptera (mainly Chironomidae) were dominant, followed by Plecoptera, with Ephemeroptera, Trichoptera, Coleoptera, Collembola, Arthropoda, Gastropoda and Oligochaeta all represented at one or both sites.

Hasgill Beck. Sites 4 and 5. There appeared a marked difference in the numbers of invertebrates present at these two sites, with the estimated densities at sites 4 and 5 of $325m^{-2}$ and $1100m^{-2}$ respectively. Site 4, the upstream site, showed limited diversity with Plecoptera, Diptera, Trichoptera and Coleoptera present. In accord with site 1 on the River Hodder, Plecoptera were dominant with Perlodidae the most important family. Of the high invertebrate density at site 5, Diptera were dominant (mainly Chironomidae and Simuliidae), with Plecoptera and Ephemeroptera well represented and Coleoptera and Trichoptera present.

Bottoms Beck. Sites 6, 7 and 8. Again a large variation in invertebrate density was observed between sites ranging from $700m^{-2}$ at site 6 to $1525m^{-2}$ and $1250m^{-2}$ at sites 7 and 8 respectively. At site 6, the upstream site, Plecoptera were again dominant, solely represented by Perlodidae, whilst Coleoptera, Diptera (primarily Chironomidae) and Trichoptera were well represented. Plecoptera of the family Perlodidae were similarly dominant at site 7; further, good numbers of the Ephemeroptera, Ecdyonuridae, Baetidae and Caenidae, and the Diptera Chironomidae and Simuliidae were present. At site 8, the lowest site on Bottoms Beck, Oligochaeta were dominant, possibly as a consequence of the areas of fine substratum. In accord with sites 6 and 7, Plecoptera, Coleoptera and Diptera were well represented whilst a number of Trichoptera and Ephemeroptera were present.

From this basic invertebrate survey of the electric fishing sites, Bottoms Beck appeared the most productive stream, both in terms of diversity and abundance, whilst the River Hodder was the least productive. In conjunction with the present study, work by Chase (1986) on mean invertebrate productivity, lent further weight to this conclusion.

When comparing the tributary streams, the main similarity was the ubiquitous presence of the order Plecoptera, particularly of the family Perlodidae, which were dominant at sites 1, 4, 6 and 7. This was not surprising because this order typically inhabits fast-running, upland streams (Fitter and Manuel, 1986). Similarly, Diptera were present at all sites and dominant at sites 2, 3 and 5, primarily represented by the families Chironomidae and Simuliidae. Ephemeroptera were interestingly limited to four sites, and only present in large numbers at sites 5 and 7.

All sites on the River Hodder, and the upstream sites on Hasgill Beck and Bottoms Beck, were particularly devoid of Ephemeroptera. Without exception, the upstream sites of each tributary displayed the poorest diversity and abundance of invertebrates, and were dominated by the order Plecoptera.

A possible explanation for the poor diversity and numbers of invertebrates present in the tributaries, may be the effect of acidic run-off. During periods of low summer flow the tributaries' pH ranged from 7.43 to 7.68; in spate conditions however, the lack of effective buffering might lead to a marked fall in pH levels.

It is widely accepted that acidic waters characteristically lack certain invertebrate taxa which may result in low numbers and diversity (Eilers *et al.*, 1984). If the data from the present study are compared with suggestions put forward in a report to the European Commission by North West Water concerning acid rain (Harper, 1986), then some striking similarities become apparent. The report encompasses acidic streams in upland Cumbria and the Pennines, and concludes that Plecoptera are invariably dominant in the streams surveyed, whilst Trichoptera and Diptera, especially of the families Chironomidae and Simuliidae, are unrestricted in their occurrence. Further, taxa particularly sensitive to low pH such as Gastropoda, Ephemeroptera, *Gammarus* spp. and *Baetis* spp. are conspicuously and consistently absent from the majority of sites. These taxa, especially *Gammarus* spp. and *Baetis* spp.

are recognised as indicators of possible low acidity by numerous authors, including Gledhill et al. (1976) and Alabaster and Lloyd (1983).

From comparison with the acid rain report the pattern of invertebrate taxa associated with Stocks' tributaries, show marked similarities with other upland streams in the region known to suffer acid stress. Although the present invertebrate study is based on limited samples in comparison with some other works (Elliott, 1967a), it may tentatively be suggested that the River Hodder above the reservoir, and the upper reaches of both Hasgill Beck and Bottoms Beck, may at times suffer acid stress.

The validity of the electric fishing survey

The removal method, based upon the proportionality between CPUE and population size, is perhaps the most widely used technique employed for estimating stream populations. In essence this involves the removal of a known number of fish from an enclosed site, in a series of successive samples, where the rate of decline in catch is directly related to the population.

The sampling efficiency may be defined as the proportion of the population captured with the expenditure of one unit of effort (Cross, 1976). It is therefore essential that, as far as possible, the unit of effort employed must be consistent, if accuracy of estimation is to be maintained (Ricker, 1975). To this end, much can be achieved to limit inconsistencies in unit effort, by skilled operatives utilising the same equipment and electric current characteristics throughout the surveys. Similarly, emphasis must be placed on the standardisation of sampling time, the length of bank fished and the prevailing water and weather conditions (Bohlin et al. 1989). In the present study every effort was made to ensure violation of unit effort was minimised over the survey period.

Irrespective of whether the effort employed is constant, the vulnerability to capture of individual fish in a population must remain constant, if accurate estimates are to be achieved (Libosvarsky, 1966). It is well known that catchability varies between fish species because of physiological and behavioural differences (Ricker, 1975), whilst many authors including Vibert (1967) and Zalewski (1983) note that sensitivity to an electric field is directly proportional to fish length. Consequently, free swimming fish with high metabolic rates, such as brown trout, exhibit marked galvanotaxis on exposure to a direct current, and less active fish such as carp (Cyprinus carpio) or the benthic stone loach and bullhead are not as easily attracted.

Lelek (1965), Cross and Stott (1975) and Zalewski (1983) all throw doubt on the assumption that the catchability of a population remains constant throughout a survey. They suggest that fish become less susceptible to capture after experience of an electric field, whilst further comprehensive work by Mahon (1980) demonstrates that the probability of capture declines with successive electric fishing. The resons for such a decline are not entirely clear but may have two possible explanations.

First, Vibert *et al*. (1960) suggest that fish may learn to avoid capture by responding more quickly and fleeing from subsequent electric fields. Work with chub (*Leuciscus cephalus*) by Lelek (1965), attributes the fall in catchability to the stunning of some fish on exposure to further electrical stimulation. Chmielewski *et al*. (1973), note similar results for rainbow trout (*Salmo gairdneri*) and eels (*Anguilla anguilla*); certainly incapacitated fish were not an uncommon sight during the present survey. Further, Cross and Stott (1975) suggest learning is not involved, as the decline in catchability associated with repeated electric fishing is absent after a period of 24 hours.

The second explanation for the decline in catchability, may be that vulnerability to capture remains constant for individuals, but varies within a population, possibly due to differences in physiology, behaviour or habitat preference. This may result in vulnerable fish being removed first during a survey, with the consequence that the catchability of the remaining fish appears to decline (Seber and Whale, 1970).

Whatever the cause, the overall effect of the decline in catch efficiency with successive samples, resulting from the low catchability of the remaining fish, leads to the general underestimation of population by removal methods (Cross and Stott, 1975 ; Bohlin and Sundstrom, 1977; Mahon, 1980). Bohlin *et al*. (1989) suggest therefore, that removal methods should be regarded as relative rather than absolute methods.

Further work on the precision of the removal technique, discussed by Bohlin et al. (1989), indicates that with three samples and a catchability greater than 0.5 precision is generally good, enabling a comparison between population densities. However, the not uncommon problem of small populations, at times encountered in the present survey, may lead to a decline in precision. A good level of precision is largely gained from the use of three removals, which is a strong argument in favour of the methods of Zippin (1956) and Carle and Strub (1978), rather than the method of Seber-LeCren (1967), which relies only on two removals.

It was initially proposed that Zippin's (1956) removal method would be adequate for the estimation of population from the electric fishing removal data. Further, a BASIC computer programme existed, which would facilitate population estimation (Higgins, 1985). See Appendix 1a.

Upon undertaking the calculations, however, the method failed on 32 occasions, representing a failure rate of 14.5%, whilst on a further 20 occasions, the confidence limits were unacceptably large for the estimate to be of any value. The occasions of failure were attributable to the fact that the third catch exceeded the first, with the consequence that the estimation becomes negative (Cowx, 1983). Similarly, unacceptably wide confidence limits were the result of catches not declining successively; a situation which may denote a possible violation of the assumption of constant effort, or a low or changeable catchability.

Such inadequacies in some of the catch data suggested the adoption of Carle and Strub's (1978) MWL method which, it is claimed, will not fail even when successive catches do not monotonically decline (Appendix 1b). In use the new method overcame the problems associated with fluctuation in catch, and the necessity to catch a large proportion of the population. An examination of the 95% confidence limits however, shows rather narrow limits, reaching zero for some small population estimates, which may suggest limitations in the method of standard error calculation derived from Moran (1951) and Zippin (1956).

From a perusal of Table XV, which records Carle and Strub's estimation of fish populations as percentages of those calculated by Zippin's method, it is apparent that on the majority of occasions, the former method yielded lower estimates; a phenomenon similarly noted by Bayley (1985). Figure 6 depicts this graphically in the form of frequency histograms for brown trout, stone loach and bullhead. This illustrates that for all species, the majority of estimates are within 30% of those estimated by Zippin's method. Here the similarities end, with the benthic bullhead and stone loach exhibiting a total of 13 lower estimates, which may be explained by their generally lower susceptibility to capture in relation to the free swimming brown trout; such that Zippin's method over estimated these populations whilst the 'robust' Carle and Strub method gave lower, and possibly more accurate, estimates.

If one examines Tables XVI and XVII, which record catchability for each survey and in summary respectively, it may be observed that brown trout generally had the highest catchability, with a combined survey mean of 0.703, whilst stone loach constantly exhibited the lowest, with a combined survey mean of 0.609. The catchability of bullhead fell in between, although in the present study, their mean catchability appears markedly greater than that of stone loach (0.695).

From such an analysis it should be emphasised that Carle and Strub's (1978) MWL method is likely to underestimate the actual population, particularly for species with lower catchability and small populations. Therefore, the calculated values should be regarded as the minimum possible estimation of population (Dr. I. Cowx, personal communication).

The fish populations

River Hodder (Sites 1, 2 and 3).

Site 1: This was the top site on the River Hodder, upstream of Cross of Greet Bridge. Rocky and fast flowing, the site had a mean water width of three metres (Table I), and was by far the least productive of the study sites, in accord with its sparse invertebrate fauna. Brown trout were the only fish ever recorded at the site, but then only spasmodically (Tables XIX to XXI). The site, on sampling in spring 1985 and winter 1986 to summer 1987, was found devoid of fish. Consequently, brown trout returned a very low mean survey density of 0.873 $100m^{-2}$, with a maximum density of 2.857 $100m^{-2}$ in winter 1985 (Table XXII).

Site 2: Located below Lock Bridge, approximately two kilometres down stream of the previous site, site 2 had a mean water width of five metres and a well defined succession of pools and riffles (Table I). A diversity of fish was recorded, with brown trout, stone loach and bullhead present at each survey (Tables XIX to XXI). Minnows were noted on the majority of occasions, although they were absent in spring and summer 1986. A total of five rainbow trout was captured over the survey period; one in winter 1985 and two in winter 1986 and spring 1987. It is probable that these introduced fish had ascended from the reservoir in an attempt to migrate to suitable spawning locations. As no rainbow trout were recorded in the summer surveys, it is assumed that they return to the reservoir or perish in their spawning attempt.

Of the native fish species present at the site, stone loach and brown trout were predominantly the most abundant, with mean survey densities of 8.836 $100m^{-2}$ and 6.931 $100m^{-2}$ respectively (Table XXII). Stone loach recorded the highest density, reaching a maximum of 27.619 $100m^{-2}$ in spring 1985, whilst brown trout and bullhead density maxima of 18.095 100^{-2} and 7.143 $100m^{-2}$ were recorded in summer 1987. Minimum density values for these species tended to occur in 1986, which coincided with a pollution incident involving effluent from a local farm. Furthermore, the site was devoid of minnow during this same period. It is probable, therefore, that the pollution incident had a marked detrimental effect on the brown trout, stone loach and minnow populations of the site. Interestingly bullhead appeared less susceptible, as they formed 63% of the fish density in the spring 1986 survey, whereas loach and bullhead were dominant at other times.

Site 3: Situated a further one and a half kilometres downstream of site 2, and upstream of the confluence with Hasgill Beck, site 3 was the lowest site on the River Hodder. By this stage the Hodder was relatively broad, with a mean water width of seven metres, although the depth was limited, as a consequence of the outcropping of shaley limestones (Table I).

The fish population of this site was continually dominated by stone loach, which displayed a mean survey density of 12.824 $100m^{-2}$ and in summer 1985 a maximum of 28.750 $100m^{-2}$ (Tables XIX to XXII). The mean survey brown trout density was poor at 2.546 $100m^{-2}$, whilst the site was devoid of brown trout in winter 1986. The occurrence of bullhead was particularly sporadic, with their absence noted at the three winter surveys and summer 1986, which resulted in a small mean survey density of 0.556 $100m^{-2}$. Minnow were present throughout the spring and summer surveys but never in the winter. This may be a consequence of the prevailing shallow nature of the stream, promoting their winter migration to deeper more accommodating pools or downstream as far as the reservoir. As experienced at site 2, the occasional rainbow trout was present in the spring and winter of 1985 and the spring of 1987, which provides further evidence of the seasonal migration of this introduced species from the reservoir.

Hasgill Beck (Sites 4 and 5).

Site 4: Situated two and a half kilometres from the source, this was the top site on Hasgill Beck, located upstream of the bridge but below the confluence with Swine Clough Beck. The site had a mean water width of two and a half metres, and was relatively shallow with a stony bed (Table II). In marked contrast with sites 1 to 3 on the River Hodder, brown trout were by far the most abundant species, with a high mean survey density of 68.889 $100m^{-2}$ and a maximum density of 171.250 $100m^{-2}$ in summer 1985 (Tables XIX to XXII). The three highest density maxima for brown trout all occurred in the summer months as a consequence of excellent fry recruitment. Bullhead and stone loach were present in much smaller numbers, with mean densities of 4.167 $100m^{-2}$ and 1.944 $100m^{-2}$ respectively. Bullhead were represented at all surveys except summer 1986, whilst stone loach occurred less frequently. Despite the lack of barriers to the upstream movement of fish, no minnow or rainbow trout was seen or captured at the site. Throughout the study period, site 4 represented the best survey site in terms of total fish density, primarily due to the continued summer recruitment of brown trout.

Site 5: The second and final site on Hasgill Beck was located one and a half kilometres downstream of site 4, and approximately a third of a kilometre upstream of the confluence with the River Hodder. In its lower reaches the beck flowed through pronounced pools which held appreciable deposits of sand and salt (Table II).

In contrast to site 4, stone loach were abundant at site 5, with a mean survey density of 33.131 $100m^{-2}$ and a maximum density of 52.727 $100m^{-2}$ in spring 1985 (Tables XIX to XXII). However, brown trout were still well represented, with a mean survey density of 23.232 $100m^{-2}$ and a maximum density in summer 1987 of 79.091 $100m^{-2}$. This abundance of brown trout in the summer and winter of 1987 was probably due to good recruitment and survival of young fish in the locality. Site 5 was devoid of bullhead in winter 1985 and spring 1986; they were the least numerous species on all other sampling occasions.

In similarity with sites 2 and 3 on the River Hodder, but in contrast to site 4 on Hasgill Beck, minnow were present throughout the study period, possibly due to the site's proximity to the reservoir and the relatively deep pools, which afforded protection in the winter months. A single rainbow trout was captured at site 5 in winter 1987, which may suggest that in season a small number may ascend Hasgill Beck as well as the River Hodder.

Beck (Sites 6, 7 and 8).

Site 6: This was the top site on Bottoms Beck, approximately five kilometres from the source, with a mean water width of five metres (Table III). Only two fish species were present throughout the study period, namely brown trout and bullhead. The mean survey density of these species was 10.392 $100m^{-2}$ and 8.889 $100m^{-2}$ respectively, which suggests their abundance was similar. Interestingly however, the maximum density for bullhead of 34,706 $100m^{-2}$ occurred in summer 1985, whilst the brown trout maximum of 32.941 $100m^{2}$ occurred in summer 1987 (Tables XIX to XXII). Within these figures is subsumed an interesting trend, in which brown trout became more abundant and bullhead less so over the study period. There does not appear to be a simple explanation for this change in species structure, such as the recruitment of a particularly strong year class.

In accord with site 4 on Hasgill Beck, the occurrence of stone loach was both spasmodic and limited in number with a mean survey density of 1.176 $100m^{-2}$. No minnow or rainbow trout was encountered at site 6 throughout the study, which may be a consequence of the isolative effect of the waterfall downstream of site 7, effectively limiting upstream fish movement (Plates 9 and 10).

Site 7: Situated one kilometre downstream of site 6, site 7 was still upstream of the waterfall. Positioned on a bend, the site was composed of a well defined pool and riffle with a mean water width of seven metres (Table III). In accord with site 6, brown trout and bullhead were the dominant species present throughout the study period, whilst stone loach were recorded on only two occasions. Of the two, brown trout were the more abundant species with a mean survey density of 8.000 $100m^{-2}$, and a maximum density of 14.667 $100m^{-2}$ in winter 1987 (Tables XIX to XXII). Contrary to the situation at site 6 mean survey density for bullhead was low at 3.630 $100m^{-2}$ with a maximum density of only 9.333 $100m^{-2}$ in spring 1985. A minor decline in bullhead numbers was apparent at site 7, although not as marked as the fall recorded at site 6. Again, no minnow or rainbow trout was recorded at the site, probably as a consequence of the waterfall.

Site 8: This site, the lowest on Bottoms Beck, was located upstream of the gauge house and covered a variety of pools and riffles (Table III). As the only site on Bottoms Beck downstream of the waterfall, the species structure of site 8 was somewhat more diverse than that of the upstream sites. In accord with sites 6 and 7, brown trout and bullhead were the only species present at all surveys, with brown trout more abundant, with a mean survey density of 18.500 $100m^{-2}$ and a maximum of 84.500 $100m^{-2}$ in summer 1985 (Tables XIX to XXII). Brown trout density maxima frequently occurred in the summer surveys as a consequence of fry recruitment, which is probably indicative of spawning fish migrating from the reservoir, a situation not readily apparent above the waterfall.

The mean survey density of bullhead was low at 2.944 $100m^{-2}$, with stone loach lower still at 1.333 $100m^{-2}$. However stone loach occurred more frequently than at site 7. Contrary to the upstream sites minnow were frequently noted, only absent in the winters of 1985 and 1986. Similarly, two rainbow trout were captured in spring 1987, which is further evidence of fish ascending the lower section of Bottoms Beck below the waterfall.

Of the three tributaries covered in the electric fishing survey, the River Hodder appeared the least productive water in terms of total species density. Both Hasgill Beck and Bottoms Beck displayed greater densities, with Hasgill Beck the more productive as a consequence of continued brown trout recruitment over the three years.

Species diversity was found to increase on all three streams in relation to distance from the source, ranging from the spasmodic presence of brown trout in the head waters of the Hodder, to the presence of brown trout, stone loach, bullhead, minnow and, in season, rainbow trout in the lower reaches of all three tributaries.

In accord with work completed by Crisp et al. (1974, 1975, 1984) on tributaries of the River Tees, Cumbria, brown trout were the most common species, recorded from all eight sampling sites. It should be noted however, that on four out of the nine surveys no fish was present at site 1 on the upper Hodder.

Excluding site 1, both stone loach and bullhead occurred at the remaining seven sampling sites. These small, benthic fish, typically found on stony substrata in both lotic and lentic habitats (Mills and Eloranta, 1985), are stated by Maitland (1972) to be widespread and common throughout England and Wales. Work conducted by numerous authors including Crisp et al. (1974, 1975, 1984) and Turnpenny (1985) however, suggests that the bullhead is more widespread in acidic, upland catchments than the stone loach. In the present study an interesting dichotomy was perceivable, in which stone loach were consistently represented in good numbers on the lower reaches of the Hodder and Hasgill Beck (Sites 2, 3 and 5), whilst on Bottoms Beck and site 4, the upper site on Hasgill Beck, bullhead were proportionately more numerous.

This phenomenon may feasibly be explained by differences in the physical characteristics of the respective habitats which favour different species. Work by Hyslop (1982) suggests that although the diet of both species consists almost exclusively of benthic invertebrates there is evidence of 'resource partitioning' which may limit competition. Keast and Webb (1966) note the importance of fishes' gape in dietary selection, such that the small gape of the stone loach places limitations upon the size of the organisms it consumes. The major food items of this species are generally small invertebrates such as the Diptera, Chironomidae and Simuliidae (Smyly, 1955), whilst the diet of the bullhead consists almost exclusively of the larger invertebrate orders Plecoptera, Trichoptera and Ephemeroptera, in accord with its wider gape (Smyly, 1957).

A further explanation of the differences in stone loach and bullhead numbers, may be associated with the tendency of stone loach to seek out quieter stretches of water, where the current is not at its strongest. The turbulent head waters of streams, therefore, may limit their successful ascent and colonisation of such waters. However, on Bottoms Beck it is more probable that the waterfall between sites 7 and 8 has a considerable limiting effect on the upstream population of stone loach. Smyly (1955), states that in tributaries of Lake Windermere, stone loach were present only as far as the first waterfall. Upstream of such an obstruction he notes the stream devoid of stone loach. Certainly in the present study, the waterfall acted as an effective barrier to the upstream movement of minnow and rainbow trout, which were never recorded at either of the upstream sites.

Above the waterfall at site 7 on Bottoms Beck, the noted decline in bullhead and increase in brown trout numbers may have been a consequence of large scale coniferous tree-felling in the vicinity. The removal of trees from a watershed is particularly detrimental to stream fauna, through serious silting of the stream bed caused by an unprotected soil surface (Smith, 1980). Throughout the three years of the survey, sporadic tree-felling was undertaken in the local vicinity which certainly gave an accumulation of fine silt deposits at site 6. Information on bullhead substrate preference given by Mills and Mann (1983) suggests that a stony substratum, particularly of pebbles in the range 40 to 120 millimetres, is preferred. The effect of silting is to bury such substrata, effectively rendering the bullhead 'homeless', with few suitable locations for egg-laying. This situation, in conjunction with the extreme variability in bullhead recruitment as a consequence of severe spring spates (Crisp et al., 1975) might have resulted in the decline in population numbers. It is suggested that localised silting may not have such a limiting effect on the brown trout population, as they may migrate larger distances to find suitable spawning locations.

For reasons concerning CPUE efficiency, minnow population densities were not estimated, although their presence was noted. From these data it was discovered that minnow were confined to the lower reaches of the three afferent streams and never found in the upper reaches, which confirms the observations for tributaries of the River Tees by Crisp et al. (1974). Abundant in both lotic and lentic environments, minnow is a pelagic species in the spring to autumn months. In the winter months however, it migrates to deeper water where it may congregate under stones (Frost, 1943). This pattern of behaviour was notable in the Stocks' tributaries, particularly at shallow sites and those very close to the reservoir. At site 2 on the Hodder and site 5 on Hasgill Beck, both sites containing deeper pools, the species was often present throughout the year.

A similar pattern of migration to deeper water and possibly the reservoir, may occur for bullhead in the lower reaches of the Hodder. At site 3, bullhead were absent during the winter surveys, a phenomenon similarly noted on afferent streams of the newly impounded Cow Green reservoir by Crisp et al. (1984), and explained by the overwintering of bullhead in the reservoir.

The final fish species caught on seven separate occasions in the electric fishing survey was the rainbow trout. This species, introduced into the reservoir for angling purposes, breeds in the period October to March (Maitland, 1972). Common to all salmonids it ascends streams and rivers to spawn, and was therefore captured in the spring and winter surveys but never in the summer. It was encountered most frequently on the River Hodder at sites 2 and 3, where a combined total of eleven fish was taken throughout the study. A single fish was captured at site 5 on Hasgill Beck, but none was seen at the upper site. On Bottoms Beck two fish were taken at site 8, although probably because of the waterfall none was caught upstream. From these data it appears that the Hodder, the major inlet stream, was the favoured spawning location for the species, in accord with the work of Northcote (1969), whilst Hasgill Beck and Bottoms Beck, possibly as a consequence of their less well defined entries into the reservoir, appeared rarely visited. At no time throughout the survey were rainbow trout fry encountered. This may indicate a lack of spawning success, which is unsurprising as they are known to breed successfully only in a limited number of localities in Britain. (Mills, D.H. 1971; Maitland, 1972).

A fish interestingly absent from the tributaries was the eel (Anguilla anguilla), a very common fish in the River Hodder and its tributaries downstream of Stocks Reservoir. In an electric fishing survey of the hydro pool below the reservoir embankment, large eels were caught in profusion. It is therefore assumed that the embankment and overspill weir are of such construction as to deter eels from ascent to the reservoir.

Bullhead and stone loach population structure

Although emphasis was placed on detailed analysis of the brown trout populations, length frequency histograms were plotted for both bullhead and stone loach (Tables XXIII and XXIV; Figures 9 and 10). No attempt was made to accurately age these species, as their otoliths must be used which require the fish to be killed (Smyly, 1957; Crisp, 1963; Crisp et al., 1974; 1975).

As catches of bullhead and stone loach were often small in a survey, the length frequency data were pooled in order to increase the sample size. This was achieved by combining the spring, summer and winter catches respectively, over the three year study period, on the assumption that growth would be at a similar stage.

In upland tributaries of the River Tees, bullhead of 10 years of age have been recorded (Crisp *et al.*, 1975; Mills and Mann, 1983), at which point they may exceed 120 millimetres in length. In a study of bullhead in Lake District waters, Smyly (1957) recorded a maximum length of 81 millimetres, whilst in the present study, the maximum length attained was 99 millimetres at site 6 on Bottoms Beck. Fish of this approximate length in Tees' tributaries were found to be from 7 to 8 years of age. In accord with the work of Smyly (1957) and Crisp (1963), 0 group bullhead were rather scarce throughout the study. This absence was probably a consequence of such small fish going unnoticed amongst the pebbles of the stream bed.

Despite the single, short breeding season of the bullhead, it was noted by Smyly (1957) that plots of length frequency often gave no clear indication of age groups. However, Crisp *et al.*, (1974) found such plots adequate for the determination of 0 group fish, but inadequate for determination of age in older fish as the length distributions of the age groups overlapped; this trend was apparent in the present study.

At no time in the present study were bullhead of the 0 group present in the summer surveys. In the winter surveys at site 4 on Hasgill Beck and sites 6, 7 and 8 on the Hodder however, a number of fish up to 40 millimetres in length were caught. These fish could be followed through the spring surveys at sites 4, 6 and 7 respectively, as they approached one year of age. Although a number of further distinct peaks is present beyond the 0 group, it becomes extremely difficult to distinguish between further age groups without additional information. From comparison with the work of Crisp (1963), Crisp et al. (1974; 1975; 1984) on tributaries of the Tees, it is probable that the major peaks are formed of either 1 or 2 year old fish.

The stone loach length frequency data were plotted for spring, summer and winter surveys, in the same manner as the bullhead data. Again if age was to be determined then otoliths would have been required.

The length frequency histograms, when plotted, were somewhat easier to interpret than those of bullhead, probably due to the larger sample sizes and the shorter life span of the stone loach. The largest samples, taken at sites 2 and 3 on the Hodder and site 5 on Hasgill Beck produced histograms with the clearest peaks. When these were compared with length for age data of fish from a similar upland location in the English Lake District (Smyly, 1955), then an approximation of age was possible. Once again 0 group fish were scarce in accord with the bullhead data. At site 2 on the Hodder however, a number of fish in the size class 25 to 30 millimetres were present in the winter surveys, whilst a larger number probably approaching 1 year of age, were apparent in the spring surveys.

Peaks representing older age groups were detectable at these sites, especially for site 5 in the summer surveys, where distinct peaks probably representing 1, 2 and 3 year age groups were apparent. As a consequence of growth slowing down in older fish, it was difficult to discern the presence of age groups older than 3 years. In comparison with the work of Smyly (1955), the fish in the present study may grow at a similar rate to those of Lake District beck fish. Further, of the fish caught, 2 year old fish probably constituted the largest single proportion.

Brown trout population structure

River Hodder (Sites 1, 2 and 3).

Site 1: Brown trout were the only fish species recorded at this site, with a maximum density of 2.857 $100m^{-2}$ in winter 1985 (Table XXII). Over the study period fish of age groups 0 to III were represented (Tables XXVIII to XXX). The presence of a single 0 group fish in summer 1985 suggests occasional successful spawning in the vicinity, which is probably severely restricted by winter spates.

Site 2: Fish species were more abundant at this site than at site 1 upstream, with brown trout showing a maximum density of 18.095 $100m^{-2}$ in summer 1987 (Table XXII). Older fish were well represented in the summer surveys as well as the winter, which was probably a consequence of the site's deeper pools and undercut banks providing suitable shelter. An old fish, questionably aged at 10 years, was the only fish recorded in the survey of spring 1986; the absence of further trout was explained by a recent pollution incident (Tables XXVIII to XXX).

Trout of age group I were often well represented at the site, with a maximum density of 11.289 $100m^{-2}$ in spring 1985. There was a marked decline between this age group and older fish, especially of age group II, which showed a maximum density (in spring 1985) of 2.605 $100m^{-2}$. In addition to mortality, this decline may be an indication of downstream movement towards the reservoir of fish in their third season of growth (Figure 11).

Trout fry were often present in low densities, which might suggest low recruitment in the vicinity. A maximum fry density of 10.477 $100m^{-2}$ was recorded in summer 1987 however, which may denote a particularly good year for recruitment. The second highest fry density of 5.820 $100m^{-2}$ occurred in winter 1985, following low fry numbers in the previous summer, a situation probably indicative of downstream drift of fry from redds above the site.

Site 3: In contrast to site 2, no fish over age group III was recorded from this site. This was probably a consequence of the lack of deeper water and suitable shelter afforded by the site, such that larger fish moved to more suitable locations.

Brown trout densities were always rather poor, reaching a maximum of 8.750 $100m^{-2}$ in summer 1987 (Table XXII). This figure was primarily composed of 0 group fish, which represented the highest fry density of the site study. By winter 1987, 0 group density had fallen to 1.250 $100m^{-2}$ as a consequence of mortality and probable downstream drift of fry.

Interestingly, densities were at a minimum in 1986 in accord with those at site 2. This fact may be an indication of the farm effluent pollution upstream of site 2 having a deleterious effect as far down stream as site 3 (Tables XXVIII to XXX).

Hasgill Beck (Sites 4 and 5).

Site 4: The top site on Hasgill Beck, site 4, represented the best location of the study for the recruitment of brown trout fry, with age groups 0 and I always dominant. Particularly high densities of 137.531 $100m^{-2}$ and 77.264 $100m^{-2}$ were recorded for 0 group fish in the summers of 1985 and 1987 respectively (Tables XXVIII and XXX).

A marked decline in density of fish older than age group I was noticable in the majority of surveys. Similarly, if a year class were followed through the study period then the same trend was apparent (Figure 11). Although losses to mortality are likely to be considerable, the drop in age group density is probably indicative of the down stream movement of fish predominantly in their third season of growth.

In the majority of surveys, no fish older than age group III was encountered, arguably because of the shallow nature of the site. It is likely that fish of age group IV, only present in the winter survey of 1987, were spawning migrants.

Site 5: The lower brown trout densities at this site, as opposed to those at site 4 upstream, were attributable to lower densities of 0 and I group fish (Tables XXVIII to XXX).

Although recruitment here was generally poor, the summer survey of 1987 saw a high fry density of 62.340 $100m^{-2}$, which corresponded with the good 0 group recruitment at site 4. This may indicate that the year 1987 was one of good recruitment throughout Hasgill Beck.

The data may further suggest a down stream movement of fish from age groups I and II (Figure 11). This migration may be partially obscured, however, by the movement of similar fish through the site from upstream. Unlike the situation at site 4, occasional older fish were present at all survey periods, probably due to the excellent locations afforded by the site's pronounced pools.

Bottoms Beck (Sites 6, 7 and 8).

Site 6: This site, situated above the waterfall on Bottoms Beck, was occupied by fish possibly as old as age group VIII (Tables XXVIII to XXX). The presence of older fish above an obstruction such as a waterfall is not unusual, and may be explained by the fish following a more sedentary existence. This pattern of behaviour is further accentuated by the continued presence of fish from age groups II and III, suggesting that the downstream movement of juvenile fish is less evident (Figure 11).

Over the period of the study, 0 group fish were always present in the summer and winter surveys, but never at high densities. Fish of age group I exhibited the highest density of 14.570 $100m^{-2}$ in summer 1987. As the fry density in summer 1986 appeared rather low, this may suggest movement of juvenile fish within the section of stream above the waterfall. It was noted that minimum overall trout densities occurred in the spring surveys, which may be indicative of movement to deeper, more favourable locations in the winter months.

Site 7: Situated upstream of the waterfall, site 7 experienced good densities of older fish throughout the year, in accord with site 6 (Tables XXVIII to XXX). The existence of a deep pool at the site, capable of providing suitable cover for such fish, may have facilitated their increased densities. Trout densities were particularly limited, however, in winter 1986, when the only fish present were of age group I. The absence of fish of other ages is not readily explicable, unless an isolated pollution associated with discharges from a local drainage pipe were to blame.

Possibly as a consequence of poor spawning locations in the vicinity of site 7, the presence of fry in the summer and winter surveys was generally limited. On the other hand, the isolative effect of the waterfall down stream, may argue for an absence of migratory spawning fish.

In accord with the situation seen at site 6, the down stream movement of fish in their second year of growth, associated with the survey sites on the Hodder and Hasgill Beck, was not readily apparent at site 7. This may suggest a limited movement towards the reservoir as a consequence of behavioural differences in the upstream population.

Site 8: In marked contrast with sites 6 and 7 upstream of the waterfall, older fish were only present at site 8 in the winter surveys, possibly indicating a spawning migration from the reservoir (Tables XXVIII to XXX). Furthermore, summer fry density which peaked at 75.171 $100m^{-2}$ in summer 1985, was much greater at site 8. In all surveys at the site, the majority of trout were of either age groups 0 or I, with a characteristic decline by age group II, suggestive of movement down stream, possibly to the reservoir (Figure 11).

Unfortunately in the winter of 1985/1986, the shallow gauging house pool at the foot of the site was excavated of its sand and gravel, with the inevitable destruction of a number of redds. This necessary but damaging undertaking, may well explain the relatively low fry density apparent in the summer survey of 1986.

It is well known that both abiotic and biotic factors affect the response of fish communities, such that their composition and productivity will change along a watercourse (Zalewski et al., 1986). In this respect the three major tributaries of Stocks' catchment were not unusual in the spectrum of their populations.

Site 1 was by far the least productive site, possibly representative of much of the head waters of the River Hodder, upstream of Cross of Greet Bridge. With a maximum brown trout density of 2.857 $100m^{-2}$, this site was on a par with the afferent streams of Lake Osensjøen, Norway, where trout densities rarely exceed 4.5 $100m^{-2}$ (Haraldstad *et al.*, 1987). By comparison with site 1, the study's seven remaining survey sites held copious and diverse fish communities.

In the afferent streams of lakes such as Stocks Reservoir, the autumnal spawning migration of mature brown trout has been well documented. Mills, D.H. (1971), notes the initial congregation of migratory fish around stream mouths as early as the last week in August. At Stocks Reservoir similar congregations probably occur; it was noted for instance that anglers often fished in the vicinity of the River Hodder in the late summer months. The main migratory ascent of tributaries is likely to occur in November, as recorded by Craig (1982) in afferent streams of Lake Windermere, where the migration was usually associated with spate conditions.

In the present study site 5 on Hasgill Beck, and site 8 below the waterfall on Bottoms Beck, clearly exhibited concentrations of older, mature fish in the winter surveys. Not surprisingly, these sites possessed suitable spawning locations and substrate in the vicinity (Mills, D.H. 1971; Heggenes, 1988). However, upstream of the waterfall on Bottoms Beck, spawning migration from the reservoir appeared minimal, with resident older fish present throughout the year.

From the annual histograms of summer fry densities and summer and winter percentage fry densities displayed in

Figures 12 and 13 respectively, it may be seen that the highest and most consistent fry densities occurred at site 4, the top site on Hasgill Beck. Down stream at site 5, the densities were less consistent, only reaching a high level in 1987. The final site to exhibit good summer fry densities was site 8, downstream of the waterfall on Bottoms Beck, although here too densities were inconsistent, with 1985 returning the only high value. The poor recruitment of 1986 and 1987, however, may have been a result of the excavation of the gauge house pool, the tail of which provided an ideal spawning location. Upstream of the waterfall sites 6 and 7 consistently displayed poor fry densities, possibly indicative of limited spawning success or low survival of eggs and fry. These low densities may have been attributable to the silting of the sites which occurred throughout the study period, possibly as a result of coniferous tree-felling in the locality (Smith, 1980). Further evidence suggests that in streams draining afforested catchments in upland areas of Scotland and Wales, where soils may afford limited buffering capacity, salmonid populations may be impaired by the leaching of acidic and metallic ions (Stoner and Gee, 1985; Turnpenny, 1985).

The River Hodder, covered by sites 1, 2 and 3, exhibited by far the lowest summer fry densities of the three tributaries, particularly when it is realized that no barrier to upstream migration exists. It should be noted, however, that a farm effluent pollution upstream of site 2 may have had a deleterious effect on recruitment, particularly in 1986. The highest fry densities at both sites 2 and 3 were recorded in 1987, possibly indicative of good recruitment in the lower stretches of the Hodder. Interestingly, sites 4 and 5 on Hasgill Beck recorded similarly high fry densities in the same year, which perhaps demonstrates that 1987 was a favourable year for brown trout recruitment in the catchment as a whole.

These fluctuations in fry density and recruitment experienced over the study period were to be expected (Mann, 1979), particularly in upland streams where environmental conditions may often be so unfavourable that recruitment to the population may be nil (Elliott, 1976; Turnpenny, 1985). Crisp et al. (1974; 1975) considered year to year fluctuations in recruitment as one of the notable features of populations in upland catchments. Further, the longevity of brown trout in such environments may be judged an adaption in order to facilitate survival, by acting as an insurance against a succession of poor years (Mann, 1979).

Throughout the study it was noted that if summer fry densities were large, then there was generally a sharp decline by the winter survey. This decline was probably accounted for by two related factors, namely downstream dispersal and heavy mortality. Upon emerging from the substrate, fry immediately start to disperse downstream, as fry in excess of those with territorial space are evicted (Mortensen, 1977). This eviction is brought about by the aggressive behaviour of the larger, healthier fry which are able better to swim against the current and hold their territory (North, 1979). Further, Elliott (1986) noted that in field studies, fry which tended to drift the furthest were generally moribund. In work on Walla Brook in south west England, Elliott (1966; 1967b) concluded that maximum fry drift occurred in March and April and is usually nocturnal, thereby coinciding with the increased availability of benthic invertebrates. Further, Ottaway and Clarke (1981) and Elliott (1987b), suggested a close relationship between flow velocity and downstream displacement of fry. Mortality is known to be highest at this stage of the life cycle, primarily because many fry fail to establish feeding territories, with the consequence that they lose weight and eventually die (Elliott, 1987b).

Mortality resulting from such displacement is referred to as density dependent mortality (Kennedy, 1985; Rasmussen, 1986), and is thought to be an important factor in the regulation of brown trout populations. Elliott (1985, 1987a) however, notes some disagreement about its importance in relation to environmental factors.

Heggenes (1988), recorded that the fry that do manage to secure territories prefer areas of coarse substrate in the region of 50 to 70 millimetres in diameter. Kennedy and Strange (1982) in their work on the distribution of salmonids in upland streams, demonstrated that fry density is significantly related to the area of shallow water habitat available. In the present study, those criteria coincided with continued high fry densities notably at site 4 on Hasgill Beck which consistently exhibited the most abundant fry densities.

At sites 4 and 8 where fry recruitment appeared particularly good, a marked decline in density between age groups I and II was often observed (Figure 11). As Mortensen (1977) described mortality as density independent at this stage in the life cycle, and typically far lower than in the early stages, it was felt that fish must be migrating from these sites, possibly towards the reservoir. In support of this hypothesis, Northcote (1969) observed both brown and rainbow trout in afferent streams of some British Columbian lakes, residing there for at least one and often two or more winters, before commencement of lakeward migration, whilst Rasmussen (1986) recorded a similar situation in a Danish stream. Similarly, Craig (1982) noted that 70% of fish entering Lake Windermere from afferent streams were of age group II, whilst the majority of Loch Leven fish were observed to migrate at Age I (Arawomo, 1982). In tributaries of Loch Leven, Scotland, the onset of migration of such fish was found to coincide with increased stream discharge caused by heavy rainfall (Arawomo, 1981a). This migration extended from October to July, peaking in April.

At sites 6 and 7 located above the waterfall on Bottoms Beck, the continued year-round presence of older fish including those of age group II, suggested comparatively little emigration from the sites. Similar observations by Northcote (1969), demonstrated marked differences in migratory behaviour between above and below waterfall populations. Further experimental work by Northcote (1981) who used artificial stream channels, established the limited downstream movement of juvenile trout from above waterfall populations, whilst those from below readily moved downstream, especially at night. In tributaries of Lake Windermere, it was noted by Elliott (1988) that in Black Brows Beck, where no barrier to upstream movement existed, juvenile fish up to two years of age predominated. This pertains to the situation in the present study on the River Hodder, Hasgill Beck and Bottoms Beck below the waterfall. In Wilfin Beck, however, an example of an isolated population similar to Bottoms Beck upstream of the waterfall, larger fish over two years of age predominated. Elliott (1987a) reasoned that this difference in migratory behaviour is attributable to strong selection in resident trout for genotypes resistant to downstream migration, whilst the population is held in check by the frequency of unfavourable environmental conditions, such as spates and drought.

The presence of older fish at sites other than those upstream of the waterfall on Bottoms Beck was noted, particularly at sites 2 and 5. This phenomenon was not regarded as usual, as trout are known to move from shallow to deeper water as they get older, with yearling and older trout apparently preferring slightly deeper habitats (Kennedy and

Strange, 1982). These sites exhibited the most pronounced pools and suitable habitat of the study for these older and generally larger fish. Similarly, the poorest catches were associated with the spring surveys, which may be a consequence of fish of all ages having moved to more sheltered, and possibly deeper locations, during the winter months, as protection against predation and displacement by increased water velocities (Hartman, 1963; Heggenes, 1988).

Brown trout population comparison

Tributaries of both the River Tees and River Eden, Northern England, rise at altitudes in excess of those encountered in the Stocks catchment, ranging from 533 metres to 739 metres (Crisp et al., 1974; Crisp and Cubby, 1978).

In accord with the Stocks tributaries however, those of the Tees and Eden exhibited considerable differences in fish densities between sites and from season to season, particularly with respect to fry (Table XXXII). Further, some streams, notably Weelhead Sike and Dubby Sike both Durham tributaries of the Tees, and Knock Ore Gill a tributary of the Eden, consistently showed better fry recruitment, in similarity with sites 4 and 5 on Hasgill Beck and site 8 downstream of the waterfall on Bottoms Beck. In this respect site 4 exceeded Weelhead Sike the most abundant Tees tributary, in terms of fry and older fish densities. Sites 5 and 8 also compared favourably with the Tees tributaries, as fry recruitment was somewhat similar to that on Dubby Sike, although Knock Ore Gill, the better Eden tributary, appeared more consistent.

Site 1 on the Hodder, by far the least frequented site of the study, exhibited extremely poor fry and older fish densities similar to those of the upper Tees. It was noted by Crisp et al. (1974), that the Tees itself, including Maize Beck, consistently gave population densities lower than those of the afferent streams, with recruitment in those reaches largely supplemented by migration.

Upstream of the waterfall on Bottoms Beck, the fry and older fish densities of sites 6 and 7 resembled those of the poorer Tees tributaries, Mattergill Sike and Lodgegill Sike. It was suggested by Crisp et al. (1974) that the decreasing trout population densities of the Tees tributaries corresponded with an observed increase in liability to severe spates. In the present study such spates may help explain the low trout densities observed in the River Hodder.

As a whole, the range in trout densities of the present study showed some similarity with those of the Tees and Eden tributaries. Characteristic of both were the fluctuations in fry and older fish densities within the catchments and over time, a pattern common to many upland streams. The most abundant fry densities in the Stocks' catchment appeared to exceed those of the Tees and Eden. However, Crisp et al. (1984), in an analysis of the same streams after the impoundment of Cow Green reservoir, noted an increase in fry density in most afferent streams, ranging from 300 to 1100%. This increase, a consequence of augmented egg production through the immigration of spawning reservoir fish, produced summer fry density maxima of between 70 $100m^{-2}$ and 225 $100m^{-2}$, although considerable variation in recruitment was still apparent. Such densities occurred rarely in the present study, thereby indicating that overall recruitment within the Stocks' catchment may be limited in comparison with the present situation at Cow Green.

Brown trout observed length for age

Over the period of study, observed length for age was found to be rather similar between the tributaries, although comparison beyond age group III was not possible at sites 1, 3 and 8, as a consequence of the paucity of older fish. Further, complications in the ageing of some older fish from scale samples were experienced, so compounding the difficulties. The most extensive length for age data were acquired from deeper sites where older fish were often present, and from sites with limited downstream migration, upstream of the waterfall on Bottoms Beck (Tables XXXIII to XXXV, Figures 14 to 21).

Although overall length for age was found to be similar, some differences were perceivable, particularly in lengths of O group fish and older fish resident above the waterfall on Bottoms Beck. A similar trend in lengths of O group fish was detected by Craig (1982), in a study of the growth and mortality of brown trout in afferent streams of Lake Windermere.

In the present study at site 4 on Hasgill Beck, trout of age groups O and I were consistently shorter in length than similar fish lower downstream at site 5. This length inequality was perhaps attributable to site 4's offering a favourable environment for recruitment, resulting in the presence of higher densities of O and I group fish. In support of this hypothesis, it was noted that the minimum mean O group length of 43 millimetres, recorded at site 4 in summer 1985, corresponded with the maximum recorded fry density of 137.531 $100m^{-2}$. By age group II this difference in length was not observable, possibly as a consequence of fish moving downstream, through the site towards the reservoir.

At sites 6 and 7, upstream of the waterfall on Bottoms Beck, the observed mean length of O group fish was similar at both sites. However at site 8 located downstream of the waterfall, shorter mean lengths for O and I group fish were recorded, in accord with the situation on Hasgill Beck. This difference suggested good juvenile fish growth above the waterfall, possibly as a result of limited recruitment, whilst downstream the lower growth rate was perhaps a consequence of good recruitment and higher densities. Further, as at site 4, the lowest mean O group length of 43 millimetres corresponded with the maximum fry density of 75.171 $100m^{-2}$, recorded for site 8 in summer 1985. It is likely that this situation is indicative of regular, successful spawning by migratory fish in the vicinity of site 8, whilst the ascent of such fish above the waterfall is limited.

Unfortunately very few fish older than age group II were captured at site 8, prohibiting a comparison of length for age in older fish, both above and below the waterfall. However, comparison may be made with older fish recorded at site 2 on the River Hodder. Such a comparison may suggest that growth of older fish above the waterfall was slower than that observed at site 2, although not markedly so. The apparent slower growth rate of such fish is understandable, due to the isolated nature of the population and consequent competition for food and space, whereas fish downstream of the waterfall have unobstructed access to the reservoir. Elliott (1988), noted a similar discrepancy in growth in the populations of Wilfin and Black Brows Beck in the English Lake District.

Brown trout length for age comparison

As overall growth was found to be generally similar between the Stocks' tributaries they were compared as a whole with length for age data culled from a variety of authors, namely Thomas (1964), Crisp and Cubby (1978), Milner et al. (1978), Crisp et al. (1974, 1975, 1984) and Turnpenny (1985).

A primary comparison was undertaken with work by Crisp et al. (1974, 1984) on the trout populations of tributary streams of the River Tees, before and after the impoundment of Cow Green reservoir. As it was noted by Crisp et al. (1984), that no change in mean length for age was apparent after impoundment, the data of Crisp et al. (1974) were used for purposes of comparison.

From the annual mean values of length for age calculated for the Durham and Westmorland tributaries, and the River Tees both above and below the proposed embankment (Figure 22) growth was found to be rather slow when compared to published estimates for other waters. Growth was found least favourable in the Durham tributaries, which corresponded closely with observed length for age data from the Stocks' tributaries, particularly those recorded at sites 6 and 7 above the waterfall on Bottoms Beck. From approximately year five onwards, observed length for age of River Hodder fish exceeded that of the Durham tributaries, probably as a consequence of reservoir migration.

Similar growth data recorded by Crisp et al. (1975) for further Tees' tributaries, notably Trout Beck and Great Dodgen Sike on the Moor House National Nature Reserve, exhibited considerably slower growth rates (Figure 22). However, data from Knock Ore Gill and Swindale Beck, both Eden tributaries rising in the same upland area, demonstrated growth rates comparable to those experienced in the Stocks' tributaries, with superior rates of growth probably attributable to movement of fish to and from the Eden (Crisp and Cubby, 1978).

The growth rates of brown trout populations from a sample of oligotrophic streams in the Peak District and North and Mid Wales, were documented by Turnpenny (1985), (Figure 23). These populations exhibited growth rates corresponding to those recorded for the Durham tributaries at Cow Green and the Stocks tributaries, which further suggests that length for age observed in the Stocks' tributary study was consistent with growth from other poor upland locations.

In comparison with growth rates recorded at a number of Welsh waters, however, namely the Teify, Rheidol, Pysgotwr (Thomas, 1964) and four tributaries of the Upper Wye (Milner et al., 1978), Stocks' tributary length for age values compared less favourably. Growth rates for sites on the upper and lower Teify and the Upper Wye tributaries were markedly superior to those observed for the Stocks' tributaries, whilst it was noted by Milner et al. (1978) that growth in the Upper Wye tributaries was better than that observed in the Tees' system by Crisp et al. (1974). Although growth was similarly superior in the Rheidol and Pysgotwr the margin was less marked, with growth rates falling between those observed for the Stocks' tributaries and those of the Teify and Wye.

Scale photography

From the samples of scales procured during the electric fishing surveys, a number of photographs were taken.

Impressions of fish scales may be achieved by a number of separate techniques. The oldest and most laborious method involves photomicroscopy, whereby a camera is used to photograph the scale through a microscope, and a print produced from the ensuing negative. In the present study, the photographs were produced by projecting the scale image through an enlarger, a technique pioneered by Banks and

Irvine (1969). Although the resulting pohtograph is a negative image, this does not detract from its usefulness. Further, the technique is relatively swift, and the photographs may be of extremely high definition and quality if a high grade lens is used, stopped down to give the correct depth of field.

In preparation for photography, scales were cleaned in 8% sodium hydroxide solution and distilled water, before being mounted dry between two glass slides bound tightly together. In order to gain the desired contrast between the scale striae, it was necessary to use a 'hard' photographic paper, in this case Kodabrome II, F4.

Assuming that the equipment is available, a modern technique involving the use of a microfische projector will yield high definition scale impressions. Particularly appropriate for larger scales, this method uses a microfishe projector linked to an appropriate printer unit in order to produce a photocopy of the scale image (Cowx, 1982). Tsumura (1987) gives further details for the improvement of clarity and contrast in such photocopies.

The reason for the inclusion of Plates 11 to 13, illustrating sets of scales from age group I, II and III fish respectively, is to give an impression of the diverse scale morphology both between age groups and within a set of scales. An important point to note is the difference in morphology of scales from an individual fish, such that some scales appear to exhibit limited similarity. In conjunction with the large proportion of regenerate scales, this indicates the need for a large sample of scales to be collected from an individual fish. The increased thickness of the regenerate scale striae indicated by their brightness is also notable, particularly in the age group III sample (Plate 13).

SUMMARY

Invertebrate fauna

From invertebrate site samples collected in autumn 1985, the orders Plecoptera, Ephemeroptera, Diptera, Trichoptera, Coleoptera, Collembolla, Arthropoda and the sub-class Oligochaeta were encountered. Bottoms Beck was observed to be the most productive tributary, both in terms of invertebrate diversity and abundance, whilst the River Hodder was observed to be the least productive.

The upstream sites on each tributary displayed consistently the poorest invertebrate diversity, dominated by the order Plecoptera. Plecoptera and Diptera, typically of the families Perlodidae and Chironomidae, were ubiquitous in their distribution, whilst the conspicuous absence of *Gammarus* spp. and *Baetis* spp. may be indicative of acid stress.

Fish populations

Electric fishing surveys revealed the presence of four native and one introduced fish species, namely brown trout, bullhead, stone loach, minnow and introduced rainbow trout.

Calculated species densities using Carle and Strub's (1978) MWL method, revealed the River Hodder as the least populous tributary whilst Hasgill Beck displayed the greatest densities as a consequence of consistent brown trout recruitment.

Species density was found to increase with distance from the source on all tributaries, ranging from the spasmodic presence of brown trout in the headwaters of the River Hodder, to the presence of all encountered species in the lower reaches of the three tributaries.

Brown trout displayed the greatest distribution, whilst minnow were confined to the lower reaches of the tributaries. The distribution of bullhead and stone loach exhibited a marked dichotomy, with the former numerous on Bottoms Beck and the upper site on Hasgill Beck and the latter well represented on the River Hodder and the lower Hasgill Beck site.

Rainbow trout were encountered in the winter and spring surveys only at the lower tributary sites, with the majority captured on the River Hodder.

Bullhead and stone loach populations

For both bullhead and stone loach, 0 group fish appeared scarce, probably because of sampling difficulties.

A comparison of bullhead length frequency data with those of populations of the River Tees indicated that the majority of fish were of 1 and 2 years of age, whilst the largest individuals attained 8 years.

Similarly, a comparison of stone loach with beck fish of the English Lake District suggested that fish of 1, 2 and 3 years of age were present, with 2 year old stone loach contributing the largest proportion.

Brown trout populations

From an examination of age group density data the presence of older brown trout was apparent at the majority of the sites, particularly in the winter periods, a phenomenon probably indicative of spawning migration. The waterfall on Bottoms Beck might well preclude such upstream migration above site 8.

The greatest and most consistent brown trout fry densities occurred at site 4 on the upper reaches of Hasgill Beck, whilst at site 8 downstream of the waterfall on Bottoms Beck high fry densities similarly occurred, although excavation of the gauge house pool might have limited recruitment in 1986 and 1987. Poorer fry densities were apparent upstream of the waterfall, probably consequential of limited access to spawning migrants. The River Hodder experienced the lowest and least consistent fry densities.

Evidence of the possible downstream movement of juvenile brown trout was apparent at the majority of the sites, excluding sites 6 and 7 upstream of the waterfall on Bottoms Beck where population age group densities indicated limited migration.

Over the period of the study observed mean length for age was found to be similar between tributaries, although differences were perceivable with respect to 0 group and older brown trout resident upstream of the waterfall on Bottoms Beck. Inequalities in the mean lengths of 0 group brown trout were particularly notable in comparison with sites 4 and 8, which exhibited the highest fry densities. At these sites mean 0 group lengths were consistently shorter than at the less populous, isolated sites upstream of the waterfall. Conversely, growth of older fish above the waterfall on Bottoms Beck was observed to be slower in comparison with corresponding fish at other sites, possibly as a consequence of increasing competition and limited access to the reservoir.

In line with the findings of other authors working in this field, observed length for age of brown trout in the afferent streams of Stocks Reservoir was seen as synonymous with that for other oligotrophic upland stream locations.

Chapter III The Fishery

Introduction

The recreational pursuit of fish with a rod and line has an extremely long history, with Dame Juliana Berners' work entitled 'The Treatyse of Fysshynge wyth an Angle' published in the second Book of St. Albans, 1496, often regarded as the first English manuscript (Dill, 1978) on the subject. In 1653 Izaak Walton published his famous volume 'The Compleat Angler, or the Contemplative Man's Recreation' which was extended in 1676 with a chapter on fly fishing by Charles Cotton. In the nineteenth century fly fishing, particularly with a dry fly, reached a wider audience with publications by Stewart (1857) and Halford (1889). In this century Skues (1910) and more recently Sawyer (1952, 1958) further developed fly fishing techniques by legitimising the use of wet flies in the streams and rivers of Southern England. In recent years, a wealth of specialist literature has abounded, prompted by the acceptance of and the accelerating increase in the number of still water trout fisheries available.

Intensively stocked and managed still water fisheries are a relatively new concept, first popularised in the United States (Jenkins, 1970; Dill, 1978). In Britain, Blagdon Reservoir initially managed by the Bristol Waterworks Company in 1905, is often regarded as the earliest example (Melvin, 1957). From such beginnings still water trout fisheries developed, with large reservoirs such as Pitsford (299ha) and Grafham (635ha) open to the public in the 50's and 60's

(Saxton, 1969). However, it was not until 1969, with the formation of The Institute of Fishery Management (IFM), that a more professional approach to fishery management was adopted (Fleming-Jones, 1971).

The increase in affluence and leisure time during this period resulted in a considerable increase in angling pressure, which demanded improved management techniques and stimulated the development of new fisheries. Coles (1981), suggested that by the late 1970's over two hundred and fifty stillwater trout fisheries existed in England and Wales alone, ranging from native upland fisheries to stocked lowland reservoirs and intensively fished ponds (Small, 1983). Over the period the popularity of the native brown trout waned, whilst the introduced newcomer, the rainbow trout, has become the dominant stock fish, because of its angler-acceptance and its superior growth rate under farm conditions (Pawson, 1986).

Liddell (1977) reported that two hundred and fifty impounded waters exist under the jurisdiction of the North West Water Authority of which a number are suitable for development as trout fisheries. Stocks Reservoir, with a maximum surface area of 139 hectares, is the largest impounded water in the North West Region, and has supported a marginal fishery for a number of years.

Stocks Reservoir as a sport fishery

The establishment of Stocks Angling Club in the 1960's marked the beginning of organised rod-and-line angling at the reservoir. The club drew membership from Water Authority personnel who enjoyed fishing for native brown trout and a small number of introduced rainbow trout in a secluded, stillwater location. This marginal fishery provided upwards of 700 fish in a good season, although they tended to be relatively small. A fish of 1lb (454g) in weight was considered good; however, a few truly large fish, weighing up to 7lb (3175g), were caught by trolling in the vicinity of the island (Figure 24). Preferred fishing locations were off the dam embankment, around the margins of Hollins Bay, the location of the present fishery cabin, and at the north end of the reservoir on the banks of the Hodder; angling proved most productive in the months of May and June.

Two thirds of the fishermen employed bait techniques, usually ledgering with worms or minnows. Spinning with artificial lures or natural minnows was similarly successful, and used by a quarter of regular anglers. Flyfishing on the other hand was practised by only two or three individuals, the technique being less predictably successful. Its lack of popularity was not surprising as many anglers regard it as a difficult technique to employ, particularly on an exposed windswept water such as Stocks.

Plans of the 1970's, seeking to fulfil the Authority's statutory obligation to provide for recreational activities where feasible, included the opening of Stocks Reservoir as a public fishery. To this end Mills, M.L. (1971) produced a thesis analysing the biological potential of Stocks, as a viable site for the development of a game fishery. Similarly in the years 1977 and 1978 diagnostic fishing undertaken by Stocks Angling Club produced further data concerning such a venture. It was not until 1983, however, that the Authority's Water Management Committee approved a plan for the development of a public fishery at the reservoir, which was subsequently approved by the Board in January 1984.

The proposal was finally put to tender with a closing date in April 1984, so that the fishery might open for business as a day ticket water early in the 1985 season. The Authority provided basic facilities, including an access road and car park, an anglers' cabin with electricity and sewerage, some necessary paths and landscaping (Plates 14 and 15). Additionally, help with the initial stocking of the reservoir was undertaken through the Authority's providing half the stock on a long lease basis. A condition of the lease was that the tenant should replace this stock on termination of his lease. A proposed stocking density of 100lb per acre (112 kg ha^{-1}) was stipulated for the reservoir standing at its mean summer area of 210 acres (85 ha). Thus 21,000lb (9525 kg) of trout might be stocked at an overall density of 61lb per acre (68 kg ha^{-2}) at top water level. Such a commitment by the Authority required a lease of 7 years, with an option for two further periods of equal duration.

Mr. R. Currie, an established fish farmer from the nearby village of Bentham, finally signed the lease. The reservoir was stocked initially to the stipulated density with rainbow, brook and brown trout, before its opening as a day ticket flyfishery on 16th March 1985. An official opening ceremony was held in April of the same year at which Mr. T. Barnes, the Chairman of the Regional Fisheries Advisory Committee, unveiled the commemorative plaque (Church, 1985).

Prior to the fishery's opening, an investigation into possible fish losses on the treatment plant filter plates was undertaken (Nott, 1984). This was deemed necessary because an increase in filter plate impingement was suspected as a consequence of the high fish density associated with the new venture . The subsequent report recommended that consideration should be given to the screening of the valve tower's draw-off ports in order to minimise any future impingement. However, that suggestion had not been acted upon by 1987. Consequently both native and stocked fish have been lost regularly to the filter plates throughout the period of this study.

Methodology

Catch returns

An analysis of the fishery was based primarily on the information obtained from completed catch return forms. Such information is of value at the majority of fisheries; however, in the case of a put-and-take stillwater trout fishery the manager is particularly dependent upon these data, because the fish stock is maintained by the sporadic introduction of hatchery-reared fish (Easton and Morgan, 1974; Axford, 1979; O'Grady, 1979; Cane, 1980). Methods of procurement, and the interpretation of angler return forms, have been discussed by numerous authors, notably by Hunt and Jones (1972d), Cane (1980), Coles (1981), Bryan (1982), O'Grady (1983), Small and Downham (1985), Swales and Fish (1986) and Small (1988).

These returns should convey adequate information to the manager if a sensible management strategy is to be implemented, although the form itself should not be too complex if return rates are to be maximised and the number of spoilt forms minimised. Small (1988) notes the notorious reluctance of anglers to divulge full information concerning their catches, particularly when unsuccessful. In the present study the researcher had limited control over the format of the sheets used for the recording of anglers' catches. Despite the rudimentary nature of the sheets employed, it was felt that the data procured compared favourably with that from other fisheries; whilst the annual level of return submission varied from 95.04% to 97.96% over the study period.

The most plausible reason for the high level of returns at Stocks concerned the restricted access to the fishery, which O'Grady (1979) suggested is necessary if fairly high levels of returns are to be expected. Entry to the reservoir is via a single access road which opens on to a large car park and the fishery cabin where all permits have to be purchased (Figure 24, Plates 14 and 15). As the cabin is not staffed continuously, a self-service system of ticket purchase operates, which requires the individual angler to sign the day's catch return sheet, giving his name, type of permit purchased, time of arrival and car registration, if applicable. On his departure the angler is required to return to the cabin and 'sign off', recording his time of departure and catch details including nil returns. This procedure is facilitated by the angler's having to pass the cabin on his approach to the car park.

Over the three seasons of the study, it was usual for the researcher to analyse the returns on a weekly basis, such that any queries could be resolved easily whilst the week's events were still fresh in the minds of the fishery staff. Careful and consistent interpretation of the returns was necessary as some entries proved difficult to decipher whilst others were ambiguous. In this manner, daily information was collected for the seasons 1985 to 1987 which covered angler visits, fish caught and taken, and the number of anglers who made no return. Unfortunately, as experienced by North (1983), anglers were generally non-cooperative in providing length and weight data for the ordinary sized fish caught. However, the fishery ran a 'fish of the month' competition as an incentive for anglers to record all fish caught weighing over two pounds ($>$ 907g) on a separate conspicuous list. This competition proved popular as it probably appealed to the successful anglers' pride, thereby resulting in a further source of data. This was particularly useful for the present study as it was felt it gave an accurate indication of the number of larger ($>$ 907g) fish caught together with their weights.

Stock

In addition to data concerned with angler visits and catch which were obtained from permit sales and catch return forms respectively, the fishery manager should have an accurate record of the fish introduced into a put-and-take fishery (Fleming-Jones and Stent, 1975; Taylor, 1978; Coles, 1981; Pawson, 1982; North, 1983; Pawson, 1986; Pawson and Purdom, 1987; Small, 1987;). In the majority of cases this is not problematical as the fishery manager will implement his own stocking policy. Unfortunately, in the present study such data proved extremely difficult to obtain from the fishery leaseholder, who was unwilling to divulge such information to the researcher. After prolonged correspondence, and the intervention of the Water Authority, the situation finally improved in the 1987 season. It was thought initially that accurate records of reservoir stocking would have been easily obtainable; however, this was shown to be unfounded optimism. There is, therefore, an unfortunate gap in the fishery statistics.

Fishery comparison

In an attempt to assess the national performance of Stocks fishery, a tabular comparison with other wellknown English and Welsh stillwater trout fisheries was undertaken in a way similar to that of Crisp and Mann (1977) and Coles (1981). To this end the researcher corresponded with the regional water authorities and a number of privately run fisheries, and received relevant information from 17 fisheries covering the seasons 1985 to 1987.

The diet of angler-caught fish

A programme of sampling of angler-caught fish was undertaken throughout the 1985 and 1986 seasons, in order to evaluate the diversity and quantity of food organisms consumed (Bryan, 1982).

Sampling was undertaken whenever possible at monthly intervals on a Saturday or Sunday, because an examination of the fishery statistics indicated angler visits peaked at the weekends. The most satisfactory means of enlisting angler co-operation involved approaching him during the day's fishing in order to explain the aims of the study, and to seek his help. Although in a minority of cases the angler showed little interest, the majority of anglers was keen to assist, and if successful brought their catch to the anglers' cabin for examination. Each fish was then identified, its fork length was measured, and it was weighed before removal of its complete gut for future analysis. The gut samples were preserved individually in 5% formalin solution and stored in labelled, air-tight plastic pots. Such data collection involved two people; one to record the information whilst the other undertook the measurements and gut removal.

During this work a number of problems was encountered, concerned notably with poor weather conditions and late closing of the fishery in the summer months. On poor days anglers were generally dissuaded from visiting the fishery, and those who did so visit often fished spasmodically, sheltering in the cabin from time to time, and usually produced low catches. A further problem became manifest in the summer months, when the fishery closed late (one hour after sunset). On such occasions many anglers habitually fished until the stipulated closing time, which left little time in which to examine the catch.

Analyses of whole guts removed from the sampled fish involved primarily the identification and enumeration of food items enclosed within the stomach by using a low power binocular microscope. In distinct cases identification was to species level, although higher taxa were necessary for some food items as a consequence of identification problems, e.g. Chironomidae. The broad and somewhat arbitrary categories adopted for analysis are displayed in Table LVIII.

Although emphasis was placed on a numerical analysis of the stomach contents, a visual estimate of the degree of stomach fullness was undertaken, in accordance with the classification by Ball (1961) and the modifications of Carpenter (1982). In the present study the classification was extended to give an additional estimation of hindgut fullness (Table LIX). The anatomical demarcation between stomach and hindgut was taken as the well-defined constriction known as the pylorus.

A comparison of food items was also made with the benthos data for Stocks reservoir recorded by Mills, M.L. (1971).

Results

A detailed map of Stocks Reservoir and its adjacent surroundings is illustrated in Figure 24, with information relevant to the fishery. In an attempt to give a visual impression of the fishery's character, Plates 14 to 20 afford views of the reservoir and the fishery cabin and car park.

Angler visits

The number of angler visits was assessed both from permit sales and an analysis of catch returns, in order to enumerate the number of season permit visits and the number of anglers not making a return. Table XXXVI gives a seasonal, monthly summary of the numbers of day, half-day, season and total visits recorded, whilst the number of anglers making no return is also included. Cumulative weekly permit visits are depicted graphically in Figure 25 for the 1985, 1986 and 1987 seasons. Further, histograms of seasonal weekly permit totals are presented in Figure 26. In order to aid interpretation and discussion of the data, an additional graphical analysis includes histograms of seasonal percentage monthly permit visits (Figure 27). As the fishery data were processed on a weekly basis for reasons of convenience and clarity (O'Grady, 1979), this necessarily masked the daily pattern of angler visits. In an attempt to rectify that limitation, histograms of seasonal mean daily permit visits were drawn (Figure 28), whilst Table XXXVII provides values for combined mean daily permit visits for each season, expressed in percentages.

Angler catch

The number of rainbow trout, brook trout and brown trout taken by anglers, and the total number of fish caught, taken and returned, were evaluated from the fishery catch returns. Unlike angler visits, which may be assessed accurately, the record of fish caught is generally less accurate, thereby leaving a degree of uncertainty in the figures (O'Grady, 1979). A seasonal monthly summary of these data is displayed in Table XXXVIII whilst Figure 29 illustrates cumulative graphs of fish caught, taken and returned for the 1985, 1986 and 1987 seasons. Similarly of the fish taken, Figure 30 represents cumulative weekly numbers of rainbow trout, brook trout, and brown trout taken for each season.

Limit and nil returns

The proportions of limit and nil returns recorded at a fishery are useful measures of angling success, providing an insight into the trends of anglers' catches. In the present study these data were collected separately for day visits and half-day and season visits combined, as the day permit bag limit was three fish, whereas the limit for half-day and season permits was restricted to two fish. Table XXXIX gives a seasonal monthly summary of percentage permit limit and nil returns, with a further section for the data combined. Histograms of those percentage data in a seasonal weekly format are illustrated in Figure 31.

Catches per angler visit

Statistics of catches per angler visit are one of the most important standards for the measurement of fishery success, such that the achievement of an adequate catch rate may well be the primary concern of a fishery manager (Axford, 1979).

In the present study, initial statistics of catches per angler visit were calculated for both day visits and combined half-day and season permit visits, for the stated reason of different bag limits. Further, in order not to bias these figures, competition catches were excluded because they were not restrained by the bag limits. Similarly extra fish paid for over and above the bag limits were excluded from the calculations, as were the final two weeks of the 1987 season when a bag limit was not imposed. Histograms of seasonal weekly fish taken per visit are depicted in Figure 32 for day visits and combined half-day and season permit visits, whilst a monthly summary of these statistics is displayed in Table XL. A percentage frequency distribution analysis of fish taken per angler visit was undertaken from daily data, producing the histograms illustrated in Figure 33 for day visits and combined half-day and season visits for the seasons studied.

As catches per day permit visit and combined half-day and season permit visits were observed to fluctuate in a similar fashion, they were combined for an analysis of species catches per angler visit. Further, the analysis included competition catches, catches during periods when no bag limit was exercised, and fish taken and paid for above the bag limit. These data resulted in catch per angler visit statistics, based on total fish caught in the reservoir as a consequence of all angler visits. Such necessary statistics are used regularly for the monitoring of a water's fish stocks (Taylor, 1978). Histograms of the overall weekly values of fish caught and taken per angler visit are illustrated in Figure 34 for the three seasons. Also clearly shown in this Figure is the number of fish larger than two pounds in weight ($>$ 907g) taken per angler visits, values calculated from the fishery's '2lb plus' fish record. Seasonal monthly summaries of catches per angler visit are recorded in Table XLI.

Even more useful are the statistics referring to separate species taken per angler visit. These weekly data which include large fish ($>$ 907g), are represented graphically in Figure 35 for rainbow trout, brook trout and brown trout. Again Table XLI gives a monthly summary of these data, whilst Table XLII may be consulted for a monthly summary of large fish ($>$ 907g) of each species taken per angler visit in each of the three seasons.

Large fish ($>$ 907g)

A further analysis was undertaken into the numbers and weights of fish which weighed more than two pounds ($>$ 907g), in order to discover any trends which might affect angler visits. A seasonal synopsis of the numbers of large fish taken and as percentage proportions of those taken may be found in Table XLIII, which lists the number of fish taken monthly for each season, whilst the histograms illustrated in

Figure 36 for rainbow trout, brook trout and brown trout give a percentage weekly analysis of large fish taken for each of the three seasons.

A graphical interpretation of the mean weekly weights of large fish, with 95% confidence limits where appropriate, is illustrated in Figure 37 for each species. The mean and maximum weights of those fish with 95% confidence limits are summarised annually in Table XLIV. Percentage frequency distributions of the weights of large fish taken were drawn for each species on a monthly basis throughout each season (Figure 38). This approach yielded a deeper understanding of the monthly weight ranges and frequencies of the large fish taken.

The seasonal weekly fishery data, calculated from daily values, referred to throughout this chapter, are displayed in Appendix 3, which covers data for angler visits, catches, limit and nil returns, catches per angler visit, and large fish ($>$ 907g).

<u>Environmental parameters</u>

Although Coles (1981) suggests stock is perhaps the most important factor influencing angler visits, numerous authors including McCutcheon (1966), Taylor (1978) and Coles (1981), note the influence certain environmental parameters may have on fish catchability and angler visits. For this reason a number of aquatic and atmospheric parameters, recorded throughout the study period, are analysed.

The aquatic parameters thought to be of relevance to the fishery include reservoir drawdown (Figure 39), reservoir capacity, water colour turbidity, pH (Figure 40) and temperature (Figure 41). Annual monthly summaries of mean drawdown and percentage capacity are listed in Table XLV, whilst the remaining parameters will be found in Table XLVI. The measurements of water quality are for raw water samples taken from the valve tower collecting main.

The atmospheric parameters recorded include mean weekly maximum and minimum air temperatures (Figure 41); atmospheric pressure, cloud cover, sunshine, rainfall and windspeed, all illustrated graphically in Figure 42, whilst annual rose diagrams of wind direction are depicted in Figure 43. An annual mean monthly synopsis of these parameters, excluding wind speed and direction, is shown in Table XLVII. The exclusion of wind speed and direction was felt necessary, because mean values for such parameters may prove misleading.

Appendix 4 lists the mean weekly environmental data, calculated from daily values, upon which the preceding Figures and Tables are based.

Correlation analysis

In an attempt to elucidate the relationships between the recorded fishery variables and environmental parameters use was made of multiple correlation analysis (Taylor, 1978; Coles, 1981). This technique involves the computation of correlation coefficient matrices from vectors composed of mean weekly values, giving a measure of linear association between the variables.

The usual Pearson product moment correlation coefficient(r) is used, calculated from the following equation:

$$r = \frac{\sum (x - \bar{x}) \quad (y - \bar{y})}{\sqrt{\quad (x - \bar{x})^2 \quad (y - \bar{y})^2}}$$

(Ryan _et al_., 1985).

The resulting matrices are divided into two sections, namely those associated with the fishery and those comprising correlations between the environmental parameters. Both sections are subdivided into annual and combined study period data for the years 1985 to 1987, the former comprising Tables XLVIII and XLIX and the latter Tables L and LI. For all matrices, a single or double asterisk confers a value's significance at the 95% and 99% levels respectively. It should be noted further that the matrices covering the fishery data, Tables XLVIII and XLIX, also subsume the fish plate impingement data examined in Chapter IV.

A trial analysis of correlation values was undertaken using multivariate analysis, a technique based fundamentally on the measurement of the dependence between variables and sets of variables (Anderson, 1984). As the technique did not aid interpretation, possibly as a consequence of the necessary exclusion of fish stock values, the results were discarded and a reliance placed upon an interpretation of the correlation matrices.

<u>Estimation of introduced stock</u>

As the leaseholder was unwilling to divulge stocking data directly to the researcher, stocking consent documents were obtained from the Water Authority, as these proved the most reliable source available. A letter dated 30th January 1986 from the leaseholder to the Authority expressing the leaseholder's proposed stocking intentions is relied upon for the 1986 data, because no applications for stocking consent are available. These data are recorded in Table LII for the seasons 1985 to 1987. Although the veracity and reliability of such data may be questioned, the data were used to provide an informed estimate of the introduced stock. It was for these reasons of uncertainty, however, that fishery analysis was not based wholly on estimated introduced reservoir stock.

Stock estimation was undertaken in accord with the following assumptions:

1) Data abstracted from consent documents and letter of intent (1986) were used. Introduction of further fish was assumed to be zero.

2) On occasions when introductions were recorded as occurring between two dates, the fish were spread evenly over the period.

3) Fish plate losses were accounted for. As the majority of impiged brown trout were native fish, only fish $>$ 300mm were regarded as introduced.

4) Natural mortality was assumed to be zero throughout the seasons (Coles, 1981).

5) Between seasons natural mortality was calculated at 1% per week (Pawson, 1986).

Estimated reservoir stock in relation to fish taken by anglers, by impingement and by natural winter mortality, is displayed for all three trout species for the seasons 1985 to 1987 in Table LIII, whilst fish taken and impingement, displayed as percentages of estimated stock and annual introductions, are similarly recorded in Table LIV. A seasonal, weekly graphical analysis of estimated stock, fish taken per angler visit and impingement, is illustrated for rainbow trout, brook trout and brown trout in Figure 44.

Fishery comparison

In an attempt to rank Stocks' fishery in the national context, a comparison was made with other waters over the seasons 1985 to 1987. Information forthcame from the majority of Water Authorities and privately run fisheries, although no replies were received from Grafham Water and Clowbridge, a fishery local to Stocks reservoir.

Modelled on formats adopted by Crisp and Mann (1977) and Coles (1981), the data were analysed and tabulated in order to achieve values ha^{-1} yr^{-1}, a method adopted to limit the problem of differing fishery size. A record of basic information for the waters compared is displayed in Table LV, listed for each Water Authority area in order of increasing altitude. Similarly, comparative fishery data was represented for upland unstocked, upland stocked and lowland stocked waters respectively in Table LVI, a classification adopted by Small (1983).

Stomach content analysis

A summary of angler caught fish sampled in the 1985 and 1986 seasons for stomach content work is given in Table LVII. Over this period, a total of 127 rainbow trout, 7 brook trout and 8 brown trout were sampled, which is proportionately similar to the overall species catch for the two seasons.

On examination, the stomachs of all 7 brook trout were devoid of food items, whilst 67.72% and 75.00% of rainbow trout and brown trout stomachs respectively contained some items. Tables LX and LXI summarise the overall occurrence and composition of the food items for both rainbow trout and brown trout respectively, categorised in accord with the adopted classification displayed in Table LVIII.

As few brown trout were sampled, histograms of composition and occurrence were constructed for the combined seasonal data (Figure 45), whilst the larger rainbow trout sample enabled histograms of composition and occurrence to be drawn for the 1985 and 1986 seasons respectively (Figure 46). A further analysis of rainbow trout data included the construction of percentage composition histograms which were based on combined seasonal data for early, mid and late season periods (Crisp et al., 1978). These periods covered the months April/May, June/July and September/October including the first few days of November (Figure 47).

In addition to the numerical analysis of stomach contents, a visual estimation of rainbow trout stomach and hind gut fullness was undertaken in accord with the classification in Table LIX. The results for the combined rainbow trout data are illustrated graphically in Figure 48 for early, mid and late season periods.

Data abstracted from the work of Mills, M.L. (1971), covering the benthic invertebrate taxa present at selected depth zones in the reservoir, are recorded in Table LXII. A graphical representation of these data is included in order to aid interpretation and comparison with the stomach content data collected in the present study (Figure 49).

Discussion

Opened as a trout fly fishery in March 1985, Stocks Reservoir primarily caters for anglers from the Lancashire and Yorkshire regions (Figure 1). As a consequence of the oligotrophic nature of the water and the high angling pressure, the fishery was stocked initially with rainbow, brook and brown trout on a put-and-take basis. Such a stocking policy helps in the attraction of anglers (Crisp and Mann, 1977), and renders the fishery largely independent of natural productivity. (Millichamp, 1974; Welcome, 1978; O'Hara, 1986).

The aim of the present study involved the monitoring of the fishery during its initial three seasons, by means of recording and analysing reservoir visits and catches. A clear and candid declaration of reservoir fish introductions was required from the fishery leaseholder, but this was not totally forthcoming. For reasons of ambiguity and lack of details in much of these data, it was felt that fishery analysis could not hinge on the estimated stock available for capture (Coles, 1981; North, 1983), which subsequently played a smaller role in the analysis. Further work included an attempt to place the fishery in a broader context (Crisp and Robson, 1982), whilst an attempt was made to identify and enumerate the diet of angler caught fish in relation to the invertebrate fauna of the reservoir.

The validity of return form data

The procurement of angling data may play an important role in the management of both game and coarse fisheries (Easton and Morgan, 1974). It is in the management of intensively-stocked, put-and-take trout fisheries however, that accurate information concerning angling success is of paramount importance if a suitable stocking policy is to be implemented (O'Grady, 1979; Cane, 1980). As the primary aim of the fishery manager is to obtain an adequate catch rate, then a system of catch returns recording catches and allowing subsequent comparison is required (Axford, 1979). To this end Cousins et al. (1981) described a computer programme to aid in the analysis of catch return data.

Unfortunately the collation of return form data is handicapped, to a greater or less degree, by a number of limitations, notably by overestimations of catch and by erratic submissions of returns.

It was noted by Cane (1980) and Moore (1982), that catches calculated from returns are always greater than those assessed by fishery bailiffs, sometimes by a margin of 35%. Although there is no reason to question the veracity of these returns, it is concluded that those returns received represented a sample of anglers biased towards the more successful, as anglers with poor or nil catches are less inclined to make a return. Interestingly, the same phenomenon was perceived at Stocks Reservoir, where the bailiffs' assessment of angler success was lower than that calculated from the returns. Furthermore, it must be remembered that anglers often appear reluctant to divulge full information concerning their catches (North, 1983 ; Small and Downham, 1985; Small, 1988), whilst false entries and spoilt forms may occasionally occur due to perversity, incomprehension or suspicion of research motives (O'Grady, 1979).

In addition to the problems association with the interpretation of returns, their lack of completeness may pose further interpretive difficulties (Small, 1988). It was noted by Cane (1980) that anglers not submitting returns are likely to be the least successful, whilst O'Grady (1979). amongst others, suggested treating lack of submission as indicative of a nil return. At some stillwater fisheries, however, difficulties may be experienced with season permit holders as they may not be required to make returns for individual visits (Small and Downham, 1985); a situation noted when compiling comparative data from Severn-Trent Water's Foremark and Ladybower eservoirs. Small and Downham (1985), further proposed suitable methods for the adjustment of incomplete data in order to give a more complete pattern of effort and catch. In the present study, however, season permit holders were required to submit daily returns, whilst as a consequence of the extremely high submission rate, the outstanding returns were disregarded, in accord with the suggestions of Fleming-Jones and Stent (1975) and O'Grady (1979).

The annual submission of returns at Stocks reservoir of 97.40%, 95.04% and 97.96% for 1985, 1986 and 1987 respectively, compared admirably with the 65% level quoted for a typical English Midlands reservoir by Small and Downham (1985). It is the practice of many fisheries to encourage submission of returns by offering incentives such as monthly lotteries. Implementing such a scheme, Cousins et al. (1981) recorded a 91% level at Toft Newton reservoir, whilst Cane (1980) recorded a 93% level at the Ffestiniog fishery. Small and Downham (1985) suggested further that a 90% level of returns is typical at a well-supervised water, whilst O'Grady (1979) was more optimistic in proposing a submission rate between 90% and 100%.

As suggested in the methodology, the high level of returns achieved at Stocks Reservoir is perhaps a consequence of restricted access to the fishery, which ensures that anglers return to the car park via the fishery cabin (Plate 15). Similarly, limited access was considered important by O'Grady (1979) and North (1983) in the high submission rates achieved at both Queen Mother and Farmoor reservoirs, and Draycote Water respectively.

Angler visits

Throughout the period of study the fishing season at Stocks reservoir commenced in mid-March and ran until the first days of November in 1985, and mid-November in both 1986 and 1987.

The majority of permits was purchased daily, and was categorised as either day or half-day permits, the former permitting a bag limit of three fish and the latter a bag limit of two fish. The half-day permit allowed the purchaser to fish for a period not exceeding four hours. Over the study period there was an increase in permit costs from £6 to £7 for day permits, and from £4 to £5 for half-day permits.

Season permits were purchased annually for week day visits only or including weekends, at costs of £95 and £115 respectively. Over the study period the cost of these permits remained constant, although the number of visits permitted was cut from 35 per season in 1985 and 1986 to 30 per season in 1987. A season permit holder was entitled to take two fish on each visit in accord with the half-day permit bag limit.

As proposed by Mawle and Randerson (1983), the rational management of recreational fisheries not only requires a knowledge of catches, but also the levels and patterns of angler visits. From 1985 to 1987, Stocks Reservoir attracted seasonally 6427, 6537 and 5486 anglers respectively (Table XXXVI, Figure 25). The rise in seasonal angler visits in 1986 may be attributed to the increase in the season length from 34 to 36 weeks; however, the total for the 1987 season was 1051 visits down on the 1986 total. This represented a total decline of 16%, comprising day and half-day visits declining by 15% and 14% respectively, whilst local season permit patronage declined by 38%. Such a decrease may be indicative of a degree of angler despondency following an initial flush of enthusiasm. This is emphasised further by the purchase of season permits, which after an initial rise from eleven to eighteen from 1985 to 1986, fell sharply to twelve in 1987. Interestingly over the period of study, only three-quarters of possible season permit visits were taken up.

During the 1985 and 1986 seasons maximum angler patronage occurred in May, whilst in 1987, patronage was at a maximum in April, which may be associated with longer day length and improving weather conditions.

By a weekly analysis, day visits were always the most numerous, followed by half-day and season permit patronage, with percentage proportions calculated for the three seasons of 64%, 31% and 5% respectively. Although correlation analysis indicated significant correlations between permit visits for the three seasons' data combined (Table XLIX), on a seasonal level there was a notable mid-season decline in the proportion of day visit patronage, with a corresponding increase in the proportion of half-day visits (Figure 27). This phenomenon, generally at a maximum during the summer months of June, July and August, may have been a consequence of anglers purchasing half-day permits to take advantage of the summer evenings, a situation noted by Pawson (1986).

In accord with work by Crisp and Robson (1982) at Cow Green reservoir, angler visits were found to peak at weekends, with considerably more visits on Sundays than Saturdays (Table XXXVII). Over the period 1985 to 1987 the proportion of daily visits occurring over the weekend increased from 46.4% to 50.6%, comprising a marked increase in the proportion of Sunday visits which countered a decline in those occurring on Saturdays. Of the visits made at weekends the majority comprised day and half-day visits, with season permit visits making up the smallest proportion (Figure 28). Mean daily season permit visits were in fact at their lowest over the weekend period, possibly as a consequence of the popularity of the cheaper weekday season permit, and the conscious decision of season permit holders to fish mid-week when the reservoir was least busy. Interestingly, over the three seasons studied, day visits were consistently at a minimum on Tuesdays and Thursdays, a pattern which may usefully be taken into account when organising time off for fishery staff.

It has been argued by Pawson (1986) that the pattern of recorded angler visits may be generated more by the anglers' choice of fishing conditions than by their desire to maximise fishing success. Thus, in order to establish possible links between angler visits and some environmental parameters, a series of correlation matrices was calculated (Tables XLVIII and XLIX). From this analysis a number of significant correlations was apparent. Combined seasonal correlations showed all permit visits to be significantly correlated ($\geqq$ 95% level) with atmospheric pressure and sunshine, probably indicating a general preference by anglers for good weather conditions. Furthermore, day and half-day visits exhibited significant negative correlations (99% levels) with cloud cover and rainfall, whilst day visits only were similarly negatively correlated (95% levels) with wind speed, which may together be indicative of the deleterious effect of poor weather conditions, particularly with respect to day visits and less markedly half-day visits. Significant correlations (99% levels) were also apparent between half-day and season visits with maximum and minimum air temperatures, which may signify the importance of warm weather in inducing such visits, perhaps in the longer summer evenings. Interestingly, there was a negative combined seasonal correlation (99% level) between return form submission and rainfall, which may indicate a link between wet weather and an increase in the number of blank returns, a phenomenon noted by O'Grady (1979).

With respect to reservoir conditions, significant combined seasonal correlations were apparent between day and half-day visits with reservoir level and capacity (99% and 95% levels respectively), possibly indicating that such anglers prefer high water levels. This is understandable because under conditions of drawdown, the reservoir margin is unsightly and often unpleasantly muddy. Such correlations were particularly pronounced in the 1986 season, possibly as a consequence of severe drawdown in comparison with 1985 and 1987. Similar significant correlations between day and half-day visits with upper draw-off port flow, and negative correlations with middle and lower port flows were also linked with reservoir level, through operational procedures associated with drawdown. Reservoir water turbidity was the only measurement of water quality to exhibit a consistent association with day and half-day visits, giving a significant negative correlation (99% level). This may feasibly be explained by increased turbidity primarily resulting from rain and wind, indicated by the significant correlations (99% level) displayed between these parameters (Tables L and LI). The general lack of consistent correlations with season permit visits were likely to be associated with the relatively small numbers of visits made in relation to those for day and half-day visits.

Catches

The total number of fish caught, taken and returned all exhibited a decline over the seasons 1985 to 1987. Over this period anglers caught seasonally 16430, 14805 and 12221 fish (Table XXXVIII, Figure 29), representing a fall of 34.8% in catches by 1987. Similarly, the total number of fish taken seasonally by anglers amounted to 10554, 9685 and 8392, a decline of 20.5% by 1987. Apparent from these figures was the decline in the proportion of fish returned as catches decreased, denoted by the increased proportion of fish taken from 64.2% in 1985 to 68.7% in 1987. Maximum monthly values of fish caught occurred in the May of 1985 and 1986 and the August of 1987, coinciding with the high monthly values of angler visits.

The practice of returning fish to a water after capture is questioned by numerous authors, for reasons of decreased susceptibility to future capture effectively removing fish from the catchable population, and the increased risk of mortality as a consequence of rough handling and bacterial and fungal infections (Fleming-Jones, 1971; Welcomme, 1978; Dotson, 1982; Raat, 1985; O'Hara, 1986). At a water such as Stocks Reservoir with its native brown trout population, however, such a system may be necessary, although in an attempt to limit mortality anglers were requested to use hooks with flattened barbs if fish were to be returned.

Of the rainbow trout, brook trout and brown trout taken (Table XXXVIII, Figure 30), both rainbow trout and brown trout exhibited a decline from 1985 to 1987 of 10.3% and 71.1% respectively, whilst the number of brook trout taken displayed a small rise in 1986 before declining by 98.6% in the 1987 season. Catches of rainbow trout were consistently dominant, representing 84.7% of fish taken in 1985, rising to 95.6% in 1987, with a corresponding decrease in the proportions of both brook trout and brown trout taken.

In addition to the decline in total catches, the above trend may denote a shift in stocking policy over the three seasons from that of introductions of rainbow trout, brook trout, and brown trout, to a total reliance on introduced rainbow trout. This would agree with the experience of many stocked trout fisheries in England, which rely heavily on rainbow trout as a consequence of the species' adaptability and its ease of cultivation (Fleming-Jones, 1971; Pawson, 1986). Furthermore, the species is available at an acceptable cost to a fishery, whilst fulfilling the anglers' requirements for a challenging, edible quarry, susceptible to capture by fly fishing techniques (Pawson and Purdom, 1987).

The introduction of brook trout was only of limited success at Stocks reservoir, because of the species' vulnerability to fungal infections and eyefluke (Diplostomum spathaceum) infestation which caused heavy mortalities. Introductions to other local stillwaters have met with a similar lack of success (Dr. R.B. Broughton, Personal communication).

The decline in brown trout taken of 71.1% by 1987 followed an initial stocking in 1985. As catches decreased markedly in subsequent seasons, this may indicate the limited role played by the native brown trout population in the fishery. Such a situation was perhaps expected, as the majority of anglers employed techniques suited to the capture of introduced fish accustomed to hatchery feeding conditions, whilst the behaviour of native brown trout may not predispose them to capture (Bryan, 1982; Moore, 1982; Ersbak and Haase, 1983).

Although understandable from a fisheries point of view, the increased reliance on rainbow trout, and the discontinued stocking of brook trout and brown trout may be important considerations in the perceived reduced popularity of the fishery. Further, possibly in an attempt to make up for the discontinued stocking of both brook trout and brown trout, it was apparent from '2lb plus' (> 907g) records, that the number of large rainbow trout taken continuously increased from 427 in 1985 to 779 in 1987, representing 4.8% and 9.7% of rainbow trout taken in each season (Table XLIII). Over the same period large brook trout were only caught in quantity in 1985, when 130 large fish were taken representing 38.3% of the total, whilst the numbers of large brown trout taken seasonally were fewer at 40, 31 and 4 respectively, representing proportions of 3.1%, 7.7% and 1.1%. A seasonal weekly analysis of the percentage proportions of large fish taken for each species, depicted a succession of peaks (Figure 36). This was particularly noticable in the case of rainbow trout, and may be indicative of introductions of larger fish.

In addition to the increase in numbers of large rainbow trout taken over the study period, the seasonal mean weight reached a maximum in 1987, having risen by 228g or 17.5% from the 1986 value. Similarly, the seasons' heaviest rainbow trout rose from 2325g in 1985 to 3175g in 1987 (Table XLIV). Weights of large brook trout and brown trout taken were generally lower than those of rainbow trout. However, due to the low numbers of brown trout caught, the capture of a few larger fish in 1986 increased the seasonal mean weight, as denoted by the wide confidence limits.

From a graphical interpretation of large fish weights (Figure 37), it may be seen that all species showed marked fluctuation in mean weights over the seasons. Rainbow trout exhibited the least fluctuation in weekly mean weights in the 1986 season, corresponding with the lowest seasonal mean weights, whilst the most pronounced fluctuations occurred in 1987. In 1987, the mean weight of large rainbow trout exceeded 1600 grammes for a period of four weeks from 26/7/87 to 23/8/87 (weeks 20 to 24), which coincided with a reduction in the proportion of large rainbow trout taken. This may indicate that introductions of very large fish were infrequent, and occurred at the expense of introductions of smaller fish. The negatively skewed nature of percentage frequency histograms based on large fish weights further emphasised this point, with the majority of fish of all species weighing less than 1200 grammes (Figure 38). A minority of fish exceeded this weight, although in the 1987 season an increase in the number of larger rainbow trout taken was apparent. Furthermore, these histograms indicated that introductions of larger rainbow trout were probably made throughout the 1987 season, whereas in 1985 and 1986 introductions were notably more sporadic.

Catches per angler visit

Studies at many stillwater trout fisheries have shown catch rates to be predominantly influenced by number of fish stocked, number of angler visits and to a lesser extent some environmental parameters (Coles, 1981). Many authors including Fleming-Jones and Stent (1975) and North (1983), have expressed the importance of stocking policy in determining catches at put-and-take trout fisheries, whilst Taylor (1978) suggested rainbow trout catches exhibit greater stock dependency than brown trout.

The less than perfect stocking data extracted from Stocks Reservoir consent documents (Table LII), and the decline in catches and increased proportion of rainbow trout caught, indicated changes in stocking policy affecting catch. Similarly, in accord with Coles (1981), angler visits were significantly correlated with catches, generally indicating that increased fishing effort produces higher catches.

In order to monitor and control catches in such a way that the majority of anglers remain satisfied and continue to visit a fishery, a measure of angler success is required (O'Hara, 1986; Pawson, 1986). Based primarily on catches divided by visits, such statistics are effectively a measure of catch per unit effort (CPUE), enabling a fishery manager to monitor angler success and to manipulate catch by a policy of judicious stocking. Unfortunately, certain assumptions have to be made regarding measurement of fishing effort, as it is generally ill defined. Whereas North (1983) suggested that anglers at Draycote Water employed very similar techniques with a similar degree of skill, it was intimated by Welcomme (1978), that measurement of fishing effort was problematical because of the range of angler competence. In addition, the period spent actually fishing is difficult to evaluate, since angler effort is likely to vary with weather conditions and fatigue.

In the present study, fish taken per visit were calculated separately for day permit visits and half-day and season permit visits, in order to facilitate a comparison and to make allowance for the difference in bag limits. In addition to catch per visit statistics, percentage limit and nil returns were calculated for both day permit and half-day and season permit visits. Whilst displaying significant correlations with catch per angler visit statistics, such values were included as they enumerate the most and least successful anglers visiting the fishery.

Over the three seasons studied, a continuous decline was observed in both mean seasonal fish taken per day permit visit and half-day and season permit visit, in accord with the general decline in catches (Table XL). Such a decline was similarly manifest in a decrease in combined seasonal percentage limit returns and a corresponding increase in percentage nil returns recorded

(Table XXXIX). Fish taken per day permit visit fell from a seasonal mean of 1.96 in 1985 to 1.77 in 1987, whilst half-day and season permit visit catches were reduced from a seasonal mean of 1.10 in 1985 to 0.97 in 1987. These reductions represented a decline in rates of fish taken of 10% and 12% respectively.

From a review of literature associated with catch per angler visit statistics, an average catch rate of 1.5 fish per visit is perhaps regarded as satisfactory to a majority of anglers, whilst imposing an acceptable cost on the fishery (Small, 1983). Such a rate is not attained by all fisheries, however, with Cow Green an upland, native brown trout fishery and Llyn Alaw falling short (Crisp and Robson, 1982; Jones, 1977). By way of comparison, large eutrophic, lowland waters with high growth rates such as Grafham and Rutland, may at times attain seasonal mean catch rates of 2.5 fish per visit (Fleming-Jones and Stent, 1975; Moore, 1982). Despite the trend for rates of fish taken to decrease, mean seasonal rates recorded at Stocks Reservoir were consistently greater than 1.5 fish per day permit visits. However, rates for half-day and season permit visits were lower as a consequence of the inhibiting effect of the two fish bag limit and a maximum visit of four hours. Interestingly, half-day and season permit visits exhibited proportionately fewer limit returns and a markedly greater proportion of nil returns than day permit visits, such that the proportion of nil returns exceeded limit returns in the 1986 and 1987 seasons, implying that as a group such anglers were less successful than day permit anglers. Although there was no obvious reason for this difference, it is suggested that angler competence, as noted by Welcomme (1978) may be relevant particularly with respect to half-day visitors.

From seasonal percentage frequency histograms, constructed from mean daily values for both fish taken per day permit visit and half-day and season permit visit, a further evaluation of angler success was possible (Figure 33). In the 1985 and 1986 seasons, daily rates of fish taken by both day permit anglers and half-day and season permit anglers exhibited twin peaks to the histograms. These phenomena may be attributable to an increase in angling efficiency for a number of days, or more plausibly, they were a result of high fish introductions, possibly early in the season. Certainly this trend was not apparent in the 1987 season, where stocking consent data would suggest the acceptance of a more frequent policy of stocking (Table LII), an approach more likely to encourage consistent fishery performance (Pawson, 1982). This policy may have found favour due to the decrease in angler success in the 1986 season, arising probably from a reduction in stock and a decrease in the fishes' accessibility to the majority of anglers (Pawson, 1986). Frequent stocking with small numbers of fish may have helped alleviate this decline, by minimising great fluctuations in catch, and ensuring that the majority of fish stocked was available to bank anglers (North, 1983). Furthermore, such a policy would reduce the average period stocked fish would remain in the reservoir, possibly minimising the decline in condition often prevelant at heavily stocked, oligotrophic waters like Stocks Reservoir.

Histograms of mean weekly fish taken and percentage proportions of limit and nil returns were plotted seasonally, for both day permit visits and half-day and season permit visits (Figures 32 and 31). The inclusion of such graphs facilitated an analysis of the trends in angler success for each of the three seasons. As a consequence of the links between fish taken per visit and the proportion of limit and nil returns, weekly values were observed to fluctuate similarly, with low rates of fish taken corresponding with proportionately low limit returns and high nil returns, and vice versa.

Although day permit anglers were as a group more successful than half-day and season permit anglers, seasonal trends were comparable, except in the first weeks of the 1986 seasons when the success of day permit anglers increased, whilst that of half-day and season permit anglers inexplicable decreased.

Over the seasons 1985 to 1987, the most pronounced decline in both day permit and half-day and season permit angler success occurred in the 1985 season. This fall spanned weeks 19 to 22 (14/7/85 to 11/8/85) of the season, reaching a minimum in week 21 (4/8/85) when fish taken per visit declined to 0.89 and 0.43 respectively. From reference to stocking consent documentation, it is impossible to ascertain if fish were introduced as a consequence of the low catch rates. However, a comparison with observed environmental parameters reveals some pertinent associations.

Decline in angler success occurred at a period of low reservoir level which necessitated the use of the middle and lower draw-off ports, and coincided with a decline in atmospheric pressure and extremely heavy rainfall, with correspondingly high cloud cover and limited sunshine. The increase in precipitation induced a rise in reservoir water level, a dramatic increase in turbidity and colour and a decline in pH value. (Figures 39, 40 and 42). Although it is likely that inclement weather conditions may lead to a decline in angler effectiveness, it is probable that the particularly high values of water turbidity and colour may have been more important considerations. Whilst high turbidity levels are known to affect fish behaviour and, possibly, fish catchability (Alabaster and Lloyd, 1983), the reduction in underwater visibility may have severely limited the efficiency of fly fishing techniques, which rely primarily on visual attraction.

A decrease in fishery patronage also exhibited congruity with the decline in angler success. This continued in spite of a resurgency in angler success until week 24 (25/8/85) and was perhaps indicative of previous fishery performance determining subsequent angler patronage, a trend similarly noted by O'Grady (1979).

Although less pronounced than in 1985, declines in fish taken per angler visit occurred in 1986 and 1987. In the 1986 season, weeks 13 to 19 (8/6/86 to 20/7/86) displayed a downward trend in fish taken by both day permit anglers and half-day and season permit anglers, reaching minima for the season in week 18 (13/7/86) of 1.13 and 0.67 respectively. Whilst a coincidental decrease in fishery patronage was observed, no clear association with environmental parameters was perceivable. The 1986 season also experienced the greatest degree of draw-down for the three seasons studied, with a decline from top water level of 10.71 metres by week 32 of the season (19/10/86). Reservoir level commenced rising in week 33 (26/10/86) in response to heavy rainfall, whilst water turbidity increased as a consequence of the rainfall and the predominantly westerly wind (Figures 42 and 43). Both angler success and patronage were observed to diminish at this time, with fish taken per visit falling to 1.44 and 0.96 respectively. In spite of marked draw-down however, increase in water turbidity was limited in comparison to 1985, probably as a consequence of less prolonged rainfall. As draw-down was much greater than in 1985, and angler success did not approach the 1985 minima, it may be suggested speculatively that water turbidity was the primary environmental parameter measured which determined decline in angler success.

In the 1987 season, minor decreases in angler success occurred frequently for both day permit visits and half-day and season permit visits. However, no clear congruity was observed with environmental parameters. It is suggested that this was attributable to favourable environmental conditions, and an amended stocking policy reliant on judicious introductions of fish throughout the season. As draw-down was not extreme in 1987, and patterns of rainfall were conducive to gentle rises in water level, then turbidity levels remained rermarkably stable. It is therefore proposed that fluctuations in angler success were perhaps associated more with stocking policy in the 1987 season, than with environmental factors prevalent in the previous two seasons.

Periods of increased angler success over the three seasons displayed no well-defined associations with environmental parameters, whilst trends in angler patronage were only broadly similar, exhibiting their closest association during periods of declining angler success. Traditionally, overcast, wet and breezy conditions are generally regarded as synonymous with good fishing conditions, particularly with respect to stillwater fishing (Maunsell, 1933). This traditional view was supported at Eyebrook reservoir, where Taylor (1978) discovered angling success was better during windy, dull periods, than when the weather was calm and sunny. At Toft Newton reservoir however, Coles (1981) found a significant correlation between hours of sunshine and catch rate, which was at variance with the findings at Eyebrook.

From observed associations at Stocks Reservoir, water turbidity would appear to be an important factor determining angler success. Although correlations between angler success and environmental parameters were found to be generally low and uncertain in accord with the work of Small (1987), significant negative correlations existed between angler success and turbidity in 1985 (Table XLVIII). As turbidity was significantly correlated with both rainfall and windspeed, such weather conditions may, at times, appear detrimental to angler success. Furthermore, as turbidity was observed to peak in both 1985 and 1986 with a rise in water level from maximum draw-down, then a decline in water level may be a pre-requisite for a marked increase in turbidity. It must be borne in mind, however, that whilst environmental parameters may at times exert an important influence on angler success, at Stocks Reservoir, the number of fish present in the water is likely to be of primary consequence. (Fleming-Jones and Stent, 1975; Crisp and Mann, 1977; Pawson, 1986).

In an attempt to analyse species taken per visit, day, half-day and season permit data were combined and supplemented with competition data and extra fish taken, such that fish caught and taken per angler visit related directly to stock. These statistics revealed that mean seasonal catch per angler visit declined from 2.56 in 1985 to 2.23 in 1987, whilst fish taken per angler visit decreased from 1.64 in 1985 to 1.48 in 1986 before recovering to 1.53 in 1987. The recovery in fish taken per angler visit in 1987 occurred at the expense of fish returned, which declined continuously from season to season (Table XLI and Figure 34).

In accord with the large numbers stocked, rainbow trout were the predominant species taken per angler visit, exhibiting a maximum mean seasonal rate of 1.46 in 1987. Conversely, mean seasonal rates for both brook trout and brown trout taken declined over the period, in agreement with the decline in numbers stocked. Of the mean seasonal rate of fish taken per angler visit in 1985, 18% comprised brook trout and brown trout. By 1987 this had declined to 5%, emphasising the fishery's increased reliance on introduced rainbow trout.

Although there was a general decline in mean seasonal angler success, the rate of large ($>$ 907g) fish taken per angler visit increased over the period from 0.09 to 0.14. As the rate of large brook trout and brown trout taken declined over the period, the rise was primarily due to an increase in large rainbow trout taken from 0.07 in 1985 to 0.14 in 1987 (Table XLII). This again emphasises the increased importance for the fishery of rainbow trout, and suggests an increase in the numbers of large fish stocked, perhaps as a measure of compensation for the cessation of introductions of brook trout and brown trout. From species histograms of mean weekly fish taken per angler visit (Figure 35), one may observe the seasonal distributions of species taken per angler visit, including larger fish. Apparent from these graphs are the low rates of angler success for all species in 1985, associated with the marked rise in turbidity in week 21 of the season (4/8/85). Similarly in the 1986 season, all species exhibit a decline in angler success in weeks 18 (13/7/86) and 33 (26/10/86). On this latter occasion however, no brown trout are recorded as the season closed at the end of September.

Introduced stock

Based on stocking consent documents and correspondence in 1986 expressing proposed stocking intentions (Table LII), an attempt was made to quantify the reservoir's introduced stock as an informed estimate was desirable for further fishery analysis. It should be noted, however, that although consent was granted by the Authority for a particular stocking, it may not represent the number of fish actually introduced, whilst further fish may have been introduced without the necessary consent having been obtained. In addition, some of the consent information was rather ambiguous, for it related that a particular number of fish was introduced over a period of time. Although unlikely in reality, the fish were evenly spread between the dates in such circumstances in order not to prejudice the results.

The assumptions that anglers failing to make a return captured no fish, and that natural mortality was regarded as zero throughout the seasons, may have resulted in an overestimation of trout numbers. As substantial overwinter mortality is a common problem at many fisheries (Fleming-

Jones, 1971; Moore, 1982), an attempt was made to limit any further overestimation by calculating natural mortality between seasons at 1% per week in accord with the work of Pawson (1986).

Over the three seasons studied, general declines were estimated for introduced stocks of all species (Table LIII and Figure 44), in agreement with the decreases in catches.

Rainbow trout was the only species to be introduced annually into the reservoir, amounting to an estimated 34,000 fish for the three seasons combined. In 1985 rainbow trout stock probably increased until week 7 (28/4/85) of the season, as 17,500 fish were introduced. A further 1,200 fish were documented as introduced throughout the remaining weeks of the season, whilst the overall stock steadily declined as a consequence of catches. The season's catch of 8943 fish represented 47.8% of the annual stocking (Table LIV), which was calculated as 135 fish ha^{-1} yr^{-1} at top water level. In 1986 a further 5850 fish, representing 42 fish ha^{-1} yr^{-1} were introduced apparently early in the season, which raised the estimated annual stock to 100 fish ha^{-1} yr^{-1} at top water level. The catch of 8928 rainbow trout was estimated as 152.6% of the number stocked in 1986, which indicates a good proportion of fish probably overwintered successfully, whilst the catch represented 64.3% of the total estimated rainbow trout population. In 1987, 9450 rainbow trout were introduced throughout the season, contrary to the previous procedure where the majority of fish was introduced in the first weeks. This stocking calculated as 68 fish ha^{-1} yr^{-1}, increased the annual estimated stock to 98 fish ha^{-1} yr^{-1} at top water level, whilst the season's catch of 8020 fish represented 84.9% of the fish introduced in 1987, and 59% of the estimated stock.

From stocking consent documentation, brook trout appeared to be introduced in 1985 only, when 1000 fish were initially stocked before the season commenced. A further 375 fish were documented as introduced throughout the season, although exact dates were not proferred. As the 375 fish were spread evenly over the season in accord with the assumptions made, stock appeared to follow a 'U' shaped curve. It is perceived that the extra fish were not stocked in this manner, but possibly in a distinct batch. Comparison with brook trout taken per angler visit (Figure 44), reveals a second distinct peak in catches observed between weeks 14 and 16 (16/6/85 to 30/6/85) of the season, which may date the second introduction. Whenever the fish were introduced, the annual stock in 1985 was calculated at 10 fish ha^{-1} yr^{-1}, whilst a catch of 339 fish represented only 24.7% of the stock. From catch return data, a further 352 brook trout were taken in the 1986 season, which represented 43.7% of the estimated annual stock now reduced to 6 fish ha^{-1} yr^{-1}. By way of similarity with 1986, no brook trout was documented as introduced in 1987, resulting in an estimated population of 1.5 fish ha^{-1} yr^{-1}. As only 5 fish were taken during the course of the season, and none was impinged on the reservoir fish plates, this would indicate a very low level of remaining stock.

Contrary to both rainbow trout and brook trout, brown trout was native to the reservoir and catchment, such that the population sustained a marginal trout fishery before the advent of the present fishery. From documentary evidence, the native brown trout population was only supplemented in 1985 when 2500 fish were stocked initially prior to the commencement of the season, whilst a further 1200 fish were introduced throughout the season. This represented an estimated annual introduced stock of 27 fish ha^{-1} yr^{-1}. In accord with the 1985 brook trout stock curve, the even spreading of the 1200 brown trout produced a similar 'U' shaped curve. Again, in reality, it is likely that these fish were introduced in distinct batches, possibly indicative of the trend observed in brown trout taken per angler visit.

Of the fish stocked in 1985, 1272 or 34.4% were taken, whilst in the 1986 and 1987 seasons the number taken fell markedly to 405 and 367 fish respectively, representing 21.3% and 31.0% of the estimated annual stocks. With the decline in estimated introduced stock to 14 fish ha^{-1} yr^{-1} in 1986 and 9 fish ha^{-1} yr^{-1} in 1987, this may indicate that native brown trout played a limited role in the catches.

The general decline in catches and estimated stock observed from 1985 to 1987 (Table LIII) indicates that catches may be determined primarily by levels of stock, a trend noted by many authors including Crisp and Mann (1977), Fleming-Jones and Stent (1975), Coles (1981), Moore (1982), North (1983) and Pawson (1982, 1986). This trend was particularly notable at Stocks Reservoir for brown trout, despite the additional influence of the native population (Swales and Fish, 1986), possibly as a consequence of the brown trout introduced in 1985 exhibiting a higher degree of catchability than the indigenous fish. Furthermore, the adoption of modern stillwater angling techniques by the majority of anglers may have militated against the capture of native fish.

The least clear similarity between catch and estimated stock was exhibited by brook trout, whose catch increased in the 1986 season despite documentary evidence for introductions in 1985 only. Although no documentary evidence was forthcoming, it was learnt from fishery staff that a further batch of brook trout was introduced in 1986, as recompense for a heavy mortality in 1985, associated with fungal infection and eyefluke infestation (Diplostomum Spathaceum). If accurate, this stocking intelligence would explain the very low catches of brook trout experienced early in the 1986 season, preceeding a dramatic increase in catches from week 8 (4/5/86) of the season (Figure 44). As only 5 brook trout were captured in the 1987 season, this would indicate low over-winter survival of the remaining fish.

Fleming-Jones (1974), Crisp and Mann (1977) and Pawson (1986) all noted that rainbow trout recapture rates are generally greater than those for brown trout, relative to the numbers stocked due to differences in catchability. This phenomenon was experienced in the present study, where in the 1985 season estimated recapture rates for rainbow trout and brown trout were calculated at 47.8% and 34.4% respectively. Brook trout, however, returned the lowest estimated rate at 24.7%, possibly on account of heavy mortality in 1985 (Table LIV). Subsequently, estimated rates of recapture for rainbow trout increased to 152.6% in 1986 and 84.9% in 1987. As Taylor (1978) noted recapture rates of 60% to 80% as good, the 1986 value may be an overestimate due to incomplete stocking data, whilst many fish may have overwintered successfully.

As the majority of rainbow trout was introduced before and during the first weeks of the 1985 and 1986 seasons, the estimated stocks were observed to decline throughout the seasons, in accord with the findings of Moore (1982). The change in stocking policy in 1987, to one of judicious introductions throughout the season, resulted in an estimated stock curve which exhibited some similarity with the rate of fish taken, notably during weeks 10 to 20 (17/5/87 to 26/7/87). This method of 'staggered' put-and-take stocking, relying on takeable fish resident for short periods is now much in vogue, as it has the potential to provide a sustained, high production fishery in excess of other techniques (Millichamp, 1974; Coles, 1981; Pawson, 1986).

Fishery comparison

In an attempt to rank nationally the performance of

Stocks Reservoir, correspondence with the ten regional Water Authorities and some private fisheries resulted in the obtaining of data from a cross-section of stillwaters. The fisheries covered all Authority areas excluding Wessex Water, and ranged from unstocked upland waters relying on natural recruitment through to stocked lowland fisheries administered on a put-and-take basis. The accrued data were, for the sake of simplicity, expressed as total mean values in accord with Crisp and Mann (1977), and based on data from the 1985, 1986 and 1987 seasons, whilst the waters were divided into categories of upland unstocked, upland stocked and lowland stocked (Small, 1983) (Table LV). The terms upland and lowland were somewhat arbitrary, although waters classified as upland were all situated at or above 180 metres in altitude in areas of moorland or poor quality pasture, and generally supported indigenous brown trout populations. Lowland waters, on the other hand, were situated in arable areas at altitudes not exceeding 150 metres; the majority of these would naturally support coarse fish populations if not specifically managed as trout fisheries.

Angler visits were at a minimum at the unstocked upland waters of Selset and Cow Green, which recorded angler visits of 2.0 ha^{-1} yr^{-1} and 3.0 ha^{-1} yr^{-1} respectively (Table LVI). It would appear that such waters have considerable appeal to an important minority of anglers, for whom uncrowded conditions and the opportunity to catch native brown trout are vital considerations (Crisp and Mann, 1977; Steinmetz, 1983). However, both stocked upland and lowland reservoirs attracted greater numbers of anglers, with respective mean values of 58.0 ha^{-1} yr^{-1} and 75.8 ha^{-1} yr^{-1}. In the stocked upland category, Stocks Reservoir returned a low value for angler visits of 44.2 ha^{-1} yr^{-1}, with only Hury Reservoir recording fewer, whilst Grassholme Reservoir attracted the most at 105.8 ha^{-1} yr^{-1}. Although stocked lowland reservoirs generally attracted more anglers than stocked upland reservoirs Rutland Water, Llyn Alaw and Pitsford returned lower values for angler visits than Stocks Reservoir, possibly as a consequence of their larger areas, particularly in regard to Rutland Water which extends to 1277 ha.

Upland reservoirs recorded a mean stock of 127.9 ha^{-1} yr^{-1}, although introductions at Stocks Reservoir were lower at 93.7 ha^{-1} yr^{-1}. Of these upland waters only Hury Reservoir exhibited a lower stock level, whilst the maximum value of 184.9 ha^{-1} yr^{-1} was displayed by Grassholme Reservoir, in accord with the values for angler visits. The highest stocking levels occurred at the intensively run lowland reservoirs, which recorded a mean of 189.0 ha^{-1} yr^{-1} and a maximum stock value of 349.8 ha^{-1} yr^{-1} at Thames Waters' Farmoor 2 reservoir. In a similar vein to angler visits, Llyn Alaw, Rutland Water and Pitsford all recorded stock values similar to or less than that displayed by Stocks.

As one would expect Selset and Cow Green reservoirs, both unstocked upland waters, recorded the lowest rates of catch of 3.2 ha^{-1} yr^{-1} and 4.5 ha^{-1} yr^{-1} respectively, whilst Upper Tamar Reservoir, an intensively stocked lowland water, returned the highest catch rate of 219.8 ha^{-1} yr^{-1}. Lowland reservoirs as a whole exhibited a mean catch value of 135.8 ha^{-1} yr^{-1}, with Llyn Alaw and Pitsford portraying poor values, possible only account of their low rates of stocking. Upland stocked waters recorded a lower mean catch rate of 108.3 ha^{-1} yr^{-1}, with Grassholme Reservoir returning a maximum value of 167.1 ha^{-1} yr^{-1} because of a policy of generous stocking. The lowest category value of 68.7 ha^{-1} yr^{-1} displayed by Stocks Reservoir, was in accord with its lower rate of stocking.

As a fishery, Stocks Reservoir was observed to rate rather poorly with the majority of stocked fisheries analysed. Understandably Selset and Cow Green reservoirs, both unstocked waters, performed less well, whilst of the stocked upland waters only Hury Reservoir performed similarly. Lowland waters generally exhibited the highest performances, although because of its immense area Rutland Water returned the least good figures, whilst Llyn Alaw and Pitsford appeared less heavily stocked and successful than Stocks Reservoir. Generally, higher rates of stock were observed to correspond with improved catches and angler visits. Speculatively, reservoir size and proximity to centres of large population may both influence the adoption of specific stocking policies.

Stomach and hind gut analysis

The study of trout diets based on the analysis of stomach contents has been undertaken by numerous authors. Studies by Ball (1961), Hunt and Jones (1972b), Harper (1977), Crisp et al. (1978) and Arawomo (1981b) concentrate primarily on the food of trout from varied stillwater habitats; whilst Slack (1934) and Hunt and O'Hara (1973) discuss the overwinter feeding of brown trout and rainbow trout respectively. Although the analysis of stomach contents in fish ecology is a standard practice, Hyslop (1980) notes that surprisingly little literature exists describing the range of analytical methods commonly used. For any method to supply maximum data however, the time interval from gut collection to preservation should be minimised, in order to inhibit further digestion (Windell and Bowen, 1978), a problem generally more acute in the summer months as a result of higher temperatures (Ball, 1961).

Methods of stomach content analysis are often divided into three distinct areas: numerical, volumentric and gravimetric methods. In essence, numerical analysis involves the identification and direct counting of food items in order to produce statistics of percentage occurrence and composition (Crisp et al., 1978). Volumentric analysis is based on the direct or indirect estimation of the volumes occupied by particular food categories. It is usual for the volume of each category to be expressed as a percentage of the total stomach volumes (Hunt and Jones, 1972b). Finally, a gravimetric analysis uses the weight of each food category, determined in either a wet or dry state. Each category is generally expressed as a percentage of the total weight of the stomach contents analysed.

The choice of one or more of these methods is dependent upon the aims of a particular study. In the present study, the primary reason for undertaking an investigation of stomach contents was to assess the main dietary components of angler caught fish, and compare them with the reservoir benthos data of Mills, M.L. (1971). Adoption of numerical analysis was therefore regarded as satisfactory.

It is well recognised however, that despite its popularity, expressing dietary composition in purely numerical terms suffers the disadvantage of overestimating the importance of small, numerous food items (Hellawell and Abel, 1971; Mohan and Sankaran, 1988). This problem was circumvented to a degree by Crisp et al. (1978), who omitted planktonic crustacea from percentage composition analysis. This technique would have been adopted in the present study if planktonic crustacea had been consumed in larger quantities. It should be remembered however, that both volumetric and gravimetric analyses suffer an opposite and similarly problematical bias.

In the present study which spans the 1985 and 1986 seasons, the 7 brook trout sampled contained no food items, whilst of the 8 brown trout sampled 6 had items in their stomachs. Although the composition and occurrence of brown trout food items is included (Table LXI, Figure 45), the sample is too small for the drawing of significant conclusions.

Both brown trout and rainbow trout are regarded as carniverous, opportune feeders, generally taking commonly obtainable organisms present in their environment (Pentelow, 1932). Of the 86 rainbow trout present in the 127 sampled retaining stomach contents, the items eaten may be divided into three broad categories namely, aquatic, aerial aquatic and terrestrial, and non-food items referred to by Bryan (1982) as 'rubbish'. As only 22.79% of the rainbow trout diet by number for the combined seasons is composed of the aquatic groups planktonic crustacea, Chironomidae, Mollusca and aquatic Coleoptera, this may be indicative of a limited aquatic fauna. Within this category, planktonic Crustacea and Chironomidae are most numerous, particularly in the 1986 season where they composed the major proportion of the diet by number (Table LX and Figure 46).

The aerial aquatic and terrestrial group make up the greatest proportion of the diet in the 1985 seasons, giving a combined seasonal value of 54.22% by number. The major contributary group in 1985 is Formicoidea which were eaten in profusion late in the season, although they were present in only 11.81% of stomachs examined, possibly on account of limited availability. Aerial insects on the other hand are present in 22.83% of stomachs examined, and are recorded in both seasons. Terrestrial Coleoptera are similarly eaten in both the 1985 and 1986 seasons, whilst they are present in only 8.66% of rainbow trout stomachs. In accord with the present study the consumption of large numbers of terrestrial insects, particularly ants, aphids and ladybirds was noted at Tittesworth Reservoir by Bryan (1982).

Although rainbow trout are known to be carniverous, 31.50% of the sample had consumed grass, reed and twig fragments, whilst 24.41% had eaten feathers and 9.45% small stones. Similarly out of the 8 brown trout sampled, 2 had consumed non-food items. In the case of rainbow trout non-food items amounted to 22.91% of all items consumed, whereas this only amounted to 0.9% for brown trout. The presence of non-food items in the diet of rainbow trout was also noted at Tittesworth Reservoir by Bryan (1982), whilst it may be attributable to the conditioning of introduced fish to a pellet-feed diet when in the farm environment. Bryan (1982) however, proposed that grass, reed and twig fragments were possibly eaten in mistake for Trichoptera larvae, although this is unlikely at Stocks Reservoir where Trichoptera were absent from the stomachs sampled.

In addition to the three categories of items eaten a single black-headed gull chick, Larus ridibundus, was discovered in the stomach of a 335 millimetre rainbow trout caught on 7/9/86. Although the consumption of such large prey may not be commonplace, there are numerous examples chronicled of trout eating small mammals and birds, a further example being the discovery of shrews in the stomachs of

Rutland Water trout (Harper, 1977). Another unexpected find was a profusion of maggots in the stomach of a 330 millimetre brown trout caught on 8/9/85. A likely explanation for the presence of such dipteran larvae may be illegal bait fishing, employed by a minority of anglers. At an upland water such as Stocks Reservoir, where continued vigilance is almost impossible due to the water's size and intricate shoreline, illegal fishing may prove to be a perennial and insoluble problem.

From the stomach samples collected over the 1985 and 1986 seasons, an attempt was made to divide the rainbow trout data into early, mid and late season periods, in accord with the work of Crisp et al. (1978) (Figure 47). From this analysis, the greater proportion of the rainbow trout diet early in the season (April/May) was found to comprise non-food items, namely grass, reed and twig fragments, stones and feathers. Together these made up 57.56% of the diet by number, whilst aquatic organisms contributed only 20.15%, restricted to Chironomidae and aquatic Coleoptera, and aerial insects and Terrestrial Coleoptera the remaining 22.31%. This phenomenon may be seen as a consequence of the large introductions of farm reared rainbow trout, stocked before and during the first weeks of the 1985 and 1986 seasons.

By mid season (June/July) the proportion of non-food items consumed had declined to 25% by number, whilst the proportion of aerial insects and terrestrial Coleoptera was similarly reduced to 17.16%. Aquatic organisms, notably planktonic Crustacea, Chironomidae and aquatic Coleoptera composed the majority or 57.85% of the diet during this period, although it should be recognised that the importance of planktonic Crustacea may be overestimated by the adoption of the numerical method (Crisp et al., 1978).

In the latter period of the season (September/November), the proportion of aquatic organisms consumed was observed to decline to 17.29%, whilst Formicoidea, aerial insects and terrestrial Coleoptera together, composed 63.95% of the diet by number. Interestingly, this may indicate a greater importance in food taken from the surface in the latter months of the season. However, the large numbers of Formicoidea consumed may be unrepresentative, as they were noted in the 1985 season only. During this period the number of non-food items consumed by the rainbow trout sampled declined to 18.67%, the lowest proportion of the season.

From a visual assessment of stomach and hindgut fullness undertaken for early, mid and late season periods (Figure 48), only 14.29% of rainbow trout were observed to have empty stomachs in the early season period, whilst the major proportion (35.71%) of stomachs were up to a quarter full. Although no fish had distended stomachs, 14.29% were recorded as having full stomachs. In accord with a minority of fish exhibiting empty stomachs, 85.71% of hind guts were either full or partly full, concurrent with previous feeding.

Surprisingly, in the mid-season period, the number of fish displaying stomachs devoid of food increased to 51.52%, whilst the number of full stomachs decreased to 3.03%. Contrary to the proportion of empty stomachs however, 96.97% of hind guts sampled were either full or partly full. This may be indicative of increased rates of digestion as a consequence of summer temperatures, a phenomenon noted by Ball (1961).

By the late season period, the proportion of empty stomachs had declined to 27.50%, whilst the largest proportion of 32.50% were up to a quarter full, commensurate with the early season period. In addition to 12.50% of stomachs recorded as full, a further 3.75% were observed to be distended and classified as very full, primarily on account of the consumption of large numbers of Formicoidea. Of the late season sample, 68.75% of fish were found to have full or partly full hind guts indicative of previous feeding, although the proportion of hind guts devoid of digested material was greater than that observed in the early and mid season periods.

Whilst an analysis of the guts sampled may result in a general understanding of the items eaten primarily by rainbow trout, such an analysis is necessarily limited as a consequence of the small sample size and the method of sample procurement. Since the small sample was collected from angler caught fish, then the data were biased towards the fish most susceptible to the angling techniques employed, and were therefore unlikely to be representative of the introduced stock as a whole. Furthermore, as anglers were likely to take only the largest fish caught, then extrapolation to the whole population becomes impossible.

Reservoir fauna

The limited diversity of aquatic invertebrates consumed by the trout sampled, was concurrent with the benthic invertebrate data of Mills, M.L. (1971). This study, based on a series of Ekman Grab samples passed through a 500 micron sieve, found the taxa Chironomidae, Pisidium and Oligochaeta dominant at each depth zone, whilst both Hirudinea and a miscellaneous category consisting of Cnidaria, Hydracarina, Trichoptera, Coleoptera and Diptera were present in far smaller number (Table LXII, Figure 49).

Such a limited benthic fauna, devoid of many common taxa found in waters such as Llyn Alaw and Loch Leven (Hunt and Jones, 1972b; Jones, 1977; Arawomo, 1981b) is probably a consequence of fluctuating reservoir level. Repeated drawdown generally associated with supply reservoirs such as Stocks, is well documented as deleterious to a varied littoral fauna, as wave action and fluctuations in water level result in a uniform and barren shoreline zone as depicted in Plate 16 (Hunt and Jones, 1972a; Hunt and Linfield, 1973). In an environment of repeated exposure and inundation, macrovegetation comprising necessary habitat for Mollusca, Coleoptera, Hemiptera, Odonata and Ephemeroptera is unable to survive (Hunt and Jones, 1972c), whilst typical littoral fauna is unable to become established. Under such conditions Lumbriculidae, Pisidium spp. and Chironomidae are the only invertebrates likely to occur in significant numbers (Hunt and Linfield, 1973), whilst Fillion (1967) showed that Chironomidae are likely to predominate, as they may survive long periods of exposure once water levels drop. Reservoir fauna is generally at a maximum in such waters immediately below the draw down zone (Hunt and Linfield, 1973), a phenomenon apparent in the Stocks Reservoir data of Mills, M.L. (1971), where all invertebrate categories exhibited an increase in numbers by the 5 metre to 10 metre depth zone. The greatest diversity of invertebrate fauna in such a water would be expected in the vicinity of river and stream inlets, as a consequence of downstream drift.

Summary

Patronage

From 1985 to 1987 Stocks fishery attracted seasonally 6427, 6537 and 5486 angler visits, which represented a 16% decline in patronage from 1985 to 1987.

On a daily basis patronage peaked at weekends with Sunday as the most popular day, whilst Tuesday and Thursday consistently proved the least frequented.

A decline in the proportion of day visits with a corresponding increase in the proportion of half-day visits was apparent in mid-season.

Half-day and season permit anglers exhibited proportionately fewer limit returns and a markedly greater proportion of nil returns than day permit anglers. This fact implied that as a group such anglers were the least successful.

Angler patronage displayed correlations with environmental parameters, suggesting an angler preference for dry, sunny conditions and a high reservoir level.

It was noted that reduced angler patronage displayed congruity with decreased angler success, thereby indicating the important influence of fishery performance upon future patronage.

Catches

From 1985 to 1987 the total seasonal catches, comprising rainbow, brook and brown trout, were 16430, 14805 and 12221. Those figures represented a decline of 34.8% over the period, whilst the number of fish taken similarly declined by 20.5% from 10554 in 1985 to 8392 in 1987.

Of the fish taken, rainbow trout was the dominant species constituting 84.7% of fish taken in 1985, rising to 95.6% in the 1987 season. The proportion of large ($\gg$ 907g) rainbow trout taken increased similarly from 4.8% in 1985 to 9.7% in 1987. The introduction of brook trout was of only limited success as a consequence of the species' susceptibility to infection, whilst the native brown trout was observed to be of limited importance to the fishery.

Angler success

In accord with the decrease in patronage and catches, fish taken per angler visit declined for each permit type over the period. This trend was evident similarly in the combined seasonal increase in the proportion of nil returns and the reduction in limit returns submitted.

Marked declines in angler success, particularly in the 1985 and 1986 seasons, occurred during periods of increased water turbidity. Values for turbidity rose because of heavy precipitation occurring at a time of low reservoir level. It is suggested speculatively that the resulting reduction in underwater visibility at such times may have severely limited the efficiency of fly fishing techniques, which rely primarily on visual attraction.

Introduced stock

Estimation of introduced stock was based on inexact stocking consent documentation, whilst natural mortality was assumed to be zero throughout the seasons and was calculated at 1% per week over the winter periods.

In accord with the decline in catches, estimated introduced populations displayed a general decline over the study period, with values for maximum stock occurring early in the 1985 season. Rainbow trout represented the greater proportion of fish introduced over the three seasons, with a total of 34000 fish stocked, whilst only 3700 and 1375 brown trout and brook trout respectively were recorded as introduced. However, it is probable that a further undocumented introduction of brook trout took place in the 1986 season.

Fishery comparison

Of the waters compared, the upland unstocked reservoirs returned understandably the lowest values for angler visits and catches, but the intensively managed lowland reservoirs returned generally the highest. Upland stocked waters such as Stocks Reservoir fell generally between these two extremes.

Within the upland stocked category Stocks Reservoir rated poorly, with a performance similar to Hury Reservoir. However, some lowland waters, notably Rutland Water, Llyn Alaw and Pitsford, displayed lower figures.

Stomach and gut analysis

An examination of angler-caught fish samples revealed that all brook trout stomachs examined were empty, whereas 25% of brown trout stomachs and 32.28% of rainbow trout stomachs were similarly devoid of ingested material.

Over the seasons 1985 and 1986, the diet of rainbow trout comprised only 22.79% aquatic organisms by number, which was possibly indicative of a limited aquatic fauna. Non-food items, including stones, sticks, reed fragments and feathers, composed 22.91% of the overall diet. Such non-food items were particularly prevalent in the early season diet of rainbow trout where they composed 57.56% of the items consumed. The diet of brown trout was composed of only 0.9% by number of non-food items.

<u>Recommendations</u>

(1) Although the submission rate of completed catch return forms was considered excellent on a national scale, the forms themselves might be improved considerably in order to provide consistent data, including length and weight measurements. This improvement would involve the provision of a measuring board and weighing scales in the fishery cabin, equipment usually absent over the study period.

(2) The acceptance of a stocking policy based on regular introductions of fish throughout a season is suggested, as an approach likely to encourage improved and consistent performance of the fishery. Furthermore, such a policy, if adopted, would avoid the occasional phenomenon of very high fish densities and would minimise the likelihood of occasional large operational fish losses (Chapter IV). Although possibly more expensive to implement, regular introductions of fish also offer the fishery manager a degree of flexibility, whereby stocking might be suitably tailored to the prevailing situation.

(3) A reliance on rainbow trout as the only introduced species by 1987, was concurrent with the perceived reduced popularity of the fishery. Consideration should be given to the resumption of stocking with other desirable quarry species in an attempt to increase patronage. However, it might be noted that introductions of brook trout were of only limited success as a consequence of infection and susceptibility to operational impingement (Chapter IV).

(4) In an attempt to limit overwintering mortality of introduced rainbow trout, and possibly increase angler patronage, consideration may be given to relaxing the fly-only rule in the later weeks of the season (North, 1983).

(5) It was observed that the native brown trout population played only a restricted role in fishery catches, probably on account of the fly fishing techniques generally employed. The promotion of techniques better suited to the capture of such fish would be of benefit to the fishery.

(6) Although angler attitudes towards the fishery are difficult to assess, it is deemed important that anglers should feel welcome at a fishery if their continued patronage is valued. It is thought that a contented angler is perhaps the best advertisement for a fishery. The availability to anglers of a pleasant and knowledgeable member of the fishery staff, and of well displayed fishery performance data are judged to be of benefit to the image of the fishery.

Chapter IV Operational filter plate impingement

Introduction

Ever since the opening of Stocks Reservoir in 1933, native brown trout have been lost to the treatment plant's filter plates. The greatest annual mortality would appear to have occurred in 1959, although verification is difficult because basic records were not kept until 1977, when the plant manager started keeping unofficial records as a result of large losses in the drought of 1976.

Due to the design of the 22 on-line filter plates, routine and emergency cleaning must be undertaken if an adequate supply is to be maintained. However, ever increasing manpower costs, and the Authority's proposal in 1983 to develop Stocks as a put-and-take trout fishery, have accentuated the need for a more effective screening system. As a result of this proposal, and the increase in reservoir fish density it would entail, an investigation of the screening problem was undertaken by the Principal Fisheries Assistant (Nott, 1984). The ensuing report concluded primarily that serious consideration should be given to the screening of the valve tower draw-off ports. To this end, an economic appraisal of various appropriate screening methods was included, although no improvements have yet been undertaken (1988).*

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*1989 - A rudimentary box screen is now in place to protect the top draw-off port.

From an operational point of view, filter plate impingement is of paramount importance, but it is not the only source of fish loss from the reservoir. In common with the valve tower draw-off ports, the river compensation water pipe continually abstracts water. Located over 30 metres below top water level in the culvert bulkhead it too is unscreened. The scour pipe, again situated at the foot of the valve tower, is similarly open to fish ingress, and may constitute a further route of escape on the rare occasions that it is in use (Figure 50, Plate 22). The final means of possible escape is via the embankment overspill weir, although this is relevant only at times of maximum capacity when the reservoir is overflowing (Plates 19 and 20).

The present study concentrates primarily on the analysis of filter plate impingement since the opening of the reservoir trout fishery in March 1985. However, the inclusion of relevant data associated with the additional sources of operational fish loss was thought appropriate.

The plant and its operation

The water treatment plant, situated downstream of the dam embankment, is capable of treating 115 megalitres of water per day. A scheme of modernisation is at present being undertaken, which involves the computerisation and general improvement of the plant (Plate 21).

A culvert initially built to divert the River Hodder during embankment construction, now houses the main conduits which draw water from the reservoir. These pipes include the

33 inch (838mm) diameter main supply to the treatment plant, the 27 inch (686mm) diameter river compensation water pipe, and the 36 inch (914mm) diameter scour (Figure 50).

Immediately above the culvert bulkhead is situated the valve or draw-off tower (Plate 18). This structure rises 33.5 metres from the toe of the dam and houses three 24 inch (610mm) diameter draw-off ports, each controlled by two 21 inch (533mm) diameter valves, which feed water to the main supply. These ports face up the reservoir at different angles, corresponding to the facia of the hexagonally cross-sectioned tower, at depths of 4.42 metres, 11.74 metres and 20.87 metres below the revised top water level.

The valve-controlled river compensation water pipe opens directly into the reservoir through the culvert bulkhead. Requirements of the 1925 Fylde Water Board Act (amended 1956), ensure that water is discharged to the Hodder downstream of the dam at a daily rate of 3 million gallons (13.638 Ml day^{-1}) between the months of October and April, whilst from May to September this is increased to 4 million gallons (18.184 Ml day^{-1}). On its passage to the river the compensation water passes through a generator turbine, which is capable of providing either standby direct current or alternating current for general plant use.

Additionally, a volume of water known as the water bank is held in reserve; in the autumn of the year its purpose is to prolong the natural rain-induced spates of the Hodder. This extra flow of up to 16 million gallons (72.736 Ml day^{-1})

is used to facilitate the upstream migration of returning salmon and sea trout. However, its release is not a regular occurrence; from 1985 to 1987 the water bank was used only twice, in the autumn of 1987. When such artificial spates are induced, the water is released directly from the reservoir through the scour pipe (Figure 51, Plate 22).

At the easterly extremity of the dam embankment is found the overspill weir. Lowered in 1972, in accord with a safety recommendation made by Binnie and Partners (Mills, M.L. 1971), it consists of a 90 metre long sill, which empties overflowing water into an open flood channel when the reservoir is at top water level (Plate 19). Three conduits conduct the water to river level, where it is discharged from submerged pipes into a concrete-lined pool at the head of the river (Plate 20).

Water destined for supply is drawn by gravity from the reservoir by means of the valve tower draw-off ports. One or two of the three ports are generally left open, allowing water and suspended debris to flow into the 33 inch (838mm) diameter supply main; combinations of different ports are regularly used depending upon the reservoir level. A port approaching 2 metres of the reservoir surface is inoperable however, as air entrained with the water induces the development of vortices within the main, which consequently reduce the rate of flow. Ultimately, in times of drought, water obstruction is possible by means of the lowest port only.

After the water has entered the supply main but prior to its reaching the filterhouse, it is injected with aluminium sulphate and various polyelectrolytes in order to facilitate purification. Now flowing under pressure due to the head of the water, the main divides initially into two; the first branch reduced to 27 inches (686mm) diameter divides again, supplying filter batteries 1 to 7 and 8 to 18 respectively, whilst the second branch still of 33 inches (838mm) diameter supplies batteries 19 to 22 (Figure 51). Prior to water entering the rapid sand filters the supply for each battery passes through a pressurised screen of perforated steel known as a filter or fish plate. Of an original design, the plates inhibit the ingress of large objects into the battery filter shells. To this end they are successful, retaining habitually fish and, less frequently, other objects (Plate 24).

In total there are 22 rising mains which supply an equal number of batteries. For batteries 1 to 18 the rising mains bifurcate, each branch incorporating a filterchamber and fish plate with appropriate values, thereby allowing the cleaning of one chamber without disrupting the flow to the battery (Figure 52, Plate 23). Batteries 19 to 22 have unbranched rising mains each with one filter chamber. As a consequence water supply to the battery must be curtailed for routine and emergency cleaning of the fish plates. Routine inspection and cleaning of all the plates takes place at least once a week; similarly a fish plate is cleaned if it becomes blocked. An occlusion is indicated whenever a significant pressure drop is measured by inlet and outlet gauges across the filter chamber. Access to a fish plate is gained through its own small rectangular opening in the site of the filter chamber, closed by a steel cover. After removal of the cover, the plate is slid out for cleaning. At times of severe fish ingress all filter batteries may become blocked and require cleaning, which may involve the working of overtime by the filter house staff.

Once the water has passed through the fish plates and a battery sand filter, it is collected by one of two mains. A 27 inch (686mm) diameter main takes water from batteries 1 to 7, whilst batteries 8 to 22 feed into a larger main of 36 inches (914mm) diameter (Figure 51).

Fish impingement and screening literature

An intensive literature survey revealed little relevant information concerning fish impingement and screening. Much of the published work, often researched by Central Electricity Research Laboratory personnel, is concerned understandably with powerstation cooling water intakes, their environmental impact and associated problems (Holmes, 1974; Langford et al., 1978; Hadderingh, 1979; Turnpenny, 1981; Goeman, 1984; Margraf et al., 1985; Turnpenny et al., 1985). Remaining papers concentrate generally on experimental screening techniques, involving electrical barriers and bubble curtain veils (Bramsnaes et al., 1945; Hyman et al., 1975; Stewart, 1981).

However, correspondence with the ten regional Water Authorities of England and Wales was more productive, although it appears that the problem of excessive fish impingement encountered at Stocks Reservoir is not a widespread phenomenon.

The Anglian and Severn Trent Authorities note minor impingement problems at a number of land drain pumping stations shielded by rudimentary screens. At large reservoirs incorporating managed trout fisheries, however, most Authorities report that inclined metal bars, appropriately spaced, are sufficient to prevent ingression of all but the occasional fish.

In the Wessex Water Authority area, Ashford (2.8 ha) and Durleigh (32.4 ha) reservoirs, both holding substantial trout and coarse fish populations, are screened efficiently by cylindrical, copper wire strainers which protect the main supplies. In each case, the strainer is situated within an intake well incorporated in the valve tower, which is open to the reservoir through a number of valve-controlled intake ports. Due to the size and shape of the cylindrical strainer, water velocity through the screen is relatively low, consequently reducing the possibility of blockage by fish or debris.

Sutton Bingham Reservoir (57.5ha), again in the Wessex Water Authority area, is one of the few operational reservoirs with a system of on-line filter plates resembling those of Stocks Reservoir. Unlike the majority of filters at

Stocks, the rising mains at Sutton Bingham do not bifurcate to maintain supply when a filter plate is being cleaned. It should be noted, however, that occlusion of the plates is not a common occurrence as fish ingress is only a fraction of that at Stocks, although improved screening arrangements are under consideration in a current programme of modernisation.

Interestingly, South West Water Authority's Colliford hatchery possesses a system of screening of a similar design to Stocks. Adopted in order to prevent the ingress of eels into the hatchery's pipe work, the intake main bifurcates, forming two filter chambers. This effectively solves the problem of maintaining a constant flow through the hatchery, but necessitates the laborious cleaning of occluded plates, as at Stocks. At present no simple solution has been devised to prevent the initial ingress of fish into the draw-offs.

Methodology

Fish plate impingement data were collected, with the assistance of treatment plant personnel, from 1st March 1985 to 31st December 1987. In addition, several operational and environmental parameters were recorded over the same period.

Impinged trout which were generally killed on impact with the plates, were removed from the filter plates during routine or emergency cleaning, and placed in polythene bags inscribed with their date of removal. Thus packaged, they were stored in a conveniently situated freezer at the treatment plant. This means of collection relied heavily upon the goodwill of plant personnel; however, a number were keen local fishermen and particularly enthusiastic in their approach. A separate record of trout impingement was also kept both for reference purposes and in order to avoid confusion, if by chance a frozen fish was wrongly labelled.

The records were personally checked, and the freezer cleared at fortnightly intervals throughout the study period. The stored fish were then allowed to thaw and were examined in order of impingement. Each fish was identified, its fork length measured to the nearest millimetre, and, where possible, weighed to the nearest 5 grammes. Such measurements were taken to discern possible trends in trout impingement based on their species and size. During examination, the stomach and hind gut from a random sample of trout impinged in 1985 were taken by sampling every fifth individual from each trout species impinged (Loveday, 1971).

Preserved in 5% formaldehyde, their contents were examined later to discern if feeding behaviour predisposed certain fish to impingement. Scale samples were similarly removed from the larger brown trout, and stored for future reference. As sampling progressed, it was noted that a number of trout had opaque lenses in one or both eyes, possibly indicative of eye fluke. Such individuals were noted and samples taken for analysis. Finally, in addition to the impingement of trout, a number of minnows were occasionally removed from the filter plates. The dates of impingement of these species were similarly recorded.

It may be useful to note for future work that, due to the large numbers and often putrid nature of many of the impinged fish, much of the above work had to be undertaken out of doors. Decomposition on the filter plates was particularly problematical in the summer months, when the water was warmer. Such decomposition rendered accurate weight measurements impossible, and an analysis of the stomach and gut contents difficult.

In an attempt to establish whether fish were lost from the reservoir by routes other than the supply draw-off ports, an electric fishing survey of the hydro-pool, downstream of the embankment, was undertaken in order to substantiate whether any fish may have originated from the reservoir (Figure 51). The survey initiated on 12th June 1985 involved the draining of the pool by levering out boards from an impoundment weir, and fishing the remaining water issuing from the compensation water pipe. Despite attempts at pool drainage, the site was still considered large in relation to the electric fishing gear available; however, it was felt that a reasonably accurate assessment of the species present was achieved.

Furthermore, consideration was given to the electric fishing of a number of representative sites downstream of the dam. However, that scheme had to be abandoned because the electric fishing equipment available was unsuitable for the broad reaches of the Hodder, whilst procurement of suitable equipment proved difficult.

As a result of such problems, contact was established with local angling clubs which hold fishing rights on the Hodder, downstream of the reservoir. This approach proved fruitful, as correspondence with Dr. R.B. Broughton, Chairman of Ribble Fishers and the Lancashire Fly Fishers Association (LFFA), resulted in the obtaining of relevant catch data and further information associated with losses to the Hodder from local trout farms and Stocks Reservoir.

Results

An analysis of filter plate impingement was undertaken in order to discern possible trends in fish impingement, associated with environmental or fishery parameters. A weekly basis for impingement data was adopted necessarily in the study as a consequence of uncertainty about the actual dates of impingement of many fish. This uncertainty stemmed from the routine weekly cleaning of all the filter plates, unless a significant drop in pressure across a plate indicated an occlusion sufficient to warrant immediate cleaning. Thus, many fish impinged during a week were not recorded until routine cleaning, a situation readily apparent from the number of putrid fish examined.

A monthly summary of rainbow trout, brook trout and brown trout impinged in 1985, 1986 and 1987 is displayed in Table LXIII, whilst percentage species impingement and percentage monthly impingement for each species may be found in Tables LXIV and LXV respectively. A cumulative graphical representation of weekly impingement of rainbow trout, brook trout and brown trout is illustrated for each year separately in Figure 53 and, for reasons of annual comparison cumulative graphs of combined species impingement for each season are displayed in Figure 54. In an attempt to reflect fluctuations in impingement with greater clarity than that provided by the use of cumulative curves, annual weekly histograms of species impingement are illustrated in Figure 55.

Further impingement analysis involved weekly quantification of the size of fish impinged. As weight measurement had proved unreliable as a consequence of decomposition on the filter plates, fork length was adopted as a most suitable measurement. Initially it was proposed to calculate weekly mean lengths, but as this technique at times proved unreliable due to limited weekly impingement, it was discarded in favour of a system of length categories. Three length categories were finally chosen, referred to as small ($<$ 150 mm), medium (150mm to 300mm) and large ($>$ 300mm), which effectively covered the range of fish impinged.

An annual summary of impinged rainbow trout, brook trout and brown trout in each length category is presented in Table XLVI, whilst Table XLVII represents the monthly percentage impingement of small, medium and large fish of each species for the years studied. A graphical representation of weekly length category impingement for each species is displayed annually in Figure 56. In addition to an analysis of length category impingement, bi-monthly percentage frequency distributions were constructed with incremental 50 millimetre length classes, in an attempt further to clarify the length structure of the impinged populations. The ensuing histograms drawn separately for rainbow trout, brook trout and brown trout are illustrated in Figure 57.

In order to assess a possible similarity between annual impingement for each species, Chisquare tests were undertaken for both rainbow trout and brown trout (Table LXVIII).

Unfortunately, as the number of brook trout impinged annually was erratic and extended to 1985 and 1986 only, it was not possible to include brook trout. For both rainbow trout and brown trout however, the null hypothesis 'Are the patterns of impingement for a given species similar from year to year?' was rejected, indicating possibly that seasonal migration was not fundamental to filter plate impingement. In addition to the computation of Chisquare values, standard residuals were calculated for each month's impingement (Table LXIX). Such residuals, either positive or negative, indicate that the frequency of impingement was greater or less great than that expected for a given month (Grant and Tyler, 1983).

Similarity between species and length categories impinged are covered by the Pearson product moment correlation matrices referred to in Chapter III (Tables XLVIII to LI). Furthermore, these matrices incorporate environmental and fishery parameters of probable importance to patterns of impingement. Significance levels of 95% and 99% are conferred by a single or double asterisk respectively. For reasons of comparison, the environmental parameters collated over the period 1985 to 1987 are to be found summarized in Tables XLV to XLVII, whilst weekly data are illustrated graphically in Figures 39 to 43.

In an attempt to analyse food items consumed by impinged fish, random samples were collected for each species comprising 15 rainbow trout, 16 brook trout and 75 brown trout taken throughout 1985. Of the stomachs examined the majority was found to be empty as a consequence of delayed sampling, putrefaction and possible regurgitation of stomach contents on impingement with the filter plates. A record of the fish examined containing food is displayed in Table LXX, although further collection was discontinued after 1985 on account of the sampling problems encountered.

Weekly data upon which much of the impingement work was based are to be found in Appendix 5.

Discussion

Observed impingement

Throughout the years studied, 1985 to 1987, total impingement was observed to vary considerably, with annual values of 528, 940 and 463 respectively (Table LXIII and Figure 54). In harmony with impingement data recorded prior to the development of the present fishery, brown trout were impinged in large numbers, exhibiting the greatest impingement of the three species over the period, comprising 71%, 64% and 89% of fish annually impinged (Table LXIV and Figure 53). Rainbow trout constituted 16%, 13% and 11% of impingement respectively, whilst brook trout impinged in 1985 and 1986 only, comprised the remaining 13% and 23% in those years. On a monthly basis however, impingement of rainbow trout in 1985 and 1986 occasionally exceeded that of brown trout early in the years, possibly as a consequence of intensive stocking.

Whilst the native brown trout population supplemented by the introduction of 3700 stock fish in 1985, generally composed the largest proportion of fish impinged, not so apparent was the difference in susceptibility to impingement between rainbow trout and brook trout (Table LIV). Of rainbow trout introductions assessed from stocking consent documentation for 1985 to 1987, annual impingement was limited to 0.4%, 1.3% and 0.4% of the annually introduced stock respectively. On the other hand, based on stocking consent documentation, 5% of brook trout introduced in 1985 were impinged by the end of the year. The disparity in the proportions of rainbow trout and brook trout stocks impinged is particulatly significant when one considers that the stock density of introduced rainbow trout in 1985 was estimated at 135 ha^{-1} yr^{-1}, whilst for brook trout only 10 ha^{-1} yr^{-1}. Although 69 brook trout were impinged in 1985, the greatest annual impingement was realised in the following year, 1986, when 220 fish were lost. From documentary evidence this appears surprising because brook trout were recorded as stocked in 1985 only, whilst catches and heavy mortality resulting from fungal infection and possibly exacerbated by insufficient food (Mills, D.H. 1971), would have severely depleted the stock by 1986. However as referred to in Chapter III it was ascertained from fishery staff that a second introduction of brook trout may have occurred in 1986, although this was not corroborated by stocking consent documentation. If accurate, this intelligence explains the recurrence of both catches and impingement of brook trout in weeks 6 (20/4/86) and 10 (18/5/86) of the 1986 season respectively (Figure 44). Furthermore, as only 5 brook trout were caught and none was impinged in 1987, this may indicate the limited overwintering success of the species, possibly augmenting the likelihood of the proposition of a further introduction in 1986.

Over the period 1985 to 1987, of the brown trout annually impinged the greater proportion was of the medimum length category (150mm to 300mm). This proportion increased continually from 54% in 1985 to 74% in 1987, in accordance with the progressive decline in large fish ($>$ 300mm) from a maximum proportion of 37% in 1985 to a minimum of 13% in 1987 (Tables LXVII and Figure 56). This trend in impingement of medium and large brown trout may, to some degree, be a consequence of the introduction of 3700 larger fish in 1985. Contrary to impingement statistics for introduced rainbow trout and brook trout, all of which exceeded 200 millimetres on stocking (Figure 57), a number of small ($<$ 150mm) brown trout was impinged annually. These smaller fish were at a minimum in 1985 when they composed 9% of brown trout impingement, whereas in 1986 and 1987 they constituted 17% and 13% of impingement respectively.

From bi-monthly percentage frequency distributions (Figure 57), it may be observed from May through to October 1985 that the greatest proportions of brown trout impinged were subsumed by the class range 251mm to 350mm. Subsequently, in 1986 and 1987 the greatest proportions tended to occur at smaller length classes, generally covered by the range 150mm to 300mm. It may be suggested speculatively, in accord with the length category data, that this declining trend is attributable to generous brown trout introductions in March 1985, with subsequent introductions occurring throughout the season.

Also from a study of percentage frequency distributions, the annual recruitment of juvenile brown trout to the reservoir population is apparent from the impingement of smaller fish ($<$ 150mm), notably of the 101mm to 150mm length class. The impingement of juvenile brown trout of this length class is concurrent with the proposed downstream movement of two year old tributary stream fish, the vast majority of which was of the 101mm to 150mm length class.

Of the rainbow trout impinged, there was a marked annual change in the proportion of medium (150mm to 300mm) and large ($>$ 300mm) sized fish impinged over the study period (Table LXVII). Whilst in 1985 medium and large fish categories contributed 70% and 30% of impingement respectively, by 1987 the situation was reversed, with medium sized fish comprising 29% of impingement and large fish 71%. This change, clearly illustrated in the bi-monthly percentage frequency distributions of length class impingement (Figure 57), was probably associated with modifications in stocking policy. Changes in policy are apparent from reference to stocking consent documentation (Table LII), from which it would appear that as reliance on introduced rainbow trout increased from 1985 to 1987, so there was an accompanying rise in the number and proportion of large rainbow trout stocked. Furthermore, the overall low level of rainbow trout impingement in 1987 may be, to some extent, associated with stock, which was estimated to be at a minimum in 1987 (Table LIII), whilst an adopted policy of judicious stocking throughout the season may have resulted in the avoidance of the higher stock densities associated with 1985 and 1986.

Although brook trout were impinged in 1985 and 1986 only, there was a marked difference in the proportions of medium and large fish impinged over the period. In 1985, medium and large fish categories composed 39% and 61% of impingement respectively, whilst in 1986 the reverse was the case, with the proportion of medium sized fish impinged increasing to 78% and large fish declining to 22% (Table LXVII). This trend may similarly be observed in bi-monthly percentage frequency distributions of length class impingement (Figure 57), where in 1985 impingement generally peaked at length class 301mm to 350mm, whereas in 1986 this declined to 251mm to 300mm. If as would appear likely, brook trout were introduced in 1986, it is probable that such fish were of a smaller size than those stocked in 1985.

In an attempt to establish whether a similarity existed between annual impingement for each species, the null hypothesis 'Are the patterns of impingement for a given species similar from year to year?' was tested by Chisquare analysis for both brown trout and rainbow trout (Table LXVIII). From these tests the null hypothesis was rejected for both species, thereby establishing that differences in annual impingement existed over the period 1985 to 1987. These differences may indicate that seasonal migration is not fundamental to filter plate impingement.

Similarity between species impingement was ascertained both annually, and for the years combined, by the use of correlation analysis (Tables XLVIII and XLIX). For the annual data combined, significant positive correlations

($\geqq$ 95%) were apparent between impingement of all species, although on an annual basis correlations were more diverse. In 1985 and 1986, the two years when brook trout were impinged, significant positive correlations at the 99% level existed between total brook trout and brown trout impingement, a trend clearly observable in histograms of weekly species impingement (Figure 55). Furthermore, both medium and large category brook trout and brown trout in 1985 and 1986 similarly exhibited significant correlations at the 99% level. Such correlations may suggest that similar behavioural and environmental parameters are influential in the impingement of both species. In both 1985 and 1987, impingement of rainbow trout was not significantly correlated with either brook trout or brown trout impingement. However, in 1986, when annual impingement of all species was at a maximum, rainbow trout and brown trout impingement were positively correlated at the 99% level.

Environmental parameters

Correlation analyses between combined annual species impingement and environmental parameters established certain correlations over the period 1985 to 1987. However, on an annual basis correlations exhibited marked diversity, possibly as a consequence of annual fish introductions and variations in environmental parameters, such as weather conditions and related reservoir conditions.

Combined annual rainbow trout impingement exhibited limited correlation with environmental parameters over the period, significantly correlated at the 95% level with turbidity only. A division into medium (150mm to 300mm) and large ($>$ 300mm) categories, however, revealed a number of disparate correlations. Medium sized rainbow trout displayed significant positive correlations with supply (99% level) and total flow (95% level), and positive and negative correlations (95% levels) with the use of the upper and middle draw-off ports respectively. In addition, both water and air temperatures were significantly negatively correlated (95% levels) with impingement of medium sized rainbow trout. Taken together this may indicate that impingement of such rainbow trout was most likely when the reservoir was relatively full and the weather was cool, conditions generally experienced both early and late in the year. From stocking consent documentation (Table LII), it may be observed that in 1985 and 1986 in particular, the majority of rainbow trout was introduced early in the season and probably fell within the medium length category. Such introductions preceded peaks in rainbow trout impingement, the greater proportion of which was of the medium length category (Figure 56). It may therefore be hypothesised that an increase in rainbow trout density preceeds an increased impingement.

Large rainbow trout, however, displayed contrasting correlations for the combined period, exhibiting significant negative correlations (99% level) with reservoir level and percentage capacity, negative and positive correlations with the use of the upper (95% level) and lower (99% level) draw-off ports respectively. This may indicate that impingement is more likely during periods of lower reservoir level when the lower port is operable, a condition generally prevalent sometime between mid June and October. This may possibly be associated with mid season introductions of larger fish, introduced to supplement the remaining stock. The lack of consistent annual correlations between rainbow trout impingement and environmental parameters would similarly cohere with increases in stock density primarily influencing rainbow trout impingement.

Although an increase in rainbow trout density might expose fish to a greater likelihood of impingement, the disproportionately large numbers of brook trout and brown trout impinged in relation to the numbers of rainbow trout present, would suggest differences in susceptibility to impingement between species, possibly exacerbated by competitive influences (Gatz et al., 1987).

In accord with the significant positive correlations (99% level) between brook trout and brown trout impingement present in both 1985 and 1986, a trend clearly observable in weekly impingement histograms (Figure 55), numerous correlations with environmental parameters were common to both species. These included negative correlations (99% level) between impingement and reservoir level and percentage capacity, negative and positive correlations (99% level) with the use of the upper and lower draw-off ports respectively, and negative correlations (99% level) with both the supply and total flow from the reservoir. This would indicate that low reservoir level and hence capacity, tended to be concurrent with increased impingement of both brook trout and brown trout. From a reference to environmental correlation matrices (Tables L and LI), it is apparent that changes in both port operation and supply and total flow are dependent upon reservoir level (Figures 39 and 40), such that increases in impingement tend to occur when the lower draw-off port is in operation and total flow at a minimum. This may refute the commonly held opinion that fish might be involuntarily 'sucked' through the ports with escalating flow velocity. Significant negative correlations displayed primarily between brown trout impingement and water colour (99% level), whilst less markedly so for brook trout, are probably similarly coincident with a declining reservoir level, such that impingement tends to peak during periods of minimum water colour. Furthermore, significant positive correlations exhibited between brook trout impingement and water temperature (99% level) and air temperatures (95% levels), are perhaps of a seasonal nature (Figure 41), associated with increased impingement in the summer months concurrent with reservoir drawdown and stocking. In the 1985 season only, impingement of small ($<$150mm) and large ($>$300mm) sized brown trout displayed divergence in correlations with water and air temperature. Whereas small brown trout exhibited significant negative correlations with both water temperature (99% level) and air temperature (95% level), large fish displayed significant positive correlations (99% level). From a reference to stocking consent documentation and histograms of size category impingement (Table LII and Figure 56), this difference is likely to be an artefact of stocking, with introductions of larger fish possibly leading to the peak in impingement between weeks 20 and 30 of 1985 (19/5/85 to 28/7/85).

The correlations between brook trout and brown trout impingement present in the combined annual data were evident in both 1985 and 1986; years when reservoir drawdown declined sharply to minima of 24.09 metres and 19.47 metres respectively. In 1987 however, when reservoir level was recorded as declining over a longer period to a minimum of 24.38 metres (Figure 39), correlations were limited, although impingement of brown trout was still substantial. It should be noted that although drawdown might appear modest, capacity declines rapidly as a consequence of the shallowness of the upper reaches of the reservoir. Thus, capacity declined to 47%, 23% and 49% of maximum in the years 1985 to 1987 respectively, reductions which may have resulted in rapid increases in densities as fish displaced from the shallow areas moved down the reservoir into deeper water.

During periods of drawdown in 1985 and 1986, it may be observed from standard residuals calculated from Chisquare analyses for brown trout and rainbow trout only (Table LXIX), that brown trout losses were greater than expected in June and July 1985 and from August to November 1986, periods which coincided with maximum drawdown and minimum capacity (Figures

39 and 40). In accord with the limited consistent correlations between rainbow trout impingement and environmental parameters no similar pattern was perceivable for total rainbow trout impingement.

Contrary to the decline in angler catch associated with increased turbidity, filter plate impingement would at first appear little influenced by high water turbidity values. However in 1986, significant positive correlations were present between rainbow trout and brown trout impingement and turbidity, although it is apparent from Figures 40 and 55 that increased impingement preceeded the rise in turbidity resulting from a period of heavy precipitation and strong, predominantly westerly winds. Similarly in 1985, heavy fish impingement preceeded a sharp rise in turbidity and colour. The phenomenon of a peak in fish plate impingement preceeding a rise in water turbidity measured at the valve tower, may be indicative of a deterioration in water quality at the head of the reservoir displacing fish, and resulting in an escalation of stock density in the vicinity of the valve tower. Such fish movements associated with suspended solids are discussed by Alabaster and Lloyd (1983), although the evidence is somewhat contradictory.

This hypothesis, possibly explaining a proportion of the filter plate losses could be further investigated by the procurement of turbidity readings from a number of reservoir sites during periods of heavy and prolonged precipitation.

From a daily monitoring of pH values over the period

1985 to 1987 (Table XLVI, Figure 40), it is noted that the mean value was 7.1, whilst a minimum value of 6.7 is recorded for the week ending 21/12/86 (week 51) and a maximum of 7.4 for the weeks ending 17/5/87 (week 20) and 20/12/87 (week 51). From the relevant literature it is noted that the range pH 6.7 to 7.4 is well within the range not directly lethal to salmonid species (Campbell, 1961; Alabaster and Lloyd, 1983; Eilers et al., 1984). Furthermore it was found by Höglund (1961) that pH values within the range 5.3 to 7.4 are non-directive for salmon parr. However, experiments in which fish have been exposed to steep pH gradients have been questioned, because in the field changes in concentration are likely to occur over greater distance and a longer time period, thereby allowing for progressive adaptation to the conditions (Alabaster and Lloyd, 1983). In concurrence with disparate annual correlations, it is therefore suggested speculatively that pH has little relevance to increased fish impingement.

Stomach and hind gut samples

In an attempt to determine the importance of trout diet in filter plate impingement, possibly associated with shoaling in the vicinity of the valve tower as a consequence of the abundance of prey species, a random sample comprising 106 stomachs and hindguts was procured. This random sample constituted guts from 75 brown trout, 16 brook trout and 15 rainbow trout, based on the sampling of every fifth fish of each species impinged throughout 1985. However, of the stomachs examined, the majority was found to be empty, with ingested items present in only 8.0%, 6.7% and 20.0% of brown trout, brook trout and rainbow trout stomachs respectively. In comparison with samples of angler caught fish, the proportions of empty stomachs greatly exceeded the 25.0% and 32.3% recorded for brown trout and rainbow trout respectively. Two reasons for this disparity might be suggested, notably a prolonged delay in sample collection and a regurgitation on impact with a filter plate. Whilst a delay in procuring stomach contents after death, resulting in continued digestion is well documented, less frequently examined is the extent of stomach content regurgitation associated with sampling methods, which both Healy (1956) and Treasurer (1988) conclude may lead to spurious results. In the present study regurgitation of stomach contents is regarded as highly probable, because many of the impinged fish were severely impacted with the filter plates. Furthermore, from an analysis of brown trout hindgut fullness, 30.7% of fish were observed to have digested material present in the hindgut, a figure somewhat in excess of the 8.0% of brown trout stomachs observed to contain ingested items. For these reasons, a detailed analysis was not pursued, whilst possible future work might benefit from the use of strategically placed gillnets in the vicinity of the valve tower, in order accurately to determine the diet of fish susceptible to impingement.

With regard to stomach content data procured in 1985 (Table LXX), terrestrial Coleoptera found in the stomachs of two rainbow trout (18/5/85) were characteristic of surface feeding behaviour. However, 12 Trichoptera larvae present in the stomach of a brown trout (15/6/85) may indicate benthic feeding, a characteristic which may predispose the species to impingement whilst limiting angler catchability. The presence of short lengths of stick in the stomachs of all species is rather ambiguous, as they may have been ingested accidentally, or as suggested by Bryan (1982) they may have been mistaken for Trichoptera larvae. Interestingly, a brown trout impinged between 14/3/85 and 18/3/85 and another on 16/6/85, were both found to contain a partly digested minnow. Throughout the study period from 1985 to 1987 impingement of minnow was regularly noted, with incidences in impingement often increasing during periods of increased trout species impingement. Whilst it is feasible that trout species may be impinged as a consequence of the pursuit of minnow, it is equally probable that minnow impingement may respond to similar influences as the trout species. Unfortunately, it is not possible from the present study to ascertain which of the above explanations is the more probable.

Eye fluke infestation

During the course of examination of fish from the filter plates, it became apparent that a significant proportion of trout of all species exhibited opacity of the lens in one or both eyes. An examination of numerous eye samples by Dr. I. Williams of the University of Hull, revealed that the opacity resulted from an infestation of the eye fluke, *Diplostomum* spathaceum, a common parasite of cold-blooded vertebrates and particularly of freshwater fish. Sweeting (1974) noted that the eye-fluke has been recorded in at least 23 British freshwater fish species and in 105 species throughout Europe and North America (Skrjabin, 1964), although analyses of host specificity have received little attention (Betterton, 1974).

The adult fluke parasitises the intestine of various piscivorous birds, notably gulls of the family Laridae (Smyth, 1962; Mills, D.H. 1971). The first intermediate host are lymnaeid snails, in which cercariae develop and are released directly into the water. The free-swimming cercariae are able to penetrate the skin of a variety of freshwater fish, whence they migrate to the eye as metacercariae. The metacercariae accumulate beneath the lens capsule (Shariff et al., 1980), where in acute cases of infestation they may cause exopthalmia and opacity of the lens, causing blindness (Gaten, 1987). In wild fish populations the resulting decreased visual acuity may lead to a reduced feeding efficiency and a stunted growth, whilst decreases in catch may occur at freshwater sport fisheries.

At Stocks Reservoir a large colony of black-headed gulls Larus ridibundus, is the probable host of the adult fluke (Jones et al., 1978), whilst the first intermediate host Lymnaea pereger is known to inhabit the reservoir from the results of gut analysis of angler caught fish. Brook trout were the most commonly afflicted species with 19.5% of impinged fish in 1986 exhibiting characteristic opacity in one or both eyes, whilst 13.6% and 14.7% of rainbow trout and brown trout respectively, displayed such infection in the period 1986 to 1987. Although the mean size of heavily infected rainbow trout and brook trout impinged was dependent upon the size of the fish introduced, of the infected brown trout impinged the majority fell within the medium size category (150mm to 300mm), with a mean of 247 millimetres. This indicates that heavy infestations characteristic of lens opacity are generally prevalent in older brown trout impinged. Because of the highly selective nature of the sample however, this may not be common to the brown trout population as a whole.

Further routes of fish loss

Whilst from an operational point of view, filter plate impingement is of paramount importance, it does not constitute the sole source of fish loss from the reservoir. Other sources include the unscreened river compensation water and scour pipes (Figure 50), and the 90 metre long embankment overspill weir (Plate 19). In common with the valve tower draw-off ports, the compensation or hydro pipe continually abstracts water; however, as it flows through an electricity generator turbine it is an improbable route of live fish loss. The scour and embankment overspill weir on the other hand, are likely sources of some live fish loss, but the scour is rarely operable and the overspill weir is relevant only at times of maximum reservoir capacity.

Over the period 1985 to 1987 the scour was used on two occasions only, during the weeks ending 1/11/87 and 13/12/87. However over the same period, the reservoir overflowed for a period of 22 weeks generally between the months of October to April, which may constitute a period of substantial fish loss to the River Hodder. In order to establish whether rainbow trout and brook trout in particular were lost to the river, a preliminary electric fishing survey of the hydro pool was undertaken (Figure 51, Plate 21). From the results of this work in addition to 43 brown trout, 7 chub (*Leuciscus cephalus*) and 45 eels (*Anguilla anguilla*), 5 rainbow trout were captured between 264 millimetres and 340 millimetres in length. Whilst it is possible that such fish may have originated from fish farms in the Hodder Valley, it is more likely that they were reservoir escapees. Further evidence for this conclusion was gleaned from correspondence in 1988 with Dr. R.B. Broughton, the Chairman of both Ribble Fisheries and the Lancashire Fly Fishers Association (LFFA).

Referring to the River Hodder downstream of Stocks Reservoir, which has never been officially stocked with rainbow trout, there are three possible sources of rainbow trout in the vicinity, namly trout farms at Dunsop Bridge and Heaning, and Stocks Reservoir. Of the trout farms, Dunsop Bridge appears secure, whilst intermittent losses of small fish have been reported from Heaning. The capture of approximately 20 rainbow trout, therefore, of up to 3½lb ($\leq$ 1580g), from May to October 1987 may indicate a considerable escape from Stocks Reservoir. Interestingly, no brook trout was caught or observed in the Hodder, which may not be surprising on account of the brook trout's susceptibility to infection, a problem similarly noted by Dr. Broughton at other stillwater fisheries in the locality.

Summary

General impingement

Total annual impingement from 1985 to 1987 was observed to vary considerably with 528, 940 and 463 trout impinged respectively.

Brown trout exhibited the greatest losses comprising 71%, 64% and 89% of trout impinged annually, whereas rainbow trout constituted only 16%, 13% and 11% annually. Brook trout were impinged in 1985 and 1986 only, when they comprised the remaining 13% and 23%.

Of the species wholly introduced, rainbow trout and brook trout, susceptibility to impingement appeared markedly different, with impingement of the former limited to 0.4%, 1.3% and 0.4% of those documented as stocked annually, whilst the figure for the latter was 5% in 1985. This is particularly significant when one considers the disparity in the species' stock densities.

Length categories

Of the brown trout impinged the greater proportion was of the medium length category (150mm to 300mm), a proportion which was observed to increase annually with a corresponding decline in the proportion of large fish ($>$ 300mm) impinged. This trend was probably an artefact of introductions of larger brown trout in 1985 which supplemented the native population.

By way of comparison to introduced rainbow trout and brook trout, a number of small ($<$ 150mm) brown trout was impinged annually, a phenomenon concurrent with the recruitment of juvenile tributary stream fish to the reservoir population.

As a consequence of changes in stocking policy, the annual impingement of medium and large rainbow trout displayed a trend contrary to that of brown trout, with the proportion of large fish impinged increasing over the study period. However, the impingement of brook trout exhibited a trend similar to that for brown trout by displaying a decline in the proportion of large fish impinged.

Impingement correlations

From Chisquare analysis it was ascertained that species impingement showed an annual dissimilarity, particularly for brown trout, which might indicate that seasonal migration is not fundamental to an increase in impingement. Between the species brown trout and brook trout impingement displayed significant positive correlations, which suggests that similar behavioural and environmental parameters are of probable importance, whilst rainbow trout impingement exhibits little correlation with that of brown and brook trout.

As impingement of rainbow trout showed limited correlation with environmental parameters, it is probable that peaks in rainbow trout impingement are determined largely by increases in fish density as a consequence of stocking.

However, both brown trout and brook trout impingement, particularly in 1985 and 1986, exhibited significant correlations with low reservoir level and to some extent rises in turbidity. Furthermore, such peaks in impingement occurred during periods of minimum supply of water, thereby refuting the claim that fish might be involuntarily 'sucked' through the draw-off ports with escalating flow velocity.

Stomach and hind gut analysis

A random sample of 106 stomach and hind gut samples was procured from impinged fish in 1985, comprising 75 brown trout, 16 brook trout and 15 rainbow trout.

The majority of stomachs was found to be devoid of contents, a situation probably resulting from prolonged delays in sampling, and regurgitation on impact with the filter plates. A detailed study was not therefore undertaken. However, impingement of minnow, a likely prey species, was noted; two such fish were recorded in the stomach contents of two impinged brown trout.

Eye fluke infestation

As sampling of impinged fish progressed, lens opacity resulting from eye-fluke infestation was noted and enumerated. Brook trout were observed to be the most commonly afflicted species.

Further fish loss

A brief discussion of further routes of probable operational fish loss from the reservoir is included.

Recommendations

(1) Introduced rainbow trout proved the least susceptible trout species to filter plate impingement, to the extent that only 0.7% of the 34000 stocked from 1985 to 1987 were impinged. Therefore from an operational perspective, the continued introduction of rainbow trout is desirable.

(2) Although relatively few brook trout were introduced, they composed 13% and 23% of total impingement in 1985 and 1986 respectively, indicative of a high susceptibility to impingement. As the species also suffered a heavy natural mortality, it is suggested that future introductions should be discontinued.

(3) Over the period 1985 to 1987 brown trout composed 72% of all fish impinged. Because the overwhelming majority of these fish was native to the reservoir, and played only a restricted role in the fishery, then fishery remuneration may exclude the value of such fish.

(4) In an attempt to minimise the occurrence of high fish densities which might result in an increased impingement, frequent introductions of fish throughout the season might be of benefit. Such a policy would also enhance the consistency of fishery performance at the reservoir.

(5) Consideration should be given to physical, electrical or chemical screening of the valve tower inlet parts, thereby mitigating filter plate impingement. However, as this would be an expensive and inherently problematical solution, it might be desirable to improve filter chamber access in order

to facilitate filter plate cleaning and so reduce operating costs.

(6) It was judged that the overflow sill might, at times of maximum capacity, pose a route of substantial fish loss into the River Hodder. Consideration should therefore be given to erecting a simple net screen along the sill in order to avoid such losses.

(7) Further recording of water quality parameters from the head of the reservoir, and from other strategic points, in conjunction with an analysis of impingement and fishery data, should together lead to a fuller understanding of the role played by fluctuations of water quality in increased levels of fish impingement.

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THE UNIVERSITY OF HULL

THE FISH AND FISHERY OF STOCKS RESERVOIR, LANCASHIRE

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VOLUME II

The Plates, Tables, Figures
and Appendices.

VOLUME II

Top. Plate 1.

Survey site 1, River Hodder, SD 702 590.

Middle. Plate 2.

Survey site 2, River Hodder, SD 715 583.

Bottom. Plate 3.

Survey site 3, River Hodder, SD 724 572.

Top. Plate 4.

Survey site 4, Hasgill Beck, SD 733 586.

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Survey site 6, Bottoms Beck, SD 746 575.

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Survey site 7, Bottoms Beck, SD 745 567.

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Survey site 8, Bottoms Beck, SD 745 565.

Top. Plate 9.

Waterfall on Bottoms Beck, upper tier, SD 745 566.

Bottom. Plate 10.

Waterfall on Bottoms Beck, lower tier, SD 745 566.

Plate 11.

An example of scales from a 97mm, age group I fish, taken in summer 1985 (site 4).

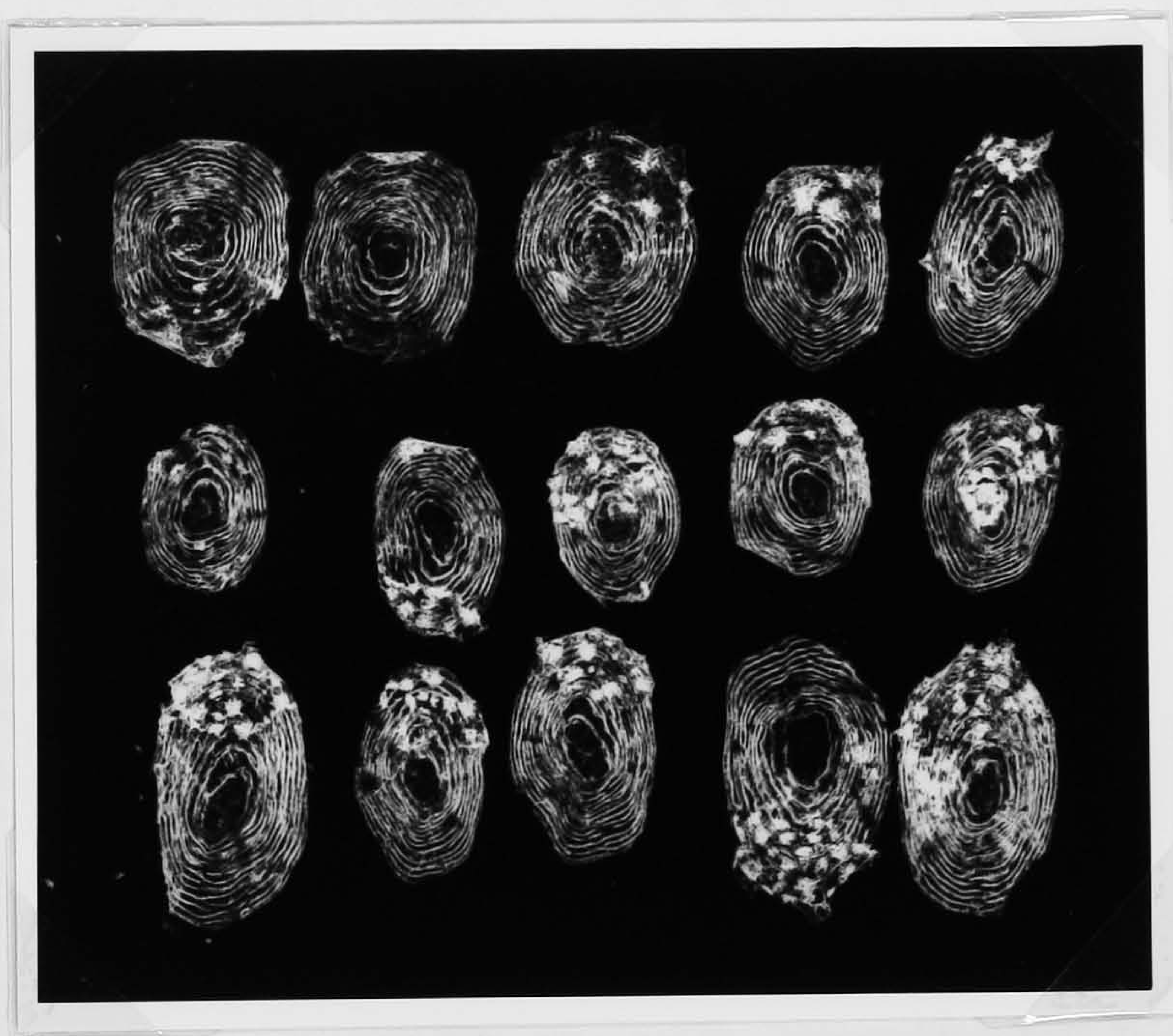

Plate 12.

An example of scales from a 130mm, age group II fish, taken in summer 1986 (site 8).

Plate 13.

An example of scales from a 175mm, age group III fish, taken in summer 1986 (site 8).

Top. Plate 14.

The fishery cabin, carpark and reservoir.

Middle. Plate 15.

The fishery cabin which must be passed upon entering and leaving the fishery.

Bottom. Plate 16.

Typical barren littoral zone exposed due to drawdown, viewed from the embankment.



Top. Plate 17.

The reservoir embankment and valve tower. Top water level clearly visible.

Bottom. Plate 18.

The valve tower and access bridge.

Top. Plate 19.

The 90 metre long overspill sill situated at the eastern end of the embankment.

Bottom. Plate 20.

The overspill channel and conduits designed to channel excess water into the River Hodder.

Top. Plate 21.

The filterhouse, hydropool and overspill channel from the embankment.

Bottom. Plate 22.

The compensation water mushroom and culvert housing the scour which both empty into the hydropool.

Top. Plate 23.

Filter batteries 1 to 6, showing the bifurcating rising mains which house the filter plates.

Bottom. Plate 24.

An example of a steel filter plate.

TABLE I. RIVER HODDER SURVEY SITE DATA

GENERAL DATA

Altitude of source (m)	450
Tributary length (km)	7
Mean gradient	0.038

SITE DATA	Site 1	Site 2	Site 3
Map reference	SD 702 590	SD 715 583	SD 724 572
Distance from source (km)	3	5	6.5
Altitude (m)	240	205	185
Local land use	Moorland	Pasture	Pasture
Bank-side shading	None	Tree lined	Tree lined
Dominant trees	None	Alder	Alder/Sycamore
Site length (m)	42	43	36
Mean channel width (m)	7	9	11
*Mean water width (m)	3	5	7
*Estimated water area (m^2)	140	210	240
*Depth range (m)	0.15 to 0.40	0.15 to 1.00	0.20 to 0.30
*Estimated flow rate	Fast	Medium	Medium

SUBSTRATUM (%)	Site 1	Site 2	Site 3
Bed rock	-	-	20
Boulders	20	5	5
Cobbles	40	30	25
Pebbles	30	40	25
Gravel	10	20	20
Sand	-	5	5
Silt	-	-	-

*Measured at mean summer level

TABLE II. HASGILL BECK SURVEY SITE DATA

GENERAL DATA

Altitude of source (m)	400
Tributary length (km)	4.5
Mean gradient	0.048

SITE DATA	Site 4	Site 5
Map reference	SD 733 586	SD 724 574
Distance from source (km)	2.5	4
Altitude (m)	245	190
Local land use	Pasture	Pasture
Bankside shading	Woodland	Tree lined
Dominant trees	Alder/Ash	Alder/ Sycamore/Ash
Site length (m)	33	38
Mean channel width (m)	4	4
*Mean water width (m)	2.5	2.5
*Estimated water area (m^2)	80	110
*Depth range (m)	0.10 to 0.40	0.15 to 0.60
*Estimated flow rate	Fast/Medium	Medium/Slow

SUBSTRATUM (%)	Site 4	Site 5
Bed rock	-	-
Boulders	20	5
Cobbles	30	15
Pebbles	30	40
Gravel	15	20
Sand	5	15
Silt	-	5

*Measured at mean summer level

TABLE III. BOTTOMS BECK SURVEY SITE DATA

GENERAL DATA

Altitude of source (m)	320
Tributary length (km)	7
Mean gradient	0.046

SITE DATA	Site 6	Site 7	Site 8
Map reference	SD 746 575	SD 745 567	SD 745 565
Distance from source (km)	5	6	6.5
Altitude (m)	225	205	190
Local land use	Forestry	Forestry	Forestry
Bankside shading	Tree lined	Woodland	Woodland
Dominant trees	Alder/ Sycamore/Pine	Alder/ Hawthorn/ Pine	Alder/ Sycamore/ Elderberry/ Pine
Site length (m)	40	30	40
Mean channel width (m)	5	7	7.5
*Mean water width (m)	4	5	5
*Estimated water area (m^2)	170	150	200
*Depth range (m)	0.15 to 0.60	0.15 to 1.00	0.10 to 0.40
*Estimated flow rate	Medium/Slow	Medium/Slow	Medium/Slow

SUBSTRATUM (%)	Site 6	Site 7	Site 8
Bed rock	-	-	20
Boulders	5	5	5
Cobbles	5	20	10
Pebbles	15	25	15
Gravel	25	25	20
Sand	25	20	20
Silt	25	5	10

*Measured at mean summer level

TABLE IV. ESTIMATED INVERTEBRATE NUMBERS M^{-2} FOR THE TRIBUTARY SURVEY SITES (Autumn 1985).

		River Hodder			Hasgill Beck		Bottoms Beck		
Order	Family	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
	Nemouridae	50	25	-	50	50	-	50	50
Plecoptera	Perlodidae	200	50	50	125	175	225	625	275
	Perlidae	-	-	-	-	50	-	-	-
	Ecdyonuridae	-	-	-	-	25	-	175	25
Ephemeroptera	Baetidae	-	-	25	-	250	-	175	-
	Caenidae	-	-	-	-	-	-	75	-
	Rhagionidae	25	25	50	-	25	-	25	75
	Empididae	-	25	-	-	-	-	-	-
Diptera	Chironomidae	25	75	125	50	300	125	150	100
	Simuliidae	-	25	-	25	100	-	75	25
	Ceratopogonidae	-	-	-	-	-	25	-	-
	Hydropsychidae	-	-	25	-	25	-	25	-
Trichoptera	Hydroptilidae	50	-	-	-	-	-	-	-
	Glossomomatidae	-	-	-	50	25	75	25	75
	Phryganeidae	-	-	-	-	-	50	-	-
Coleoptera	Helmidae	-	-	25	25	75	175	100	25
Collembola	Isotomidae	-	25	25	-	-	-	-	-
Arthropoda	Halacaridae	-	50	-	-	-	-	25	-
Oligochaeta (sub class)	-	-	25	-	-	-	25	-	375
Gastropoda	Ancylidae	-	-	25	-	-	-	-	-
	TOTAL	350	325	350	325	1100	700	1525	1250

TABLE V. TRIBUTARY STREAM SURVEY DATES

SPRING SURVEYS		SUMMER SURVEYS		WINTER SURVEYS	
DATE	SITES	DATE	SITES	DATE	SITES
26/3/85	1,2	8/7/85	1,6,8	25/11/85	1,2,3,5
18/4/85	4,6,7	9/7/85	2,3,4,5	26/11/85	4,6,7,8
19/4/85	3,5,8	15/7/85	7		
29/4/86	1,4,6,7,8	30/7/86	1,4,6,8	23/2/87	2,3,5,6,7
30/4/86	2,3,5	20/8/86	2,3,5,7	24/2/87	1,4,8
21/4/87	1,2,4,6	13/7/87	1,2,3,5	14/12/87	2,3,5,7,8
22/4/87	3,5,7,8	14/7/87	4,6,7,8	15/12/87	1,4,6

Electric fishing catch data.

Table VI. 1985.
Table VII. 1986.
Table VIII. 1987.

Table VI. 1985.

SITE	SPECIES	SPRING SURVEY 1	2	3	TOTAL	SUMMER SURVEY 1	2	3	TOTAL	WINTER SURVEY 1	2	3	TOTAL
1	Brown	0	0	0	0	2	0	0	2	4	0	0	4
2	Brown	7	1	9	17	9	4	2	15	11	1	6	18
	Loach	27	11	11	49	8	6	1	15	8	8	4	20
	Bullhead	7	1	2	10	0	1	0	1	2	2	0	4
	Rainbow	0	0	0	0	0	0	0	0	1	0	0	1
3	Brown	1	1	2	4	8	4	1	13	3	2	1	6
	Loach	9	6	4	19	37	14	11	62	1	4	2	7
	Bullhead	1	1	0	2	0	2	0	2	0	0	0	0
	Rainbow	3	0	0	3	0	0	0	0	1	0	0	1
4	Brown	15	11	5	31	81	27	19	127	36	10	5	51
	Loach	1	1	0	2	1	0	0	1	3	2	0	5
	Bullhead	0	1	0	1	1	0	0	1	0	1	0	1
5	Brown	5	1	2	8	15	2	2	19	16	4	0	20
	Loach	14	8	12	34	33	7	7	47	9	8	5	22
	Bullhead	2	4	1	7	1	0	0	1	0	0	0	0
6	Brown	6	0	0	6	14	10	3	27	9	3	1	13
	Loach	2	1	0	3	3	2	1	6	0	2	0	2
	Bullhead	12	6	2	20	48	8	3	59	8	5	4	17
7	Brown	9	4	1	14	14	2	3	19	7	4	1	12
	Loach	3	2	1	6	0	0	0	0	0	0	0	0
	Bullhead	6	4	3	13	1	0	0	1	6	2	3	11
8	Brown	9	10	2	21	104	18	32	154	13	7	1	21
	Loach	1	1	0	2	0	0	1	1	0	0	0	0
	Bullhead	5	3	1	9	5	6	2	13	2	1	1	4

Table VII. 1986.

SITE	SPECIES	SPRING SURVEY 1	2	3	TOTAL	SUMMER SURVEY 1	2	3	TOTAL	WINTER SURVEY 1	2	3	TOTAL
1	Brown	1	1	0	2	1	1	0	2	0	0	0	0
2	Brown	1	0	0	1	14	2	1	17	3	0	0	3
	Loach	2	2	1	5	9	4	2	15	3	1	0	4
	Bullhead	6	3	1	10	4	3	1	8	1	0	0	1
	Rainbow	0	0	0	0	0	0	0	0	2	0	0	2
3	Brown	0	1	0	1	1	1	0	2	0	0	0	0
	Loach	14	11	6	31	11	5	0	16	1	0	0	1
	Bullhead	1	0	0	1	0	0	0	0	0	0	0	0
4	Brown	15	5	5	25	43	11	8	62	26	10	3	39
	Loach	0	0	0	0	2	0	0	2	0	0	0	0
	Bullhead	1	1	1	3	0	0	0	0	5	1	0	6
5	Brown	18	2	0	20	21	3	1	25	5	2	0	7
	Loach	14	9	5	28	22	12	5	39	5	5	2	12
	Bullhead	0	0	0	0	2	2	1	5	3	3	0	6
6	Brown	1	1	1	3	10	3	3	16	5	4	1	10
	Loach	0	0	0	0	1	0	0	1	1	0	0	1
	Bullhead	4	3	2	9	7	0	0	7	6	2	1	9
7	Brown	5	4	1	10	6	1	0	7	1	0	0	1
	Bullhead	3	1	2	6	2	1	0	3	1	1	0	2
8	Brown	10	5	0	15	25	7	4	36	8	4	2	14
	Loach	0	0	0	0	1	2	0	3	0	0	1	1
	Bullhead	3	1	2	6	2	1	0	3	1	3	2	6

Table VIII. 1987.

SITE	SPECIES	SPRING SURVEY				SUMMER SURVEY				WINTER SURVEY			
		1	2	3	TOTAL	1	2	3	TOTAL	1	2	3	TOTAL
1	Brown	0	0	0	0	0	0	0	0	1	0	0	1
2	Brown	1	0	0	1	28	9	1	38	2	3	0	5
	Loach	9	0	0	9	15	7	2	24	4	7	1	12
	Bullhead	1	1	0	2	9	4	2	15	2	3	1	6
	Rainbow	0	1	1	2	0	0	0	0	0	0	0	0
3	Brown	2	1	0	3	9	4	5	18	3	1	1	5
	Loach	20	12	7	39	13	12	11	36	2	3	4	9
	Bullhead	4	0	0	4	0	3	0	3	0	0	0	0
	Rainbow	0	2	0	2	0	0	0	0	0	0	0	0
4	Brown	25	4	1	30	54	23	7	84	20	2	0	22
	Loach	2	0	0	2	1	1	0	2	0	0	0	0
	Bullhead	2	2	1	5	7	3	2	12	1	0	0	1
5	Brown	6	1	1	8	60	18	7	85	20	6	7	33
	Loach	19	8	2	29	12	13	7	32	13	11	4	28
	Bullhead	6	1	0	7	1	2	0	3	1	0	0	1
	Rainbow	0	0	0	0	0	0	0	0	1	0	0	1
6	Brown	9	3	0	12	29	18	5	52	12	2	0	14
	Loach	1	1	0	2	2	1	0	3	0	0	0	0
	Bullhead	1	0	0	1	8	2	0	10	1	0	0	1
7	Brown	7	4	1	12	8	2	1	11	17	3	2	22
	Loach	0	0	0	0	0	0	0	0	0	1	0	1
	Bullhead	2	2	0	4	4	1	0	5	1	1	0	2
8	Brown	4	1	0	5	18	9	7	34	6	4	0	10
	Loach	7	1	0	8	4	2	1	7	1	0	1	2
	Bullhead	1	1	0	2	3	2	1	6	2	0	0	2
	Rainbow	2	0	0	2	0	0	0	0	0	0	0	0

Zippin (1956) Removal Method population estimates.

Table IX. 1985.
Table X. 1986.
Table XI. 1987.

Table IX. 1985.

SITE	SPECIES	SPRING SURVEY POPULATION EST.	SPRING SURVEY ±95%CL	SUMMER SURVEY POPULATION EST.	SUMMER SURVEY ±95%CL	WINTER SURVEY POPULATION EST.	WINTER SURVEY ±95%CL
1	Brown	0	-	(2)	-	(4)	-
2	Brown	N/P	-	17	5.046	25	19.495
	Loach	63	20.972	17	5.046	34	39.671
	Bullhead	11	3.425	N/P	-	4	2.166
	Rainbow	0	-	0	-	(1)	-
3	Brown	N/P	-	14	3.050	8	7.339
	Loach	27	21.606	71	13.150	N/P	-
	Bullhead	2	1.532	N/P	-	0	-
	Rainbow	(3)	-	0	-	(1)	-
4	Brown	40	17.865	140	12.980	53	4.131
	Loach	2	1.531	(1)	-	5	1.380
	Bullhead	N/P	-	(1)	-	N/P	-
5	Brown	10	6.496	19	1.680	20	0.767
	Loach	154	683.990	50	5.450	39	50.215
	Bullhead	15	48.292	(1)	-	0	-
6	Brown	(6)	-	32	9.843	14	2.086
	Loach	3	0.716	8	7.339	N/P	-
	Bullhead	22	4.844	60	1.726	26	25.908
7	Brown	15	2.794	20	3.056	13	3.752
	Loach	8	7.339	0	-	0	-
	Bullhead	20	24.612	(1)	-	15	15.240
8	Brown	27	13.729	172	16.167	22	3.422
	Loach	2	1,532	N/P	-	0	-
	Bullhead	10	4.423	20	24.612	6	11.591

Parentheses represent minimum population estimate
N/P represents failure to estimate population

Table X. 1986.

SITE	SPECIES	SPRING SURVEY POPULATION EST.	SPRING SURVEY ±95%CL	SUMMER SURVEY POPULATION EST.	SUMMER SURVEY ±95%CL	WINTER SURVEY POPULATION EST.	WINTER SURVEY ±95%CL
1	Brown	2	1.532	2	1.532	0	-
2	Brown	(1)	-	17	0.926	(3)	-
	Loach	8	19.836	17	5.046	4	0.530
	Bullhead	11	3.425	10	6.496	(1)	-
	Rainbow	0	-	0	-	(2)	-
3	Brown	N/P	-	2	1.532	0	-
	Loach	45	29.817	16	1.542	(1)	-
	Bullhead	(1)	-	0	-	0	-
4	Brown	29	9.472	66	5.879	41	4.109
	Loach	0	-	(2)	-	0	-
	Bullhead	N/P	-	0	-	6	0.344
5	Brown	20	0.294	25	0.858	7	0.819
	Loach	36	16.978	45	9.798	18	20.076
	Bullhead	0	-	8	19.836	7	2.653
6	Brown	N/P	-	18	6.276	12	5.990
	Loach	0	-	(1)	-	(1)	-
	Bullhead	14	22.294	(7)	-	10	2.385
7	Brown	12	5.990	7	0.298	(1)	-
	Bullhead	11	32.066	3	0.716	2	1.532
8	Brown	15	1.602	38	4.206	16	5.870
	Loach	0	-	4	5.189	N/P	-
	Bullhead	11	32.066	3	0.716	N/P	-

Parentheses represent minimum population estimate
N/P represents failure to estimate population

Table XI. 1987.

SITE	SPECIES	SPRING SURVEY POPULATION EST.	SPRING ±95%CL	SUMMER SURVEY POPULATION EST.	SUMMER ±95%CL	WINTER SURVEY POPULATION EST.	WINTER ±95%CL
1	Brown	0	-	0	-	(1)	-
2	Brown	(1)	-	39	2.056	6	4.236
	Loach	(9)	-	26	4.144	18	20.076
	Bullhead	2	1.532	17	5.046	11	32.066
	Rainbow	N/P	-	0	-	0	-
3	Brown	3	0.716	29	31.528	6	4.236
	Loach	50	18.710	163	703.820	N/P	-
	Bullhead	(4)	-	N/P	-	0	-
	Rainbow	N/P	-	0	-	0	-
4	Brown	30	0.940	89	7.285	22	0.261
	Loach	(2)	-	2	1.532	0	-
	Bullhead	8	19.836	14	6.160	(1)	-
5	Brown	8	1.533	88	4.996	39	11.597
	Loach	30	3.543	63	82.358	36	16.978
	Bullhead	7	0.298	4	5.189	(1)	-
	Rainbow	0	-	0	-	(1)	-
6	Brown	12	0.918	58	9.395	14	0.422
	Loach	2	1.532	3	0.716	0	-
	Bullhead	(1)	-	10	0.543	(1)	-
7	Brown	13	3.752	11	1.682	22	1.808
	Loach	0	-	0	-	N/P	-
	Bullhead	4	2.166	5	0.384	2	1.532
8	Brown	5	0.384	44	18.709	10	1.952
	Loach	8	0.248	8	4.151	N/P	-
	Bullhead	2	1.532	8	7.339	N/P	-
	Rainbow	(2)	-	0	-	0	-

Parentheses represent minimum population estimate
N/P represents failure to estimate population

Carle and Strub (1978) MWL Method population estimates.

Table XII. 1985.
Table XIII. 1986.
Table XIV. 1987.

Table XII. 1985.

SITE	SPECIES	SPRING SURVEY POPULATION EST.	SPRING SURVEY ±95%CL	SUMMER SURVEY POPULATION EST.	SUMMER SURVEY ±95%CL	WINTER SURVEY POPULATION EST.	WINTER SURVEY ±95%CL
1	Brown	0	-	(2)	-	(4)	-
2	Brown	31	23.402	15	0	20	4.183
	Loach	58	12.054	15	0	24	7.185
	Bullhead	10	0	1	0	4	0
	Rainbow	0	-	0	-	(1)	-
3	Brown	4	0	13	0	6	0
	Loach	22	5.887	69	9.129	9	4.691
	Bullhead	2	0	2	0	0	-
	Rainbow	(3)	-	0	-	(1)	-
4	Brown	36	8.242	137	9.989	52	2.324
	Loach	2	0	(1)	-	5	0
	Bullhead	1	0	(1)	-	1	0
5	Brown	8	0	19	0	20	0
	Loach	58	35.179	49	3.787	28	10.312
	Bullhead	7	0	(1)	-	0	-
6	Brown	(6)	-	29	4.000	13	0
	Loach	3	0	6	0	2	0
	Bullhead	20	0	59	0	20	6.048
7	Brown	14	0	19	0	12	0
	Loach	6	0	0	-	0	-
	Bullhead	14	2.568	(1)	-	12	2.751
8	Brown	23	4.123	169	13.241	21	0
	Loach	2	0	1	0	0	-
	Bullhead	9	0	14	2.568	4	0

Parentheses represent minimum population estimate

Table XIII. 1986.

SITE	SPECIES	SPRING SURVEY POPULATION EST.	SPRING SURVEY ±95%CL	SUMMER SURVEY POPULATION EST.	SUMMER SURVEY ±95%CL	WINTER SURVEY POPULATION EST.	WINTER SURVEY ±95%CL
1	Brown	2	0	2	0	0	-
2	Brown	(1)	-	17	0	(3)	-
	Loach	5	0	15	0	4	0
	Bullhead	10	0	8	0	(1)	-
	Rainbow	0	-	0	-	(2)	-
3	Brown	1	0	2	0	0	-
	Loach	38	10.957	16	0	(1)	-
	Bullhead	(1)	-	0	-	0	-
4	Brown	27	4.086	64	3.541	40	2.419
	Loach	0	-	(2)	-	0	-
	Bullhead	3	0	0	-	6	0
5	Brown	20	0	25	0	7	0
	Loach	32	6.888	42	5.099	13	2.647
	Bullhead	0	-	5	0	6	0
6	Brown	3	0	16	0	10	0
	Loach	0	-	(1)	-	(1)	-
	Bullhead	9	0	(7)	-	9	0
7	Brown	10	0	7	0	(1)	-
	Bullhead	6	0	3	0	2	0
8	Brown	15	0	37	2.451	14	0
	Loach	0	-	3	0	1	0
	Bullhead	6	0	3	0	7	2.719

Parentheses represent minimum population estimate

Table XIV. 1987.

SITE	SPECIES	SPRING SURVEY POPULATION EST.	SPRING SURVEY ±95%CL	SUMMER SURVEY POPULATION EST.	SUMMER SURVEY ±95%CL	WINTER SURVEY POPULATION EST.	WINTER SURVEY ±95%CL
1	Brown	0	-	0	-	(1)	-
2	Brown	(1)	-	38	0	5	0
	Loach	(9)	-	24	0	13	2.647
	Bullhead	2	0	15	0	6	0
	Rainbow	2	0	0	-	0	-
3	Brown	3	0	21	5.807	5	0
	Loach	45	8.915	63	39.155	14	9.854
	Bullhead	(4)	-	3	0	0	-
	Rainbow	2	0	0	-	0	-
4	Brown	30	0	88	5.597	22	0
	Loach	(2)	-	2	0	0	-
	Bullhead	5	0	12	0	(1)	-
5	Brown	8	0	87	3.439	36	5.231
	Loach	29	0	45	19.432	32	6.888
	Bullhead	7	0	3	0	(1)	-
	Rainbow	0	-	0	-	(1)	-
6	Brown	12	0	56	6.050	14	0
	Loach	2	0	3	0	0	-
	Bullhead	(1)	-	10	0	(1)	-
7	Brown	12	0	11	0	22	0
	Loach	0	-	0	-	1	0
	Bullhead	4	0	5	0	2	0
8	Brown	5	0	39	7.839	10	0
	Loach	8	0	7	0	2	0
	Bullhead	2	0	6	0	2	0
	Rainbow	(2)	0	0	-	0	-

Parentheses represent minimum population estimate

Table XV. Carle and Strub (1978) MWL Method population estimates as percentages of the Zippin (1956) Removal Method estimates.

BROWN TROUT

SITE	1985 SP.	1985 SM.	1985 W.	1986 SP.	1986 SM.	1986 W.	1987 SP.	1987 SM.	1987 W.
1	-	( )	( )	100	100	-	-	-	( )
2	*	88	80	( )	100	( )	( )	97	83
3	*	93	75	*	100	-	100	72	83
4	90	98	98	93	97	98	100	99	100
5	80	100	100	100	100	100	100	99	92
6	( )	90	93	*	89	83	100	97	100
7	93	95	92	83	100	( )	92	100	100
8	85	98	95	100	97	88	100	89	100

STONE LOACH

SITE	1985 SP.	1985 SM.	1985 W.	1986 SP.	1986 SM.	1986 W.	1987 SP.	1987 SM.	1987 W.
1	-	-	-	-	-	-	-	-	-
2	92	88	71	63	88	100	( )	92	72
3	81	97	*	84	100	( )	90	39	*
4	100	( )	100	-	( )	-	( )	100	-
5	38	98	72	89	93	72	97	71	89
6	100	75	*	-	( )	( )	100	100	-
7	75	-	-	-	-	-	-	-	*
8	100	*	-	-	75	*	100	88	*

BULLHEAD

SITE	1985 SP.	1985 SM.	1985 W.	1986 SP.	1986 SM.	1986 W.	1987 SP.	1987 SM.	1987 W.
1	-	-	-	-	-	-	-	-	-
2	91	*	100	91	80	( )	100	88	54
3	100	*	-	( )	-	-	( )	*	-
4	*	( )	*	-	-	100	63	86	( )
5	47	( )	-	-	63	86	100	75	( )
6	91	98	77	64	( )	90	( )	100	( )
7	79	( )	80	55	100	100	100	100	100
8	90	70	67	55	100	*	100	75	*

\- Population zero
( ) Both models failed as fish caught on first run only
* Zippin's model failed

Table XVI.

Electric fishing species catchability values for each survey site.

SITE	SPECIES	1985 CATCHABILITY (P)			1986 CATCHABILITY (P)			1987 CATCHABILITY (P)		
		SPRING	SUMMER	WINTER	SPRING	SUMMER	WINTER	SPRING	SUMMER	WINTER
1	Brown	-	1.000	1.000	0.667	0.667	-	-	-	1.000
2	Brown	0.218	0.652	0.486	1.000	0.810	1.000	1.000	0.776	0.625
	Loach	0.450	0.652	0.417	0.556	0.652	0.800	1.000	0.686	0.500
	Bullhead	0.667	0.500	0.667	0.667	0.615	1.000	0.667	0.652	0.545
	Rainbow	-	-	1.000	-	-	1.000	0.400	-	-
3	Brown	0.444	0.684	0.600	0.500	0.667	-	0.750	0.439	0.625
	Loach	0.452	0.521	0.333	0.413	0.762	1.000	0.470	0.238	0.257
	Bullhead	0.667	0.500	-	1.000	-	-	1.000	0.500	-
	Rainbow	1.000	-	1.000	-	-	-	0.500	-	-
4	Brown	0.463	0.572	0.689	0.543	0.653	0.672	0.833	0.632	0.917
	Loach	0.667	1.000	0.714	-	1.000	-	1.000	0.667	-
	Bullhead	0.500	1.000	0.500	0.500	-	0.857	0.556	0.632	1.000
5	Brown	0.615	0.760	0.833	0.910	0.833	0.778	0.727	0.691	0.532
	Loach	0.246	0.635	0.379	0.475	0.557	0.500	0.707	0.326	0.475
	Bullhead	0.538	1.000	-	-	0.556	0.667	0.875	0.600	1.000
	Rainbow	-	-	-	-	-	-	-	-	1.000
6	Brown	1.000	0.551	0.722	0.500	0.640	0.625	0.800	0.565	0.875
	Loach	0.750	0.600	0.500	-	1.000	1.000	0.667	0.750	-
	Bullhead	0.667	0.808	0.436	0.563	1.000	0.692	1.000	0.833	-
7	Brown	0.700	0.704	0.667	0.625	0.875	1.000	0.667	0.733	0.759
	Loach	0.600	-	-	-	-	-	-	-	0.500
	Bullhead	0.500	1.000	0.500	0.545	0.750	0.667	0.667	0.833	0.667
8	Brown	0.512	0.548	0.700	0.750	0.667	0.636	0.833	0.472	0.714
	Loach	0.667	0.333	-	-	0.600	0.333	0.889	0.636	0.500
	Bullhead	0.643	0.500	0.571	0.545	0.750	0.375	0.667	0.600	1.000
	Rainbow	-	-	-	-	-	-	1.000	-	-

<u>Table XVII.</u> Summary of mean species catchability for the spring, summer and winter survey periods.

SPECIES	CATCHABILITY	SURVEY PERIOD			COMBINED
		SPRING	SUMMER	WINTER	
	RANGE	0.218 to 1.000	0.439 to 1.000	0.486 to 1.000	0.218 to 1.000
Brown Trout	$\bar{P}$	0.684	0.678	0.748	0.703
	±95%	0.090	0.056	0.041	0.041
	RANGE	0.500 to 1.000	0.500 to 1.000	0.436 to 1.000	0.436 to 1.000
Bullhead	$\bar{P}$	0.672	0.717	0.697	0.695
	±95%	0.078	0.089	0.050	0.050
	RANGE	0.246 to 1.000	0.238 to 1.000	0.257 to 1.000	0.246 to 1.000
Stone Loach	$\bar{P}$	0.626	0.645	0.547	0.609
	±95%	0.113	0.107	0.063	0.063

Table XVIII. Percentage species composition for each site survey.

SITE	SPECIES	1985 PERCENTAGE SP.	1985 SM.	1985 W.	1986 PERCENTAGE SP.	1986 SM.	1986 W.	1987 PERCENTAGE SP.	1987 SM.	1987 W.
1	Brown	0	100	100	100	100	0	0	0	100
2	Brown	31	48	41	6	42	30	7	49	21
	Loach	59	48	49	31	38	40	65	31	54
	Bullhead	10	4	8	63	20	10	14	20	25
	Rainbow	0	0	2	0	0	20	14	0	0
3	Brown	13	16	38	3	11	0	6	24	26
	Loach	71	82	56	94	89	100	83	72	74
	Bullhead	6	2	0	3	0	0	7	4	0
	Rainbow	10	0	6	0	0	0	4	0	0
4	Brown	92	98	89	90	97	87	81	86	96
	Loach	5	1	9	0	3	0	5	2	0
	Bullhead	3	1	2	10	0	13	14	12	4
5	Brown	11	28	42	38	35	27	18	65	51
	Loach	79	71	58	62	58	50	66	33	45
	Bullhead	10	1	0	0	7	23	16	2	2
	Rainbow	0	0	0	0	0	0	0	0	2
6	Brown	21	31	37	25	67	50	80	81	93
	Loach	10	6	6	0	4	5	13	4	0
	Bullhead	69	63	57	75	29	45	7	15	7
7	Brown	41	95	50	63	70	30	75	69	88
	Loach	18	0	0	0	0	0	0	0	4
	Bullhead	41	5	50	37	30	70	25	31	8
8	Brown	68	91	84	71	86	64	29	75	72
	Loach	6	1	0	0	7	4	47	13	14
	Bullhead	26	8	16	29	7	32	12	12	14
	Rainbow	0	0	0	0	0	0	12	0	0

Carle and Strub (1978) MWL Method
population density estimates ($100m^{-2}$).

Table XIX. 1985.
Table XX. 1986.
Table XXI. 1987.

Table XIX. 1985.

SITE	SPECIES	SPRING SURVEY DENSITY ($100m^{-2}$) EST.	±95%CL	SUMMER SURVEY DENSITY ($100m^{-2}$) EST.	±95%CL	WINTER SURVEY DENSITY ($100m^{-2}$) EST.	±95%CL
1	Brown	0	-	(1.429)	-	(2.857)	-
2	Brown	14.762	11.144	7.143	0	9.524	1.992
	Loach	27.619	5.740	7.143	0	11.429	3.421
	Bullhead	4.762	0	0.476	0	1.905	0
	Rainbow	0	-	0	-	(0.476)	-
3	Brown	1.667	0	5.417	0	2.500	0
	Loach	9.167	2.453	28.750	3.804	3.750	1.955
	Bullhead	0.833	0	0.833	0	0	-
	Rainbow	(1.250)	-	0	-	(0.417)	-
4	Brown	45.000	10.303	171.250	12.486	65.000	2.905
	Loach	2.500	0	(1.250)	-	6.250	0
	Bullhead	1.250	0	(1.250)	-	1.250	0
5	Brown	7.273	0	17.273	0	18.182	0
	Loach	52.727	31.981	44.545	3.443	25.455	9.375
	Bullhead	6.364	0	(0.909)	-	0	-
6	Brown	(3.529)	-	17.059	2.353	7.647	0
	Loach	1.765	0	3.529	0	1.176	0
	Bullhead	11.765	0	34.706	0	11.765	3.558
7	Brown	9.333	0	12.667	0	8.000	0
	Loach	4.000	0	0	-	0	-
	Bullhead	9.333	1.712	(0.667)	-	8.000	1.834
8	Brown	11.500	2.062	84.500	6.621	10.500	0
	Loach	1.000	0	0.500	0	0	-
	Bullhead	4.500	0	7.000	1.284	2.000	0

Parentheses represent minimum density estimate

Table XX. 1986.

SITE	SPECIES	SPRING SURVEY DENSITY $(100m^{-2})$ EST.	SPRING SURVEY ±95%CL	SUMMER SURVEY DENSITY $(100m^{-2})$ EST.	SUMMER SURVEY ±95%CL	WINTER SURVEY DENSITY $(100m^{-2})$ EST.	WINTER SURVEY ±95%CL
1	Brown	1.429	0	1.429	0	0	-
2	Brown	(0.476)	-	8.095	0	(1.429)	-
	Loach	2.381	0	7.143	0	1.905	0
	Bullhead	4.762	0	3.810	0	(0.476)	-
	Rainbow	0	-	0	-	(0.952)	-
3	Brown	0.417	0	0.833	0	0	-
	Loach	15.833	4.565	6.667	0	(0.417)	-
	Bullhead	(0.417)	-	0	-	0	-
4	Brown	33.750	5.108	80.000	4.426	50.000	3.024
	Loach	0	-	(2.500)	-	0	-
	Bullhead	3.750	0	0	-	7.500	0
5	Brown	18.182	0	22.727	0	6.364	0
	Loach	29.091	6.262	38.182	4.635	11.818	2.406
	Bullhead	0	-	4.545	0	5.455	0
6	Brown	1.765	0	9.412	0	5.882	0
	Loach	0	-	(0.588)	-	(0.588)	-
	Bullhead	5.294	0	(4.118)	-	5.294	0
7	Brown	6.667	0	4.667	0	(0.667)	-
	Bullhead	4.000	0	2.000	0	1.333	0
8	Brown	7.500	0	18.500	1.226	7.000	0
	Loach	0	-	1.500	0	0.500	0
	Bullhead	3.000	0	1.500	0	3.500	1.360

Parentheses represent minimum density estimate

Table XXI. 1987.

SITE	SPECIES	SPRING SURVEY DENSITY ($100m^{-2}$) EST.	±95%CL	SUMMER SURVEY DENSITY ($100m^{-2}$) EST.	±95%CL	WINTER SURVEY DENSITY ($100m^{-2}$) EST.	±95%CL
1	Brown	0	-	0	-	(0.714)	-
2	Brown	(0.476)	-	18.095	0	2.381	0
	Loach	(4.286)	-	11.429	0	6.190	1.260
	Bullhead	0.952	0	7.143	0	2.857	0
	Rainbow	0.952	0	0	-	0	-
3	Brown	1.250	0	8.750	2.420	2.083	0
	Loach	18.750	3.715	26.250	16.315	5.833	4.106
	Bullhead	(1.667)	-	1.250	0	0	-
	Rainbow	0.833	0	0	-	0	-
4	Brown	37.500	0	110.000	6.996	27.500	0
	Loach	(2.500)	-	2.500	0	0	-
	Bullhead	6.250	0	15.000	0	(1.250)	-
5	Brown	7.273	0	79.091	3.126	32.727	4.755
	Loach	26.364	0	40.909	17.665	29.091	6.262
	Bullhead	6.364	0	2.727	0	(0.909)	-
	Rainbow	0	-	0	-	(0.909)	-
6	Brown	7.059	0	32.941	3.559	8.235	0
	Loach	1.176	0	1.765	0	0	-
	Bullhead	(0.588)	-	5.882	0	(0.588)	-
7	Brown	8.000	0	7.333	0	14.667	0
	Loach	0	-	0	-	0.667	0
	Bullhead	2.667	0	3.333	0	1.333	0
8	Brown	2.500	0	19.500	3.920	5.000	0
	Loach	4.000	0	3.500	0	1.000	0
	Bullhead	1.000	0	3.000	0	1.000	0
	Rainbow	1.000	0	0	-	0	-

Parentheses represent minimum density estimate

Table XXII. Native fish survey density means and ranges ($100m^{-2}$) for each site.

SITE	SPECIES	MINIMUM DENSITY		MAXIMUM DENSITY		SURVEY MEAN
1	Brown	0	(sp85;w86; sp,sm87)	2.857	(w85)	0.873
2	Brown	0.476	(sp86;sp87)	18.095	(sm87)	6.931
	Loach	1.905	(w86)	27.619	(sp85)	8.836
	Bullhead	0.476	(sm85;w86)	7.143	(sm87)	3.016
3	Brown	0	(w86)	8.750	(sm87)	2.546
	Loach	0.417	(w86)	28.750	(sm85)	12.824
	Bullhead	0	(w85;sm86, w86;w87)	1.667	(sp 87)	0.556
4	Brown	27.500	(w87)	171.250	(sm85)	68.889
	Loach	0	(sp,w86; w87)	6.250	(w85)	1.944
	Bullhead	0	(sm86)	15.000	(sm87)	4.167
5	Brown	6.364	(w86)	79.091	(sm87)	23.232
	Loach	11.818	(w86)	52.727	(sp85)	33.131
	Bullhead	0	(w85;sp86)	6.364	(sp85; sp87)	3.030
6	Brown	1.765	(sp86)	32.941	(sm87)	10.392
	Loach	0	(sp86;w87)	3.529	(sm85)	1.176
	Bullhead	0.588	(sp,487)	34.706	(sm85)	8.889
7	Brown	0.667	(w86)	14.667	(w87)	8.000
	Loach	0	(sm, w85; sp,sm,w86; sp,sm87)	4.000	(sp85)	0.519
	Bullhead	0.667	(sm85)	9.333	(sp85)	3.630
8	Brown	2.500	(sp87)	84.500	(sm85)	18.500
	Loach	0	(w85;sp86)	4.000	(sp87)	1.333
	Bullhead	1.000	(sp,w87)	7.000	(sm85)	2.944

Combined seasonal bullhead and stoneloach length frequency data for the period 1985 to 1987.

Table XXIII. Bullhead.
Table XXIV. Stoneloach.

Table XXIII. Bullhead.

SIZE CLASS (mm)	SITE 2			SITE 3			SITE 4			SITE 5			SITE 6			SITE 7			SITE 8		
	SP.	SM.	W.	SP.	SM.	W.	SP.	SM.	W.	SP.	SM.	W.	SP.	SM.	W.	SP.	SM.	W.	SP.	SM.	W.
20-25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
26-30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-
31-35	-	-	-	-	-	-	1	-	1	-	-	-	-	-	1	-	-	1	1	-	1
36-40	-	-	-	-	-	-	1	-	-	1	-	-	2	2	-	-	-	-	3	-	2
41-45	4	-	-	1	-	-	3	-	4	-	1	-	-	1	1	-	-	-	-	1	-
46-50	-	-	-	2	1	-	-	-	1	4	-	-	1	12	3	-	1	-	-	5	1
51-55	1	4	-	1	2	-	-	3	-	-	-	-	1	12	1	-	4	-	1	5	1
56-60	-	9	2	1	-	-	-	7	-	1	3	1	2	8	1	3	1	1	1	5	1
61-65	-	5	2	-	-	-	-	1	-	2	-	1	2	9	3	3	-	2	5	4	2
66-70	2	1	-	1	-	-	1	1	-	-	-	1	5	9	4	6	3	1	-	1	1
71-75	3	-	1	-	1	-	-	-	-	3	2	3	5	4	3	3	-	2	2	-	1
76-80	3	4	2	-	-	-	-	-	-	2	-	-	4	12	4	3	-	3	3	-	1
81-85	4	1	3	1	1	-	1	-	1	1	3	-	4	2	3	2	-	2	1	-	-
86-90	3	-	-	-	-	-	1	1	1	-	-	-	3	3	2	3	-	2	-	1	-
91-95	2	-	1	-	-	-	1	-	-	-	-	1	1	1	-	-	-	-	-	-	-
96-100	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
TOTAL	22	24	11	7	5	0	9	13	8	14	9	7	30	76	27	23	9	15	17	22	12

Table XXIV. Stoneloach.

SIZE CLASS (mm)	SITE 2 SP.	SITE 2 SM.	SITE 2 W.	SITE 3 SP.	SITE 3 SM.	SITE 3 W.	SITE 4 SP.	SITE 4 SM.	SITE 4 W.	SITE 5 SP.	SITE 5 SM.	SITE 5 W.	SITE 6 SP.	SITE 6 SM.	SITE 6 W.	SITE 7 SP.	SITE 7 SM.	SITE 7 W.	SITE 8 SP.	SITE 8 SM.	SITE 8 W.
25-30	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31-35	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36-40	3	1	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-
41-45	6	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
46-50	-	1	-	-	1	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-
51-55	-	1	1	1	4	-	-	-	-	-	4	1	-	-	-	-	-	-	-	-	-
56-60	-	2	1	6	5	1	-	-	-	2	-	2	-	-	-	-	-	-	-	-	-
61-65	1	-	2	1	10	2	-	-	-	1	3	3	-	-	-	-	-	-	-	-	-
66-70	4	3	1	7	3	1	-	-	-	11	7	4	-	-	-	-	-	-	-	1	-
71-75	5	1	2	13	13	2	-	-	-	9	14	6	-	-	-	1	-	-	1	1	-
76-80	2	2	3	14	31	2	-	-	-	17	22	4	-	-	-	-	-	-	3	-	-
81-85	6	4	-	22	22	5	-	-	1	17	25	11	-	-	-	2	-	-	-	-	-
86-90	6	11	4	10	14	2	-	-	-	11	22	13	-	1	-	1	-	-	1	3	2
91-95	12	12	6	8	10	1	-	1	-	13	1	11	1	2	-	-	-	-	3	3	-
96-100	9	9	9	5	1	-	3	1	2	5	5	1	1	1	1	-	-	-	2	4	1
101-105	2	2	3	-	-	1	1	-	-	2	5	5	-	1	-	-	-	-	-	-	-
106-110	2	3	-	1	-	-	-	2	2	3	1	1	-	2	1	-	-	1	-	-	-
111-115	2	-	2	1	-	-	-	-	-	-	1	-	1	2	-	-	-	-	-	-	-
116-120	1	-	-	-	-	-	-	1	-	-	-	-	2	1	1	1	1	-	-	-	-
TOTAL	63	54	36	89	114	17	4	5	5	91	118	62	5	10	3	6	0	1	10	12	3

Brown trout percentage age group composition.

Table XXV. 1985.

Table XXVI. 1986.

Table XXVII. 1987.

Table XXV. 1985.

SITE	PERIOD	AGE GROUP 0	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
1	SP.	-	-	-	-	-	-	-	-	-	-	-	-
	SM.	50.00	50.00	-	-	-	-	-	-	-	-	-	-
	W.	-	-	75.00	25.00	-	-	-	-	-	-	-	-
2	SP.	-	76.47	17.65	5.88	-	-	-	-	-	-	-	-
	SM.	6.67	40.00	20.00	6.67	-	-	13.33	6.67	(6.67)	-	-	-
	W.	61.11	-	11.11	16.67	-	-	-	11.11	-	-	-	-
3	SP.	-	75.00	25.00	-	-	-	-	-	-	-	-	-
	SM.	46.15	30.77	23.08	-	-	-	-	-	-	-	-	-
	W.	16.67	50.00	16.67	16.67	-	-	-	-	-	-	-	-
4	SP.	-	80.64	16.13	3.23	-	-	-	-	-	-	-	-
	SM.	80.31	14.96	3.94	0.79	-	-	-	-	-	-	-	-
	W.	72.55	9.80	13.73	3.92	-	-	-	-	-	-	-	-
5	SP.	-	87.50	12.50	-	-	-	-	-	-	-	-	-
	SM.	36.84	31.58	26.32	-	-	-	-	-	(5.26)	-	-	-
	W.	55.00	15.00	5.00	20.00	-	-	-	-	-	(5.00)	-	-
6	SP.	-	33.33	50.00	-	16.67	-	-	-	-	-	-	-
	SM.	44.44	33.33	14.82	7.41	-	-	-	-	-	-	-	-
	W.	38.46	7.69	30.77	15.39	-	-	-	(7.69)	-	-	-	-
7	SP.	-	42.86	14.29	28.57	-	7.14	-	-	-	-	(7.14)	-
	SM.	5.26	26.32	10.53	26.32	-	21.05	5.26	-	-	-	-	(5.26)
	W.	41.67	8.33	25.00	-	-	8.33	8.33	8.33	-	-	-	-
8	SP.	-	100.00	-	-	-	-	-	-	-	-	-	-
	SM.	88.96	9.74	1.30	-	-	-	-	-	-	-	-	-
	W.	76.19	19.05	-	-	-	-	-	-	-	(4.76)	-	-

Parentheses denote uncertainty in ageing

Table XXVI. 1986.

SITE	PERIOD	AGE GROUP 0	I	II	III	IV	V	VI	VII	VIII	IX	X
1	SP.	-	-	-	100.000	-	-	-	-	-	-	-
	SM.	-	100.00	-	-	-	-	-	-	-	-	-
	W.	-	-	-	-	-	-	-	-	-	-	-
2	SP.	-	-	-	-	-	-	-	-	-	-	(100.00)
	SM.	5.88	52.94	29.41	5.88	-	5.88	-	-	-	-	-
	W.	-	33.33	66.67	-	-	-	-	-	-	-	-
3	SP.	-	100.000	-	-	-	-	-	-	-	-	-
	SM.	-	100.000	-	-	-	-	-	-	-	-	-
	W.	-	-	-	-	-	-	-	-	-	-	-
4	SP.	-	92.00	8.00	-	-	-	-	-	-	-	-
	SM.	51.61	46.78	1.61	-	-	-	-	-	-	-	-
	W.	56.41	43.59	-	-	-	-	-	-	-	-	-
5	SP.	-	95.00	5.00	-	-	-	-	-	-	-	-
	SM.	20.00	48.00	28.00	4.00	-	-	-	-	-	-	-
	W.	42.85	28.57	-	14.29	-	14.29	-	-	-	-	-
6	SP.	-	-	66.67	-	-	-	-	-	(33.33)	-	-
	SM.	18.75	25.00	6.25	37.50	-	12.50	-	-	-	-	-
	W.	30.00	60.00	-	10.00	-	-	-	-	-	-	-
7	SP.	-	20.00	50.00	20.00	10.00	-	-	-	-	-	-
	SM.	-	14.29	14.29	42.86	-	-	14.29	14.29	-	-	-
	W.	-	100.00	-	-	-	-	-	-	-	-	-
8	SP.	-	100.00	-	-	-	-	-	-	-	-	-
	SM.	16.67	77.78	2.78	2.78	-	-	-	-	-	-	-
	W.	92.86	7.14	-	-	-	-	-	-	-	-	-

Parentheses denote uncertainty in ageing

Table XXVII. 1987.

SITE	PERIOD	AGE GROUP 0	I	II	III	IV	V	VI	VII	VIII	IX	X
1	SP.	-	-	-	-	-	-	-	-	-	-	-
	SM.	-	-	-	-	-	-	-	-	-	-	-
	W.	-	100.000	-	-	-	-	-	-	-	-	-
2	SP.	-	-	-	-	-	-	100.00	-	-	-	-
	SM.	57.90	21.05	5.26	2.63	-	-	10.53	2.63	-	-	-
	W.	60.00	-	20.00	-	20.00	-	-	-	-	-	-
3	SP.	-	66.67	33.33	-	-	-	-	-	-	-	-
	SM.	94.44	5.56	-	-	-	-	-	-	-	-	-
	W.	60.00	20.00	20.00	-	-	-	-	-	-	-	-
4	SP.	-	83.33	16.67	-	-	-	-	-	-	-	-
	SM.	70.24	26.19	3.57	-	-	-	-	-	-	-	-
	W.	54.54	31.82	4.55	-	9.09	-	-	-	-	-	-
5	SP.	-	25.00	50.00	-	12.50	-	12.50	-	-	-	-
	SM.	78.82	7.06	11.77	-	-	-	-	(1.18)	(1.18)	-	-
	W.	48.49	39.39	9.09	-	-	-	-	-	-	(3.03)	-
6	SP.	-	16.67	66.67	-	8.33	-	8.33	-	-	-	-
	SM.	11.54	44.23	19.23	21.15	1.92	-	1.92	-	-	-	-
	W.	7.14	35.71	14.29	14.29	7.14	14.29	-	-	(7.14)	-	-
7	SP.	-	33.33	41.67	-	25.00	-	-	-	-	-	-
	SM.	45.46	18.18	-	-	18.18	-	9.09	-	(9.09)	-	-
	W.	-	18.18	27.27	9.09	22.73	18.18	-	-	(4.55)	-	-
8	SP.	-	100.00	-	-	-	-	-	-	-	-	-
	SM.	47.06	32.35	17.65	2.94	-	-	-	-	-	-	-
	W.	50.00	20.00	10.00	-	-	-	-	-	-	(10.00)	(10.00)

Parentheses denote uncertainty in ageing

Brown trout age group density estimates ($100m^{-2}$).

Table XXVIII. 1985.

Table XXIX. 1986.

Table XXX. 1987.

Table XXVIII. 1985.

SITE	PERIOD	AGE GROUP 0	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
1	SP.	-	-	-	-	-	-	-	-	-	-	-	-
	SM.	0.715	0.715	-	-	-	-	-	-	-	-	-	-
	W.	-	-	2.143	0.714	-	-	-	-	-	-	-	-
2	SP.	-	11.289	2.605	0.868	-	-	-	-	-	-	-	-
	SM.	0.476	2.857	1.429	0.476	-	-	0.952	0.476	(0.476)	-	-	-
	W.	5.820	-	1.058	1.588	-	-	-	1.058	-	-	-	-
3	SP.	-	1.250	0.417	-	-	-	-	-	-	-	-	-
	SM.	2.500	1.667	1.250	-	-	-	-	-	-	-	-	-
	W.	0.417	1.250	0.417	0.417	-	-	-	-	-	-	-	-
4	SP.	-	36.288	7.259	1.454	-	-	-	-	-	-	-	-
	SM.	137.531	25.619	6.747	1.353	-	-	-	-	-	-	-	-
	W.	47.158	6.370	8.925	2.548	-	-	-	-	-	-	-	-
5	SP.	-	6.364	0.909	-	-	-	-	-	-	-	-	-
	SM.	6.363	5.455	4.546	-	-	-	-	-	(0.909)	-	-	-
	W.	10.000	2.727	0.909	3.636	-	-	-	-	-	(0.909)	-	-
6	SP.	-	1.176	1.765	-	0.588	-	-	-	-	-	-	-
	SM.	7.581	5.686	2.528	1.264	-	-	-	-	-	-	-	-
	W.	2.941	0.588	2.353	1.177	-	-	-	(0.588)	-	-	-	-
7	SP.	-	4.000	1.334	2.666	-	0.666	-	-	-	-	(0.666)	-
	SM.	0.666	3.334	1.334	3.334	-	2.666	0.666	-	-	-	-	(0.666)
	W.	3.334	0.666	2.000	-	-	0.666	0.666	0.666	-	-	-	-
8	SP.	-	11.500	-	-	-	-	-	-	-	-	-	-
	SM.	75.171	8.230	1.099	-	-	-	-	-	-	-	-	-
	W.	8.000	2.000	-	-	-	-	-	-	-	(0.500)	-	-

Parentheses denote uncertainty in ageing

Table XXIX. 1986.

SITE	PERIOD	AGE GROUP 0	I	II	III	IV	V	VI	VII	VIII	IX	X
1	SP.	-	-	-	1.429	-	-	-	-	-	-	-
	SM.	-	1.429	-	-	-	-	-	-	-	-	-
	W.	-	-	-	-	-	-	-	-	-	-	-
2	SP.	-	-	-	-	-	-	-	-	-	-	(0.476)
	SM.	0.476	4.285	2.381	0.476	-	0.476	-	-	-	-	-
	W.	-	0.476	0.953	-	-	-	-	-	-	-	-
3	SP.	-	0.417	-	-	-	-	-	-	-	-	-
	SM.	-	0.833	-	-	-	-	-	-	-	-	-
	W.	-	-	-	-	-	-	-	-	-	-	-
4	SP.	-	31.050	2.700	-	-	-	-	-	-	-	-
	SM.	41.288	37.424	1.288	-	-	-	-	-	-	-	-
	W.	28.205	21.795	-	-	-	-	-	-	-	-	-
5	SP.	-	17.273	0.909	-	-	-	-	-	-	-	-
	SM.	4.545	10.909	6.364	0.909	-	-	-	-	-	-	-
	W.	2.727	1.818	-	0.909	-	0.909	-	-	-	-	-
6	SP.	-	-	1.177	-	-	-	-	-	(0.588)	-	-
	SM.	1.765	2.353	0.588	3.530	-	1.177	-	-	-	-	-
	W.	1.765	3.529	-	0.588	-	-	-	-	-	-	-
7	SP.	-	1.333	3.334	1.333	0.667	-	-	-	-	-	-
	SM.	-	0.667	0.667	2.000	-	-	0.667	0.667	-	-	-
	W.	-	0.667	-	-	-	-	-	-	-	-	-
8	SP.	-	7.500	-	-	-	-	-	-	-	-	-
	SM.	3.084	14.389	0.514	0.514	-	-	-	-	-	-	-
	W.	6.500	0.500	-	-	-	-	-	-	-	-	-

Parentheses denote uncertainty in ageing

Table XXX. 1987.

SITE	PERIOD	AGE GROUP 0	I	II	III	IV	V	VI	VII	VIII	IX	X
1	SP.	-	-	-	-	-	-	-	-	-	-	-
	SM.	-	-	-	-	-	-	-	-	-	-	-
	W.	-	0.714	-	-	-	-	-	-	-	-	-
2	SP.	-	-	-	-	-	-	0.476	-	-	-	-
	SM.	10.477	3.809	0.952	0.476	-	-	1.905	0.476	-	-	-
	W.	1.429	-	0.476	-	0.476	-	-	-	-	-	-
3	SP.	-	0.833	0.417	-	-	-	-	-	-	-	-
	SM.	8.264	0.487	-	-	-	-	-	-	-	-	-
	W.	1.250	0.417	0.417	-	-	-	-	-	-	-	-
4	SP.	-	31.249	6.251	-	-	-	-	-	-	-	-
	SM.	77.264	28.809	3.927	-	-	-	-	-	-	-	-
	W.	14.999	8.751	1.251	-	2.500	-	-	-	-	-	-
5	SP.	-	1.818	3.637	-	0.909	-	0.909	-	-	-	-
	SM.	62.340	5.584	9.309	-	-	-	-	(0.933)	(0.933)	-	-
	W.	15.869	12.891	2.975	-	-	-	-	-	-	(0.992)	-
6	SP.	-	1.177	4.706	-	0.588	-	0.588	-	-	-	-
	SM.	3.801	14.570	6.335	6.967	0.632	-	0.632	-	-	-	-
	W.	0.588	2.941	1.177	1.177	0.588	1.177	-	-	(0.588)	-	-
7	SP.	-	2.666	3.334	-	2.000	-	-	-	-	-	-
	SM.	3.334	1.333	-	-	1.333	-	0.667	-	(0.667)	-	-
	W.	-	2.666	4.000	1.333	3.334	2.666	-	-	(0.667)	-	-
8	SP.	-	2.500	-	-	-	-	-	-	-	-	-
	SM.	9.177	6.308	3.442	0.573	-	-	-	-	-	-	-
	W.	2.500	1.000	0.500	-	-	-	-	-	-	(0.500)	(0.500)

Parentheses denote uncertainty in ageing

Table XXXI. Survey site population density estimates ($100m^{-2}$) for 0 group and older brown trout.

RIVER HODDER

YEAR	SEASON	SITE 1 0 GROUP	SITE 1 OLDER	SITE 2 0 GROUP	SITE 2 OLDER	SITE 3 0 GROUP	SITE 3 OLDER
1985	SPRING	-	0	-	14.762	-	1.667
	SUMMER	0.715	0.715	0.476	6.666	2.500	2.917
	WINTER	0	2.857	5.820	3.704	0.417	2.084
1986	SPRING	-	1.429	-	0.476	-	0.417
	SUMMER	0	1.429	0.476	7.618	0	0.883
	WINTER	0	0	0	1.429	0	0
1987	SPRING	-	0	-	0.476	-	1.250
	SUMMER	0	0	10.477	7.618	8.264	0.487
	WINTER	0	0.714	1.429	0.952	1.250	0.834

HASGILL BECK

YEAR	SEASON	SITE 4 0 GROUP	SITE 4 OLDER	SITE 5 0 GROUP	SITE 5 OLDER
1985	SPRING	-	45.001	-	7.273
	SUMMER	137.531	33.719	6.363	10.910
	WINTER	47.158	17.843	10.000	8.181
1986	SPRING	-	33.750	-	18.182
	SUMMER	41.288	38.712	4.545	18.182
	WINTER	28.205	21.795	2.727	3.636
1987	SPRING	-	37.500	-	7.273
	SUMMER	77.264	32.736	62.340	16.759
	WINTER	14.999	12.502	15.869	16.858

BOTTOMS BECK

YEAR	SEASON	SITE 6 0 GROUP	SITE 6 OLDER	SITE 7 0 GROUP	SITE 7 OLDER	SITE 8 0 GROUP	SITE 8 OLDER
1985	SPRING	-	3.529	-	9.332	-	11.500
	SUMMER	7.581	9.478	0.666	12.000	75.171	9.329
	WINTER	2.941	4.706	3.334	4.664	8.000	2.500
1986	SPRING	-	1.765	-	6.667	-	7.500
	SUMMER	1.765	7.648	0	4.668	3.084	15.417
	WINTER	1.765	4.117	0	0.667	6.500	0.500
1987	SPRING	-	7.059	-	8.000	-	2.500
	SUMMER	3.801	29.136	3.334	4.000	9.177	10.323
	WINTER	0.588	7.648	0	14.666	2.500	2.500

Table XXXII. Density estimates ($100m^{-2}$) for 0 group and older brown trout in tributaries of the River Tees and Eden, Northern England, after Crisp *et al*. (1974) and Crisp and Cubby (1978).

RIVER TEES TRIBUTARIES

SURVEY		DURHAM TRIBUTARIES				WESTMORLAND TRIBUTARIES			
		WEELHEAD SIKE		DUBBY SIKE		MATTERGILL SIKE		LODGEGILL SIKE	
YEAR	MONTH	O GROUP	OLDER	O GROUP	OLDER	O GROUP	OLDER	O GROUP	OLDER
1967	August	27.40	31.60	-	-	0.90	16.20	-	-
	October	6.20	35.30	21.80	18.20	0.90	12.30	6.00	7.30
	May	-	24.80	-	28.60	-	3.90	-	7.20
1968	July	46.90	24.80	1.60	38.10	4.60	5.90	0	2.90
	October	35.40	17.90	3.20	17.50	5.20	7.80	0	7.20
	May	-	28.30	-	19.10	-	4.60	-	4.30
1969	August	113.30	23.90	73.00	19.10	9.10	7.20	5.8	2.90
	October	64.00	19.50	39.70	14.30	6.50	7.80	4.7	3.60
1970	May	-	67.80	-	27.00	-	14.90	-	3.60

Cont.

RIVER TEES

SURVEY		TEES (UPPER)		MAIZE BECK		TEES (LOWER)	
YEAR	MONTH	O GROUP	OLDER	O GROUP	OLDER	O GROUP	OLDER
1967	August	-	-	0	5.90	0	5.20
	October	2.00	0	2.20	3.50	0.40	5.10
1968	May	-	0.80	-	1.80	-	4.70
	July	0.80	1.10	0	1.30	0	3.80
	October	0.40	0	0.30	2.10	0	4.30
1969	May	-	-	-	1.70	-	1.90
	August	-	-	0.30	0.70	0	1.90
	October	-	-	0.70	2.40	0.50	2.40
1970	May	-	-	-	3.30	-	4.70

RIVER EDEN TRIBUTARIES

SURVEY		KNOCK ORE GILL		SWINDALE BECK	
YEAR	MONTH	O GROUP	OLDER	O GROUP	OLDER
1973	August	10.00	30.00	8.00	25.00
1975	May	-	44.80		
	August	51.00	40.90	-	21.00
	October	32.00	26.40		

Observed mean values of brown trout length (mm) for age based on scale reading.

Table XXXIII. River Hodder.
Table XXXIV. Hasgill Beck.
Table XXXV. Bottoms Beck.

Table XXXIII. River Hodder.

YEAR CLASS	1985 SPRING	1985 SUMMER	1985 WINTER	1986 SPRING	1986 SUMMER	1986 WINTER	1987 SPRING	1987 SUMMER	1987 WINTER
SITE 1									
0	-	51	-	-	-	-	-	-	-
I	-	106	-	-	118	-	-	-	110
II	-	-	143±13.2	-	-	-	-	-	-
III	-	-	166	159	-	-	-	-	-
SITE 2									
0	-	52	78±6.9	-	59	-	-	52±1.9	77±27.4
I	85±4.6	106±7.4	-	-	107±5.9	115	-	103±7.2	-
II	131±42.4	135±29.4	144	-	135±13.8	138	-	158	134
III	161	180	172±24.5	-	165	-	-	181	-
IV	-	-	-	-	-	-	-	-	201
V	-	-	-	-	238	-	-	-	-
VI	-	268	-	-	-	-	258	265±11.3	-
VII	-	281	295	-	-	-	-	295	-
VIII	-	(316)	-	-	-	-	-	-	-
IX	-	-	-	-	-	-	-	-	-
X	-	-	-	(375)	-	-	-	-	-
SITE 3									
0	-	43±9.5	85	-	-	-	-	46±4.0	83±6.6
I	79±16.5	102±24.3	122±24.9	74	104	-	73	87	96
II	110	124±8.0	148	-	-	-	115	-	129
III	-	-	170	-	-	-	-	-	-

Parentheses denote uncertainty in ageing

Table XXXIV. Hasgill Beck.

YEAR CLASS	1985 SPRING	1985 SUMMER	1985 WINTER	1986 SPRING	1986 SUMMER	1986 WINTER	1987 SPRING	1987 SUMMER	1987 WINTER
SITE 4									
0	-	43±1.2	62±2.6	-	52±1.5	66±2.1	-	51±1.5	64±5.9
I	75±3.8	91±4.9	107±13.9	68±3.7	91±4.1	108±6.0	70±4.6	91±4.3	110±5.2
II	122±5.8	130±10.2	137±10.4	124	135	-	124±11.4	121±7.6	140
III	150	170	188	-	-	-	-	-	-
IV	-	-	-	-	-	-	-	-	211
SITE 5									
0	-	52±6.5	75±6.3	-	64±3.8	79±10.0	-	52±1.5	74±3.0
I	88±5.2	103±8.3	104±37.3	79±7.3	107±4.6	118	85	113±2.7	97±3.6
II	134	125±6.6	140	137	129±4.2	-	120±16.7	140±6.1	138±12.3
III	-	-	170±15.9	-	170	190	-	-	-
IV	-	-	-	-	-	-	195	-	-
V	-	-	-	-	-	235	-	-	-
VI	-	-	-	-	-	-	240	-	-
VII	-	-	-	-	-	-	-	(280)	-
VIII	-	(312)	-	-	-	-	-	(305)	-
IX	-	-	(338)	-	-	-	-	-	(325)

Parentheses denote uncertainty in ageing

Table XXXV. Bottoms Beck.

YEAR CLASS	1985 SPRING	1985 SUMMER	1985 WINTER	1986 SPRING	1986 SUMMER	1986 WINTER	1987 SPRING	1987 SUMMER	1987 WINTER
SITE 6									
0	-	43±2.8	69±4.8	-	57±16.3	63±27.4	-	51±10.7	70
I	76	110±3.8	125	-	113±13.8	110±14.1	85	105±3.9	113±10.3
II	118_6.6	143±12.9	147±15.8	133	150	-	125±11.1	137±8.3	150
III	-	167	169	-	172±14.3	160	-	173±9.5	178
IV	193	-	-	-	-	-	188	203	207
V	-	-	-	-	227	-	-	-	234
VI	-	-	-	-	-	-	238	240	-
VII	-	-	(278)	-	-	-	-	-	-
VIII	-	-	-	(278)	-	-	-	-	(290)
SITE 7									
0	-	56	72±3.6	-	-	-	-	51±8.5	-
I	83±9.9	105±10.5	113	72±25.4	119	120	84±14.4	110	112±8.4
II	132	125	129±5.2	126±11.5	128	-	128±12.9	-	148±7.6
III	156±21.1	161±8.8	-	159±19.1	166±5.2	-	-	-	172
IV	-	-	-	190	-	-	189±24.0	195	191±7.2
V	205	211±18.1	220	-	-	-	-	-	232±15.0
VI	-	247	256	-	250	-	-	245	-
VII	-	-	265	-	273	-	-	-	-
VIII	-	-	-	-	-	-	-	(290)	(288)
IX	-	-	-	-	-	-	-	-	-
X	(337)	-	-	-	-	-	-	-	-
XI	-	(355)	-	-	-	-	-	-	-

Parentheses denote uncertainty in ageing

Cont.

BOTTOMS BECK

YEAR CLASS	SPRING	1985 SUMMER	WINTER	SPRING	1986 SUMMER	WINTER	SPRING	1987 SUMMER	WINTER
SITE 8									
O	-	43 ± 1.0	65 ± 6.2	-	48 ± 10.8	68 ± 6.0	-	50 ± 2.6	65 ± 11.6
I	66 ± 5.78	96 ± 6.2	107 ± 7.4	65 ± 4.6	85 ± 3.8	115	79 ± 16.6	103 ± 5.6	120
II	-	125	-	-	130	-	-	133 ± 13.9	148
III	-	-	-	-	175	-	-	170	-
IV	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
VI	-	-	-	-	-	-	-	-	-
VII	-	-	-	-	-	-	-	-	-
VIII	-	-	-	-	-	-	-	-	-
IX	-	-	(310)	-	-	-	-	-	(350)
X	-	-	-	-	-	-	-	-	(355)

Parentheses denote uncertainty in ageing

Table XXXVI. Summary of monthly permit visits for the seasons 1985 to 1987.

1985 SEASON

MONTH	DAY VISITS	HALF-DAY VISITS	SEASON VISITS	TOTAL VISITS	NO RETURNS
March (16th)	315	66	7	388	3
April	470	234	19	723	35
May	825	336	40	1201	33
June	440	366	36	842	2
July	456	284	39	779	9
August	400	271	36	707	28
September	611	299	35	945	31
October	484	218	49	751	20
November (3rd)	53	36	2	91	6
SEASON	4054	2110	263	6427	167

1986 SEASON

MONTH	DAY VISITS	HALF-DAY VISITS	SEASON VISITS	TOTAL VISITS	NO RETURNS
March (15th)	435	139	28	602	24
April	549	237	53	839	39
May	739	337	73	1149	67
June	509	257	73	839	51
July	552	334	57	943	57
August	504	267	54	825	40
September	568	218	43	829	29
October	261	109	41	411	17
November (15th)	57	27	16	100	0
SEASON	4174	1925	438	6537	324

1987 SEASON

MONTH	DAY VISITS	HALF-DAY VISITS	SEASON VISITS	TOTAL VISITS	NO RETURNS
March (15th)	306	118	11	435	13
April	555	267	37	859	28
May	475	286	43	804	3
June	446	223	36	705	9
July	412	231	37	680	25
August	528	238	31	797	7
September	423	151	36	610	14
October	252	102	29	383	9
November (15th)	153	48	12	213	4
SEASON	3550	1664	272	5483	112

Table XXXVII. Percentage distributions of combined mean daily permit visits for the seasons 1985 to 1987.

DAY	1985	1986	1987
Monday	10.5	10.5	10.4
Tuesday	9.0	8.8	8.8
Wednesday	11.3	10.5	10.1
Thursday	11.2	9.9	8.8
Friday	11.6	12.5	11.3
Saturday	20.4) 46.4	18.9) 47.8	17.6) 50.6
Sunday	26.0)	28.9)	33.0)

Table XXXVIII. Summary of monthly fish caught, taken and returned for the seasons 1985 to 1987.

1985 SEASON

MONTH	RAINBOWS TAKEN	BROOKS TAKEN	BROWNS TAKEN	TOTAL TAKEN	TOTAL RETURNED	TOTAL CAUGHT
March (16th)	613	6	68	687	330	1017
April	766	72	251	1089	663	1752
May	1719	80	417	2216	1410	3626
June	1122	115	243	1480	742	2222
July	994	36	76	1106	481	1587
August	1097	14	110	1221	652	1873
September	1493	13	97	1603	829	2432
October	1067	2	10	1079	722	1801
November (3rd)	72	1	0	73	47	120
SEASON	8943	339	1272	10554	5876	16430

1986 SEASON

MONTH	RAINBOWS TAKEN	BROOKS TAKEN	BROWNS TAKEN	TOTAL TAKEN	TOTAL RETURNED	TOTAL CAUGHT
March (15th)	696	0	6	702	692	1394
April	1259	5	21	1285	935	2220
May	1503	74	44	1621	1011	2636
June	892	83	96	1071	387	1458
July	1454	49	74	1577	559	2136
August	1231	66	83	1380	697	2077
September	1249	65	81	1395	513	1908
October	544	9	0	553	259	812
November (15th)	100	1	0	101	67	168
SEASON	8928	352	405	9685	5120	14805

1987 SEASON

MONTH	RAINBOWS TAKEN	BROOKS TAKEN	BROWNS TAKEN	TOTAL TAKEN	TOTAL RETURNED	TOTAL CAUGHT
March (15th)	701	0	7	708	837	1545
April	909	3	82	994	377	1371
May	725	1	137	863	228	1091
June	1415	0	49	1464	243	1707
July	992	1	27	1020	521	1541
August	1242	0	40	1282	742	2024
September	974	0	23	997	442	1439
October	674	0	2	676	396	1072
November (15th)	388	0	0	388	43	431
SEASON	8020	5	367	8392	3829	12221

Table XXXIX. Summary of monthly percentage limit and nil returns for the seasons 1985 to 1987.

DAY VISITS

MONTH	1985 LIMIT	1985 NIL	1986 LIMIT	1986 NIL	1987 LIMIT	1987 NIL
March	45	18	23	34	48	21
April	43	19	40	20	29	30
May	52	10	35	18	28	33
June	51	8	31	28	58	15
July	35	28	44	17	40	19
August	48	11	53	13	45	17
September	46	12	52	9	43	21
October	36	18	33	23	46	14
November	17	49	21	42	36	26
SEASON	45	15	39	20	41	22

HALF DAY AND SEASON VISITS

MONTH	1985 LIMIT	1985 NIL	1986 LIMIT	1986 NIL	1987 LIMIT	1987 NIL
March	40	34	33	43	35	42
April	34	31	42	31	22	51
May	48	24	34	36	17	54
June	49	31	28	45	36	37
July	40	37	31	41	33	33
August	48	22	40	31	31	38
September	40	32	34	33	38	30
October	35	39	37	35	46	23
November	16	42	21	47	40	42
SEASON	42	31	34	37	30	41

COMBINED

MONTH	1985 LIMIT	1985 NIL	1986 LIMIT	1986 NIL	1987 LIMIT	1987 NIL
March	44	21	26	37	44	27
April	40	23	41	24	27	37
May	51	14	35	25	23	42
June	50	19	30	34	50	23
July	37	32	39	27	37	25
August	48	15	48	20	40	24
September	44	19	47	17	41	24
October	36	26	35	27	46	17
November	16	46	21	44	37	31
			38	26	37	29

Table XL. Summary of monthly fish taken per day permit visit and half day and season permit visits for the seasons 1985 to 1987.

MONTH	1985 SEASON		1986 SEASON		1987 SEASON	
	DAY	HALF/ SEASON	DAY	HALF/ SEASON	DAY	HALF/ SEASON
March	1.84	1.17	1.39	0.90	1.78	0.88
April	1.88	1.00	1.73	1.14	1.55	0.90
May	2.16	1.06	1.82	1.06	1.47	0.67
June	2.33	0.86	1.62	0.86	1.99	1.05
July	1.70	0.91	1.73	0.91	1.78	1.04
August	2.03	1.16	2.01	1.16	1.95	0.91
September	2.07	1.04	2.06	1.04	1.94	1.08
October	1.75	1.08	1.82	1.08	1.76	1.25
November	0.79	0.97	1.24	0.97	1.58	1.25
SEASON	1.96	1.10	1.78	1.02	1.77	0.97

Table XLI. Summary of monthly species taken with totals caught, taken and returned per angler visit.

1985 SEASON

MONTH	RAINBOWS TAKEN	BROOKS TAKEN	BROWNS TAKEN	TOTAL TAKEN	TOTAL RETURNED	TOTAL CAUGHT
March (16th)	1.58	0.02	0.18	1.77	0.85	2.62
April	1.06	0.10	0.35	1.51	0.92	2.42
May	1.43	0.07	0.35	1.85	1.17	3.02
June	1.33	0.14	0.29	1.76	0.88	2.64
July	1.28	0.05	0.10	1.42	0.62	2.04
August	1.55	0.02	0.16	1.73	0.92	2.65
September	1.58	0.01	0.10	1.70	0.88	2.57
October	1.42	0.003	0.01	1.44	0.96	2.40
November (3rd)	0.79	0.01	0	0.80	0.52	1.32
SEASON	1.39	0.05	0.20	1.64	0.91	2.56

1986 SEASON

MONTH	RAINBOWS TAKEN	BROOKS TAKEN	BROWNS TAKEN	TOTAL TAKEN	TOTAL RETURNED	TOTAL CAUGHT
March (15th)	1.16	0	0.01	1.17	1.15	2.32
April	1.50	0.01	0.03	1.53	1.11	2.65
May	1.31	0.06	0.04	1.41	0.88	2.29
June	1.06	0.01	0.11	1.28	0.46	1.74
July	1.54	0.05	0.08	1.67	0.59	2.27
August	1.49	0.08	0.10	1.67	0.84	2.52
September	1.51	0.08	0.10	1.68	0.62	2.30
October	1.32	0.02	0	1.35	0.63	1.98
November (15th)	1.00	0.01	0	1.01	0.67	1.68
SEASON	1.37	0.05	0.06	1.48	0.78	2.26

1987 SEASON

MONTH	RAINBOWS TAKEN	BROOKS TAKEN	BROWNS TAKEN	TOTAL TAKEN	TOTAL RETURNED	TOTAL CAUGHT
March (15th)	1.61	0	0.02	1.63	1.92	3.55
April	1.06	0.003	0.10	1.16	0.44	1.60
May	0.90	0.001	0.17	1.07	0.28	1.36
June	2.01	0	0.07	2.08	0.34	2.42
July	1.46	0.001	0.04	1.50	0.77	2.27
August	1.56	0	0.05	1.61	0.93	2.54
September	1.60	0	0.04	1.64	0.73	2.36
October	1.76	0	0.01	1.77	1.03	2.80
November (15th)	1.82	0	0	1.82	0.20	2.02
SEASON	1.46	0.001	0.07	1.53	0.70	2.23

Table XLII. Summary of monthly large (>907g) rainbow trout, brook trout and brown trout taken per angler visit for the seasons 1985 to 1987.

MONTH	1985 SEASON			1986 SEASON			1987 SEASON	
	RAINBOW	BROOK	BROWN	RAINBOW	BROOK	BROWN	RAINBOW	BROWN
March	0.054	0.005	0.013	0.135	0	0	0.283	0
April	0.010	0.024	0.004	0.125	0.001	0.002	0.153	0
May	0.016	0.006	0.007	0.095	0	0.016	0.111	0
June	0.017	0.083	0.017	0.094	0	0.004	0.214	0.004
July	0.060	0.028	0.003	0.090	0	0.002	0.100	0
August	0.194	0.011	0.001	0.132	0.001	0.006	0.100	0.001
September	0.113	0.004	0.007	0.105	0	0.001	0.146	0
October	0.100	0	0	0.095	0	0	0.110	0
November	0.033	0	0	0.050	0	0	0.028	0
SEASON	0.066	0.020	0.006	0.107	0.0003	0.005	0.142	0.001

Table XLIII. Summary of monthly large (>907g) fish taken and as percentages of those taken for each species for the seasons 1985 to 1987.

RAINBOW TROUT

MONTH	1985 SEASON NO.	%	1986 SEASON NO.	%	1987 SEASON NO.	%
March	21	3.4	81	11.6	123	17.5
April	7	0.9	105	8.3	131	14.4
May	19	1.1	109	7.3	89	12.3
June	14	1.2	79	8.9	151	10.7
July	47	4.7	85	5.8	68	6.9
August	137	12.5	109	8.9	80	6.4
September	107	7.2	87	7.0	89	9.1
October	72	6.7	39	7.2	42	6.2
November	3	4.2	5	5.0	6	1.5
SEASON	427	4.8	699	7.8	779	9.7

BROOK TROUT

MONTH	1985 SEASON NO.	%	1986 SEASON NO.	%
March	2	33.3	0	-
April	17	23.6	1	20.0
May	7	8.8	0	-
June	70	60.9	0	-
July	22	61.1	0	-
August	8	57.1	1	1.5
September	4	30.8	0	-
October	0	-	0	-
November	0	-	0	-
SEASON	130	38.3	2	0.6

BROWN TROUT

MONTH	1985 SEASON NO.	%	1986 SEASON NO.	%	1987 SEASON NO.	%
March	5	7.4	0	-	0	-
April	3	1.2	2	40.0	0	-
May	8	1.9	18	24.3	0	-
June	14	5.8	3	3.6	3	6.1
July	2	2.6	2	4.1	0	-
August	1	0.9	5	7.6	1	2.5
September	7	7.2	1	1.5	0	-
SEASON	40	3.1	31	7.7	4	1.1

Table XLIV. Annual summaries of mean and maximum weights of large (>907g) rainbow trout, brook trout and brown trout taken.

SPECIES	SEASON	TOTAL	MEAN WEIGHT(g)	±95% C.L.	MAXIMUM WEIGHT(g)
	1985	427	1180	27	2325
RAINBOW	1986	699	1077	16	2381
	1987	779	1305	35	3175
	1985	130	1057	25	1418
BROOK	1986	2	1049	907 - 1191*	1191
	1987	0	-	-	-
	1985	40	1101	69	1616
BROWN	1986	31	1258	145	2070
	1987	4	1162	907 - 1588*	1588

* Range as frequency less than 5

Table XLV. Annual monthly summaries of reservoir level, percentage capacity, supply and draw-off port aperture (inches).

1985

MONTH	LEVEL (m)	CAP. (%)	SUPPLY (Ml)	PORTS
January	29.570	92	102.34	T.24 : M.12
February	29.660	93	105.34	T.24 : M.12
March	28.305	80	92.27	T.24 : M.12
April	29.635	93	92.27	T.24 : M.12
May	28.360	80	110.24	T.24 : M.21
June	26.247	62	102.65	M.24 : B.15
July	24.605	50	58.45	M.24 : B.18
August	29.012	86	90.68	T.24 : M.24
September	30.310	100	97.57	T.24 : M.14
October	29.985	96	96.78	T.24 : M.14
November	29.486	91	105.70	T.24 : M.14
December	29.945	96	90.61	T.24 : M.14

1986

MONTH	LEVEL (m)	CAP. (%)	SUPPLY (Ml)	PORTS
January	30.339	100	92.58	T.24 : M.14
February	29.484	91	92.68	T.24 : M.14
March	29.185	88	90.05	T.24 : M.14
April	30.127	98	97.51	T.24 : M.14
May	29.942	96	90.45	T.24 : M.14
June	29.665	93	78.69	T.24 : M.14
July	27.527	73	80.99	M.24 : B.24
August	25.416	56	90.98	M.24 : B.24
September	23.668	44	89.36	M.24 : B.24
October	21.386	32	79.17	M.24 : B.24
November	27.603	74	94.42	T.24 : M.18
December	30.385	100	98.33	T.24 : M.18

1987

MONTH	LEVEL (m)	CAP. (%)	SUPPLY (Ml)	PORTS
January	29.806	94	98.97	T.24 : M.18
February	28.971	86	98.17	T.24 : M.18
March	29.012	86	97.55	T.24 : M.18
April	30.030	97	102.98	T.24 : M.18
May	28.112	78	99.86	M.24 : B.9
June	27.141	69	99.63	M.24 : B.9
July	25.686	58	98.83	M.24 : B.9
August	25.042	53	99.33	M.24 : B.12
September	25.645	58	98.98	M.24 : B.12
October	27.000	69	92.20	T.24 : M.12
November	29.136	88	89.45	T.24 : M.24
December	29.007	86	106.11	T.24 : M.24

Table XLVI. Annual monthly summaries of raw water temperature, colour, turbidity and pH.

1985

MONTH	TEMP (°C)	COLOUR	TURBIDITY	pH
January	3.9	49	5.5	7.1
February	3.3	51	10.7	7.1
March	4.4	44	8.2	7.1
April	7.0	40	8.7	7.2
May	10.6	35	6.9	7.2
June	12.5	31	4.1	7.1
July	13.8	47	21.1	7.0
August	13.5	69	28.9	7.1
September	13.2	76	5.8	7.1
October	12.0	78	5.8	7.1
November	7.7	68	6.0	7.1
December	6.1	63	9.2	7.2

1986

MONTH	TEMP (°C)	COLOUR	TURBIDITY	pH
January	3.9	56	20.9	7.0
February	2.1	50	17.5	6.9
March	3.4	44	19.1	6.8
April	5.2	36	14.5	6.9
May	8.7	25	5.4	7.2
June	12.4	25	3.7	7.2
July	15.1	25	3.2	7.1
August	13.4	35	9.5	6.9
September	12.1	34	6.6	7.0
October	10.5	31	20.3	7.1
November	7.3	37	13.7	6.9
December	5.8	39	10.4	6.9

1987

MONTH	TEMP (°C)	COLOUR	TURBIDITY	pH
January	2.8	35	10.2	7.1
February	2.9	35	11.8	7.0
March	3.5	34	10.9	7.1
April	6.2	33	12.0	7.2
May	10.1	23	5.0	7.3
June	11.8	28	3.8	7.2
July	13.9	26	5.3	7.2
August	14.8	42	7.8	7.2
September	14.3	55	10.1	7.2
October	10.5	54	11.5	7.3
November	7.7	45	9.8	7.3
December	4.9	40	7.0	7.3

Table XLVII. Annual monthly summaries of atmospheric pressure, cloud cover, sunshine, rainfall and temperature.

1985

MONTH	PRESSURE (mmHg)	CLOUD ($\frac{1}{8}$ths)	SUNSHINE (Hrs)	RAINFALL (mm)	TEMP. (°C)
January	746	6	1.3	3.5	0.2
February	751	7	2.2	0.8	1.6
March	745	5	3.5	2.8	3.2
April	745	7	3.3	4.2	7.1
May	748	5	5.3	2.7	10.6
June	746	6	6.2	2.3	12.1
July	747	7	5.2	5.7	14.9
August	744	7	4.0	8.8	12.7
September	750	7	3.3	4.8	12.8
October	754	6	2.8	2.9	9.9
November	746	5	2.5	3.7	2.3
December	744	7	0.7	8.1	5.0

1986

MONTH	PRESSURE (mmHg)	CLOUD ($\frac{1}{8}$ths)	SUNSHINE (Hrs)	RAINFALL (mm)	TEMP. (°C)
January	741	6	1.4	7.4	2.0
February	751	6	2.8	0.1	-1.1
March	743	6	3.5	5.5	3.7
April	746	6	4.1	2.9	5.1
May	745	6	5.9	4.9	10.2
June	750	6	5.9	2.2	13.5
July	749	6	4.3	1.9	14.4
August	746	7	3.8	3.5	12.5
September	754	5	-	1.0	-
October	746	6	2.7	7.7	-
November	745	6	2.1	7.3	-
December	745	7	1.3	9.8	-

1987

MONTH	PRESSURE (mmHg)	CLOUD ($\frac{1}{8}$ths)	SUNSHINE (Hrs)	RAINFALL (mm)	TEMP. (°C)
January	753	6	1.7	2.3	-0.5
February	747	6	2.2	3.8	1.2
March	746	6	3.4	5.1	2.6
April	746	6	4.8	2.2	9.4
May	750	5	7.3	1.6	9.4
June	746	7	3.8	4.8	11.3
July	750	6	5.7	3.6	15.0
August	748	7	-	4.2	14.3
September	747	6	5.1	4.3	12.0
October	741	7	2.5	6.2	7.9
		7	1.3	3.9	5.6
		7	0.8	5.0	4.6

Table XLVIII.

Fishery and fish plate impingement correlation matrices for the years 1985 to 1987.

	1985	1986	1987
Fishery data d.f.	33	35	35
Impingement data d.f.	42	51	51

<u>1985.</u>

	ANGLERS	DAY	1/2DAY	SEASON	NODATA	D/NIL
DAY	0.912**					
1/2DAY	0.740**	0.403*				
SEASON	0.245	0.087	0.280			
NODATA	0.241	0.330	0.016	-0.132		
D/NIL	0.153	0.218	-0.001	-0.108	0.145	
D/LIMIT	0.755**	0.818**	0.345	0.123	0.211	-0.307
S/NIL	0.476**	0.230	0.662**	0.410*	-0.139	0.392*
S/LIMIT	0.628**	0.333	0.853**	0.317	-0.154	-0.285
CAUGHT	0.807**	0.727**	0.613**	0.192	0.226	-0.309
TAKEN	0.898**	0.840**	0.630**	0.205	0.135	-0.232
RETURNED	0.554**	0.464**	0.479**	0.141	0.286	-0.338
RAINBOW	0.889**	0.834**	0.609**	0.281	0.128	-0.126
BROOK	0.165	0.056	0.308	-0.126	-0.147	-0.282
BROWN	0.401*	0.401*	0.264	-0.098	0.137	-0.351*
CGHT/AV	0.276	0.249	0.216	0.025	0.027	-0.663**
TAKEN/AV	0.276	0.298	0.134	0.003	-0.171	-0.717**
RET/AV	0.204	0.147	0.220	0.035	0.166	-0.448*
RW/AV	0.234	0.273	0.058	0.139	-0.199	-0.515**
BK/AV	0.028	-0.090	0.246	-0.168	-0.147	-0.289
BN/AV	0.128	0.144	0.082	-0.205	0.080	-0.430*
R/W.NO	0.018	-0.020	0.042	0.227	0.169	-0.260
R/W.MN	-0.101	-0.125	-0.044	0.140	-0.125	-0.009
B/K.NO	-0.052	-0.197	0.225	-0.041	-0.293	-0.269
B/K.MN	-0.090	-0.116	0.011	-0.157	0.093	-0.193
B/N.NO	0.050	0.032	0.084	-0.150	-0.257	-0.345
B/N.MN	0.044	0.142	-0.099	-0.293	-0.042	-0.214
M.R/W	0.587**	0.619**	0.298	0.085	-0.005	0.105
L.R/W	0.478**	0.645**	-0.011	0.146	-0.061	0.228
T.R/W	0.620**	0.696**	0.240	0.113	-0.022	0.153
M.B/K	0.107	0.038	0.200	-0.102	-0.307	0.182
L.B/K	-0.265	-0.307	-0.101	0.059	-0.269	0.215
T.B/K	-0.084	-0.148	0.063	-0.028	-0.333	0.229
S.B/N	-0.186	-0.047	-0.304	-0.352*	-0.145	0.096
M.B/N	0.003	0.004	0.024	-0.165	-0.263	0.343
L.B/N	0.078	-0.113	0.352*	0.179	-0.438*	0.123
T.B/N	0.013	-0.071	0.158	-0.043	-0.406*	0.257
LEVEL	0.115	0.221	-0.112	-0.003	0.480**	-0.202
CAP.%	0.101	0.204	-0.117	0.015	0.487**	-0.200
UPPER	0.367*	0.393*	0.207	-0.156	0.030	-0.191
MIDDLE	-0.001	-0.103	0.140	0.245	-0.100	-0.035
LOWER	-0.367*	-0.393*	-0.207	0.156	-0.030	0.191
SUPPLY	0.364*	0.374*	0.193	0.118	0.167	-0.386*
HYDRO	0.358*	0.155	0.528**	0.297	-0.097	-0.218
TOTAL.FL	0.403*	0.390*	0.252	0.151	0.156	-0.410*
R.PH	0.346	0.430*	0.108	-0.244	0.058	-0.335
R.TEMP	0.214	-0.024	0.451**	0.627**	-0.075	-0.012
R.COLOUR	-0.189	-0.170	-0.197	0.327	0.253	0.088
R.TURB	-0.357*	-0.363*	-0.228	0.107	-0.026	0.102
H.PH	0.161	0.328	-0.146	-0.292	0.191	-0.194
H.TEMP	0.178	-0.051	0.414*	0.624**	-0.026	-0.013
H.COLOUR	-0.149	-0.149	-0.139	0.312	0.250	-0.042
H.TURB	-0.378*	-0.373*	-0.256	0.066	0.022	0.028
AT.PRESS	0.421*	0.333	0.349*	0.437*	-0.034	0.063
TEMP.MAX	0.387*	0.175	0.525**	0.548**	-0.082	-0.015
TEMP.MIN	0.156	-0.035	0.348	0.521**	-0.076	-0.034
SUN	0.401*	0.287	0.454**	-0.055	-0.135	0.094
CLOUD	-0.477**	-0.470**	-0.305	-0.029	0.028	-0.270
RAIN	-0.363*	-0.332	-0.280	0.002	-0.049	0.061
WIND.SP	[illegible]	[illegible]	-0.030	-0.253	0.083	-0.026

1985,cont.

	D/LIMIT	S/NIL	S/LIMIT	CAUGHT	TAKEN	RETURNED
S/NIL	-0.039					
S/LIMIT	0.464**	0.284				
CAUGHT	0.841**	0.088	0.705**			
TAKEN	0.924**	0.175	0.710**	0.923**		
RETURNED	0.590**	-0.027	0.568**	0.901**	0.665**	
RAINBOW	0.842**	0.260	0.645**	0.847**	0.940**	0.584**
BROOK	0.262	-0.073	0.440*	0.268	0.295	0.187
BROWN	0.611**	-0.158	0.396*	0.592**	0.567**	0.511**
CGHT/AV	0.589**	-0.340	0.492**	0.773**	0.580**	0.848**
TAKEN/AV	0.706**	-0.382*	0.482**	0.619**	0.656**	0.461**
RET/AV	0.347	-0.219	0.370*	0.683**	0.371*	0.910**
RW/AV	0.542**	-0.249	0.330	0.462**	0.521**	0.311
BK/AV	0.126	-0.082	0.353*	0.130	0.152	0.081
BN/AV	0.418*	-0.308	0.257	0.382*	0.340	0.358*
R/W.NO	0.062	-0.183	0.158	0.102	0.112	0.072
R/W.MN	-0.131	0.014	-0.002	-0.138	-0.110	-0.145
B/K.NO	0.003	-0.078	0.388*	0.032	0.078	-0.025
B/K.MN	0.059	-0.263	0.150	0.060	0.027	0.087
B/N.NO	0.258	-0.188	0.299	0.230	0.239	0.177
B/N.MN	0.321	-0.240	0.058	0.253	0.211	0.253
M.R/W	0.527**	0.198	0.264	0.444*	0.535**	0.258
L.R/W	0.499**	0.096	0.003	0.253	0.438*	-0.003
T.R/W	0.578**	0.190	0.217	0.437*	0.566**	0.210
M.B/K	-0.037	-0.010	0.304	-0.007	0.087	-0.113
L.B/K	-0.383*	-0.043	-0.042	-0.277	-0.314	-0.183
T.B/K	-0.236	-0.030	0.158	-0.159	-0.123	-0.170
S.B/N	-0.063	-0.367*	-0.115	-0.116	-0.121	-0.089
M.B/N	-0.149	0.049	0.040	-0.131	-0.077	-0.168
L.B/N	-0.099	0.306	0.379*	0.010	0.038	-0.024
T.B/N	-0.142	0.133	0.215	-0.080	-0.038	-0.113
LEVEL	0.231	-0.173	-0.136	0.242	0.151	0.300
CAP.%	0.213	-0.179	-0.141	0.230	0.136	0.294
UPPER	0.498**	-0.037	0.264	0.502**	0.476**	0.438*
MIDDLE	-0.115	0.064	0.168	-0.088	-0.019	-0.149
LOWER	-0.498**	0.037	-0.264	-0.502**	-0.476**	-0.438*
SUPPLY	0.520**	-0.100	0.309	0.537**	0.503**	0.476**
HYDRO	0.264	0.194	0.625**	0.339	0.421*	0.183
TOTAL.FL	0.549**	-0.078	0.378*	0.574**	0.549**	0.495**
R.PH	0.616**	-0.346	0.321	0.580**	0.539**	0.518**
R.TEMP	-0.065	0.378*	0.437*	0.077	0.128	0.004
R.COLOUR	-0.252	0.031	-0.274	-0.230	-0.274	-0.138
R.TURB	-0.392*	0.067	-0.298	-0.434*	-0.435*	-0.352*
H.PH	0.412*	-0.330	-0.045	0.347	0.277	0.363*
H.TEMP	-0.095	0.356*	0.393*	0.055	0.088	0.008
H.COLOUR	-0.194	0.001	-0.188	-0.163	-0.196	-0.095
H.TURB	-0.388*	-0.007	-0.302	-0.443*	-0.431*	-0.374*
AT.PRESS	0.284	0.336	0.305	0.343	0.359*	0.261
TEMP.MAX	0.173	0.401*	0.537**	0.248	0.342	0.095
TEMP.MIN	0.001	0.253	0.390*	0.040	0.129	-0.068
SUN	0.154	0.391*	0.340	0.257	0.323	0.135
CLOUD	-0.236	-0.498**	-0.103	-0.235	-0.336	-0.077
RAIN	-0.351*	-0.158	-0.245	-0.431*	-0.376*	-0.412*
WIND.SP	-0.125	-0.126	-0.060	-0.105	-0.083	-0.110

1985, cont.

	RAINBOW	BROOK	BROWN	CGHT/AV	TAKEN/AV	RET/AV
BROOK	0.003					
BROWN	0.258	0.727**				
CGHT/AV	0.477**	0.265	0.512**			
TAKEN/AV	0.563**	0.335	0.495**	0.790**		
RET/AV	0.288	0.144	0.390*	0.892**	0.426*	
RW/AV	0.639**	-0.207	-0.055	0.595**	0.808**	0.281
BK/AV	-0.130	0.979**	0.633**	0.190	0.265	0.084
BN/AV	0.011	0.763**	0.945**	0.469**	0.476**	0.341
R/W.NO	0.305	-0.489**	-0.390*	0.127	0.208	0.034
R/W.MN	-0.092	-0.059	-0.091	-0.114	-0.062	-0.122
B/K.NO	-0.123	0.837**	0.388*	0.113	0.244	-0.013
B/K.MN	-0.138	0.391*	0.399*	0.089	0.094	0.062
B/N.NO	0.045	0.598**	0.524**	0.328	0.377*	0.205
B/N.MN	0.066	0.329	0.447*	0.351*	0.310	0.289
M.R/W	0.446*	0.194	0.472**	0.120	0.160	0.059
L.R/W	0.497**	-0.107	0.058	-0.021	0.181	-0.165
T.R/W	0.511**	0.127	0.403*	0.092	0.184	-0.001
M.B/K	0.127	0.107	-0.120	-0.102	0.037	-0.177
L.B/K	-0.184	-0.293	-0.459**	-0.180	-0.230	-0.096
T.B/K	-0.027	-0.099	-0.328	-0.161	-0.106	-0.159
S.B/N	-0.223	0.207	0.196	0.051	0.075	0.020
M.B/N	-0.157	0.281	0.120	-0.180	-0.124	-0.174
L.B/N	0.019	0.269	-0.013	-0.054	-0.033	-0.056
T.B/N	-0.107	0.330	0.087	-0.111	-0.067	-0.114
LEVEL	0.211	-0.323	-0.008	0.305	0.152	0.338
CAP.%	0.204	-0.334	-0.036	0.299	0.143	0.335
UPPER	0.432*	0.254	0.278	0.526**	0.484**	0.419*
MIDDLE	0.049	-0.177	-0.164	-0.223	-0.109	-0.249
LOWER	-0.432*	-0.254	-0.278	-0.526**	-0.484**	-0.419*
SUPPLY	0.428*	0.191	0.412*	0.544**	0.509**	0.426*
HYDRO	0.399*	0.199	0.203	0.092	0.226	-0.032
TOTAL.FL	0.472**	0.213	0.434*	0.553**	0.534**	0.421*
R.PH	0.386*	0.406*	0.605**	0.639**	0.586**	0.509**
R.TEMP	0.245	-0.099	-0.275	-0.163	-0.133	-0.143
R.COLOUR	-0.056	-0.653**	-0.598**	-0.233	-0.315	-0.111
R.TURB	-0.414*	-0.235	-0.196	-0.464**	-0.473**	-0.336
H.PH	0.133	0.174	0.526**	0.463**	0.349*	0.425*
H.TEMP	0.225	-0.184	-0.331	-0.165	-0.164	-0.122
H.COLOUR	0.028	-0.641**	-0.584**	-0.143	-0.201	-0.063
H.TURB	-0.398*	-0.275	-0.220	-0.447*	-0.422*	-0.348
AT.PRESS	0.476**	-0.129	-0.154	0.192	0.147	0.175
TEMP.MAX	0.411*	0.035	-0.065	-0.062	0.035	-0.117
TEMP.MIN	0.222	-0.044	-0.219	-0.174	-0.055	-0.217
SUN	0.265	0.251	0.253	0.040	0.084	-0.003
CLOUD	-0.394*	0.167	-0.035	0.038	-0.040	0.086
RAIN	-0.332	-0.214	-0.249	-0.384*	-0.262	-0.373*
WIND.SP	-0.181	0.182	0.208	-0.100	-0.033	-0.123

1985, cont.

	RW/AV	BK/AV	BN/AV	R/W.NO	R/W.MN	B/K.NO
BK/AV	-0.266					
BN/AV	-0.120	0.718**				
R/W.NO	0.530**	-0.477**	-0.414*			
R/W.MN	-0.021	-0.038	-0.079	0.225		
B/K.NO	-0.145	0.864**	0.483**	-0.238	0.161	
B/K.MN	-0.216	0.407*	0.478**	-0.046	-0.019	0.340
B/N.NO	0.028	0.542**	0.557**	-0.197	0.134	0.620**
B/N.MN	0.051	0.284	0.466**	-0.232	0.020	0.177
M.R/W	0.020	0.053	0.290	-0.383*	-0.296	-0.185
L.R/W	0.288	-0.213	-0.094	-0.064	-0.024	-0.244
T.R/W	0.101	-0.020	0.209	-0.332	-0.249	-0.223
M.B/K	0.104	0.079	-0.158	0.102	0.099	0.176
L.B/K	0.009	-0.261	-0.418*	0.193	0.164	-0.065
T.B/K	0.067	-0.098	-0.328	0.168	0.151	0.069
S.B/N	-0.125	0.201	0.335	-0.177	0.157	0.181
M.B/N	-0.288	0.273	0.194	-0.352*	0.255	0.331
L.B/N	-0.075	0.257	-0.023	-0.278	0.199	0.410*
T.B/N	-0.208	0.318	0.143	-0.365*	0.268	0.431*
LEVEL	0.250	-0.331	-0.036	0.386*	-0.020	-0.452**
CAP.%	0.253	-0.337	-0.061	0.418*	0.013	-0.451**
UPPER	0.379*	0.221	0.219	-0.151	-0.185	0.078
MIDDLE	0.023	-0.206	-0.203	0.395*	0.035	-0.080
LOWER	-0.379*	-0.221	-0.219	0.151	0.185	-0.078
SUPPLY	0.365*	0.123	0.340	0.019	0.057	0.005
HYDRO	0.173	0.139	0.097	0.280	0.091	0.275
TOTAL.FL	0.383*	0.138	0.350*	0.050	0.067	0.036
R.PH	0.310	0.304	0.547**	-0.135	-0.200	0.077
R.TEMP	0.070	-0.113	-0.386*	0.450**	0.212	0.121
R.COLOUR	0.081	-0.614**	-0.611**	0.639**	0.244	-0.414*
R.TURB	-0.405*	-0.209	-0.145	0.044	0.052	-0.151
H.PH	0.094	0.117	0.531**	-0.209	-0.261	-0.179
H.TEMP	0.077	-0.194	-0.436*	0.511**	0.216	0.040
H.COLOUR	0.201	-0.605**	-0.602**	0.758**	0.230	-0.403*
H.TURB	-0.336	-0.248	-0.157	0.127	0.068	-0.177
AT.PRESS	0.351*	-0.170	-0.312	0.196	0.299	-0.140
TEMP.MAX	0.142	-0.005	-0.205	0.326	0.113	0.138
TEMP.MIN	0.098	-0.049	-0.296	0.444*	0.085	0.106
SUN	-0.034	0.215	0.167	-0.215	0.277	0.286
CLOUD	-0.137	0.229	0.094	0.158	-0.020	0.232
RAIN	-0.166	-0.175	-0.174	0.229	-0.110	-0.107
WIND.SP	-0.221	0.226	0.279	-0.007	-0.053	0.137

1985,cont.

	B/K.MN	B/N.NO	B/N.MN	M.R/W	L.R/W	T.R/W
B/N.NO	0.248					
B/N.MN	0.262	0.668**				
M.R/W	-0.017	0.003	0.007			
L.R/W	-0.336	-0.112	-0.080	0.468**		
T.R/W	-0.113	-0.030	-0.018	0.961**	0.693**	
M.B/K	0.171	0.022	0.014	0.022	0.042	0.031
L.B/K	0.252	-0.192	-0.192	-0.191	-0.234	-0.229
T.B/K	0.243	-0.094	-0.098	-0.095	-0.107	-0.111
S.B/N	0.211	0.286	0.226	-0.048	0.024	-0.032
M.B/N	0.322	0.121	0.007	0.128	0.112	0.139
L.B/N	0.262	0.183	-0.055	0.038	-0.017	0.025
T.B/N	0.347	0.216	0.013	0.077	0.051	0.079
LEVEL	-0.400*	-0.146	-0.020	-0.056	0.103	-0.013
CAP.%	-0.389*	-0.166	-0.037	-0.093	0.094	-0.047
UPPER	-0.233	0.215	0.243	0.115	0.159	0.144
MIDDLE	0.185	-0.115	-0.269	0.156	0.082	0.153
LOWER	0.233	-0.215	-0.243	-0.115	-0.159	-0.144
SUPPLY	-0.251	0.156	0.116	0.297	0.261	0.324*
HYDRO	0.479**	0.219	0.060	0.169	-0.058	0.119
TOTAL.FL	-0.196	0.181	0.122	0.327*	0.254	0.346*
R.PH	0.081	0.440*	0.475**	0.364*	0.097	0.327*
R.TEMP	0.030	-0.082	-0.333	-0.065	0.053	-0.037
R.COLOUR	-0.377*	-0.288	-0.266	-0.423**	-0.046	-0.360*
R.TURB	0.197	-0.112	0.002	-0.103	-0.156	-0.133
H.PH	-0.067	0.177	0.395*	0.330*	0.086	0.296
H.TEMP	-0.007	-0.119	-0.349*	-0.093	0.047	-0.061
H.COLOUR	-0.390*	-0.275	-0.278	-0.445**	-0.003	-0.364*
H.TURB	0.173	-0.123	-0.030	-0.116	-0.144	-0.140
AT.PRESS	-0.502**	-0.140	-0.094	0.032	0.252	0.104
TEMP.MAX	0.197	-0.060	-0.216	0.038	0.121	0.068
TEMP.MIN	0.231	-0.139	-0.286	-0.065	0.023	-0.046
SUN	-0.036	0.169	0.020	0.189	0.163	0.205
CLOUD	0.404*	0.059	-0.013	-0.245	-0.339*	-0.305*
RAIN	0.255	-0.121	-0.242	-0.080	-0.134	-0.107
WIND.SP	0.273	-0.079	-0.201	0.051	-0.032	0.032

1985,cont.

	M.B/K	L.B/K	T.B/K	S.B/N	M.B/N	L.B/N
L.B/K	0.532**					
T.B/K	0.879**	0.871**				
S.B/N	0.070	0.091	0.092			
M.B/N	0.464**	0.405**	0.496**	0.517**		
L.B/N	0.548**	0.482**	0.589**	-0.081	0.545**	
T.B/N	0.559**	0.495**	0.603**	0.390*	0.906**	0.832**
LEVEL	-0.553**	-0.498**	-0.601**	0.067	-0.499**	-0.812**
CAP.%	-0.531**	-0.462**	-0.568**	0.067	-0.480**	-0.794**
UPPER	-0.092	-0.312*	-0.229	0.172	-0.126	-0.215
MIDDLE	0.169	0.270	0.250	-0.301	-0.047	0.168
LOWER	0.092	0.312*	0.229	-0.172	0.126	0.215
SUPPLY	-0.390*	-0.607**	-0.568**	0.037	-0.335*	-0.355*
HYDRO	0.204	0.128	0.190	-0.278	0.063	0.310*
TOTAL.FL	-0.362*	-0.593**	-0.544**	-0.007	-0.328*	-0.309*
R.PH	0.091	-0.301	-0.117	0.309*	-0.017	-0.207
R.TEMP	0.289	0.336*	0.357*	-0.450**	-0.047	0.460**
R.COLOUR	-0.353*	-0.040	-0.227	-0.145	-0.454**	-0.464**
R.TURB	-0.063	0.040	-0.014	-0.094	-0.064	-0.084
H.PH	-0.330*	-0.514**	-0.481**	0.327*	-0.134	-0.589**
H.TEMP	0.261	0.330*	0.337*	-0.442**	-0.079	0.409**
H.COLOUR	-0.275	-0.041	-0.182	-0.221	-0.510**	-0.477**
H.TURB	-0.044	0.059	0.008	-0.084	-0.094	-0.131
AT.PRESS	0.130	0.062	0.110	-0.142	-0.044	0.091
TEMP.MAX	0.339*	0.359*	0.399**	-0.317*	0.022	0.499**
TEMP.MIN	0.329*	0.381*	0.405**	-0.314*	0.003	0.403**
SUN	0.251	0.085	0.193	-0.120	0.302	0.479**
CLOUD	-0.012	0.189	0.099	0.124	0.003	-0.045
RAIN	-0.067	0.132	0.036	-0.083	-0.145	-0.075
WIND.SP	-0.031	-0.038	-0.040	-0.010	0.185	-0.004

	T.B/N
LEVEL	-0.704**
CAP.%	-0.684**
UPPER	-0.156
MIDDLE	0.019
LOWER	0.156
SUPPLY	-0.365*
HYDRO	0.160
TOTAL.FL	-0.343*
R.PH	-0.073
R.TEMP	0.160
R.COLOUR	-0.519**
R.TURB	-0.097
H.PH	-0.347*
H.TEMP	0.116
H.COLOUR	-0.568**
H.TURB	-0.137
AT.PRESS	0.005
TEMP.MAX	0.241
TEMP.MIN	0.177
SUN	0.405**
CLOUD	-0.002
RAIN	-0.130
WIND.SP	0.089

1986.

	ANGLERS	DAY	1/2DAY	SEASON	NODATA	D/NIL
DAY	0.964**					
1/2DAY	0.874**	0.719**				
SEASON	0.498**	0.371*	0.528**			
NODATA	0.661**	0.664**	0.513**	0.399*		
D/NIL	0.461**	0.502**	0.295	0.176	0.206	
D/LIMIT	0.803**	0.805**	0.665**	0.244	0.556**	-0.037
S/NIL	0.635**	0.452**	0.828**	0.622**	0.329*	0.249
S/LIMIT	0.820**	0.723**	0.835**	0.526**	0.467**	0.206
CAUGHT	0.902**	0.880**	0.782**	0.366*	0.646**	0.307
TAKEN	0.905**	0.878**	0.797**	0.353*	0.669**	0.146
RETURNED	0.631**	0.622**	0.529**	0.276	0.422**	0.441**
RAINBOW	0.890**	0.872**	0.774**	0.299	0.667**	0.157
BROOK	0.388*	0.329*	0.368*	0.559**	0.235	-0.027
BROWN	0.380*	0.298	0.436**	0.389*	0.206	-0.032
CGHT/AV	0.410*	0.428**	0.323	0.026	0.370*	0.023
TAKEN/AV	0.484**	0.474**	0.438**	0.068	0.419**	-0.330*
RET/AV	0.127	0.157	0.054	-0.022	0.128	0.293
RW/AV	0.427**	0.443**	0.361*	-0.076	0.405*	-0.312
BK/AV	0.210	0.145	0.227	0.530**	0.087	-0.109
BN/AV	0.261	0.170	0.351*	0.371*	0.109	-0.088
R/W.NO	0.550**	0.496**	0.533**	0.370*	0.340*	0.134
R/W.MN	-0.165	-0.088	-0.259	-0.248	0.015	-0.105
B/K.NO	0.046	0.054	0.015	0.048	0.253	-0.037
B/K.MN	0.032	0.035	0.015	0.032	0.230	-0.024
B/N.NO	0.307	0.296	0.231	0.365*	0.294	0.001
B/N.MN	0.315	0.267	0.303	0.436**	0.191	0.052
M.R/W	-0.100	-0.011	-0.204	-0.383*	-0.148	0.314
L.R/W	-0.431**	-0.442**	-0.300	-0.353*	-0.355*	-0.328*
T.R/W	-0.360*	-0.306	-0.344*	-0.503**	-0.342*	-0.005
M.B/K	-0.366*	-0.400*	-0.255	-0.009	-0.214	-0.271
L.B/K	-0.350*	-0.334*	-0.313	-0.172	-0.224	-0.181
T.B/K	-0.370*	-0.388*	-0.282	-0.065	-0.223	-0.248
S.B/N	-0.296	-0.328*	-0.196	-0.011	-0.253	-0.357*
M.B/N	-0.509**	-0.458**	-0.490**	-0.370*	-0.376*	-0.322
L.B/N	-0.545**	-0.525**	-0.465**	-0.343*	-0.301	-0.355*
T.B/N	-0.560**	-0.527**	-0.504**	-0.352*	-0.391*	-0.390*
LEVEL	0.461**	0.412*	0.432**	0.436**	0.352*	0.493**
CAP.%	0.462**	0.417*	0.424**	0.446**	0.355*	0.513**
UPPER	0.521**	0.473**	0.481**	0.445**	0.428**	0.590**
MIDDLE	-0.467**	-0.457**	-0.358*	-0.446**	-0.410*	-0.547**
LOWER	-0.521**	-0.473**	-0.481**	-0.445**	-0.428**	-0.590**
SUPPLY	0.337*	0.338*	0.269	0.171	0.331*	0.187
HYDRO	0.675**	0.535**	0.808**	0.445**	0.283	0.120
TOTAL.FL	0.529**	0.485**	0.509**	0.301	0.397*	0.212
R.PH	0.249	0.197	0.253	0.434**	0.234	-0.006
R.TEMP	0.082	-0.048	0.300	0.216	0.079	-0.362*
R.COLOUR	-0.297	-0.184	-0.406*	-0.500**	-0.290	0.058
R.TURB	-0.488**	-0.398*	-0.524**	-0.534**	-0.364*	-0.010
H.PH	0.209	0.240	0.077	0.269	0.116	0.122
H.TEMP	0.031	-0.080	0.221	0.178	0.002	-0.404*
H.COLOUR	-0.258	-0.203	-0.277	-0.369*	-0.189	0.061
H.TURB	-0.537**	-0.450**	-0.560**	-0.540**	-0.392*	-0.060
AT.PRESS	0.200	0.182	0.201	0.075	0.089	0.154
TEMP.MAX	0.204	0.068	0.376*	0.480**	0.260	-0.162
TEMP.MIN	0.018	-0.139	0.268	0.379*	0.064	-0.106
SUN	0.521**	0.485**	0.472**	0.371*	0.350*	-0.018
CLOUD	-0.030	-0.073	0.023	0.214	-0.127	0.268
RAIN	-0.482**	-0.453**	-0.467**	-0.111	-0.531**	-0.059
			-0.120	-0.034	-0.156	0.117

1986, cont.

	D/LIMIT	S/NIL	S/LIMIT	CAUGHT	TAKEN	RETURNED
S/NIL	0.366*					
S/LIMIT	0.716**	0.491**				
CAUGHT	0.832**	0.467**	0.854**			
TAKEN	0.931**	0.553**	0.769**	0.914**		
RETURNED	0.444**	0.208	0.719**	0.823**	0.523**	
RAINBOW	0.911**	0.530**	0.744**	0.913**	0.991**	0.532**
BROOK	0.411*	0.334*	0.396*	0.316	0.377*	0.137
BROWN	0.451**	0.327*	0.418**	0.279	0.369*	0.069
CGHT/AV	0.532**	0.014	0.543**	0.721**	0.539**	0.762**
TAKEN/AV	0.801**	0.236	0.488**	0.611**	0.776**	0.199
RET/AV	0.025	-0.172	0.290	0.414*	0.054	0.797**
RW/AV	0.736**	0.156	0.407*	0.584**	0.732**	0.203
BK/AV	0.264	0.263	0.267	0.153	0.215	0.022
BN/AV	0.339*	0.285	0.346*	0.174	0.256	0.006
R/W.NO	0.508**	0.308	0.708**	0.629**	0.499**	0.624**
R/W.MN	-0.043	-0.275	-0.229	-0.152	-0.116	-0.157
B/K.NO	0.074	-0.139	0.101	0.075	0.067	0.063
B/K.MN	0.056	-0.142	0.091	0.058	0.049	0.053
B/N.NO	0.305	0.092	0.397*	0.422**	0.307	0.457**
B/N.MN	0.245	0.307	0.289	0.258	0.262	0.176
M.R/W	-0.188	-0.241	-0.148	-0.052	-0.183	0.148
L.R/W	-0.341*	-0.222	-0.349*	-0.409*	-0.371*	-0.341*
T.R/W	-0.360*	-0.317	-0.338*	-0.312	-0.377*	-0.128
M.B/K	-0.283	-0.136	-0.251	-0.408*	-0.328*	-0.399*
L.B/K	-0.274	-0.243	-0.304	-0.369*	-0.301	-0.355*
T.B/K	-0.287	-0.176	-0.276	-0.406*	-0.328*	-0.395*
S.B/N	-0.147	-0.140	-0.021	-0.253	-0.237	-0.201
M.B/N	-0.358*	-0.440**	-0.408*	-0.469**	-0.429**	-0.385*
L.B/N	-0.402*	-0.390*	-0.445**	-0.520**	-0.458**	-0.452**
T.B/N	-0.388*	-0.438**	-0.410*	-0.518**	-0.470**	-0.432**
LEVEL	0.120	0.498**	0.337*	0.400*	0.286	0.441**
CAP.%	0.099	0.499**	0.329*	0.391*	0.274	0.438**
UPPER	0.113	0.570**	0.340*	0.417*	0.322	0.426**
MIDDLE	-0.091	-0.496**	-0.255	-0.399*	-0.299	-0.420**
LOWER	-0.113	-0.570**	-0.340*	-0.417*	-0.322	-0.426**
SUPPLY	0.293	0.096	0.401*	0.435**	0.324	0.462**
HYDRO	0.551**	0.707**	0.634**	0.541**	0.614**	0.277
TOTAL.FL	0.448**	0.316	0.575**	0.577**	0.497**	0.517**
R.PH	0.122	0.376*	0.147	0.030	0.212	-0.235
R.TEMP	0.243	0.324	0.172	-0.024	0.203	-0.336*
R.COLOUR	-0.187	-0.558**	-0.200	-0.072	-0.283	0.247
R.TURB	-0.451**	-0.508**	-0.427**	-0.332*	-0.483**	-0.022
H.PH	0.035	0.116	0.080	0.114	0.097	0.103
H.TEMP	0.230	0.216	0.137	-0.071	0.157	-0.370*
H.COLOUR	-0.175	-0.385*	-0.114	-0.048	-0.241	0.238
H.TURB	-0.479**	-0.525**	-0.466**	-0.378*	-0.516**	-0.074
AT.PRESS	0.213	0.138	0.112	0.127	0.178	0.017
TEMP.MAX	0.213	0.428**	0.246	0.060	0.215	-0.176
TEMP.MIN	-0.061	0.411*	0.076	-0.129	-0.002	-0.269
SUN	0.544**	0.403*	0.383*	0.429**	0.517**	0.178
CLOUD	-0.217	0.181	-0.043	-0.122	-0.129	-0.075
RAIN	-0.518**	-0.267	-0.401*	-0.442**	-0.508**	-0.218
WIND.SP	-0.390*	0.035	-0.266	-0.253	-0.295	-0.119

1986, cont.

	RAINBOW	BROOK	BROWN	CGHT/AV	TAKEN/AV	RET/AV
BROOK	0.261					
BROWN	0.251	0.795**				
CGHT/AV	0.545**	0.155	0.103			
TAKEN/AV	0.765**	0.311	0.325*	0.606**		
RET/AV	0.071	-0.056	-0.132	0.770**	-0.042	
RW/AV	0.759**	0.042	0.053	0.603**	0.955**	-0.009
BK/AV	0.097	0.960**	0.757**	0.094	0.251	-0.084
BN/AV	0.137	0.769**	0.971**	0.085	0.287	-0.123
R/W.NO	0.493**	0.133	0.253	0.457**	0.296	0.336*
R/W.MN	-0.101	-0.105	-0.169	-0.029	0.065	-0.089
B/K.NO	0.077	-0.100	0.006	0.108	0.096	0.058
B/K.MN	0.057	-0.088	0.014	0.097	0.082	0.056
B/N.NO	0.275	0.419**	0.210	0.377*	0.216	0.300
B/N.MN	0.217	0.508**	0.276	0.116	0.172	0.008
M.R/W	-0.118	-0.515**	-0.472**	0.017	-0.228	0.204
L.R/W	-0.349*	-0.233	-0.295	-0.264	-0.104	-0.248
T.R/W	-0.317	-0.514**	-0.525**	-0.167	-0.228	-0.027
M.B/K	-0.345*	0.063	-0.048	-0.331*	-0.074	-0.356*
L.B/K	-0.291	-0.112	-0.204	-0.316	-0.080	-0.333*
T.B/K	-0.336*	0.004	-0.103	-0.335*	-0.078	-0.358*
S.B/N	-0.254	-0.038	0.105	-0.058	-0.060	-0.024
M.B/N	-0.398*	-0.326*	-0.365*	-0.238	-0.075	-0.239
L.B/N	-0.435**	-0.268	-0.315	-0.277	-0.104	-0.265
T.B/N	-0.445**	-0.306	-0.318	-0.253	-0.093	-0.243
LEVEL	0.284	0.114	0.091	0.144	-0.124	0.280
CAP.%	0.278	0.088	0.042	0.115	-0.142	0.258
UPPER	0.328*	0.058	0.067	0.098	-0.086	0.193
MIDDLE	-0.324	-0.006	0.131	-0.128	0.070	-0.218
LOWER	-0.328*	-0.058	-0.067	-0.098	0.086	-0.193
SUPPLY	0.326*	0.081	0.098	0.396*	0.099	0.418**
HYDRO	0.563**	0.550**	0.517**	0.136	0.350*	-0.110
TOTAL.FL	0.483**	0.251	0.257	0.411*	0.204	0.352*
R.PH	0.165	0.418**	0.344*	-0.280	0.112	-0.441**
R.TEMP	0.135	0.479**	0.556**	-0.134	0.361*	-0.457**
R.COLOUR	-0.245	-0.390*	-0.305	0.298	-0.171	0.512**
R.TURB	-0.432**	-0.506**	-0.469**	0.076	-0.263	0.306
H.PH	0.119	-0.044	-0.181	-0.137	-0.123	-0.073
H.TEMP	0.086	0.497**	0.545**	-0.147	0.350*	-0.466**
H.COLOUR	-0.228	-0.260	-0.082	0.321	-0.128	0.506**
H.TURB	-0.467**	-0.488**	-0.488**	0.024	-0.271	0.248
AT.PRESS	0.157	0.161	0.230	0.079	0.139	-0.012
TEMP.MAX	0.149	0.474**	0.542**	-0.143	0.191	-0.333*
TEMP.MIN	-0.064	0.423**	0.410*	-0.222	0.021	-0.295
SUN	0.493**	0.324	0.316	0.137	0.336*	-0.098
CLOUD	-0.172	0.285	0.199	-0.076	-0.099	-0.016
RAIN	-0.481**	-0.282	-0.389*	-0.193	-0.333*	0.025
WIND.SP	-0.294	-0.039	-0.159	-0.159	-0.318	0.056

1986, cont.

	RW/AV	BK/AV	BN/AV	R/W.NO	R/W.MN	B/K.NO
BK/AV	-0.030					
BN/AV	0.004	0.784**				
R/W.NO	0.253	0.099	0.234			
R/W.MN	0.114	-0.066	-0.205	-0.131		
B/K.NO	0.114	-0.103	0.017	0.058	-0.081	
B/K.MN	0.095	-0.088	0.030	0.027	-0.077	0.990**
B/N.NO	0.156	0.293	0.136	0.185	-0.157	-0.125
B/N.MN	0.071	0.412*	0.254	0.112	-0.276	-0.186
M.R/W	-0.081	-0.507**	-0.445**	-0.088	0.118	-0.082
L.R/W	-0.040	-0.166	-0.251	-0.240	0.246	-0.092
T.R/W	-0.083	-0.463**	-0.477**	-0.223	0.248	-0.119
M.B/K	-0.117	0.214	0.031	-0.163	0.569**	-0.008
L.B/K	-0.054	0.004	-0.174	-0.197	0.706**	-0.103
T.B/K	-0.098	0.148	-0.038	-0.179	0.631**	-0.041
S.B/N	-0.102	0.030	0.203	0.006	-0.085	-0.163
M.B/N	0.012	-0.231	-0.318	-0.384*	0.569**	-0.133
L.B/N	-0.038	-0.166	-0.263	-0.379*	0.595**	0.014
T.B/N	-0.023	-0.199	-0.252	-0.369*	0.542**	-0.116
LEVEL	-0.139	0.008	0.047	0.333*	-0.550**	0.087
CAP.%	-0.145	-0.019	-0.005	0.331*	-0.488**	0.079
UPPER	-0.082	-0.053	0.002	0.332*	-0.250	-0.027
MIDDLE	0.030	0.090	0.170	-0.273	0.219	-0.000
LOWER	0.082	0.053	-0.002	-0.332*	0.250	0.027
SUPPLY	0.086	0.015	0.085	0.227	-0.450**	0.178
HYDRO	0.210	0.460**	0.480**	0.446**	-0.270	-0.095
TOTAL.FL	0.148	0.161	0.233	0.354*	-0.503**	0.135
R.PH	0.015	0.331*	0.286	-0.086	0.134	-0.058
R.TEMP	0.195	0.524**	0.578**	-0.056	0.077	-0.057
R.COLOUR	-0.085	-0.325*	-0.246	0.074	-0.040	0.094
R.TURB	-0.127	-0.465**	-0.430**	-0.209	0.152	-0.031
H.PH	-0.057	-0.149	-0.277	0.051	0.222	-0.133
H.TEMP	0.180	0.553**	0.575**	-0.083	0.139	-0.075
H.COLOUR	-0.105	-0.178	-0.005	0.155	-0.169	0.058
H.TURB	-0.139	-0.427**	-0.442**	-0.213	0.240	-0.058
AT.PRESS	0.077	0.190	0.228	-0.024	0.306	-0.124
TEMP.MAX	0.029	0.488**	0.542**	0.043	-0.019	0.052
TEMP.MIN	-0.130	0.465**	0.455**	-0.175	-0.165	-0.032
SUN	0.266	0.261	0.255	0.371*	0.020	0.119
CLOUD	-0.206	0.337*	0.290	-0.214	-0.340*	-0.012
RAIN	-0.253	-0.214	-0.358*	-0.261	-0.026	-0.066
WIND.SP	-0.298	-0.068	-0.139	-0.222	-0.413*	-0.152

1986, cont.

	B/K.MN	B/N.NO	B/N.MN	M.R/W	L.R/W	T.R/W
B/N.NO	-0.124					
B/N.MN	-0.184	0.703**				
M.R/W	-0.071	-0.118	-0.185			
L.R/W	-0.101	-0.211	-0.206	0.292*		
T.R/W	-0.117	-0.224	-0.267	0.822**	0.784**	
M.B/K	0.014	-0.167	-0.126	-0.089	0.363**	0.159
L.B/K	-0.102	-0.143	-0.185	0.006	0.377**	0.228
T.B/K	-0.025	-0.163	-0.149	-0.060	0.377**	0.186
S.B/N	-0.156	-0.085	-0.028	-0.067	0.050	-0.014
M.B/N	-0.129	-0.100	-0.179	0.290*	0.597**	0.543**
L.B/N	0.035	-0.231	-0.274	0.043	0.594**	0.382**
T.B/N	-0.106	-0.152	-0.207	0.194	0.579**	0.471**
LEVEL	0.064	0.285	0.319	0.113	-0.398**	-0.164
CAP.%	0.052	0.297	0.331*	0.144	-0.370**	-0.127
UPPER	-0.060	0.227	0.220	0.179	-0.321*	-0.075
MIDDLE	0.033	-0.283	-0.303	-0.286*	0.250	-0.037
LOWER	0.060	-0.227	-0.220	-0.179	0.321*	0.075
SUPPLY	0.161	0.296	0.176	0.084	-0.515**	-0.252
HYDRO	-0.064	0.147	0.393*	-0.286*	-0.280*	-0.352*
TOTAL.FL	0.129	0.322	0.289	-0.079	-0.537**	-0.371**
R.PH	-0.082	0.227	0.328*	-0.346*	-0.063	-0.262
R.TEMP	-0.021	-0.106	0.058	-0.533**	0.031	-0.327*
R.COLOUR	0.098	-0.181	-0.359*	0.386**	0.039	0.274*
R.TURB	-0.041	-0.197	-0.305	0.502**	0.367**	0.544**
H.PH	-0.187	0.221	0.188	0.071	-0.020	0.034
H.TEMP	-0.040	-0.130	0.060	-0.535**	0.038	-0.324*
H.COLOUR	0.064	-0.219	-0.409*	0.303*	0.021	0.209
H.TURB	-0.068	-0.213	-0.306	0.481**	0.418**	0.561**
AT.PRESS	-0.107	-0.112	-0.010	0.015	-0.094	-0.046
TEMP.MAX	0.077	0.040	0.112	-0.527**	-0.111	-0.408**
TEMP.MIN	0.009	0.027	0.167	-0.471**	-0.003	-0.308*
SUN	0.122	-0.035	0.086	-0.308*	-0.133	-0.279*
CLOUD	0.017	0.134	0.302	0.121	-0.012	0.071
RAIN	-0.053	-0.010	-0.009	-0.069	0.057	-0.011
WIND.SP	-0.145	0.105	0.220	0.131	0.091	0.139

1986, cont.

	M.B/K	L.B/K	T.B/K	S.B/N	M.B/N	L.B/N
L.B/K	0.885**					
T.B/K	0.988**	0.946**				
S.B/N	0.213	0.019	0.154			
M.B/N	0.649**	0.683**	0.677**	0.355**		
L.B/N	0.783**	0.720**	0.782**	0.251	0.825**	
T.B/N	0.699**	0.668**	0.707**	0.498**	0.973**	0.887**
LEVEL	-0.690**	-0.665**	-0.700**	-0.272	-0.674**	-0.765**
CAP.%	-0.650**	-0.601**	-0.651**	-0.298*	-0.622**	-0.725**
UPPER	-0.533**	-0.428**	-0.512**	-0.341*	-0.505**	-0.615**
MIDDLE	0.447**	0.382**	0.437**	0.309*	0.398**	0.546**
LOWER	0.533**	0.428**	0.512**	0.341*	0.505**	0.615**
SUPPLY	-0.576**	-0.585**	-0.594**	-0.092	-0.535**	-0.592**
HYDRO	-0.232	-0.241	-0.241	-0.142	-0.403**	-0.303*
TOTAL.FL	-0.560**	-0.571**	-0.578**	-0.142	-0.614**	-0.608**
R.PH	0.221	0.180	0.213	0.115	0.091	0.109
R.TEMP	0.516**	0.295*	0.456**	0.323*	0.179	0.316*
R.COLOUR	-0.350*	-0.204	-0.310*	-0.225	-0.205	-0.219
R.TURB	-0.078	0.040	-0.041	0.051	0.320*	0.273*
H.PH	-0.134	0.049	-0.077	-0.076	0.103	-0.065
H.TEMP	0.550**	0.338*	0.494**	0.362**	0.240	0.360**
H.COLOUR	-0.309*	-0.221	-0.288*	-0.199	-0.277*	-0.236
H.TURB	0.034	0.165	0.078	0.057	0.387**	0.338*
AT.PRESS	0.157	0.151	0.159	0.045	0.058	-0.019
TEMP.MAX	0.419**	0.192	0.354**	0.299*	0.103	0.215
TEMP.MIN	0.441**	0.195	0.371**	0.272	0.111	0.270
SUN	0.060	-0.081	0.015	0.019	-0.110	-0.128
CLOUD	0.075	-0.029	0.042	-0.047	-0.061	-0.044
RAIN	-0.033	0.030	-0.013	0.063	0.168	0.203
WIND.S	-0.332*	-0.320*	-0.337*	-0.171	-0.169	-0.147

	T.B/N
LEVEL	-0.722**
CAP.%	-0.681**
UPPER	-0.579**
MIDDLE	0.482**
LOWER	0.579**
SUPPLY	-0.545**
HYDRO	-0.384**
TOTAL.FL	-0.613**
R.PH	0.114
R.TEMP	0.271
R.COLOUR	-0.243
R.TURB	0.302*
H.PH	0.036
H.TEMP	0.332*
H.COLOUR	-0.291*
H.TURB	0.367**
AT.PRESS	0.042
TEMP.MAX	0.187
TEMP.MIN	0.203
SUN	-0.107
CLOUD	-0.062
RAIN	0.183
WIND.SP	-0.188

1987.

	ANGLERS	DAY	1/2DAY	SEASON	NODATA	D/NIL
DAY	0.956**					
1/2DAY	0.898**	0.733**				
SEASON	0.357*	0.182	0.463**			
NODATA	0.384*	0.473**	0.197	-0.098		
D/NIL	0.719**	0.643**	0.694**	0.439**	0.215	
D/LIMIT	0.580**	0.703**	0.316	-0.141	0.305	-0.020
S/NIL	0.784**	0.619**	0.905**	0.442**	0.066	0.811**
S/LIMIT	0.473**	0.401*	0.486**	0.358*	0.192	-0.015
CAUGHT	0.536**	0.649**	0.296	-0.149	0.283	-0.072
TAKEN	0.669**	0.766**	0.427**	-0.065	0.304	0.104
RETURNED	0.063	0.142	-0.050	-0.196	0.106	-0.296
RAINBOW	0.629**	0.732**	0.389*	-0.100	0.326*	0.050
BROOK	0.572**	0.520**	0.559**	0.201	0.165	0.569**
BROWN	0.252	0.212	0.251	0.244	-0.168	0.367*
CGHT/AV	-0.201	-0.044	-0.381*	-0.434**	0.041	-0.633**
TAKEN/AV	-0.089	0.083	-0.311	-0.420**	0.066	-0.585**
RET/AV	-0.227	-0.130	-0.319	-0.313	0.009	-0.476**
RW/AV	-0.103	0.062	-0.310	-0.427**	0.108	-0.594**
BK/AV	0.516**	0.477**	0.489**	0.203	0.199	0.499**
BN/AV	0.074	0.050	0.082	0.166	-0.207	0.213
R/W.NO	0.604**	0.618**	0.492**	0.081	0.351*	0.216
R/W.MN	0.035	0.042	0.013	0.032	-0.253	-0.040
B/N.NO	0.271	0.365*	0.096	-0.130	0.048	0.017
B/N.MN	0.123	0.175	0.014	0.023	0.015	0.052
M.R/W	0.226	0.276	0.116	-0.025	0.461**	0.103
L.R/W	0.013	-0.009	0.037	0.083	0.101	-0.176
T.R/W	0.091	0.090	0.073	0.062	0.249	-0.114
S.B/N	0.439**	0.496**	0.280	0.047	0.534**	0.513**
M.B/N	0.529**	0.568**	0.398*	-0.011	0.332*	0.631**
L.B/N	0.210	0.343*	-0.030	-0.099	0.274	-0.049
T.B/N	0.569**	0.640**	0.377*	-0.010	0.469**	0.620**
LEVEL	0.142	0.155	0.112	-0.062	0.165	0.421**
CAP.%	0.155	0.169	0.122	-0.067	0.178	0.438**
UPPER	-0.038	-0.019	-0.047	-0.122	0.049	0.382*
MIDDLE	-0.208	-0.197	-0.204	0.020	-0.139	-0.499**
LOWER	-0.005	-0.003	-0.024	0.107	-0.083	-0.386*
SUPPLY	0.202	0.250	0.146	-0.336*	0.250	0.194
HYDRO	0.040	-0.041	0.146	0.191	-0.158	0.036
TOTAL.FL	0.191	0.205	0.178	-0.229	0.165	0.183
R.PH	-0.023	-0.112	0.127	0.040	-0.336*	-0.115
R.TEMP	0.063	0.014	0.094	0.312	-0.167	-0.184
R.COLOUR	-0.341*	-0.211	-0.500**	-0.152	-0.077	-0.295
R.TURB	-0.328*	-0.240	-0.409*	-0.211	-0.059	-0.087
H.PH	0.010	0.040	-0.034	-0.070	-0.016	0.027
H.TEMP	-0.008	-0.035	-0.002	0.275	-0.199	-0.258
H.COLOUR	-0.253	-0.144	-0.403*	-0.042	-0.076	-0.322
H.TURB	-0.210	-0.132	-0.301	-0.107	-0.051	-0.118
AT.PRESS	0.409*	0.403*	0.316	0.349*	0.078	0.347*
TEMP.MAX	0.416*	0.306	0.474**	0.513**	0.015	0.223
TEMP.MIN	0.141	0.086	0.170	0.324	-0.017	-0.040
SUN	0.602**	0.498**	0.632**	0.494**	0.110	0.468**
CLOUD	-0.539**	-0.425**	-0.598**	-0.467**	-0.033	-0.423**
RAIN	-0.503**	-0.494**	-0.399*	-0.366*	-0.127	-0.295
WIND.SP	-0.521**	-0.518**	-0.436**	-0.168	-0.228	-0.227

1987, cont.

	D/LIMIT	S/NIL	S/LIMIT	CAUGHT	TAKEN	RETURNED
S/NIL	0.078					
S/LIMIT	0.543**	0.128				
CAUGHT	0.922**	0.033	0.558**			
TAKEN	0.972**	0.187	0.577**	0.868**		
RETURNED	0.372*	-0.213	0.242	0.680**	0.226	
RAINBOW	0.968**	0.147	0.570**	0.866**	0.990**	0.236
BROOK	0.053	0.620**	0.015	0.063	0.137	-0.079
BROWN	0.007	0.268	0.038	-0.004	0.045	-0.075
CGHT/AV	0.496**	-0.537**	0.170	0.657**	0.342*	0.785**
TAKEN/AV	0.680**	-0.499**	0.293	0.622**	0.619**	0.305
RET/AV	0.201	-0.403*	0.022	0.484**	0.021	0.919**
RW/AV	0.649**	-0.487**	0.278	0.596**	0.586**	0.302
BK/AV	0.071	0.497**	0.066	0.078	0.142	-0.056
BN/AV	-0.090	0.101	-0.033	-0.094	-0.065	-0.087
R/W.NO	0.608**	0.336*	0.483**	0.660**	0.589**	0.424**
R/W.MN	0.113	-0.026	-0.005	0.060	0.084	-0.007
B/N.NO	0.606**	-0.038	0.229	0.460**	0.662**	-0.076
B/N.MN	0.252	-0.084	0.124	0.202	0.302	-0.049
M.R/W	0.251	-0.057	0.282	0.280	0.284	0.130
L.R/W	0.147	-0.070	0.150	0.215	0.091	0.288
T.R/W	0.214	-0.080	0.228	0.283	0.178	0.292
S.B/N	0.146	0.329*	-0.058	0.122	0.140	0.031
M.B/N	0.295	0.444**	0.008	0.194	0.334*	-0.113
L.B/N	0.401*	-0.095	0.064	0.436**	0.379*	0.296
T.B/N	0.335*	0.416*	-0.002	0.260	0.357*	-0.018
LEVEL	-0.098	0.309	-0.283	-0.120	-0.067	-0.137
CAP.%	-0.098	0.320	-0.285	-0.118	-0.068	-0.130
UPPER	-0.290	0.195	-0.436**	-0.247	-0.281	-0.070
MIDDLE	0.122	-0.381*	0.277	0.042	0.143	-0.129
LOWER	0.263	-0.242	0.388*	0.235	0.236	0.112
SUPPLY	0.228	0.171	-0.008	0.331*	0.181	0.383*
HYDRO	-0.017	0.114	0.088	-0.055	-0.000	-0.109
TOTAL.FL	0.194	0.190	0.024	0.272	0.159	0.298
R.PH	0.017	0.085	0.128	-0.111	0.041	-0.279
R.TEMP	0.122	-0.075	0.330*	0.035	0.153	-0.158
R.COLOUR	-0.034	-0.461**	-0.122	-0.055	-0.104	0.045
R.TURB	-0.205	-0.277	-0.374*	-0.132	-0.267	0.137
H.PH	0.070	0.011	-0.076	0.019	0.056	-0.045
H.TEMP	0.119	-0.169	0.312	0.039	0.139	-0.129
H.COLOUR	0.048	-0.425**	0.017	0.028	-0.016	0.079
H.TURB	-0.085	-0.237	-0.204	-0.008	-0.142	0.194
AT.PRESS	0.169	0.358*	0.035	0.151	0.155	0.067
TEMP.MAX	0.101	0.314	0.402*	0.060	0.178	-0.146
TEMP.MIN	0.051	0.004	0.305	-0.003	0.106	-0.161
SUN	0.169	0.536**	0.451**	0.209	0.209	0.102
CLOUD	-0.150	-0.527**	-0.406*	-0.241	-0.196	-0.183
RAIN	-0.359*	-0.352*	-0.253	-0.375*	-0.343*	-0.229
WIND.SP	-0.448**	-0.373*	-0.145	-0.378*	-0.468**	-0.050

1987,cont.

	RAINBOW	BROOK	BROWN	CGHT/AV	TAKEN/AV	RET/AV
BROOK	0.130					
BROWN	-0.096	0.027				
CGHT/AV	0.374*	-0.253	-0.228			
TAKEN/AV	0.650**	-0.256	-0.223	0.774**		
RET/AV	0.045	-0.173	-0.162	0.870**	0.362*	
RW/AV	0.646**	-0.232	-0.431**	0.765**	0.974**	0.368*
BK/AV	0.135	0.939**	0.027	-0.212	-0.217	-0.144
BN/AV	-0.200	-0.048	0.964**	-0.206	-0.209	-0.141
R/W.NO	0.592**	0.348*	-0.043	0.294	0.207	0.272
R/W.MN	0.073	-0.061	0.076	-0.051	-0.030	-0.053
B/N.NO	0.659**	-0.094	0.009	0.148	0.461**	-0.142
B/N.MN	0.304	-0.097	-0.020	0.039	0.185	-0.087
M.R/W	0.257	-0.051	0.183	0.059	0.085	0.020
L.R/W	0.096	-0.210	-0.034	0.193	0.057	0.240
T.R/W	0.173	-0.198	0.036	0.186	0.079	0.213
S.B/N	0.115	0.489**	0.164	-0.095	-0.170	-0.008
M.B/N	0.263	0.275	0.487**	-0.222	-0.143	-0.216
L.B/N	0.392*	-0.139	-0.098	0.215	0.210	0.154
T.B/N	0.300	0.339*	0.390*	-0.154	-0.123	-0.132
LEVEL	-0.098	0.241	0.215	-0.224	-0.262	-0.126
CAP.%	-0.099	0.261	0.212	-0.229	-0.277	-0.122
UPPER	-0.306	0.123	0.178	-0.220	-0.357*	-0.046
MIDDLE	0.189	-0.212	-0.330*	0.160	0.434**	-0.102
LOWER	0.264	-0.126	-0.199	0.266	0.361*	0.111
SUPPLY	0.179	0.086	0.012	0.183	-0.078	0.330*
HYDRO	0.001	-0.189	-0.001	-0.263	-0.267	-0.180
TOTAL.FL	0.157	0.010	0.011	0.070	-0.161	0.228
R.PH	0.028	0.002	0.095	-0.108	0.101	-0.238
R.TEMP	0.157	-0.152	-0.027	-0.078	0.137	-0.222
R.COLOUR	-0.056	-0.178	-0.334*	0.293	0.304	0.195
R.TURB	-0.221	-0.161	-0.317	0.152	-0.067	0.277
H.PH	0.062	0.073	-0.044	0.045	0.114	-0.021
H.TEMP	0.151	-0.176	-0.090	-0.022	0.186	-0.177
H.COLOUR	0.029	-0.262	-0.311	0.290	0.322	0.176
H.TURB	-0.095	-0.178	-0.324	0.160	-0.031	0.259
AT.PRESS	0.115	0.210	0.270	-0.130	-0.180	-0.051
TEMP.MAX	0.143	0.190	0.236	-0.288	-0.157	-0.302
TEMP.MIN	0.105	0.038	0.001	-0.184	-0.022	-0.253
SUN	0.147	0.241	0.428**	-0.214	-0.271	-0.104
CLOUD	-0.135	-0.163	-0.422**	0.124	0.206	0.022
RAIN	-0.312	-0.245	-0.207	-0.022	0.049	-0.070
WIND.SP	-0.437**	-0.267	-0.203	-0.024	-0.153	0.083

1987, cont.

	RW/AV	BK/AV	BN/AV	R/W.NO	R/W.MN	B/N.NO
BK/AV	-0.196					
BN/AV	-0.426**	-0.045				
R/W.NO	0.218	0.331*	-0.126			
R/W.MN	-0.048	0.018	0.086	-0.132		
B/N.NO	0.435**	-0.100	-0.036	0.279	0.093	
B/N.MN	0.180	-0.104	-0.037	0.155	0.066	0.846**
M.R/W	0.042	-0.019	0.160	0.118	-0.114	0.124
L.R/W	0.061	-0.224	-0.031	0.041	-0.189	-0.064
T.R/W	0.067	-0.199	0.030	0.077	-0.202	-0.011
S.B/N	-0.185	0.515**	0.108	0.429**	-0.125	-0.084
M.B/N	-0.224	0.285	0.385*	0.345*	-0.043	0.228
L.B/N	0.216	-0.214	-0.087	0.127	0.027	0.357*
T.B/N	-0.186	0.341*	0.300	0.417*	-0.069	0.202
LEVEL	-0.281	0.186	0.161	0.238	-0.400*	-0.037
CAP.%	-0.294	0.204	0.157	0.238	-0.390*	-0.048
UPPER	-0.362*	0.060	0.139	0.020	-0.291	-0.239
MIDDLE	0.468**	-0.149	-0.283	-0.305	0.191	0.188
LOWER	0.372*	-0.065	-0.161	-0.060	0.320	0.183
SUPPLY	-0.068	0.039	-0.018	0.515**	-0.344*	0.113
HYDRO	-0.252	-0.141	0.025	-0.102	0.169	0.128
TOTAL.FL	-0.147	-0.015	-0.007	0.417*	-0.244	0.143
R.PH	0.070	0.023	0.099	-0.066	0.204	-0.065
R.TEMP	0.130	-0.120	-0.011	-0.264	0.451**	0.154
R.COLOUR	0.358*	-0.191	-0.324	-0.287	-0.047	-0.042
R.TURB	0.010	-0.167	-0.305	-0.215	-0.218	-0.083
H.PH	0.115	0.045	-0.044	0.133	-0.142	-0.094
H.TEMP	0.186	-0.138	-0.056	-0.274	0.446**	0.148
H.COLOUR	0.370*	-0.273	-0.302	-0.289	0.005	-0.002
H.TURB	0.045	-0.173	-0.312	-0.185	-0.174	-0.042
AT.PRESS	-0.211	0.212	0.188	0.203	0.074	0.070
TEMP.MAX	-0.194	0.191	0.204	-0.088	0.404*	0.100
TEMP.MIN	-0.029	0.082	0.035	-0.252	0.417*	0.106
SUN	-0.323	0.213	0.305	0.387*	0.126	-0.022
CLOUD	0.259	-0.117	-0.291	-0.333*	0.041	0.019
RAIN	0.065	-0.231	-0.081	-0.442**	0.047	-0.120
WIND.SP	-0.109	-0.227	-0.129	-0.213	-0.107	-0.108

1987, cont.

	B/N.MN	M.R/W	L.R/W	T.R/W	S.B/N	M.B/N
M.R/W	-0.021					
L.R/W	-0.128	0.191				
T.R/W	-0.117	0.560**	0.920**			
S.B/N	-0.112	0.208	-0.011	0.074		
M.B/N	0.034	0.325*	0.135	0.244	0.680**	
L.B/N	0.323	0.136	0.319*	0.324*	0.030	0.151
T.B/N	0.045	0.324*	0.152	0.258	0.809**	0.960**
LEVEL	-0.113	0.093	-0.168	-0.105	0.338*	0.292*
CAP.%	-0.124	0.101	-0.165	-0.099	0.354**	0.295*
UPPER	-0.248	0.078	-0.205	-0.142	0.251	0.175
MIDDLE	0.195	0.004	0.144	0.124	-0.392**	-0.274*
LOWER	0.219	-0.115	0.188	0.113	-0.251	-0.205
SUPPLY	-0.008	-0.045	-0.064	-0.072	0.114	0.040
HYDRO	0.133	-0.225	0.002	-0.088	-0.129	-0.126
TOTAL.FL	0.039	-0.122	-0.052	-0.093	0.045	-0.014
R.PH	-0.247	0.060	0.055	0.071	-0.088	0.158
R.TEMP	0.206	-0.030	0.163	0.125	-0.192	-0.047
R.COLOUR	0.060	-0.101	0.021	-0.023	-0.176	-0.271
R.TURB	0.019	-0.001	0.101	0.085	0.037	-0.109
H.PH	-0.213	0.149	0.079	0.126	0.117	0.224
H.TEMP	0.208	-0.050	0.150	0.106	-0.213	-0.098
H.COLOUR	0.102	-0.114	0.142	0.075	-0.224	-0.300*
H.TURB	0.049	-0.024	0.209	0.167	0.003	-0.158
AT.PRESS	0.136	-0.047	-0.164	-0.157	0.145	0.053
TEMP.MAX	0.190	0.041	0.168	0.158	0.055	0.158
TEMP.MIN	0.179	0.031	0.176	0.161	-0.043	0.024
SUN	0.059	0.057	-0.006	0.018	0.226	0.355**
CLOUD	-0.041	-0.084	0.024	-0.013	-0.036	-0.217
RAIN	-0.094	0.003	-0.066	-0.054	-0.161	-0.130
WIND.SP	0.108	-0.166	-0.031	-0.093	-0.206	-0.213

	L.B/N	T.B/N
T.B/N	0.301*	
LEVEL	-0.269	0.268
CAP.%	-0.275*	0.273*
UPPER	-0.369**	0.138
MIDDLE	0.133	-0.296*
LOWER	0.355**	-0.161
SUPPLY	-0.095	0.048
HYDRO	0.044	-0.123
TOTAL.FL	-0.061	-0.007
R.PH	-0.203	0.049
R.TEMP	0.315*	-0.037
R.COLOUR	0.098	-0.232
R.TURB	0.138	-0.041
H.PH	-0.139	0.172
H.TEMP	0.326*	-0.078
H.COLOUR	0.266	-0.238
H.TURB	0.301*	-0.057
AT.PRESS	-0.059	0.073
TEMP.MAX	0.329*	0.191
TEMP.MIN	0.315*	0.061
SUN	0.261	0.374**
CLOUD	0.010	-0.166
RAIN	-0.083	-0.159
WIND.SP	-0.019	-0.222

Table XLIX.

Fishery and fish plate impingement correlation matrix for the combined study period, 1985 to 1987.

Fishery data d.f.	105
Impingement data d.f.	146

1985 to 1987.

	ANGLERS	DAY	1/2DAY	SEASON	NODATA	D/NIL
DAY	0.949**					
1/2DAY	0.846**	0.642**				
SEASON	0.375**	0.247*	0.363**			
NODATA	0.496**	0.529**	0.289**	0.327**		
D/NIL	0.438**	0.446**	0.307**	0.218*	0.199*	
D/LIMIT	0.723**	0.778**	0.480**	0.070	0.358**	-0.124
S/NIL	0.620**	0.436**	0.761**	0.467**	0.149	0.526**
S/LIMIT	0.658**	0.507**	0.760**	0.307**	0.203*	-0.073
CAUGHT	0.779**	0.775**	0.621**	0.150	0.417**	-0.021
TAKEN	0.834**	0.835**	0.654**	0.156	0.410**	0.009
RETURNED	0.477**	0.466**	0.394**	0.098	0.304**	-0.054
RAINBOW	0.803**	0.817**	0.606**	0.155	0.423**	0.039
BROOK	0.327**	0.252**	0.354**	0.282**	0.211*	-0.105
BROWN	0.337**	0.306**	0.340**	-0.043	0.012	-0.104
CGHT/AV	0.124	0.182	0.032	-0.202*	0.083	-0.463**
TAKEN/AV	0.188	0.256**	0.069	-0.214*	0.056	-0.540**
RET/AV	0.032	0.062	-0.008	-0.123	0.076	-0.244*
RW/AV	0.099	0.187	-0.041	-0.213*	0.055	-0.469**
BK/AV	0.217*	0.133	0.287**	0.249**	0.144	-0.136
BN/AV	0.176	0.147	0.215*	-0.097	-0.055	-0.150
R/W.NO	0.331**	0.315**	0.263**	0.210*	0.235*	0.108
R/W.MN	-0.155	-0.138	-0.137	-0.120	-0.236*	-0.019
B/K.NO	0.049	-0.034	0.213*	-0.113	-0.141	-0.176
B/K.MN	0.117	0.081	0.195*	-0.190	0.023	-0.165
B/N.NO	0.238*	0.223*	0.201*	0.119	0.125	-0.132
B/N.MN	0.252**	0.258**	0.167	0.161	0.170	-0.043
M.R/W	0.272**	0.323**	0.141	-0.055	0.026	0.131
L.R/W	-0.109	-0.081	-0.137	-0.023	-0.116	-0.141
T.R/W	0.144	0.196*	0.031	-0.054	-0.043	0.022
M.B/K	-0.139	-0.172	-0.092	0.220*	0.040	-0.085
L.B/K	-0.181	-0.196*	-0.123	0.014	-0.085	-0.066
T.B/K	-0.160	-0.188	-0.107	0.159	-0.002	-0.083
S.B/N	-0.006	0.019	-0.064	0.073	0.080	0.117
M.B/N	-0.123	-0.092	-0.142	-0.086	-0.108	0.127
L.B/N	-0.106	-0.166	0.034	-0.071	-0.209*	-0.128
T.B/N	-0.121	-0.116	-0.095	-0.066	-0.129	0.063
LEVEL	0.312**	0.311**	0.237*	0.106	0.268**	0.261**
CAP.%	0.313**	0.315**	0.230*	0.123	0.291**	0.269**
UPPER	0.341**	0.326**	0.297**	0.061	0.213*	0.272**
MIDDLE	-0.334**	-0.337**	-0.247*	-0.123	-0.293**	-0.271**
LOWER	-0.343**	-0.326**	-0.314**	0.007	-0.139	-0.277**
SUPPLY	0.326**	0.334**	0.241*	0.066	0.227*	-0.098
HYDRO	0.346**	0.225*	0.456**	0.283**	0.062	0.018
TOTAL.FL	0.385**	0.370**	0.322**	0.118	0.234*	-0.092
R.PH	0.026	0.028	0.044	-0.141	-0.186	-0.101
R.TEMP	0.106	-0.021	0.273**	0.253**	-0.054	-0.225*
R.COLOR	-0.123	-0.088	-0.133	-0.176	-0.089	-0.125
R.TURB	-0.309**	-0.286**	-0.275**	-0.104	-0.105	0.017
H.PH	0.002	0.074	-0.090	-0.226*	-0.154	-0.007
H.TEMP	0.056	-0.052	0.206*	0.207*	-0.102	-0.269**
H.COLOR	-0.087	-0.072	-0.076	-0.133	-0.073	-0.171
H.TURB	-0.338**	-0.308**	-0.309**	-0.129	-0.116	-0.034
AT.PRESS	0.332**	0.300**	0.288**	0.242*	0.061	0.200*
TEMP.MAX	0.310**	0.168	0.440**	0.406**	0.065	0.018
TEMP.MIN	0.093	-0.038	0.260**	0.306**	-0.026	-0.072
SUN	0.484**	0.408**	0.489**	0.262**	0.136	0.209*
CLOUD	-0.340**	-0.318**	-0.298**	-0.115	-0.096	-0.138
RAIN	-0.436**	-0.416**	-0.363**	-0.164	-0.274**	-0.123
			-0.163	-0.017	-0.029	-0.018

1985 to 1987 Cont.

	D/LIMIT	S/NIL	S/LIMIT	CAUGHT	TAKEN	RETURNED
S/NIL	0.123					
S/LIMIT	0.571**	0.245*				
CAUGHT	0.863**	0.177	0.745**			
TAKEN	0.943**	0.287**	0.691**	0.905**		
RETURNED	0.503**	-0.021	0.596**	0.830**	0.514**	
RAINBOW	0.906**	0.295**	0.612**	0.862**	0.971**	0.465**
BROOK	0.317**	0.106	0.496**	0.338**	0.336**	0.240*
BROWN	0.410**	0.030	0.446**	0.416**	0.385**	0.335**
CGHT/AV	0.529**	-0.366**	0.385**	0.675**	0.461**	0.757**
TAKEN/AV	0.700**	-0.291**	0.378**	0.579**	0.652**	0.312**
RET/AV	0.214*	-0.300**	0.259**	0.519**	0.153	0.847**
RW/AV	0.578**	-0.280**	0.207*	0.455**	0.538**	0.211*
BK/AV	0.219*	0.080	0.423**	0.231*	0.233*	0.162
BN/AV	0.268**	-0.060	0.336**	0.269**	0.237*	0.231*
R/W.NO	0.324**	0.201	0.203*	0.337**	0.324**	0.255**
R/W.MN	-0.099	-0.054	-0.180	-0.170	-0.120	-0.186
B/K.NO	0.086	-0.062	0.403**	0.130	0.131	0.089
B/K.MN	0.181	-0.137	0.379**	0.236*	0.190	0.226*
B/N.NO	0.321**	-0.035	0.405**	0.369**	0.328**	0.314**
B/N.MN	0.310**	0.021	0.266**	0.311**	0.303**	0.229*
M.R/W	0.253**	0.005	0.225*	0.282**	0.244*	0.248*
L.R/W	0.001	-0.075	-0.130	-0.078	-0.062	-0.077
T.R/W	0.188	-0.037	0.097	0.167	0.148	0.143
M.B/K	-0.136	-0.017	-0.039	-0.186	-0.147	-0.181
L.B/K	-0.176	-0.106	-0.047	-0.184	-0.167	-0.153
T.B/K	-0.156	-0.049	-0.044	-0.194*	-0.161	-0.180
S.B/N	-0.037	0.062	-0.091	-0.108	-0.088	-0.104
M.B/N	-0.130	0.006	-0.197*	-0.224*	-0.149	-0.255**
L.B/N	-0.077	-0.035	0.159	-0.063	-0.047	-0.065
T.B/N	-0.122	0.006	-0.091	-0.194*	-0.135	-0.214*
LEVEL	0.127	0.229*	0.130	0.269**	0.194*	0.289**
CAP.%	0.118	0.228*	0.122	0.263**	0.185	0.289**
UPPER	0.135	0.236*	0.257**	0.303**	0.214*	0.330**
MIDDLE	-0.141	-0.224*	-0.194*	-0.303**	-0.203*	-0.345**
LOWER	-0.150	-0.246*	-0.236*	-0.312**	-0.244*	-0.311**
SUPPLY	0.400**	0.015	0.366**	0.479**	0.383**	0.465**
HYDRO	0.240*	0.318**	0.386**	0.250**	0.311**	0.096
TOTAL.FL	0.437**	0.075	0.432**	0.516**	0.434**	0.473**
R.PH	0.107	0.032	-0.018	0.003	0.101	-0.126
R.TEMP	0.120	0.153	0.280**	0.035	0.171	-0.153
R.COLOR	-0.041	-0.232*	0.009	0.002	-0.060	0.084
R.TURB	-0.313**	-0.140	-0.254**	-0.287**	-0.336**	-0.137
H.PH	0.070	-0.071	-0.128	0.034	0.035	0.022
H.TEMP	0.107	0.062	0.264**	0.023	0.143	-0.141
H.COLOR	-0.003	-0.203*	0.062	0.039	-0.011	0.092
H.TURB	-0.315**	-0.189	-0.270**	-0.298**	-0.343**	-0.150
AT.PRESS	0.224*	0.286**	0.171	0.209*	0.226*	0.125
TEMP.MAX	0.159	0.361**	0.348**	0.118	0.233*	-0.068
TEMP.MIN	0.005	0.186	0.242*	-0.022	0.079	-0.149
SUN	0.264**	0.459**	0.301**	0.270**	0.323**	0.120
CLOUD	-0.210*	-0.315**	-0.160	-0.210*	-0.227*	-0.126
RAIN	-0.393**	-0.275**	-0.245*	-0.388**	-0.392**	-0.269**
WIND.SP.	-0.308**	-0.136	-0.106	-0.206*	-0.265**	-0.066

1985 to 1987 Cont.

	RAINBOW	BROOK	BROWN	CGHT/AV	TAKEN/AV	RET/AV
BROOK	0.161					
BROWN	0.160	0.586**				
CGHT/AV	0.437**	0.143	0.234*			
TAKEN/AV	0.640**	0.173	0.233*	0.748**		
RET/AV	0.127	0.071	0.155	0.854**	0.293**	
RW/AV	0.625**	-0.139	-0.161	0.667**	0.911**	0.246*
BK/AV	0.060	0.978**	0.545**	0.105	0.136	0.044
BN/AV	0.014	0.545**	0.955**	0.190	0.199*	0.118
R/W.NO	0.421**	-0.213*	-0.263**	0.217*	0.177	0.174
R/W.MN	-0.080	-0.261**	-0.137	-0.070	0.002	-0.102
B/K.NO	-0.004	0.601**	0.472**	0.135	0.181	0.052
B/K.MN	0.063	0.342**	0.552**	0.178	0.161	0.130
B/N.NO	0.225*	0.564**	0.407**	0.263**	0.251**	0.182
B/N.MN	0.220*	0.473**	0.332**	0.169	0.187	0.097
M.R/W	0.191*	0.066	0.324**	0.085	0.021	0.106
L.R/W	-0.036	-0.114	-0.103	-0.038	-0.016	-0.042
T.R/W	0.122	-0.012	0.185	0.043	0.007	0.056
M.B/K	-0.152	0.191*	-0.103	-0.187	-0.115	-0.180
L.B/K	-0.158	0.011	-0.109	-0.147	-0.094	-0.138
T.B/K	-0.162	0.138	-0.110	-0.182	-0.113	-0.174
S.B/N	-0.101	0.061	0.009	-0.097	-0.137	-0.032
M.B/N	-0.148	-0.067	-0.035	-0.231*	-0.149	-0.216*
L.B/N	-0.073	0.140	0.055	-0.024	0.010	-0.042
T.B/N	-0.147	0.021	-0.001	-0.182	-0.125	-0.164
LEVEL	0.176	-0.006	0.162	0.097	-0.043	0.173
CAP.%	0.170	-0.011	0.144	0.080	-0.063	0.165
UPPER	0.147	0.227*	0.313**	0.104	-0.029	0.173
MIDDLE	-0.137	-0.279**	-0.289**	-0.113	0.063	-0.213*
LOWER	-0.200*	-0.082	-0.268**	-0.145	-0.053	-0.167
SUPPLY	0.314**	0.259**	0.374**	0.366**	0.218*	0.356**
HYDRO	0.295**	0.225*	0.110	-0.073	0.029	-0.128
TOTAL.FL	0.363**	0.296**	0.386**	0.344**	0.219*	0.324**
R.PH	0.075	-0.038	0.179	0.054	0.236*	-0.107
R.TEMP	0.170	0.129	0.019	-0.090	0.157	-0.253**
R.COLOR	-0.021	-0.272**	-0.110	0.136	0.074	0.138
R.TURB	-0.310**	-0.211*	-0.168	-0.160	-0.266**	-0.022
H.PH	0.033	-0.214*	0.106	0.115	0.143	0.054
H.TEMP	0.148	0.092	-0.006	-0.058	0.172	-0.219*
H.COLOR	0.032	-0.270**	-0.111	0.159	0.120	0.135
H.TURB	-0.308**	-0.247*	-0.201*	-0.149	-0.242*	-0.024
AT.PRESS	0.229*	0.037	0.057	0.019	-0.002	0.029
TEMP.MAX	0.213*	0.156	0.122	-0.168	0.006	-0.248*
TEMP.MIN	0.078	0.112	-0.008	-0.166	-0.000	-0.239*
SUN	0.286**	0.185	0.226**	-0.066	-0.020	-0.079
CLOUD	-0.230*	0.094	-0.103	0.050	0.058	0.027
RAIN	-0.371**	-0.177	-0.180	-0.158	-0.131	-0.125
WIND.SP.	-0.292**	0.107	-0.010	-0.094	-0.200*	0.021

1985 to 1987 Cont.

	RW/AV	BK/AV	BN/AV	R/W.NO	R/W.MN	B/K.NO
BK/AV	-0.176					
BN/AV	-0.210*	0.537**				
R/W.NO	0.302**	-0.222*	-0.287**			
R/W.MN	0.068	-0.242*	-0.103	0.104		
B/K.NO	-0.071	0.633**	0.501**	-0.224*	0.029	
B/K.MN	-0.075	0.358**	0.558**	-0.225*	-0.168	0.513**
B/N.NO	0.060	0.495**	0.373**	-0.056	-0.065	0.480**
B/N.MN	0.030	0.418**	0.301**	-0.066	-0.160	0.176
M.R/W	-0.047	0.000	0.199*	-0.223*	-0.275**	-0.049
L.R/W	0.047	-0.117	-0.141	-0.051	-0.042	-0.143
T.R/W	-0.009	-0.063	0.072	-0.193*	-0.227*	-0.113
M.B/K	-0.111	0.253**	-0.108	-0.040	-0.042	-0.037
L.B/K	-0.072	0.073	-0.092	-0.094	0.041	0.026
T.B/K	-0.103	0.203*	-0.108	-0.060	-0.015	-0.017
S.B/N	-0.161	0.085	0.040	0.202*	-0.038	-0.031
M.B/N	-0.140	-0.025	-0.015	-0.039	0.120	0.017
L.B/N	-0.029	0.174	0.050	-0.259**	0.091	0.364**
T.B/N	-0.139	0.067	0.017	-0.074	0.103	0.137
LEVEL	-0.085	-0.054	0.144	0.213*	-0.188	-0.088
CAP.%	-0.098	-0.056	0.126	0.222*	-0.185	-0.102
UPPER	-0.145	0.184	0.272**	-0.035	-0.274**	0.180
MIDDLE	0.192*	-0.259**	-0.281**	0.085	0.249**	-0.207*
LOWER	0.032	-0.031	-0.240*	-0.036	0.113	-0.155
SUPPLY	0.091	0.210*	0.295**	0.079	-0.163	0.100
HYDRO	-0.019	0.171	0.074	0.168	0.069	0.091
TOTAL.FL	0.085	0.238*	0.302**	0.109	-0.147	0.116
R.PH	0.188	-0.085	0.173	-0.005	0.261**	-0.009
R.TEMP	0.138	0.136	0.000	-0.035	0.225*	0.090
R.COLOR	0.139	-0.247*	-0.098	0.005	0.080	-0.031
R.TURB	-0.194*	-0.187	-0.136	-0.088	-0.026	-0.086
H.PH	0.142	-0.255**	0.101	0.053	0.156	-0.082
H.TEMP	0.164	0.103	-0.018	-0.043	0.242*	0.073
H.COLOR	0.184	-0.247*	-0.098	0.069	0.096	-0.045
H.TURB	-0.158	-0.216*	-0.163	-0.056	0.003	-0.109
AT.PRESS	-0.005	0.030	-0.003	0.119	0.150	-0.054
TEMP.MAX	-0.040	0.145	0.082	0.055	0.173	0.085
TEMP.MIN	-0.013	0.122	-0.011	-0.030	0.142	0.083
SUN	-0.096	0.153	0.167	0.214*	0.158	0.123
CLOUD	0.048	0.135	-0.022	-0.125	0.019	0.114
RAIN	-0.074	-0.141	-0.113	-0.198*	-0.029	-0.035
WIND.SP.	-0.216*	0.107	0.008	-0.157	-0.174	0.043

1985 to 1987 Cont.

	B/K.MN	B/N.NO	B/N.MN	M.R/W	L.R/W	T.R/W
B/N.NO	0.245*					
B/N.MN	0.217*	0.700**				
M.R/W	0.139	0.041	0.025			
L.R/W	-0.189	-0.138	-0.137	0.289**		
T.R/W	0.002	-0.044	-0.055	0.862**	0.734**	
M.B/K	-0.081	-0.034	0.017	0.018	0.304**	0.174*
L.B/K	0.131	-0.054	-0.053	0.014	0.230**	0.132
T.B/K	-0.012	-0.043	-0.006	0.018	0.292**	0.167*
S.B/N	-0.136	0.020	0.011	0.004	0.057	0.033
M.B/N	-0.111	-0.016	-0.083	0.206*	0.426**	0.371**
L.B/N	0.291**	0.086	-0.025	0.097	0.300**	0.227**
T.B/N	0.002	0.025	-0.061	0.169*	0.397**	0.330**
LEVEL	0.083	0.126	0.163	0.064	-0.268**	-0.096
CAP.%	0.077	0.122	0.164	0.071	-0.238**	-0.076
UPPER	0.212*	0.223*	0.186	0.164*	-0.207*	0.007
MIDDLE	-0.247*	-0.279**	-0.327**	-0.178*	0.156	-0.044
LOWER	-0.155	-0.184	-0.141	-0.123	0.248**	0.044
SUPPLY	0.077	0.245*	0.188	0.247**	-0.070	0.138
HYDRO	0.066	0.126	0.181	-0.094	-0.123	-0.132
TOTAL.FL	0.088	0.263**	0.219*	0.201*	-0.103	0.088
R.PH	-0.083	0.057	0.012	-0.168*	-0.077	-0.159
R.TEMP	0.069	-0.050	-0.024	-0.203*	0.057	-0.114
R.COLOR	0.260**	-0.084	-0.078	-0.043	-0.049	-0.057
R.TURB	0.143	-0.096	-0.050	0.133	0.129	0.163*
H.PH	-0.094	0.007	-0.026	0.008	-0.045	-0.018
H.TEMP	0.088	-0.066	-0.028	-0.204*	0.050	-0.118
H.COLOR	0.226*	-0.089	-0.087	-0.086	-0.020	-0.072
H.TURB	0.105	-0.116	-0.081	0.129	0.189*	0.192*
AT.PRESS	-0.138	-0.069	0.019	-0.001	-0.047	-0.026
TEMP.MAX	0.099	-0.001	0.011	-0.167*	0.010	-0.113
TEMP.MIN	0.124	-0.036	-0.000	-0.181*	0.040	-0.107
SUN	-0.031	0.043	0.042	-0.024	-0.027	-0.031
CLOUD	0.113	0.043	0.054	-0.095	-0.075	-0.107
RAIN	0.104	-0.059	-0.103	-0.035	-0.011	-0.031
WIND.SP.	0.029	0.047	0.113	0.098	0.074	0.109

1985 to 1987 Cont.

	M.B/K	L.B/K	T.B/K	S.B/N	M.B/N	L.B/N
L.B/K	0.810**					
T.B/K	0.980**	0.912**				
S.B/N	0.208*	0.044	0.161			
M.B/N	0.543**	0.532**	0.563**	0.495**		
L.B/N	0.522**	0.575**	0.563**	0.068	0.526**	
T.B/N	0.586**	0.561**	0.604**	0.569**	0.949**	0.715**
LEVEL	-0.542**	-0.519**	-0.559**	-0.044	-0.426**	-0.608**
CAP.%	-0.480**	-0.448**	-0.491**	-0.031	-0.371**	-0.584**
UPPER	-0.296**	-0.229**	-0.287**	-0.025	-0.221**	-0.281**
MIDDLE	0.189*	0.144	0.182*	-0.032	0.139	0.159
LOWER	0.473**	0.358**	0.454**	0.147	0.336**	0.361**
SUPPLY	-0.204*	-0.315**	-0.251**	0.024	-0.230**	-0.280**
HYDRO	-0.066	-0.116	-0.086	-0.107	-0.207*	-0.053
TOTAL.FL	-0.210*	-0.329**	-0.260**	-0.011	-0.278**	-0.277**
R.PH	-0.106	-0.075	-0.100	-0.062	0.000	-0.083
R.TEMP	0.277**	0.233**	0.275**	-0.055	0.036	0.344**
R.COLOR	-0.235**	-0.017	-0.171*	-0.213**	-0.286**	-0.144
R.TURB	0.009	0.062	0.028	0.024	0.114	0.058
H.PH	-0.302**	-0.179*	-0.274**	-0.049	0.009	-0.259**
H.TEMP	0.269**	0.247**	0.274**	-0.065	0.031	0.348**
H.COLOR	-0.208*	-0.021	-0.153	-0.237**	-0.324**	-0.142
H.TURB	0.065	0.126	0.089	0.028	0.139	0.072
AT.PRESS	0.073	0.075	0.077	0.035	0.027	0.015
TEMP.MAX	0.236**	0.180*	0.227**	0.061	0.082	0.321**
TEMP.MIN	0.237**	0.187*	0.230**	0.000	0.035	0.315**
SUN	0.064	-0.016	0.040	0.078	0.119	0.180*
CLOUD	0.003	0.006	0.004	-0.018	-0.099	-0.047
RAIN	0.002	0.066	0.024	-0.036	0.024	0.049
WIND.SP.	-0.086	-0.147	-0.111	-0.077	-0.068	-0.061

	T.B/N
LEVEL	-0.505**
CAP.%	-0.457**
UPPER	-0.250**
MIDDLE	0.141
LOWER	0.380**
SUPPLY	-0.245**
HYDRO	-0.178*
TOTAL.FL	-0.282**
R.PH	-0.043
R.TEMP	0.134
R.COLOR	-0.285**
R.TURB	0.100
H.PH	-0.098
H.TEMP	0.130
H.COLOR	-0.314**
H.TURB	0.122
AT.PRESS	0.031
TEMP.MAX	0.182*
TEMP.MIN	0.135
SUN	0.159
CLOUD	-0.085
RAIN	0.025
WIND.SP.	-0.083

Table L.

Environmental parameter correlation matrices for the years 1985 to 1987.

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1985.

	LEVEL	CAP.%	UPPER	MIDDLE	LOWER	SUPPLY
CAP.%	0.997**					
UPPER	0.417**	0.410**				
MIDDLE	-0.317*	-0.313*	-0.666**			
LOWER	-0.417**	-0.410**	-1.000**	0.666**		
SUPPLY	0.537**	0.507**	0.541**	-0.325*	-0.541**	
HYDRO	-0.294*	-0.281*	-0.272	0.517**	0.272	-0.220
TOTAL.FL	0.500**	0.472**	0.508**	-0.245	-0.508**	0.986**
R.PH	0.241	0.226	0.535**	-0.290*	-0.535**	0.338*
R.TEMP	-0.373**	-0.354**	-0.401**	0.675**	0.401**	-0.272
R.COLOUR	0.517**	0.542**	-0.130	0.203	0.130	-0.016
R.TURB	-0.105	-0.116	-0.659**	0.440**	0.659**	-0.267
H.PH	0.543**	0.512**	0.424**	-0.409**	-0.424**	0.447**
H.TEMP	-0.322*	-0.303*	-0.402**	0.676**	0.402**	-0.258
H.COLOUR	0.547**	0.571**	-0.148	0.259	0.148	0.017
H.TURB	-0.062	-0.073	-0.679**	0.479**	0.679**	-0.242
AT.PRESS	0.142	0.158	0.207	-0.084	-0.207	0.205
TEMP.MAX	-0.449**	-0.435**	-0.343*	0.600**	0.343*	-0.312*
TEMP.MIN	-0.370**	-0.347*	-0.369**	0.610**	0.369**	-0.383**
SUN	-0.426**	-0.439**	-0.192	0.280*	0.192	-0.047
CLOUD	-0.013	0.014	-0.131	0.052	0.131	-0.180
RAIN	-0.069	-0.065	-0.393**	0.423**	0.393**	-0.435**
WIND.SP	0.036	0.042	-0.108	0.056	0.108	-0.097

	HYDRO	TOTAL.FL	R.PH	R.TEMP	R.COLOUR	R.TURB
TOTAL.FL	-0.057					
R.PH	0.031	0.351*				
R.TEMP	0.559**	-0.185	-0.224			
R.COLOUR	-0.073	-0.029	-0.252	0.192		
R.TURB	0.209	-0.238	-0.391**	0.200	0.261	
H.PH	-0.275*	0.411**	0.656**	-0.616**	-0.118	-0.205
H.TEMP	0.537**	-0.173	-0.232	0.996**	0.241	0.222
H.COLOUR	-0.010	0.015	-0.222	0.281*	0.943**	0.228
H.TURB	0.231	-0.208	-0.372**	0.216	0.274*	0.974**
AT.PRESS	-0.116	0.190	0.165	0.090	0.122	-0.258
TEMP.MAX	0.496**	-0.236	-0.186	0.894**	0.011	0.137
TEMP.MIN	0.495**	-0.309*	-0.177	0.868**	0.144	0.216
SUN	0.332*	0.008	-0.104	0.455**	-0.367**	-0.007
CLOUD	-0.105	-0.202	0.013	-0.032	0.150	0.096
RAIN	0.128	-0.423**	-0.261	0.238	0.278*	0.297*
WIND.SP	-0.038	-0.105	-0.129	-0.072	-0.128	0.068

	H.PH	H.TEMP	H.COLOUR	H.TURB	AT.PRESS	TEMP.MAX
H.TEMP	-0.608**					
H.COLOUR	-0.134	0.335*				
H.TURB	-0.210	0.241	0.281*			
AT.PRESS	-0.046	0.092	0.118	-0.270		
TEMP.MAX	-0.558**	0.877**	0.101	0.156	0.048	
TEMP.MIN	-0.533**	0.857**	0.221	0.227	-0.020	0.944**
SUN	-0.348*	0.427**	-0.293*	0.018	0.104	0.478**
CLOUD	0.050	-0.032	0.106	0.084	-0.141	0.025
RAIN	-0.137	0.242	0.255	0.293*	-0.530**	0.285*
WIND.SP	0.067	-0.075	-0.096	0.061	-0.350*	0.011

	TEMP.MIN	SUN	CLOUD	RAIN
SUN	0.274*			
CLOUD	0.205	-0.592**		
RAIN	0.422**	-0.222	0.354**	
WIND.SP	0.140	-0.042	0.319*	0.491**

1986.

	LEVEL	CAP.%	UPPER	MIDDLE	LOWER	SUPPLY
CAP.%	0.993**					
UPPER	0.876**	0.895**				
MIDDLE	-0.818**	-0.849**	-0.852**			
LOWER	-0.876**	-0.895**	-1.000**	0.852**		
SUPPLY	0.514**	0.475**	0.318*	-0.244	-0.318*	
HYDRO	0.406**	0.425**	0.293*	-0.185	-0.293*	0.200
TOTAL.FL	0.599**	0.579**	0.392**	-0.281*	-0.392**	0.870**
R.PH	-0.076	-0.050	0.074	-0.088	-0.074	-0.328*
R.TEMP	-0.534**	-0.565**	-0.491**	0.564**	0.491**	-0.333*
R.COLOUR	0.296*	0.304*	0.194	-0.256	-0.194	0.251
R.TURB	0.005	0.033	0.020	-0.078	-0.020	-0.242
H.PH	0.202	0.274*	0.314*	-0.417**	-0.314*	-0.154
H.TEMP	-0.603**	-0.628**	-0.573**	0.622**	0.573**	-0.358**
H.COLOUR	0.312*	0.308*	0.216	-0.276*	-0.216	0.237
H.TURB	-0.061	-0.026	-0.032	-0.035	0.032	-0.335*
AT.PRESS	-0.257	-0.268	-0.145	0.139	0.145	0.080
TEMP.MAX	-0.391**	-0.418**	-0.357**	0.392**	0.357**	-0.249
TEMP.MIN	-0.366**	-0.396**	-0.358**	0.415**	0.358**	-0.265
SUN	-0.131	-0.155	-0.103	-0.006	0.103	-0.177
CLOUD	0.152	0.157	0.106	-0.119	-0.106	0.066
RAIN	0.093	0.114	0.058	0.067	-0.058	-0.066
WIND.SP	0.453**	0.455**	0.397**	-0.339*	-0.397**	-0.017

	HYDRO	TOTAL.FL	R.PH	R.TEMP	R.COLOUR	R.TURB
TOTAL.FL	0.657**					
R.PH	-0.002	-0.254				
R.TEMP	-0.051	-0.282*	0.447**			
R.COLOUR	0.203	0.295*	-0.490**	-0.763**		
R.TURB	-0.008	-0.190	-0.326*	-0.569**	0.591**	
H.PH	0.133	-0.052	0.535**	-0.309*	0.070	0.141
H.TEMP	-0.054	-0.303*	0.444**	0.986**	-0.749**	-0.535**
H.COLOUR	0.223	0.295*	-0.408**	-0.631**	0.954**	0.511**
H.TURB	-0.049	-0.283*	-0.298*	-0.519**	0.554**	0.981**
AT.PRESS	-0.167	-0.022	-0.004	0.297*	-0.282*	-0.438**
TEMP.MAX	-0.090	-0.237	0.463**	0.910**	-0.845**	-0.601**
TEMP.MIN	-0.044	-0.226	0.438**	0.894**	-0.802**	-0.500**
SUN	-0.197	-0.235	0.301*	0.453**	-0.547**	-0.532**
CLOUD	0.223	0.163	0.051	0.028	0.064	0.041
RAIN	0.264	0.082	-0.138	-0.263	0.249	0.440**
WIND.SP	0.259	0.117	-0.122	-0.436**	0.293*	0.471**

	H.PH	H.TEMP	H.COLOUR	H.TURB	AT.PRESS	TEMP.MAX
H.TEMP	-0.257					
H.COLOUR	-0.012	-0.646**				
H.TURB	0.145	-0.478**	0.462**			
AT.PRESS	-0.141	0.298*	-0.241	-0.432**		
TEMP.MAX	-0.198	0.893**	-0.721**	-0.580**	0.291*	
TEMP.MIN	-0.286*	0.864**	-0.663**	-0.480**	0.241	0.933**
SUN	0.051	0.450**	-0.510**	-0.506**	0.329*	0.523**
CLOUD	-0.166	0.010	0.137	-0.017	-0.141	0.018
RAIN	0.134	-0.230	0.160	0.425**	-0.568**	-0.231
WIND.SP	0.099	-0.460**	0.274*	0.419**	-0.369**	-0.407**

	TEMP.MIN	SUN	CLOUD	RAIN
SUN	0.320*			
CLOUD	0.228	-0.498**		
RAIN	-0.169	-0.486**	0.176	
WIND.SP	-0.236	-0.282*	0.145	0.388**

1987.

	LEVEL	CAP.%	UPPER	MIDDLE	LOWER	SUPPLY
CAP.%	0.998**					
UPPER	0.891**	0.889**				
MIDDLE	-0.662**	-0.669**	-0.677**			
LOWER	-0.914**	-0.908**	-0.984**	0.667**		
SUPPLY	0.533**	0.538**	0.523**	-0.724**	-0.527**	
HYDRO	0.054	0.077	-0.099	-0.247	0.084	0.285*
TOTAL.FL	0.461**	0.473**	0.398**	-0.690**	-0.403**	0.932**
R.PH	-0.213	-0.227	-0.175	0.511**	0.163	-0.531**
R.TEMP	-0.861**	-0.857**	-0.856**	0.699**	0.857**	-0.758**
R.COLOUR	-0.189	-0.184	-0.106	0.385**	0.232	-0.258
R.TURB	0.349*	0.361**	0.314*	-0.262	-0.250	0.246
H.PH	0.194	0.189	0.204	0.169	-0.169	-0.153
H.TEMP	-0.872**	-0.867**	-0.867**	0.731**	0.879**	-0.761**
H.COLOUR	-0.415**	-0.410**	-0.352*	0.532**	0.464**	-0.390**
H.TURB	0.177	0.186	0.128	-0.165	-0.068	0.174
AT.PRESS	0.185	0.187	0.186	-0.082	-0.202	0.059
TEMP.MAX	-0.742**	-0.738**	-0.746**	0.510**	0.726**	-0.627**
TEMP.MIN	-0.786**	-0.777**	-0.781**	0.647**	0.768**	-0.657**
SUN	-0.264	-0.267	-0.316*	-0.028	0.292*	-0.290*
CLOUD	-0.147	-0.142	-0.075	0.222	0.096	0.013
RAIN	-0.239	-0.237	-0.160	0.151	0.172	-0.068
WIND.SP	0.035	0.037	0.070	-0.040	-0.042	-0.013

	HYDRO	TOTAL.FL	R.PH	R.TEMP	R.COLOUR	R.TURB
TOTAL.FL	0.612**					
R.PH	-0.374*	-0.579**				
R.TEMP	-0.008	-0.628**	0.386**			
R.COLOUR	-0.216	-0.294*	0.059	0.132		
R.TURB	0.128	0.251	-0.324*	-0.371**	0.416**	
H.PH	-0.369**	-0.265	0.588**	-0.123	0.311*	0.070
H.TEMP	-0.020	-0.635**	0.364**	0.991**	0.223	-0.317*
H.COLOUR	-0.175	-0.388**	0.100	0.386**	0.926**	0.314*
H.TURB	0.118	0.188	-0.319*	-0.195	0.395**	0.928**
AT.PRESS	0.064	0.072	-0.099	-0.088	-0.147	-0.176
TEMP.MAX	-0.066	-0.543**	0.296*	0.890**	-0.085	-0.453**
TEMP.MIN	-0.052	-0.561**	0.313*	0.903**	0.042	-0.368**
SUN	-0.013	-0.244	0.149	0.460**	-0.302*	-0.335*
CLOUD	-0.044	-0.006	-0.006	0.003	0.280*	0.142
RAIN	-0.036	-0.070	0.061	0.087	0.130	-0.020
WIND.SP	0.049	0.004	0.030	-0.045	0.173	0.217

	H.PH	H.TEMP	H.COLOUR	H.TURB	AT.PRESS	TEMP.MAX
H.TEMP	-0.084					
H.COLOUR	0.198	0.468**				
H.TURB	-0.011	-0.137	0.404**			
AT.PRESS	-0.175	-0.119	-0.107	-0.184		
TEMP.MAX	-0.190	0.857**	0.171	-0.274*	-0.039	
TEMP.MIN	-0.165	0.893**	0.284*	-0.196	-0.119	0.943**
SUN	-0.104	0.402**	-0.135	-0.219	0.190	0.575**
CLOUD	0.027	0.051	0.246	0.114	-0.279*	-0.021
RAIN	0.093	0.115	0.082	-0.059	-0.700**	0.112
WIND.SP	0.072	-0.034	0.093	0.182	-0.362**	-0.150

	TEMP.MIN	SUN	CLOUD	RAIN
SUN	0.337*			
CLOUD	0.219	-0.659**		
RAIN	0.259	-0.410**	0.537**	
WIND.SP	-0.015	-0.131	0.298*	0.362**

Table LI.

Environmental parameter correlation matrix for the combined study period, 1985 to 1987.

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1985 to 1987.

	LEVEL	CAP.%	UPPER	MIDDLE	LOWER	SUPPLY
CAP.%	0.993**					
UPPER	0.774**	0.785**				
MIDDLE	-0.606**	-0.625**	-0.724**			
LOWER	-0.794**	-0.786**	-0.915**	0.663**		
SUPPLY	0.461**	0.460**	0.453**	-0.446**	-0.367**	
HYDRO	0.125	0.135	-0.012	0.046	-0.024	0.008
TOTAL.FL	0.476**	0.478**	0.426**	-0.409**	-0.355**	0.951**
R.PH	-0.033	-0.049	-0.001	0.174*	-0.175*	-0.156
R.TEMP	-0.548**	-0.565**	-0.573**	0.506**	0.489**	-0.363**
R.COLOR	0.296**	0.308**	0.131	-0.164*	-0.124	0.113
R.TURB	-0.001	0.013	-0.141	0.104	0.199*	-0.169*
H.PH	0.232**	0.237**	0.192*	-0.039	-0.331**	0.014
H.TEMP	-0.557**	-0.570**	-0.598**	0.522**	0.515**	-0.361**
H.COLOR	0.263**	0.271**	0.059	-0.111	-0.083	0.098
H.TURB	-0.032	-0.014	-0.187*	0.140	0.237**	-0.176*
AT.PRESS	-0.014	-0.005	0.070	0.010	-0.043	0.120
TEMP.MAX	-0.430**	-0.499**	-0.483**	0.424**	0.396**	-0.351**
TEMP.MIN	-0.452**	-0.468**	-0.490**	0.465**	0.401**	-0.398**
SUN	-0.245**	-0.267**	-0.214**	0.093	0.172*	-0.139
CLOUD	0.014	0.016	-0.036	0.059	-0.003	-0.089
RAIN	-0.038	-0.031	-0.120	0.162*	0.112	-0.219**
WIND.SP.	0.210**	0.214**	0.146	-0.151	-0.118	-0.030

	HYDRO	TOTAL.FL	R.PH	R.TEMP	R.COLOR	R.TURB
TOTAL.FL	0.316**					
R.PH	-0.169*	-0.200*				
R.TEMP	0.084	-0.318**	0.225**			
R.COLOR	-0.137	0.065	-0.117	-0.029		
R.TURB	0.108	-0.127	-0.331**	-0.145	0.267**	
H.PH	-0.169*	-0.039	0.721**	-0.253**	0.074	-0.107
H.TEMP	0.070	-0.321**	0.221**	0.990**	0.039	-0.111
H.COLOR	-0.110	0.059	-0.074	0.104	0.957**	0.220**
H.TURB	0.101	-0.136	-0.319**	-0.120	0.260**	0.970**
AT.PRESS	-0.073	0.091	0.041	0.091	-0.032	-0.280**
TEMP.MAX	0.058	-0.315**	0.204*	0.895**	-0.192*	-0.182*
TEMP.MIN	0.086	-0.351**	0.200*	0.883**	-0.090	-0.091
SUN	0.015	-0.128	0.099	0.450**	-0.348**	-0.201*
CLOUD	0.023	-0.078	0.072	0.001	0.136	0.066
RAIN	0.137	-0.166*	-0.134	0.007	0.172*	0.284**
WIND.SP	0.156	0.020	-0.219**	-0.201*	0.001	0.247**

	H.PH	H.TEMP	H.COLOR	H.TURB	AT.PRESS	TEMP.MAX
H.TEMP	-0.213**					
H.COLOR	0.041	0.166*				
H.TURB	-0.106	-0.080	0.244**			
AT.PRESS	-0.067	0.078	-0.012	-0.292**		
TEMP.MAX	-0.231**	0.870**	-0.062	-0.164*	0.092	
TEMP.MIN	-0.242**	0.866**	0.035	-0.077	0.025	0.939**
SUN	-0.110	0.416**	-0.271**	-0.180*	0.199*	0.525**
CLOUD	0.026	0.014	0.127	0.042	-0.184*	0.010
RAIN	-0.013	0.034	0.134	0.274**	-0.597**	0.050
WIND.SP.	-0.085	-0.205*	-0.014	0.236**	-0.359**	-0.137*

	TEMP.MIN	SUN	CLOUD	RAIN
SUN	0.307**			
CLOUD	0.219**	-0.587**		
RAIN	0.170*	-0.367**	0.346**	
WIND.SP.	-0.045	-0.137	0.213**	0.421**

Table LII. Introductions of rainbow trout, brook trout and brown trout obtained from stocking consent documentation for the years 1985 to 1987.

1985

DATE	SPECIES	NUMBER	SIZE
6/3/85	Brown trout	1250	½lb to 1½lb
11/3/85	Brook trout	1000	½lb to 1½lb
13/3/85	Brown trout	1250	½lb to 1½lb
1/3/85 to 14/3/85	Rainbow trout	5000	½lb to 1lb
		2000	1lb to 2lb
10/3/85 to 31/4/85	Rainbow trout	10500	½lb to 1lb
			some 3lb to 7lb
Throughout the season	Brook trout	375	)
	Brown trout	1200	) > 10 inches
	Rainbow trout	1200	)

*1986

DATE	SPECIES	NUMBER	SIZE
3/3/86 to 10/3/86	Rainbow trout	5000	10oz to 1lb
		800	2lb
		50	> 2lb

*Proposal for stocking only

1987

DATE	SPECIES	NUMBER	SIZE
4/3/87	Rainbow trout	2500	¾lb to 1lb
		1000	1lb to 2lbs
		100	>3lb
16/4/87	Rainbow trout	250	1lb to 3lb
27/4/87	Rainbow trout	500	11inches to 13inches
8/5/87	Rainbow trout	300	¾lb to 1lb
14/5/87	Rainbow trout	500	¾lb to 1lb
21/5/87	Rainbow trout	500	1lb
29/5/87	Rainbow trout	500	1lb
9/6/87	Rainbow trout	900	1lb
		100	> 2lb
12/6/87	Rainbow trout	200	1lb
		100	1lb to 3lb
		100	3lb to 5lb
1/7/87	Rainbow trout	100	> 2lb
28/7/87	Rainbow trout	600	1lb
		50	2lb to 8lbs
19/8/87	Rainbow trout	500	1lb
		50	> 2lb
9/9/87	Rainbow trout	600	¾lb to 1lb

Table LIII. Summary of estimated introduced reservoir stock for the seasons 1985 to 1987.

	DATE	PRE-SEASON	INTRODUCED	INITIAL STOCK	TAKEN	IMPINGED	REMAINING STOCK	MORTALITY	IMPINGED
RAINBOW TROUT	1985	-	18700	18700	8943	68	9689	1603	50
	1986	8036	5850	13886	8928	78	4880	725	7
	1987	4148	9450	13598	8020	38	5540	823	?
BROOK TROUT	1985	-	1375	1375	339	69	967	161	0
	1986	806	0	806	352	220	234	35	0
	1987	199	0	199	5	0	194	165	?
BROWN TROUT	1985	?	3700	3700	1272	142	2286	378	5
	1986	1903	0	1903	405	99	1399	208	8
	1987	1183	0	1183	367	53	763	113	?

Table LIV. Summary of fish taken, impinged and combined as percentages of annual introductions and estimated stock for the years 1985 to 1987.

SPECIES	SEASON	ANNUAL INTRODUCTIONS FISH TAKEN (%)	ANNUAL INTRODUCTIONS FISH IMPINGED (%)	ANNUAL INTRODUCTIONS COMBINED %	ESTIMATED STOCK FISH TAKEN (%)	ESTIMATED STOCK FISH IMPINGED (%)	ESTIMATED STOCK COMBINED
RAINBOW	1985	47.8	0.4	48.2	47.8	0.4	48.2
	1986	152.6	1.3	153.9	64.3	0.6	64.9
	1987	84.9	0.4	85.3	59.0	0.3	59.3
BROOK	1985	24.7	5.0	29.7	24.7	5.0	29.7
	1986	-	-	-	43.7	27.3	71.0
	1987	-	-	-	2.5	-	2.5
BROWN	1985	34.4	3.8	38.2	34.4	3.8	38.2
	1986	-	-	-	21.3	5.2	26.5
	1987	-	-	-	31.0	4.5	35.5

Table LV. Summary of basic reservoir information.

NAME	AUTHORITY AREA	NATIONAL GRID REF.	ALTITUDE (m)	AREA (ha)	CLASSIFICATION
Stocks	North West Water	SD 730 560	180	139	Upland - Stocked
*Clowbridge	" " "	SD 827 282	280	-	Upland - Stocked
Swinsty/ Fewston	Yorkshire Water	SE 195 535 SE 183 545	150	63	Lowland - Stocked
Scaling	Northumbrian Water	NZ 745 217	149	49	Lowland - Stocked
Hury	" "	NY 967 195	244	78	Upland - Stocked
Grassholme	" "	NY 947 228	290	57	Upland - Stocked
Selset	" "	NY 919 212	320	111	Upland - Unstocked
Cow Green	" "	NY 813 289	450	312	Upland - Unstocked
Llyn Alaw	Welsh Water	SH 400 870	45	314	Lowland - Stocked
Draycote	Seven-Trent Water	SP 463 686	94	243	Lowland - Stocked
Foremark	" "	SK 330 239	105	96	Lowland - Stocked
Ladybower	" "	SK 199 854	204	204	Upland - Stocked
*Grafham	Anglian Water	TL 150 680	45	635	Lowland - Stocked
Rutland	" "	TF 910 075	80	1277	Lowland - Stocked
Pitsford	" "	SP 770 695	90	299	Lowland - Stocked
Upper Tamar	South West Water	SX 285 122	145	33	Lowland - Stocked
Wimbleball	" "	ST 972 305	230	152	Upland - Stocked
Farmoor 2	Thames Water	SU 445 059	65	98	Lowland - Stocked
Bewl Water	Southern Water	TQ 680 330	75	312	Lowland - Stocked

* No reply received

Table LVI. Summary of angler visits, stock and catch ($ha^{-1} yr^{-1}$) for a sample of stillwater trout fisheries for the seasons 1985 to 1987.

RESERVOIRS	VISITS ha^{-1} yr^{-1}	STOCK ha^{-1} yr^{-1}	CATCH ha^{-1} yr^{-1}
Upland unstocked			
Selset	2.0	0	3.2
Cow Green	3.0	0	4.5
Upland stocked			
Stocks	44.2	(93.7)	68.7
Ladybower	51.8	136.2	104.4
Wimbleball	47.2	136.8	122.3
Hury	41.1	87.8	78.8
Grassholme	105.8	184.9	167.1
Lowland stocked			
Llyn Alaw	20.3	43.8	40.1
Farmoor 2	86.7	349.8	181.0
Bewl Water	72.2	181.3	154.8
Rutland	14.5	86.9	38.5
Pitsford	21.5	94.8	63.7
Draycote	88.0	207.5	196.6
Foremark	69.1	236.1	158.9
Upper Tamar	117.7	287.6	219.8
Scaling	118.3	183.7	125.8
Swinsty/Fewston	149.8	218.0	179.0

Parenthesis denotes estimated stock

Table LVII. Monthly summary of angler caught fish examined for stomach content analysis.

1985 SEASON

MONTH	SPECIES SAMPLED RAINBOW	BROOK	BROWN
April	10	1	1
May	4	3	0
June	7	0	1
July	4	0	0
August	0	0	0
September	19	0	3
October	24	0	0
November	0	0	0
TOTAL	68	4	5

1986 SEASON

MONTH	SPECIES SAMPLED RAINBOW	BROOK	BROWN
April	0	0	0
May	0	0	0
June	17	0	0
July	5	0	0
August	0	0	0
September	14	3	2
October	12	0	1
November	11	0	0
TOTAL	59	3	3

Table LVIII. Classification of stomach contents.

CLASSIFICATION	DESCRIPTION
STONES	Generally small and rounded ($\leq$12 mm dia.)
DETRITUS	Sections of grass, reed and twigs ($\leq$35 mm)
FEATHERS	Mainly white feathers ($\leq$60 mm) from geese and seagulls.
AERIAL INSECTS	Winged insects excluding Formicoidea - counting problems experienced due to fragmentation and digestion.
FORMICOIDEA	Red ants of the species *Myrmica ruginodis*.
TERRESTRIAL COLEOPTERA	Beetles of the families Carabidae and Curculionidae.
CHIRONOMIDAE	Pupae identified from hard head structures.
PLANKTONIC CRUSTACEA	Classification adopted by O'Hara (1979). Mainly Cladocera of the families *Daphnia* and *Bosmina*.
AQUATIC COLEOPTERA	of the family Dytiscidae.
MOLLUSCA	Mainly *Pisidium* spp. and *Lymnaea peregra*.

MISCELLANEOUS	DESCRIPTION
MAGGOTS	Dipteran larvae found in the stomach of a single brown trout (8/9/85).
LARUS RIDIBUNDUS	Seagull chick found in the stomach of a 335 mm rainbow trout (7/9/86).

Table LIX. Visual assessment of stomach and hindgut fullness.

Stomach Fullness

*NOT POSSIBLE	Usually due to putrefaction.
EMPTY	Stomach collapsed, no food present.
¼ FULL	Food occupying approximately one quarter of the stomach volume.
½ FULL	Food occupying approximately half of the stomach volume.
¾ FULL	Food occupying approximately three quarters of the stomach volume.
FULL	Food filling entire stomach.
DISTENDED	Stomach packed with food.

Hindgut Fullness

*NOT POSSIBLE	Usually due to putrefaction.
EMPTY	No food present in hindgut.
PARTLY FILLED	Food partly filling the tract.
FULL	Food filling entire tract.

*Refers to impinged fish Chapter

Table LX. Stomach content analysis of angler caught rainbow trout for the combined seasons 1985 to 1987.

RAINBOW TROUT

FOOD ITEMS (X)	No. STOMACHS CONT. X	% OF ALL STOMACHS CONT. X	NO. OF ITEMS OF X	% OF X OF ALL ITEMS
STONES	12	9.45	52	3.30
DETRITUS	40	31.50	196	12.44
FEATHERS	31	24.41	113	7.17
LARUS RIDIBUNDUS	1	0.79	1	0.06
AERIAL INSECTS	29	22.83	284	18.03
FORMICOIDEA	15	11.81	539	34.22
TERRESTRIAL COLEOPTERA	11	8.66	31	1.97
CHIRONOMIDAE	23	18.11	135	8.57
PLANKTONIC CRUSTACEA	16	12.60	203	12.89
AQUATIC COLEOPTERA	5	3.94	6	0.38
MOLLUSCA	3	2.36	15	0.95

Sample No. = 127
Empty stomachs = 32.28%
Containing food = 67.72%

Table LXI. Stomach content analysis of angler caught brown trout for the combined seasons 1985 to 1987.

BROWN TROUT

FOOD ITEMS (X)	NO. STOMACHS CONT. X	% OF ALL STOMACHS CONT. X	NO. OF ITEMS OF X	% OF X OF ALL ITEMS
STONES	0	-	0	-
DETRITUS	2	25.00	2	0.60
FEATHERS	1	12.50	1	0.30
MAGGOTS	1	12.50	20	6.01
AERIAL INSECTS	2	25.00	19	5.71
FORMICOIDEA	2	25.00	210	63.06
TERRESTRIAL COLEOPTERA	2	25.00	5	1.50
CHIRONOMIDAE	3	37.50	21	6.31
PLANKTONIC CRUSTACEA	3	37.50	35	10.51
AQUATIC COLEOPTERA	0	-	0	-
MOLLUSCA	2	25.00	20	6.01

Sample No. = 8
Empty stomachs = 25.00%
Containing food = 75.00%

Table LXII. Principal invertebrate groups and total benthic numbers (m^{-2}) at 5 metre depth zones in Stocks Reservoir, after Mills,M.L. (1971).

NUMBER OF ANIMALS AT EACH DEPTH ZONE

DEPTH ZONE	CHIRONO-MIDAE	OLIGOCH-EATA	PISIDIUM	HIRUDINEA	MISCELLA-NEOUS	TOTAL
0- 5m	300.2	234.6	341.1	42.6	24.8	943.3
5-10m	782.5	514.6	735.1	49.1	50.6	2132
10-15m	897.7	463.7	841.2	50.6	20.9	2274.1
15-20m	596.3	304.3	573.9	38.1	12.7	1525.3
20-25m	832.2	457.9	689.7	8.9	23.9	2012.6
25-30m	707.5	350.9	386.5	23.7	0	1468.6
30-35m	951.5	380.5	666.0	0	0	1998
RANGE	300.2	234.6	341.1	0	0	943.3
	951.5	514.6	841.2	50.6	50.6	2274.1

PERCENTAGE COMPOSITION OF ANIMAL GROUPS AT EACH DEPTH ZONE

DEPTH ZONE	CHIRONO-MIDAE	OLIGOCH-EATA	PISIDIUM	HIRUDINEA	MISCELLA-NEOUS	TOTAL %
0- 5m	31.8	24.9	36.2	4.5	2.6	100
5-10m	36.7	24.1	34.5	2.3	2.4	100
10-15m	39.5	20.4	37.0	2.2	0.9	100
15-20m	39.1	19.9	37.6	2.6	0.8	100
20-25m	41.4	22.8	34.2	0.4	1.2	100
25-30m	48.2	23.9	26.3	1.6	0	100
30-35m	47.6	19.0	33.4	0	0	100

PERCENTAGE DISTRIBUTION WITH DEPTH

DEPTH ZONE	CHIRONO-MIDAE	OLIGOCH-EATA	PISIDIUM	HIRUDINEA	MISCELLA-NEOUS
0-5m	5.9	8.7	9.4	20.0	18.6
5-10m	15.4	19.0	20.2	23.1	38.1
10-15m	17.7	17.1	23.1	23.8	15.7
15-20m	11.8	11.2	15.8	17.9	9.6
20-25m	16.4	16.9	19.0	4.2	18.0
25-30m	14.0	12.9	10.7	11.0	0
30-35m	18.8	14.2	1.8	0	0
TOTAL %	100	100	100	100	100

Table LXIII. Annual monthly summary of species impingement, 1985 to 1987.

1985

MONTH	R/W	B/K	B/N	TOTAL
March	4	7	36	47
April	10	2	51	63
May	33	3	22	58
June	6	5	74	85
July	5	31	112	148
Aug	2	10	15	27
Sept	2	5	15	22
Oct	6	6	16	28
Nov	7	0	20	27
Dec	7	0	16	23
Total	82	69	377	528

1986

MONTH	R/W	B/K	B/N	TOTAL
Jan	7	0	12	19
Feb	26	0	24	50
March	13	0	10	23
April	19	0	54	73
May	4	5	29	38
June	1	30	49	80
July	5	17	22	44
Aug	5	46	76	127
Sept	6	19	55	80
Oct	24	100	201	325
Nov	6	3	57	66
Dec	1	0	14	15
Total	117	220	603	940

1987

MONTH	R/W	B/K	B/N	TOTAL
Jan	1	0	15	16
Feb	3	0	8	11
March	5	0	49	54
April	6	0	104	110
May	1	0	60	61
June	4	0	42	46
July	10	0	27	37
Aug	3	0	22	25
Sept	5	0	27	32
Oct	4	0	21	25
Nov	5	0	17	22
Dec	5	0	19	24
			411	463

Table LXIV. Annual monthly summary of percentage species impingement, 1985 to 1987.

	1985			1986			1987		
DATE	R/W	B/K	B/N	R/W	B/K	B/N	R/W	B/K	B/N
Jan	-	-	-	37	0	63	6	0	94
Feb	-	-	-	52	0	48	27	0	73
March	8	15	77	57	0	43	9	0	91
April	16	3	81	26	0	74	5	0	95
May	57	5	38	11	13	76	2	0	98
June	7	6	87	1	38	61	9	0	91
July	3	21	76	11	39	50	27	0	73
Aug	7	37	56	4	36	60	12	0	88
Sept	9	23	68	7	24	69	16	0	84
Oct	21	58	21	7	31	62	16	0	84
Nov	26	0	74	9	5	86	23	0	77
Dec	30	0	70	7	0	93	21	0	79
Annual	16	13	71	13	23	64	11	0	89

Table LXV. Annual monthly summary of impingement for each species, 1985 to 1987.

	1985			1986			1987		
DATE	R/W	B/K	B/N	R/W	B/K	B/N	R/W	B/K	B/N
Jan	-	-	-	6	0	2	2	0	4
Feb	-	-	-	22	0	4	6	0	2
March	5	10	10	11	0	2	10	0	12
April	12	3	14	16	0	9	12	0	25
May	40	4	6	3	2	5	2	0	15
June	7	7	20	1	14	8	8	0	10
July	6	45	30	4	8	4	19	0	7
Aug	2	14	4	4	21	13	6	0	5
Sept	2	7	4	5	9	9	10	0	7
Oct	7	9	4	21	45	33	8	0	5
Nov	9	0	5	5	1	9	10	0	4
Dec	9	0	4	1	0	2	10	0	5

Table LXVI. Annual summary of impinged rainbow trout, brook trout and brown trout for respective length categories, 1985 to 1987.

SPECIES	SIZE	YEARS 1985	1986	1987
Rainbows	Small	0	0	0
	Medium	57	63	15
	Large	25	54	37
	Total	82	117	52
Brooks	Small	0	0	0
	Medium	27	171	0
	Large	42	49	0
	Total	69	220	0
Brown	Small	33	104	54
	Medium	204	397	305
	Large	140	102	52
	Total	377	603	411
	Total Impingement	528	940	463

Small <150mm
Medium 150mm to 300mm
Large >300mm

Table LXVII. Annual monthly summary of percentage species length category impingement, 1985 to 1987.

1985

MONTH	RAINBOW S	RAINBOW M	RAINBOW L	BROOK S	BROOK M	BROOK L	BROWN S	BROWN M	BROWN L
March	0	50	50	0	14	86	31	61	8
April	0	90	10	0	50	50	18	67	16
May	0	79	21	0	100	0	0	59	41
June	0	100	0	0	60	40	4	39	57
July	0	60	40	0	45	55	1	45	54
Aug	0	50	50	0	40	60	7	73	20
Sept	0	0	100	0	0	100	13	53	33
Oct	0	17	83	0	17	83	0	63	37
Nov	0	43	57	0	0	0	15	75	10
Dec	0	86	14	0	0	0	19	75	6
Total	0	70	30	0	39	61	9	54	37

1986

MONTH	RAINBOW S	RAINBOW M	RAINBOW L	BROOK S	BROOK M	BROOK L	BROWN S	BROWN M	BROWN L
Jan	0	71	29	0	0	0	17	75	8
Feb	0	62	38	0	0	0	13	83	4
March	0	85	15	0	0	0	10	80	10
April	0	84	16	0	0	0	15	85	0
May	0	50	50	0	100	0	7	93	0
June	0	0	100	0	90	10	37	53	10
July	0	0	100	0	76	24	27	50	23
Aug	0	20	80	0	87	13	30	46	24
Sept	0	33	67	0	84	16	15	69	16
Oct	0	29	71	0	67	33	7	66	27
Nov	0	33	67	0	100	0	25	63	12
Dec	0	100	0	0	0	0	36	64	0
Total	0	54	46	0	78	22	17	66	17

1987

MONTH	RAINBOW S	RAINBOW M	RAINBOW L	BROWN S	BROWN M	BROWN L
Jan	0	0	100	13	80	7
Feb	0	67	33	0	75	25
March	0	20	80	18	65	16
April	0	33	67	31	63	6
May	0	100	0	12	87	1
June	0	25	75	2	79	19
July	0	30	70	0	67	33
Aug	0	0	100	5	73	22
Sept	0	20	80	4	63	33
Oct	0	25	75	0	86	14
Nov	0	40	60	0	100	0
Dec	0	20	80	5	95	0
				13	74	13

Table LXVIII.

Chisquare tests comparing annual monthly impingement for brown trout and rainbow trout, 1985 to 1987.

BROWN TROUT.

Expected counts are printed below observed counts

	1985	1986	1987	Total
March	36 26.9	10 40.5	49 27.6	95
April	51 59.2	54 89.0	104 60.8	209
May	22 31.4	29 47.3	60 32.3	111
June	74 46.7	49 70.3	42 48.0	165
July	112 45.6	22 68.6	27 46.8	161
August	15 32.0	76 48.1	22 32.9	113
Sept.	15 27.5	55 41.3	27 28.2	97
Oct.	16 67.4	201 101.4	21 69.2	238
Nov.	20 26.6	57 40.0	17 27.3	94
Dec.	16 13.6	14 20.4	18 14.0	48
Total	377	567	387	1331

ChiSq = 3.07 + 22.94 + 16.55 +
1.14 + 13.78 + 30.76 +
2.83 + 7.07 + 23.82 +
15.91 + 6.45 + 0.74 +
96.67 + 31.64 + 8.39 +
9.04 + 16.13 + 3.59 +
5.66 + 4.53 + 0.05 +
39.21 + 97.87 + 33.57 +
1.65 + 7.18 + 3.91 +
0.43 + 2.03 + 1.17 = 507.77

df = 18
Table value at 95% = 28.869

RAINBOW TROUT.

Expected counts are printed below observed counts

	1985	1986	1987	Total
March	4 8.5	13 8.7	5 4.8	22
April	10 13.5	19 13.9	6 7.6	35
May	33 14.7	4 15.1	1 8.2	38
June	6 4.3	1 4.4	4 2.4	11
July	5 7.7	5 7.9	10 4.3	20
August	2 3.9	5 4.0	3 2.2	10
Sept.	2 5.0	6 5.2	5 2.8	13
Oct.	6 13.2	24 13.5	4 7.4	34
Nov.	7 7.0	6 7.1	5 3.9	18
Dec.	7 4.3	1 4.4	3 2.4	11
Total	82	84	46	212

```
ChiSq =   2.39 +   2.10 +   0.01 +
          0.92 +   1.90 +   0.33 +
         22.79 +   8.12 +   6.37 +
          0.72 +   2.59 +   1.09 +
          0.97 +   1.08 +   7.38 +
          0.90 +   0.27 +   0.32 +
          1.82 +   0.14 +   1.68 +
          3.89 +   8.23 +   1.55 +
          0.00 +   0.18 +   0.31 +
          1.77 +   2.59 +   0.16 = 82.57
```

df = 18

Table value at 95% = 28.869

13 cells with expected counts less than 5.0

Table LXIX. Annual monthly standard residuals for brown trout and rainbow trout impingement.

MONTH	BROWN TROUT			RAINBOW TROUT		
	1985	1986	1987	1985	1986	1987
March	2.635	-8.992	6.182	-2.809	2.694	0.130
April	-1.764	-7.665	9.264	-1.862	2.712	-0.887
May	-2.553	-5.059	7.494	9.484	-5.761	-3.911
June	6.363	-5.051	-1.394	1.411	-2.831	1.392
July	15.607	-11.151	-4.642	-1.752	-1.886	3.875
August	-4.582	7.660	-2.929	-1.647	0.869	0.722
September	-3.587	4.007	-0.344	-2.331	0.619	1.789
October	-10.636	20.989	-9.954	-3.849	5.633	-1.901
November	-1.922	5.041	-2.992	0.000	-0.747	0.777
December	0.942	-2.561	1.564	2.240	-2.831	0.521

Table LXX. Impinged fish stomach content data.

RAINBOW TROUT (n = 15)		
DATE	LENGTH (mm)	CONTENTS
18/5/85	290	1 terrestrial beetle (*Carabidae*) 2 sticks (21mm and 23mm)
18/5/85	310	1 terrestrial beetle (*Curculionidae*)
27/5/85	220	3 sticks (15mm, 15mm and 21mm)

BROOK TROUT (n = 16)		
DATE	LENGTH (mm)	CONTENTS
9/7/85	280	2 sticks (9mm and 10mm)

BROWN TROUT (n = 75)		
DATE	LENGTH (mm)	CONTENTS
14-18/3/85	170	1 minnow (45mm)
21/3/85	290	1 stick (21mm)
29/4/85	250	16 Chironomidae
15/6/85	320	12 Trichoptera
16/6/85	275	1 minnow (40mm)
14/7/85	310	2 sticks (25mm and 33mm)

Figure 1. Map of Major Population Centres and Road Network in the Vicinity of Stocks Reservoir, Lancashire.
Key.
Motorways.
A Roads.
B Roads.
Minor Roads.
NCASTER
B6480
B6479
Settle
Stocks Reservoir
Longpreston
Forest of Bowland
Slaidburn
A65
A59
Fewston and Swinsty Reservoirs.
HARROGATE
M6
Skipton
Gisburn
B6478
Ilkley
Barnoldswick
A56
A629
Otley
Clitheroe
A59
A6068
Keighley
A65
Longridge
B6243
Colne
Nelson
PADIHAM
M65
BURNLEY
Scale Kilometres.
0
5
10
LEEDS
BRADFORD
GREAT HARWOOD
PRESTON
A677
BLACKBURN
ACCRINGTON
Clowbridge Reservoir
HALIFAX
MORLEY

Figure 2.

The geology of the North Pennine Region.

Key.

Alluvium.

Keuper Marl.

Keuper and Bunter Sandstones.

Permian Limestone.

Coal Measures.

Millstone Grit.

Carboniferous Limestone.

Lavas.

Silurian, Ordovician, Pre-Cambrian.

(after Edwards and Trotter, 1954).

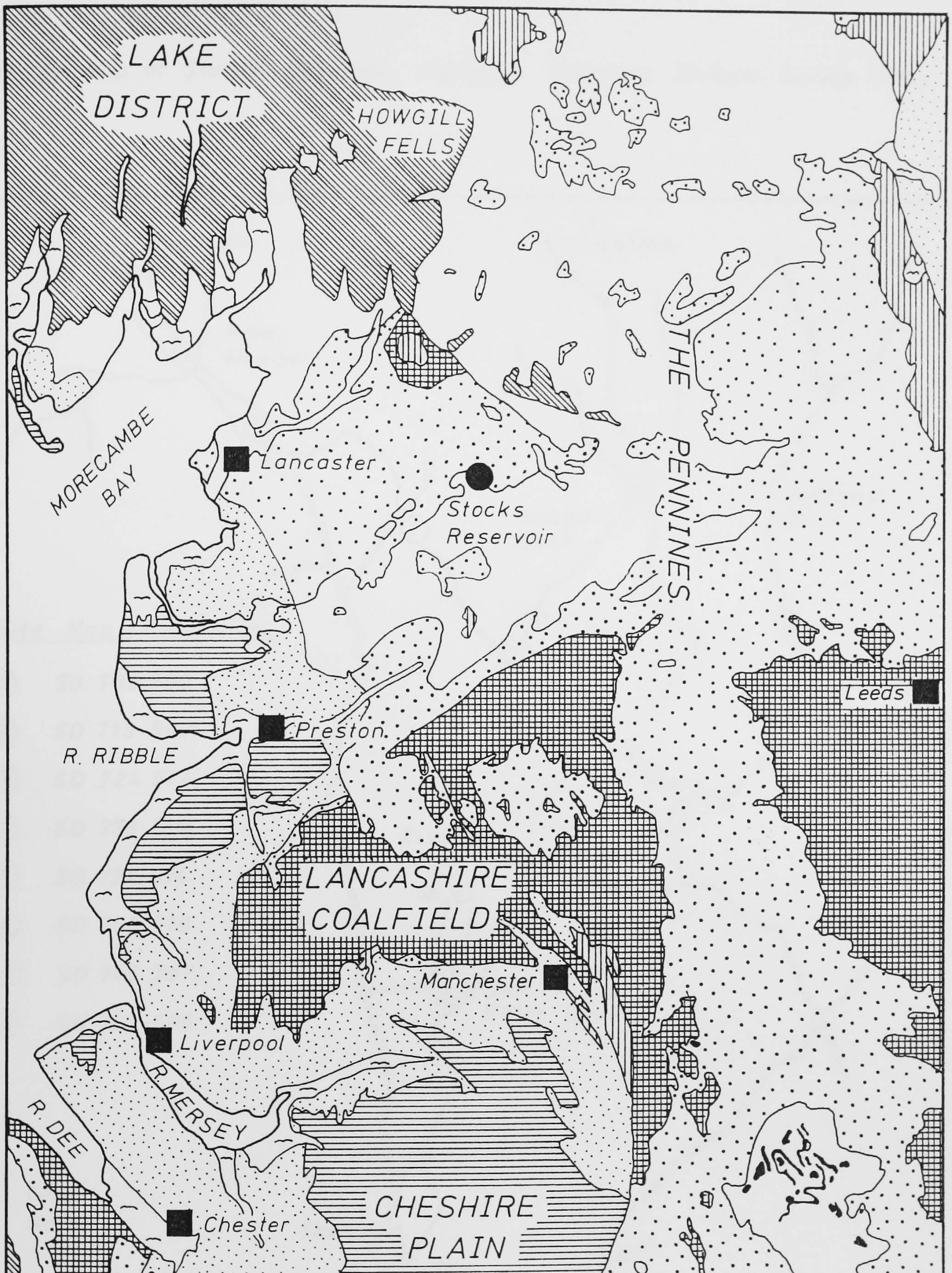

LAKE DISTRICT
HOWGILL FELLS
MORECAMBE BAY
Lancaster
Stocks Reservoir
THE PENNINES
Leeds
Preston
R. RIBBLE
LANCASHIRE COALFIELD
Manchester
Liverpool
R. MERSEY
R. DEE
Chester
CHESHIRE PLAIN
Kilometers.
0 10 20 30 40

Figure 3. Map of Stocks Reservoir including Tributary Stream Survey Sites.

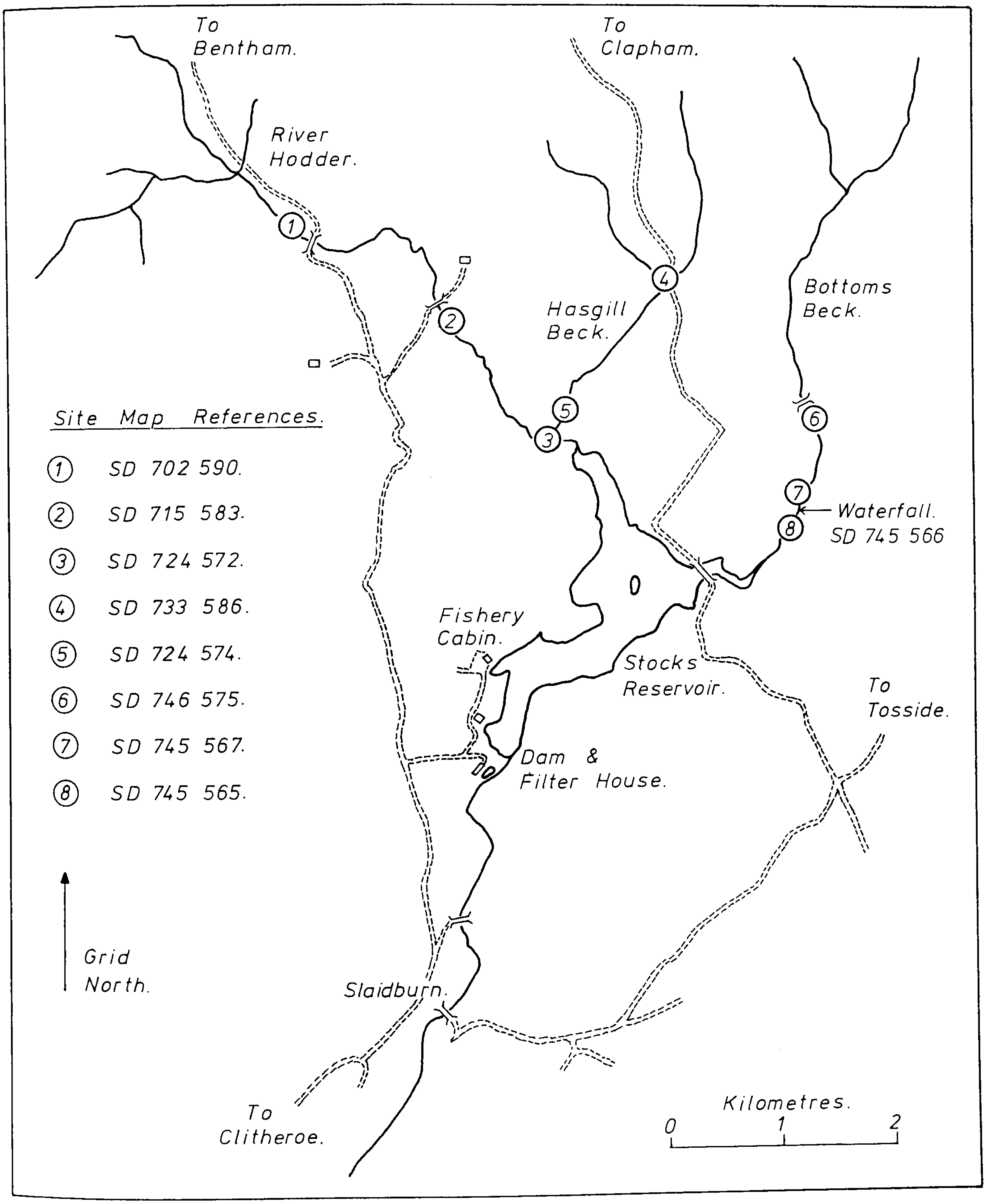


Figure 4.

Scale diagrams of the River Hodder, Hasgill Beck and Bottoms Beck electric fishing survey sites.

Key.

Shingle.

Steep Bank.

Boulders.

Bed Rock.

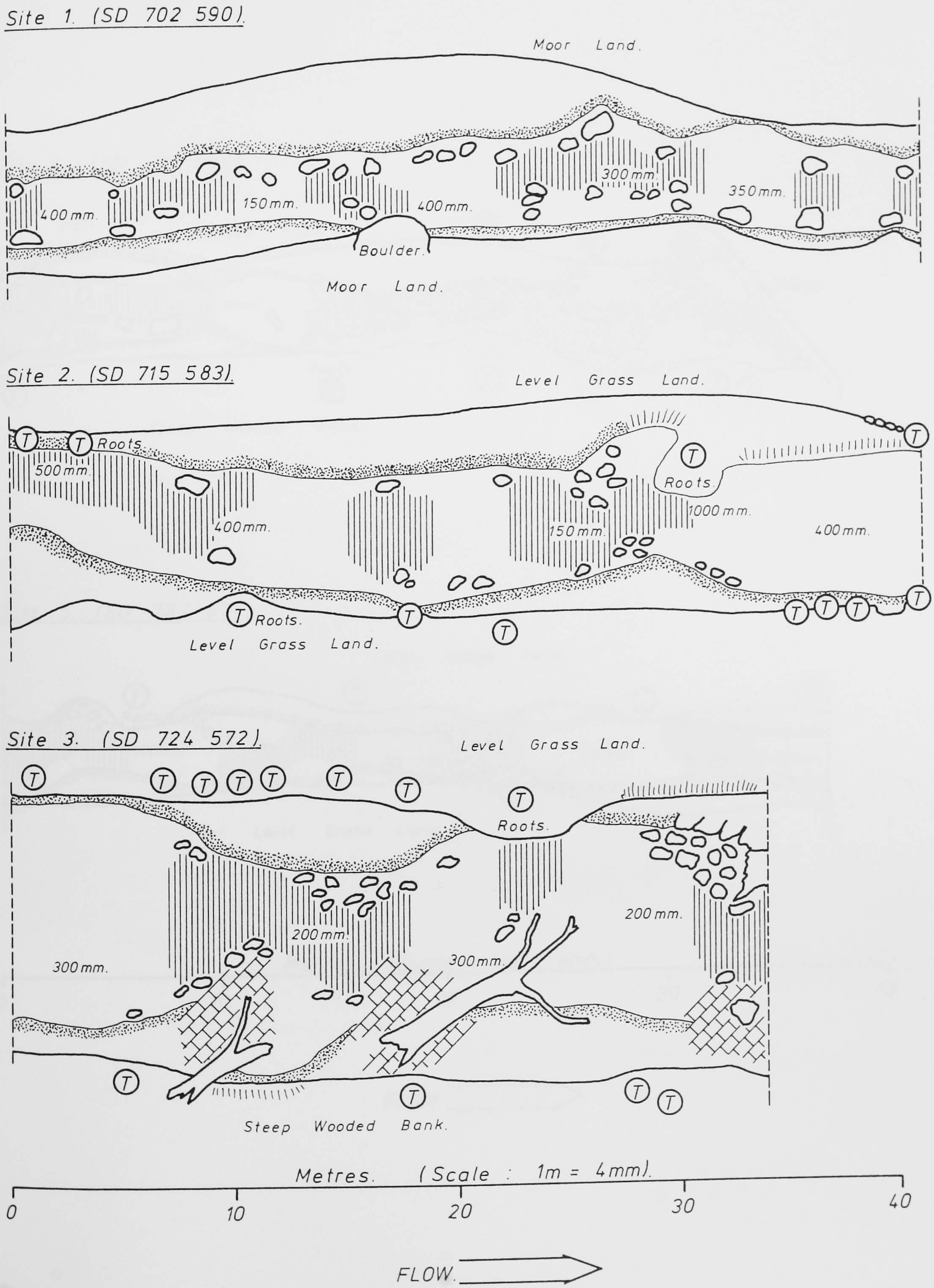
Riffle.

------ Stop Net.

200mm. Mean Depth.

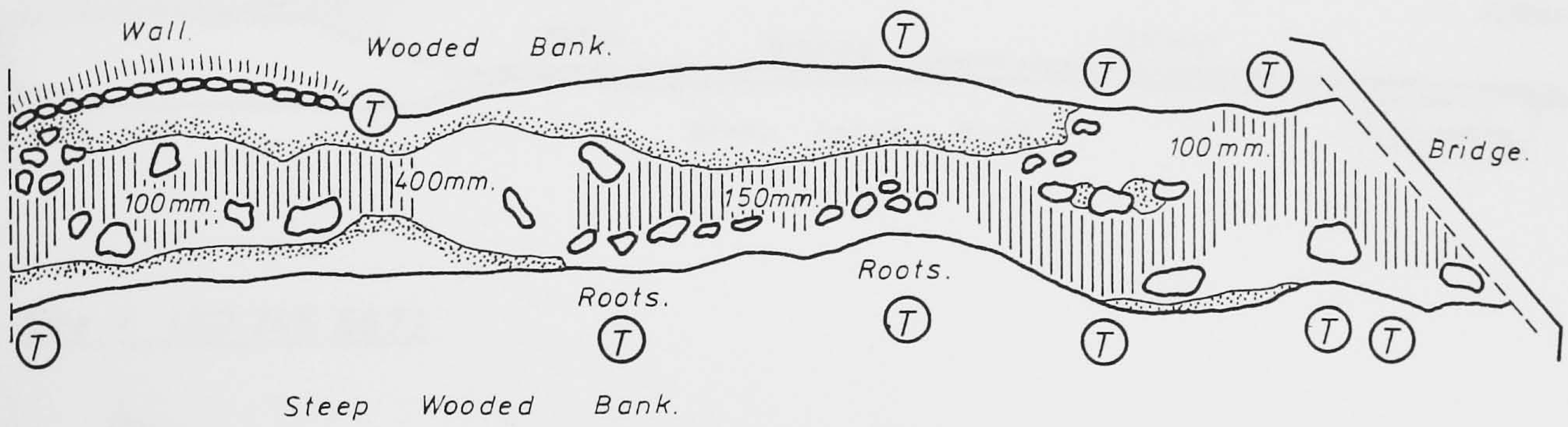
(T) Tree.

River Hodder.

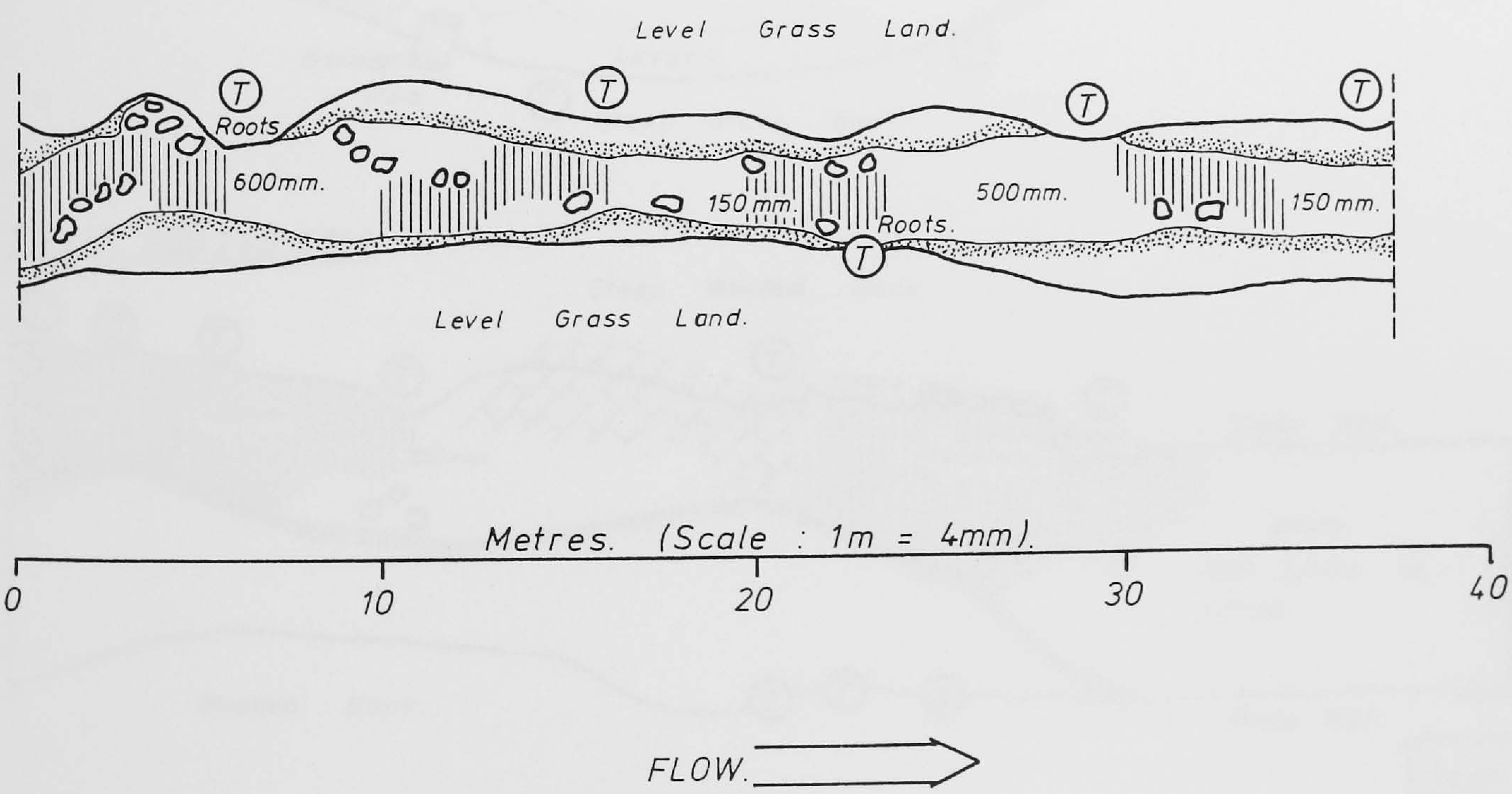


Hasgill Beck.

Site 4. (SD 733 586).



Site 5. (SD 724 574).



Bottoms Beck.

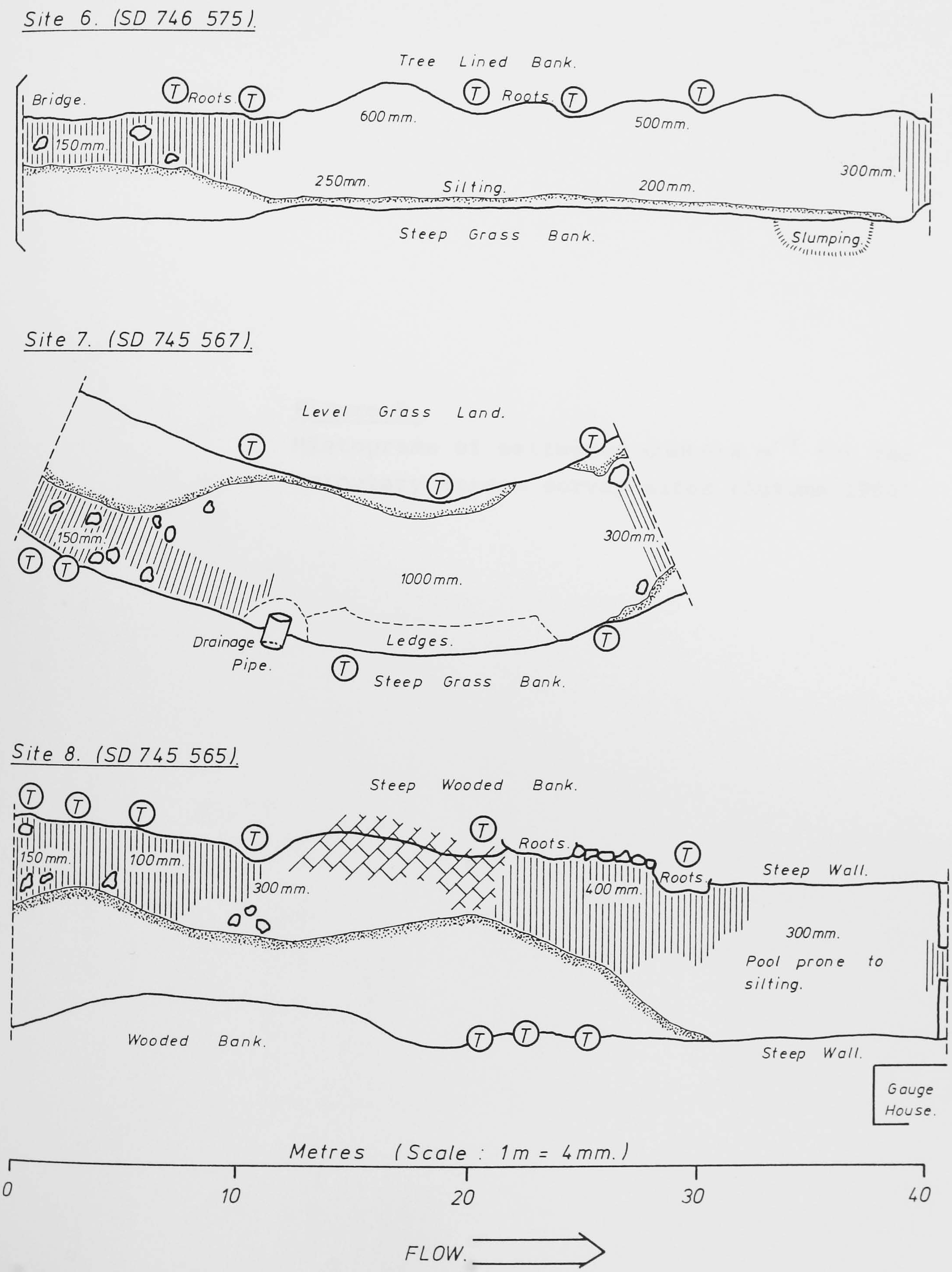


Figure 5.

Histograms of estimated numbers m^{-2} for the tributary stream survey sites (Autumn 1985).

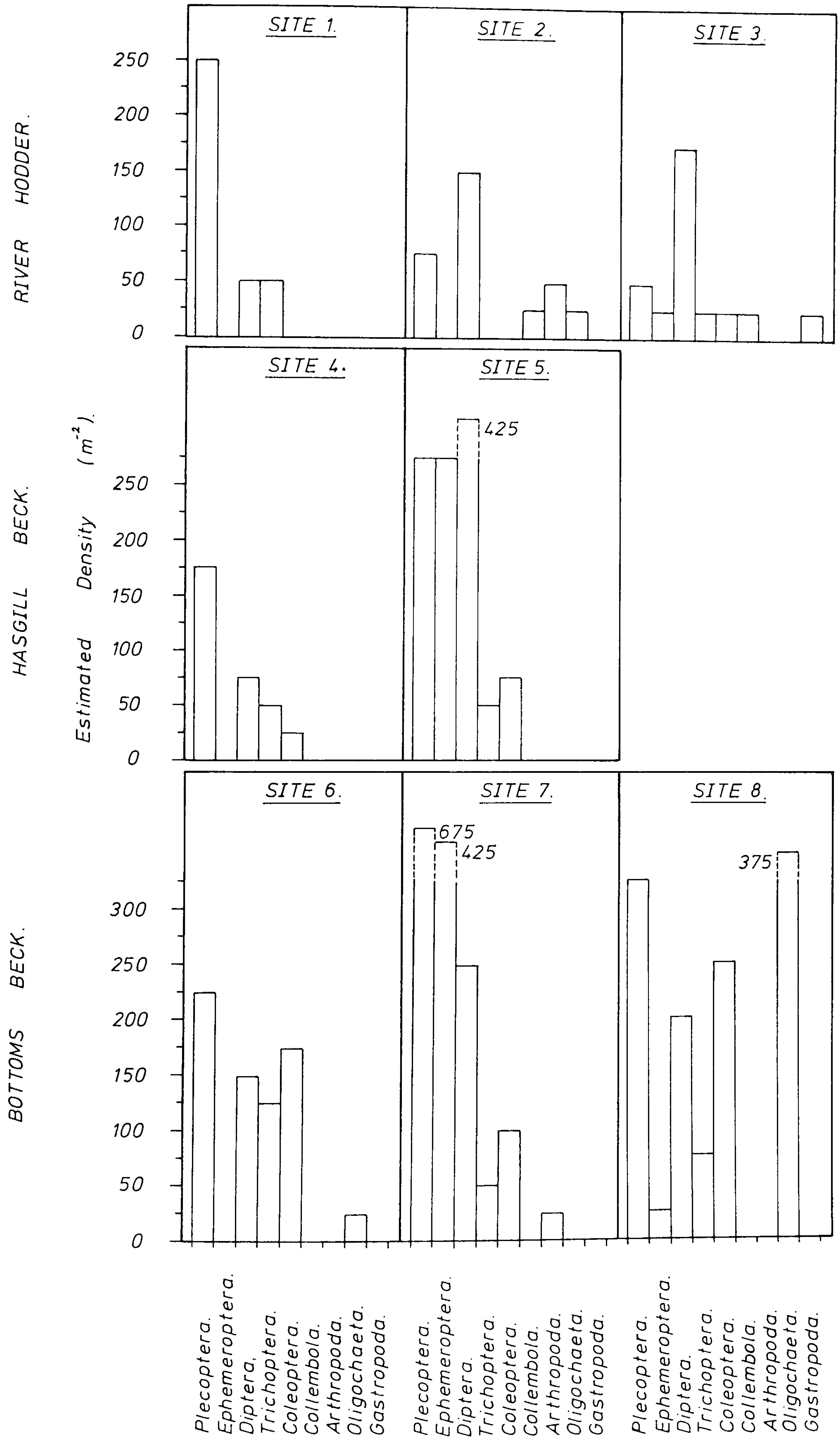
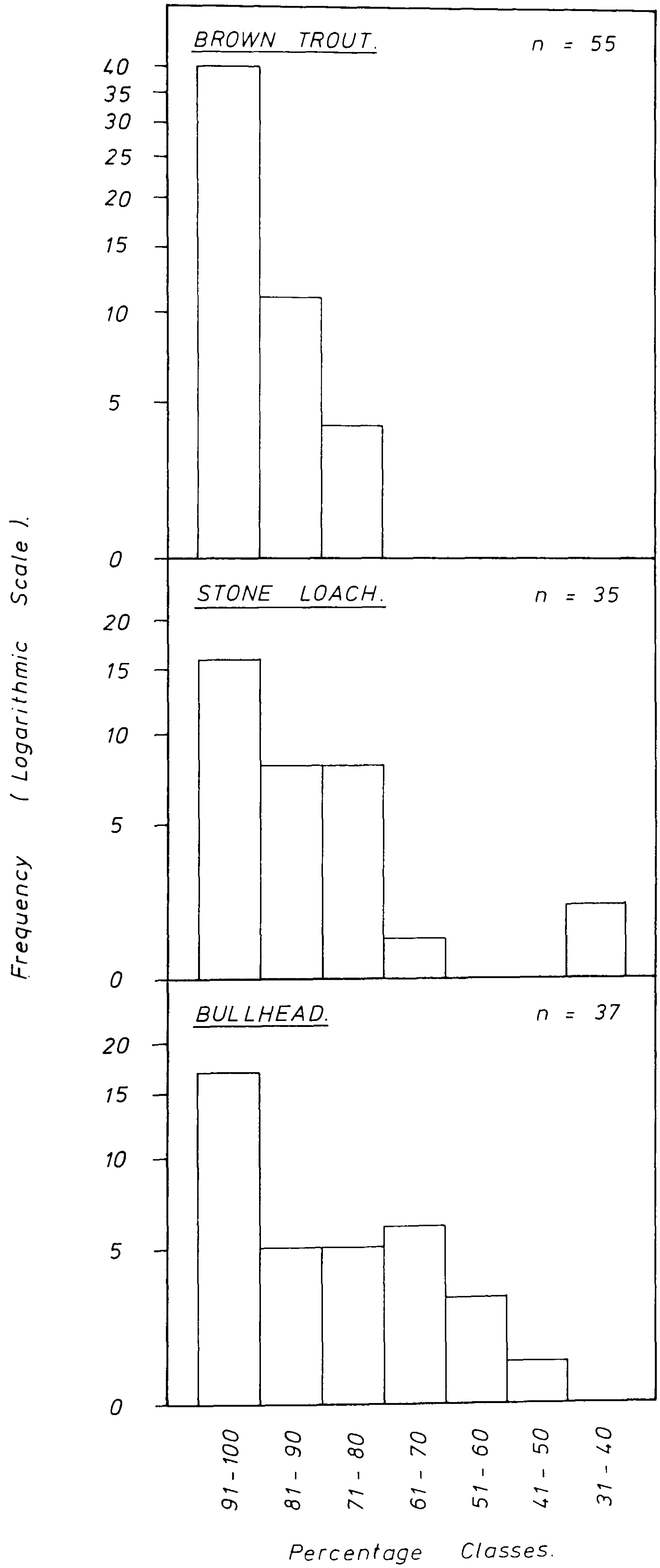

SITE 1.
SITE 2.
SITE 3.
SITE 4.
SITE 5.
SITE 6.
SITE 7.
SITE 8.
RIVER HODDER.
HASGILL BECK.
BOTTOMS BECK.
Estimated Density (m⁻²).
0
50
100
150
200
250
300
425
675
375
Plecoptera.
Ephemeroptera.
Diptera.
Trichoptera.
Coleoptera.
Collembola.
Arthropoda.
Oligochaeta.
Gastropoda.

Figure 6.

Distributions of Carle and Strub (1978) MWL Method population estimates as percentages of the Zippin (1956) Removal Method estimates.



BROWN TROUT.
n = 55
STONE LOACH.
n = 35
BULLHEAD.
n = 37
Frequency (Logarithmic Scale).
40
35
30
25
20
15
10
5
0
91 - 100
81 - 90
71 - 80
61 - 70
51 - 60
41 - 50
31 - 40
Percentage Classes.

Figure 7.

Bar charts displaying percentage species composition for successive site surveys.

Key.

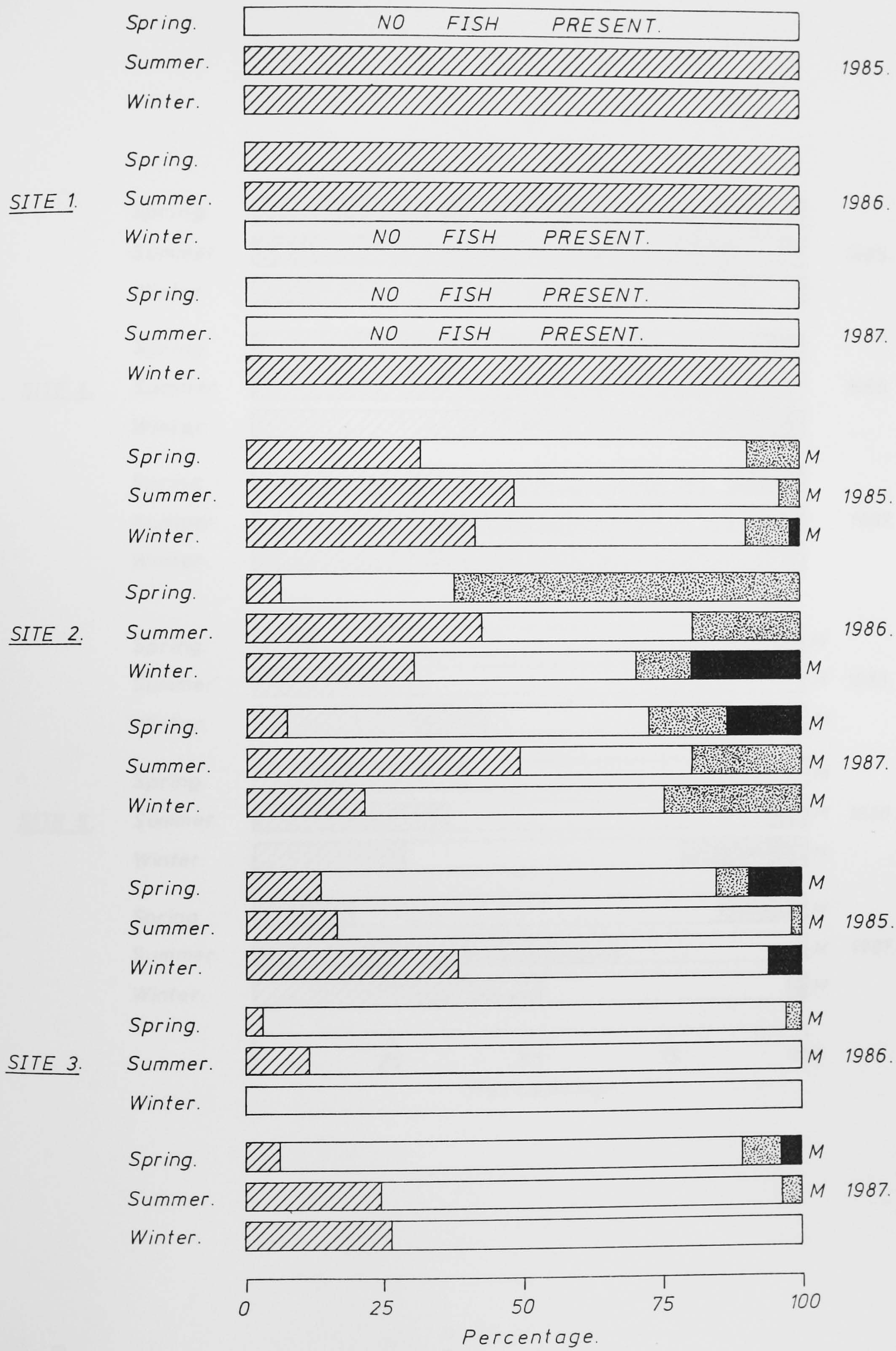
Brown trout.

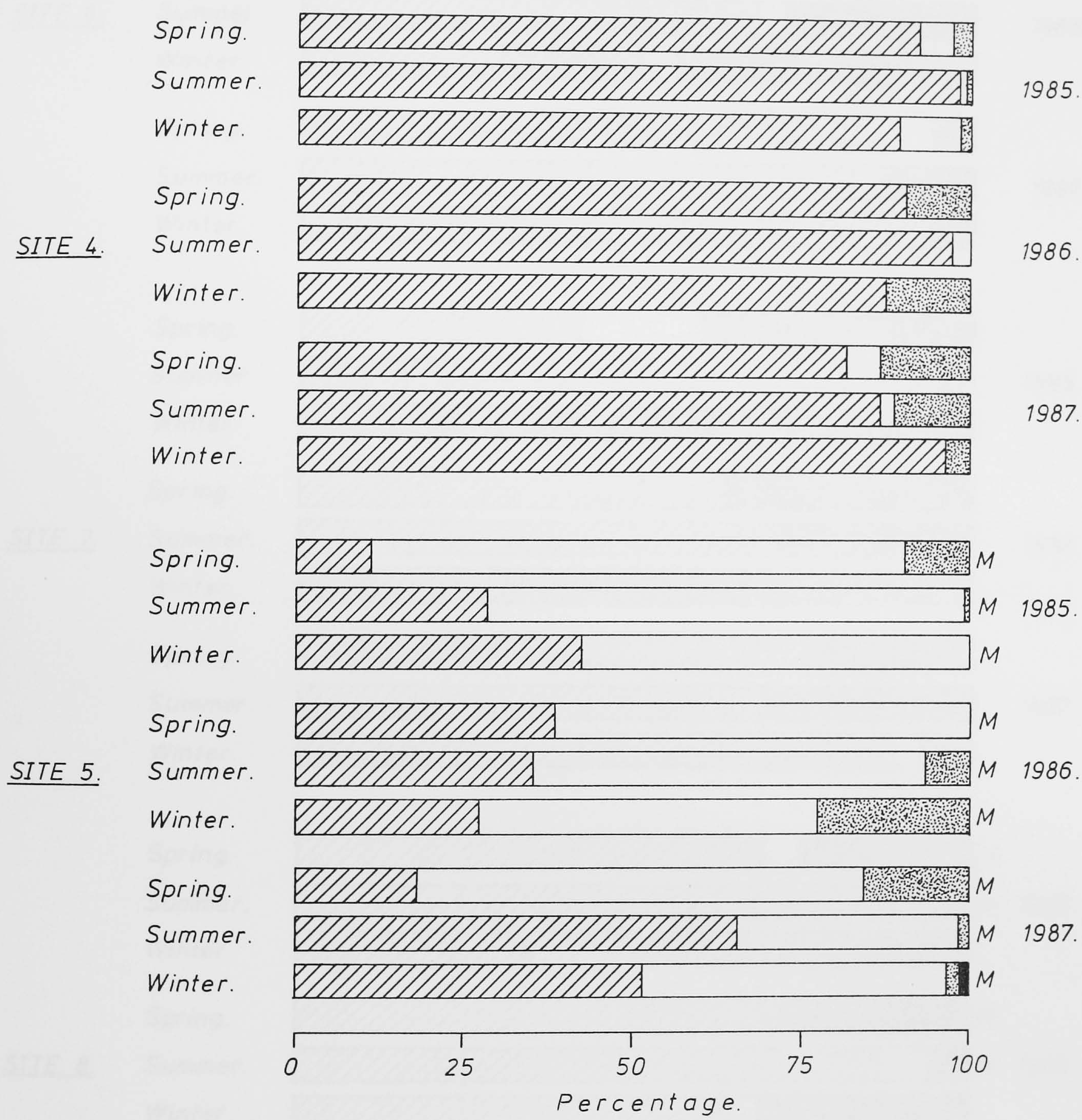
Stone loach.

Bullhead.

Rainbow trout.

M Denotes presence of minnow.


SITE 1.
SITE 2.
SITE 3.
Spring.
Summer.
Winter.
1985.
1986.
1987.
NO FISH PRESENT.
M
0
25
50
75
100
Percentage.



SITE 4.
Spring.
Summer.
Winter.
1985.
1986.
1987.
SITE 5.
M
0
25
50
75
100
Percentage.

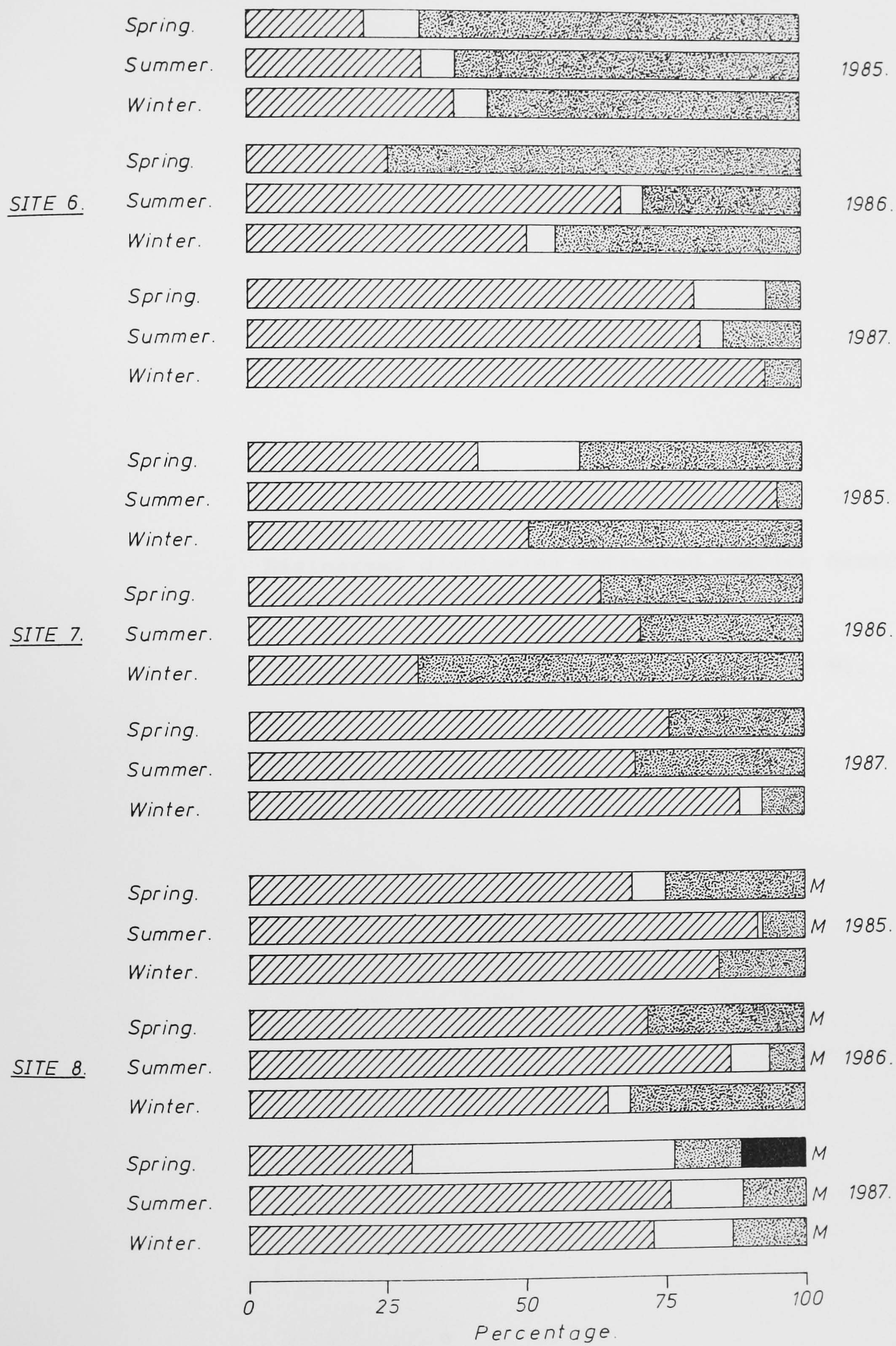
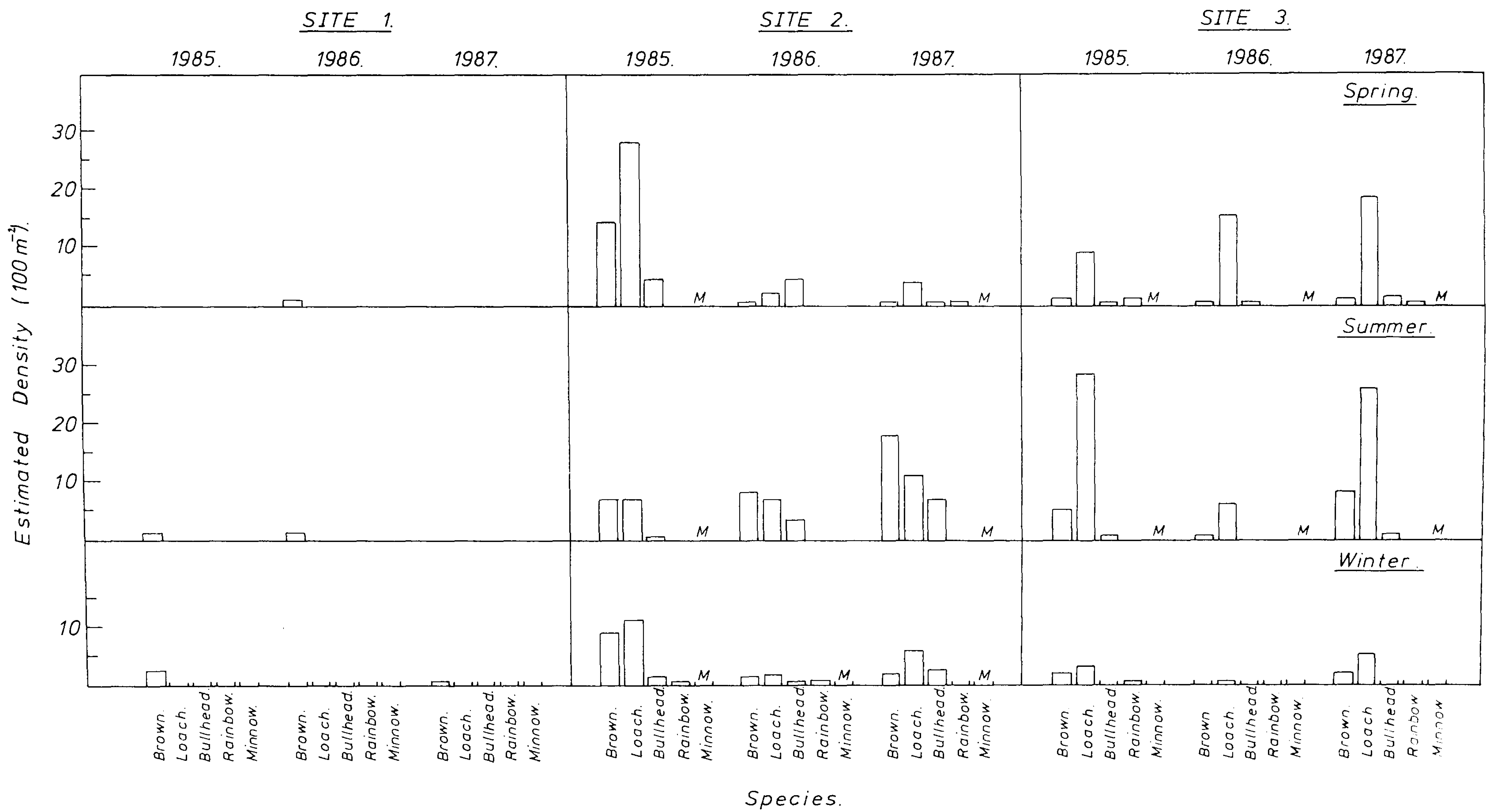

SITE 6.
Spring.
Summer.
Winter.
1985.
1986.
1987.
SITE 7.
SITE 8.
M
0
25
50
75
100
Percentage.

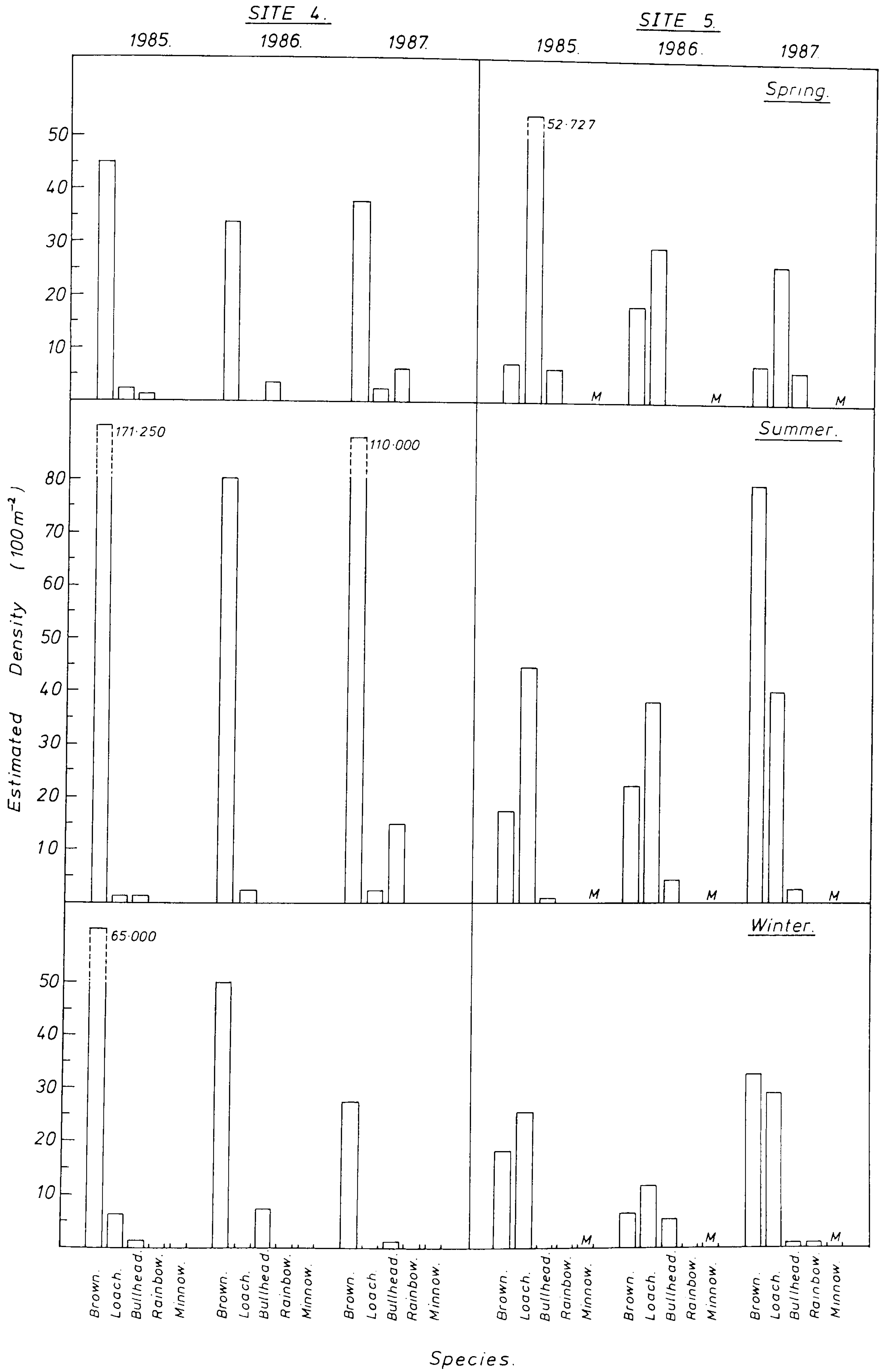
Figure 8.

Histograms displaying estimated species density ($100m^{-2}$) for each site survey.

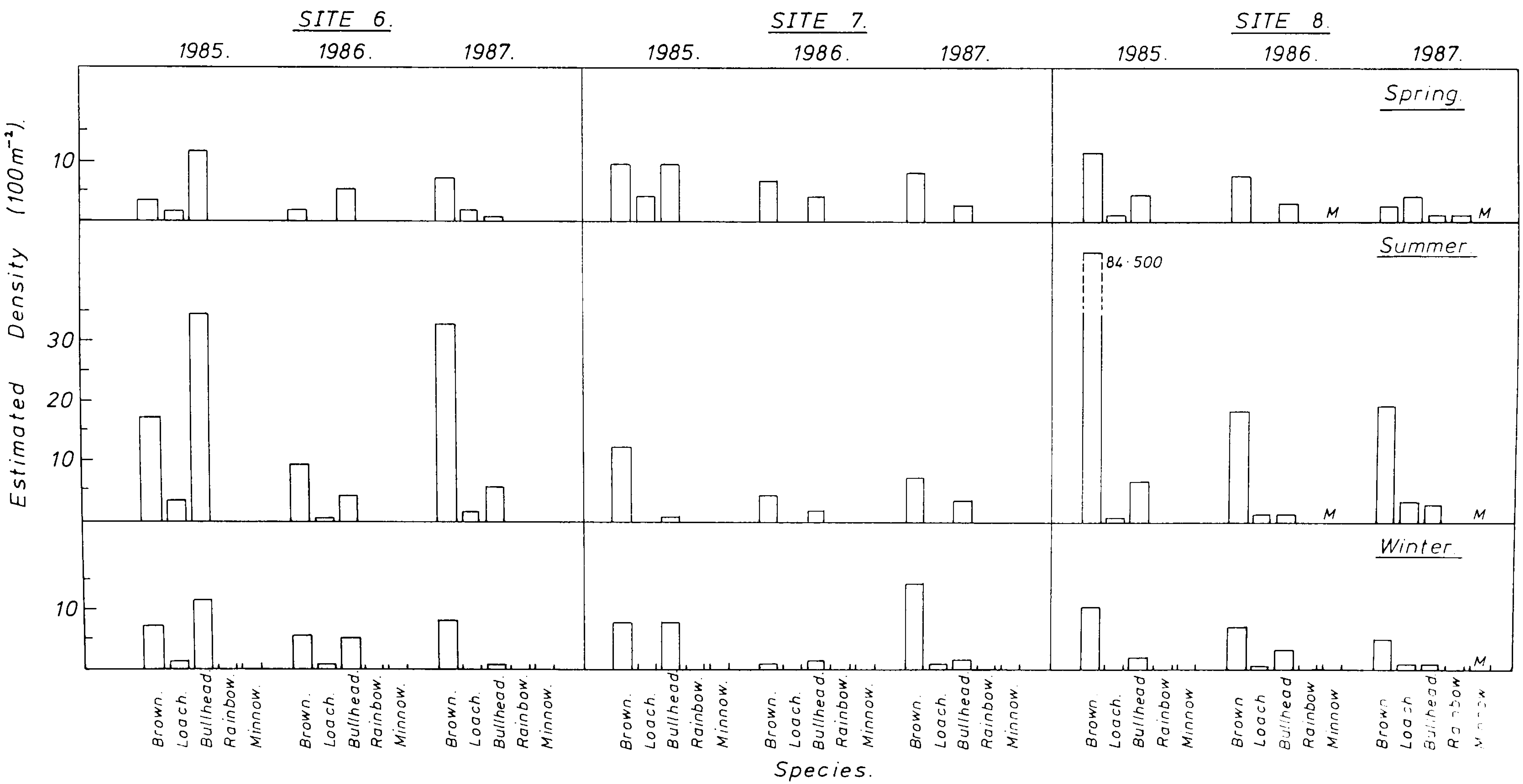
(Presence of minnow denoted by a letter M).



SITE 1.
SITE 2.
SITE 3.
1985.
1986.
1987.
Spring.
Summer.
Winter.
Estimated Density (100 m⁻²).
30
20
10
M
Brown.
Loach.
Bullhead.
Rainbow.
Minnow.
Species.



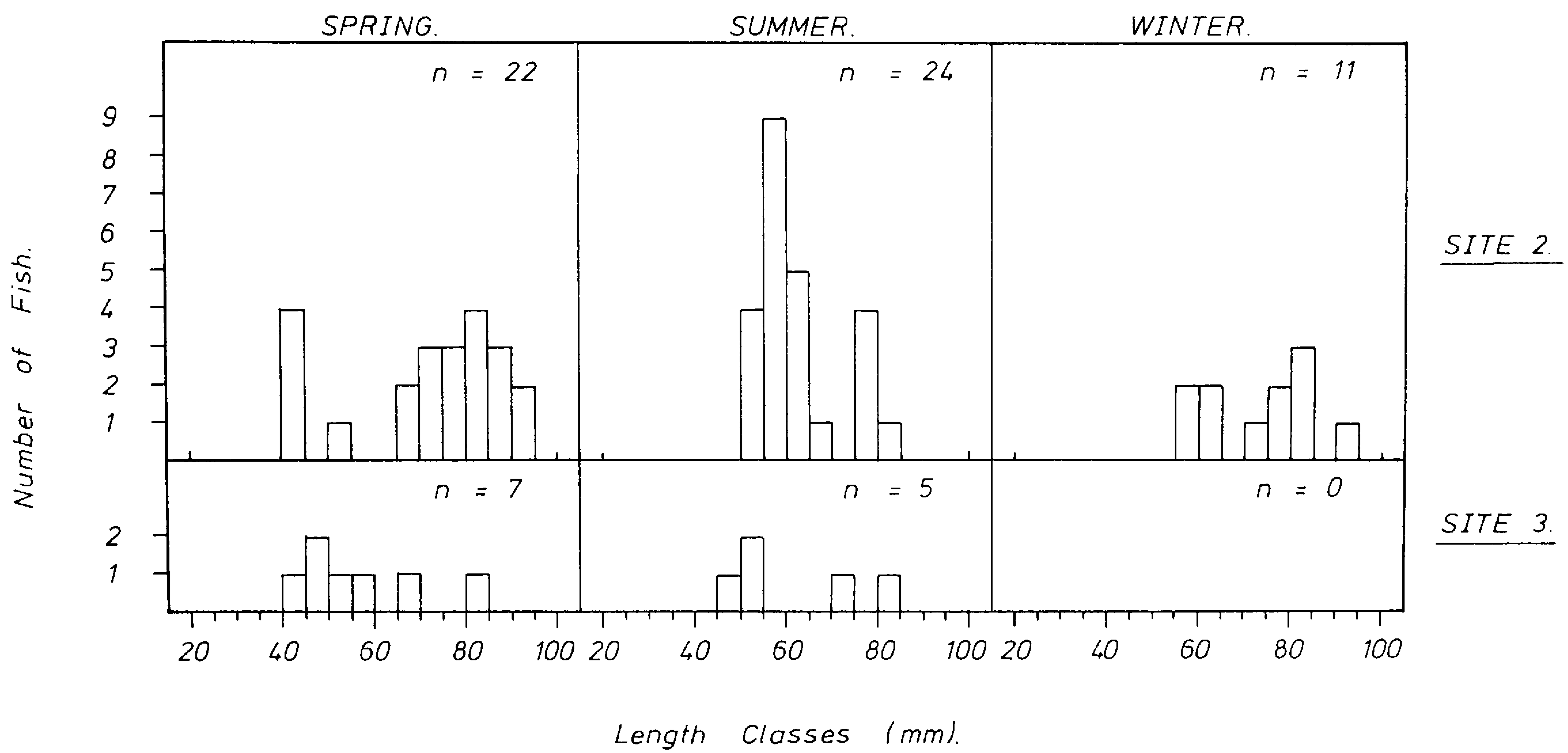
SITE 4.
1985.
1986.
1987.
SITE 5.
1985.
1986.
1987.
Spring.
52·727
M
Summer.
171·250
110·000
Winter.
65·000
Estimated Density (100 m-2)
10
20
30
40
50
60
70
80
Brown.
Loach.
Bullhead.
Rainbow.
Minnow.
Species.

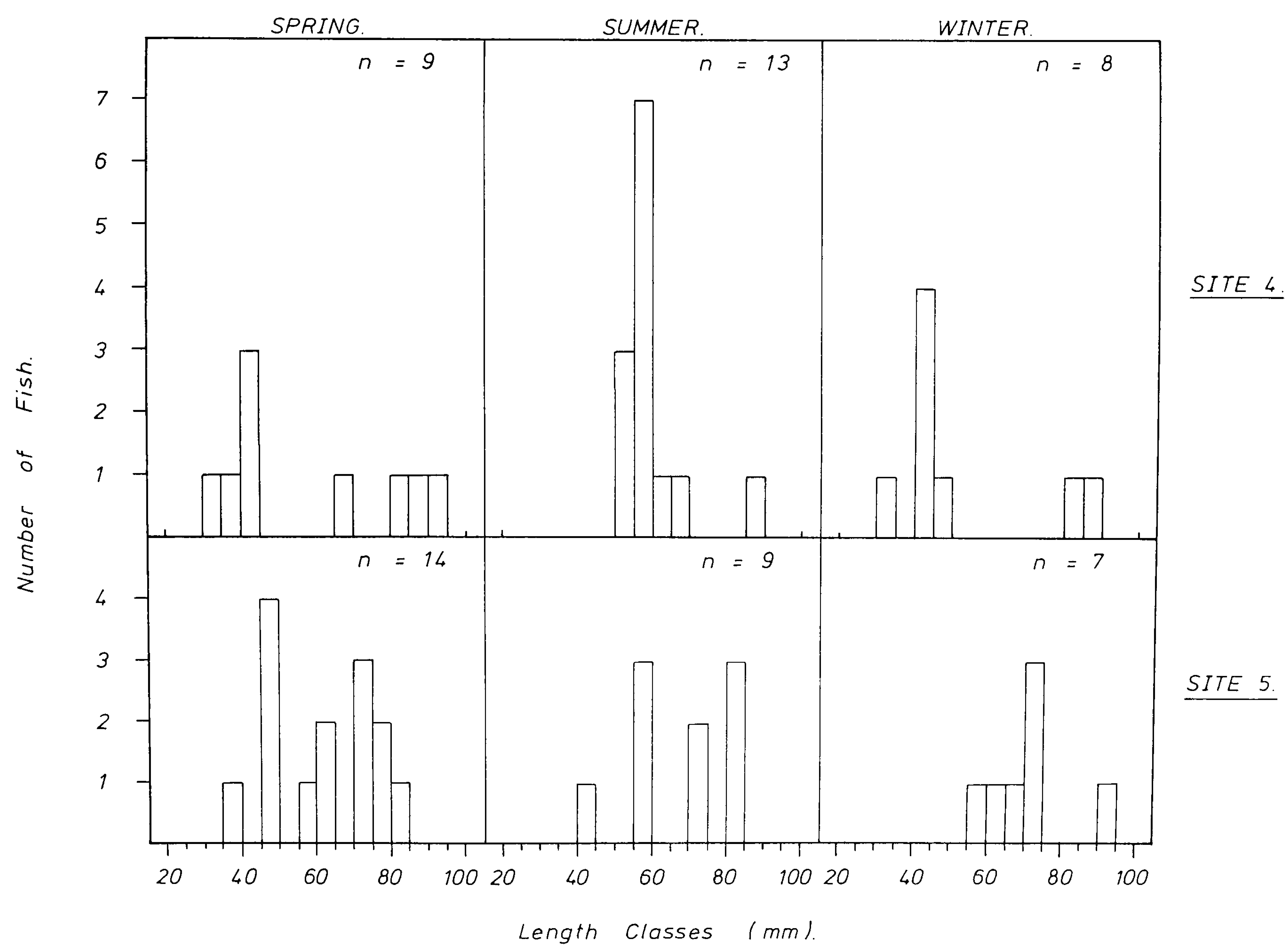


SITE 6.
SITE 7.
SITE 8.
1985.
1986.
1987.
Spring.
Summer.
Winter.
84·500
M
Estimated Density (100m⁻²).
10
20
30
Brown.
Loach.
Bullhead
Rainbow.
Minnow.
Species.

Figure 9.

Combined seasonal site length frequency histograms for bullhead, 1985 to 1987.


SPRING.
SUMMER.
WINTER.
n = 22
n = 24
n = 11
n = 7
n = 5
n = 0
SITE 2.
SITE 3.
Number of Fish.
Length Classes (mm).
9
8
7
6
5
4
3
2
1
20
40
60
80
100



SPRING.
SUMMER.
WINTER.
n = 9
n = 13
n = 8
n = 14
n = 9
n = 7
SITE 4.
SITE 5.
Number of Fish.
Length Classes (mm).

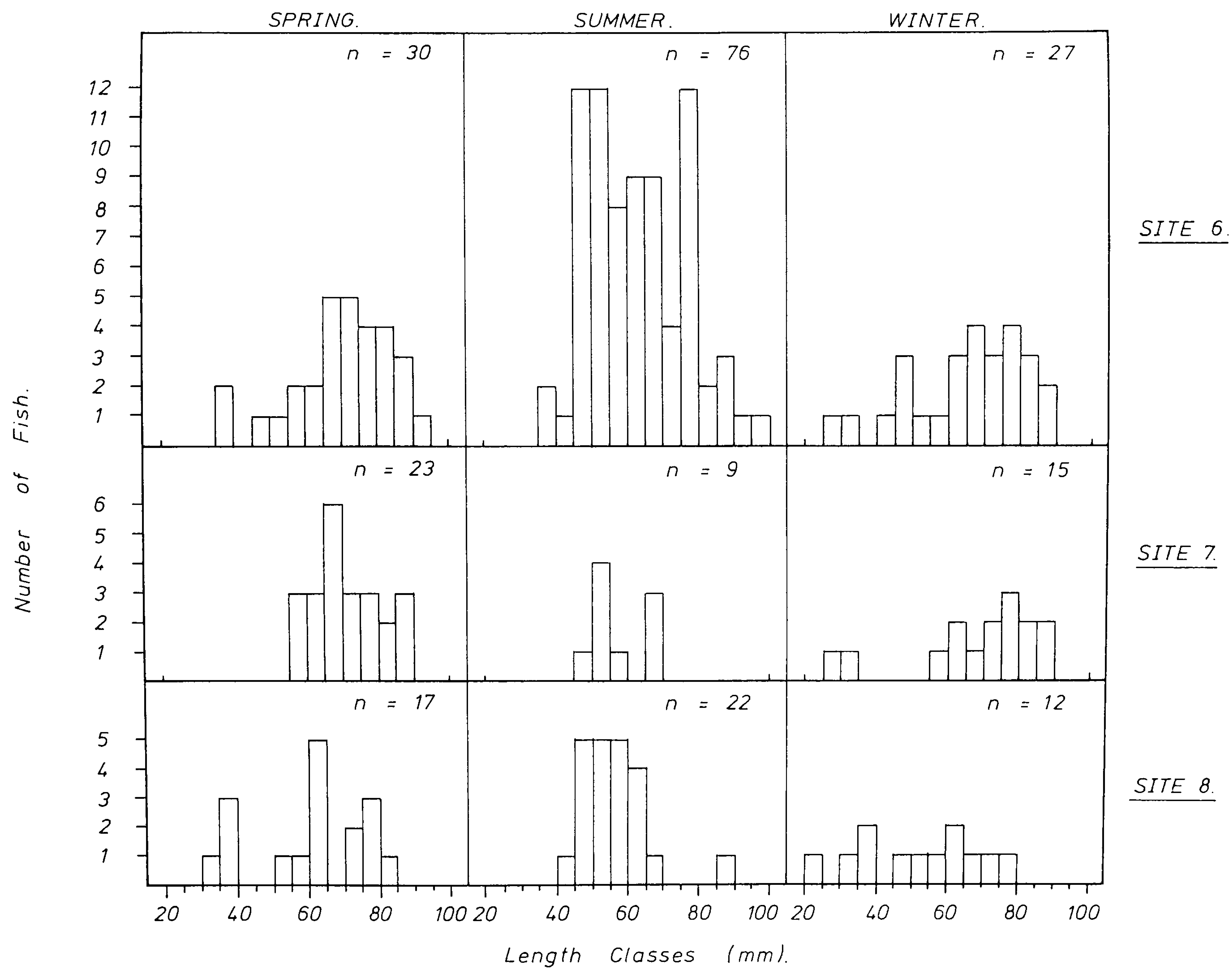
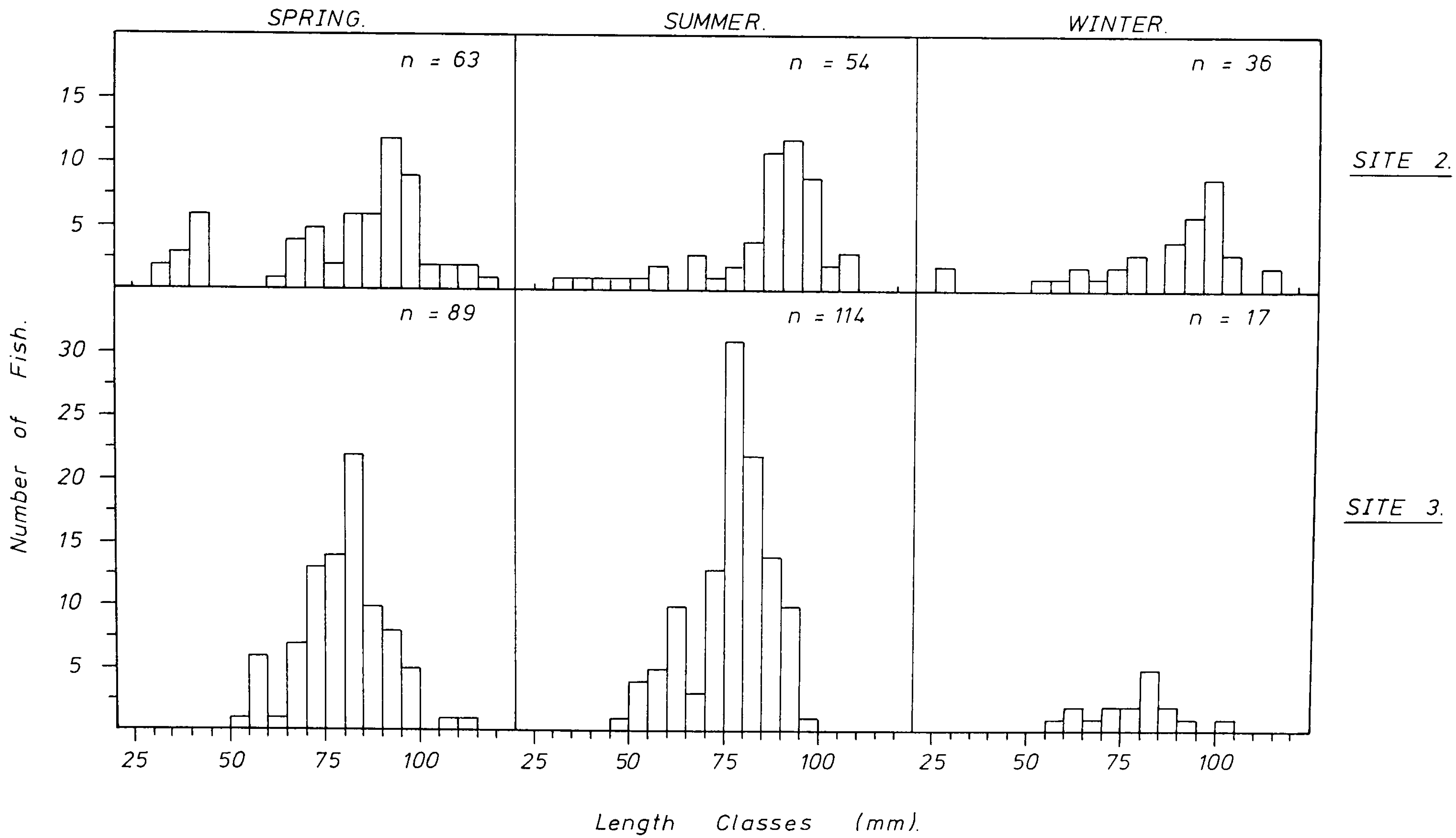
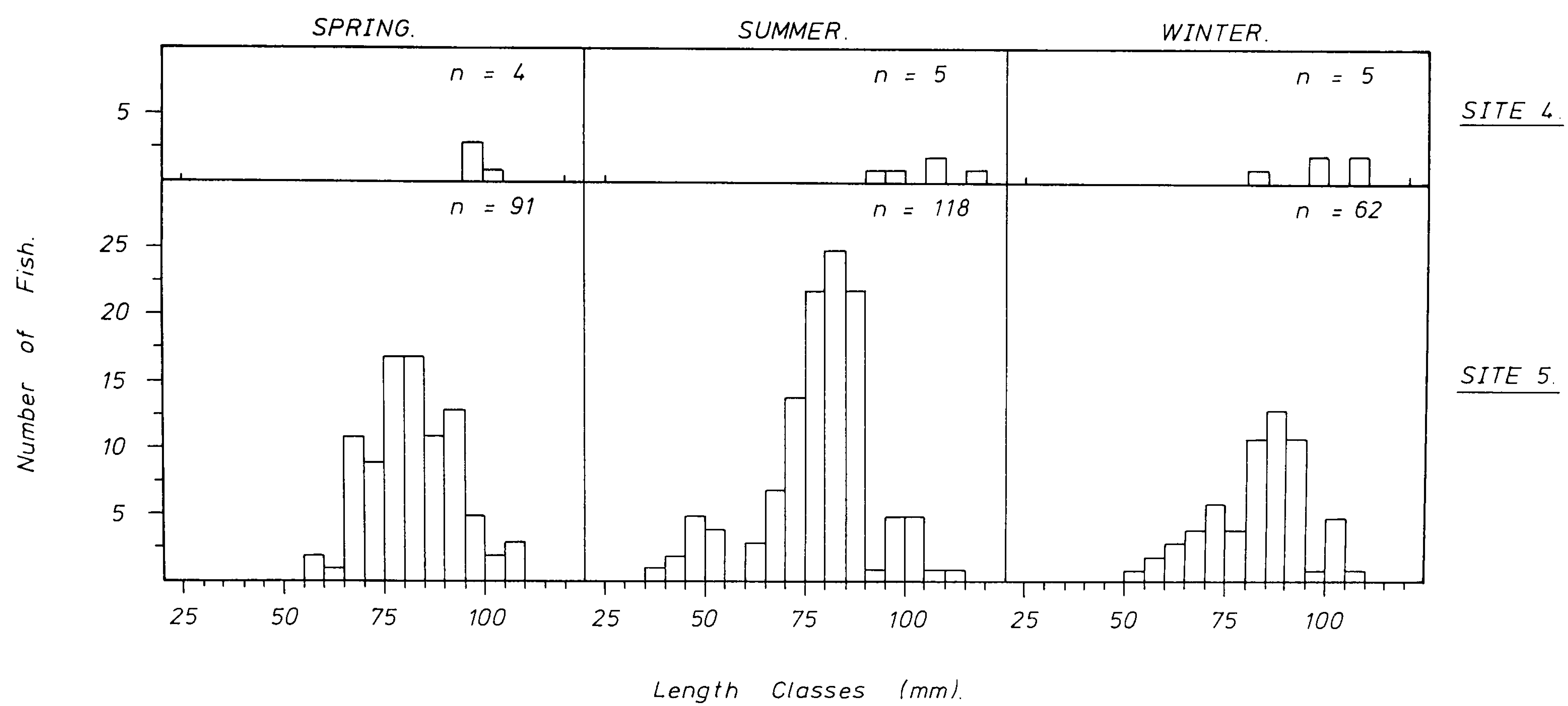

SPRING.
SUMMER.
WINTER.
SITE 6.
SITE 7.
SITE 8.
n = 30
n = 76
n = 27
n = 23
n = 9
n = 15
n = 17
n = 22
n = 12
Number of Fish.
Length Classes (mm).

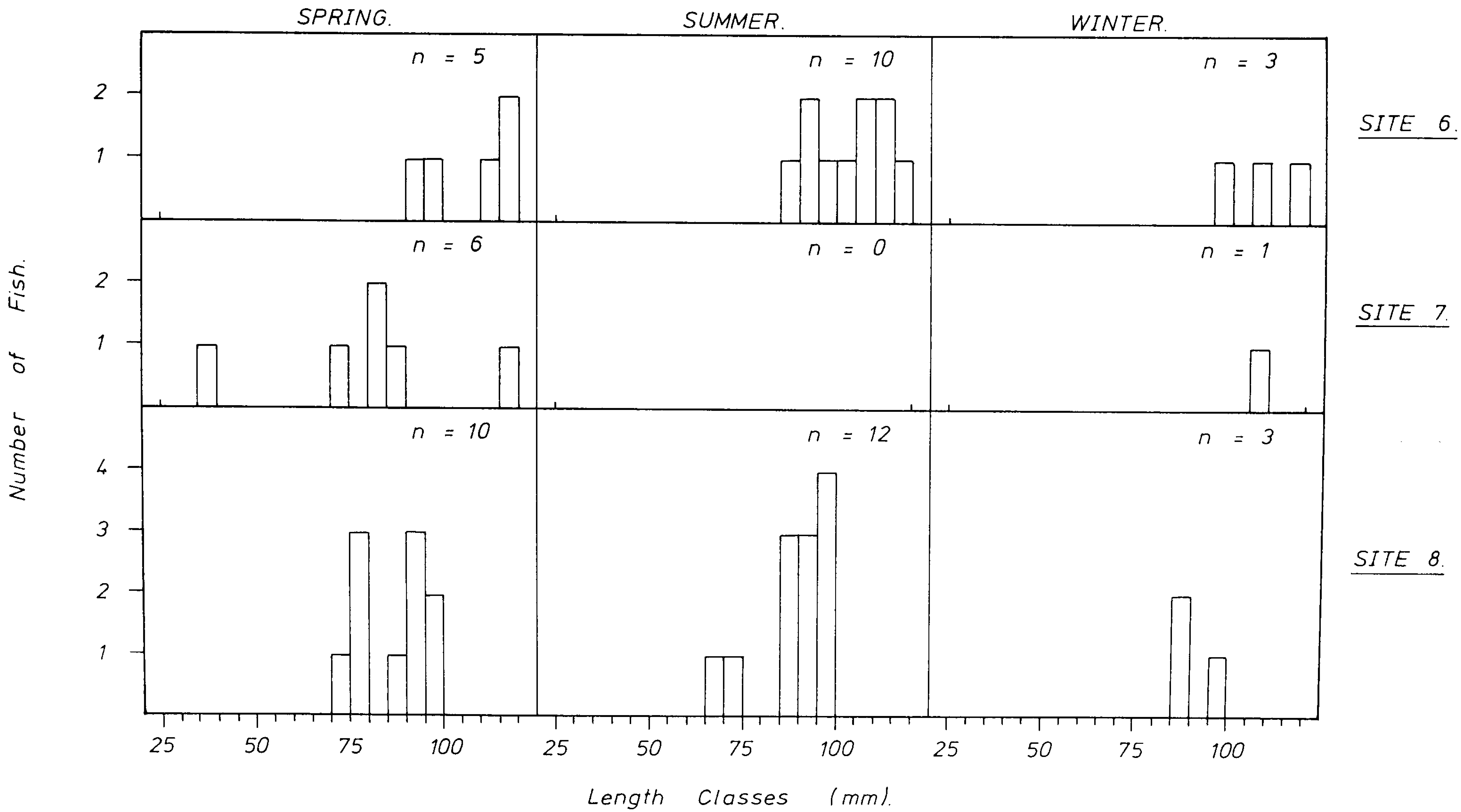
Figure 10.

Combined seasonal site length frequency histograms for stoneloach, 1985 to 1987.


SPRING.
SUMMER.
WINTER.
n = 63
n = 54
n = 36
n = 89
n = 114
n = 17
SITE 2.
SITE 3.
Number of Fish.
15
10
5
30
25
20
15
10
5
25
50
75
100
Length Classes (mm).



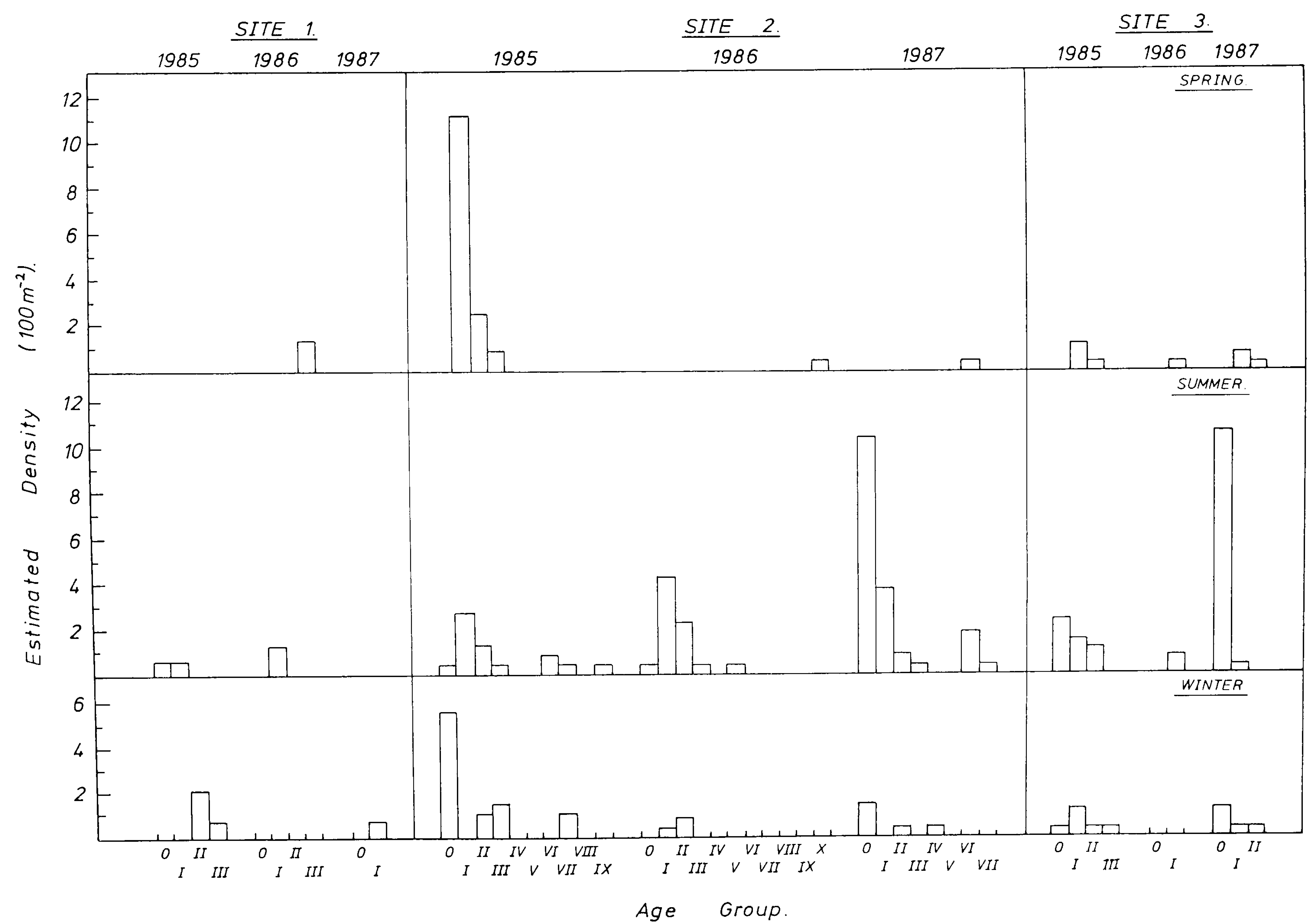
SPRING.
SUMMER.
WINTER.
n = 4
n = 5
n = 5
SITE 4.
n = 91
n = 118
n = 62
SITE 5.
Number of Fish.
5
25
20
15
10
5
25
50
75
100
Length Classes (mm).

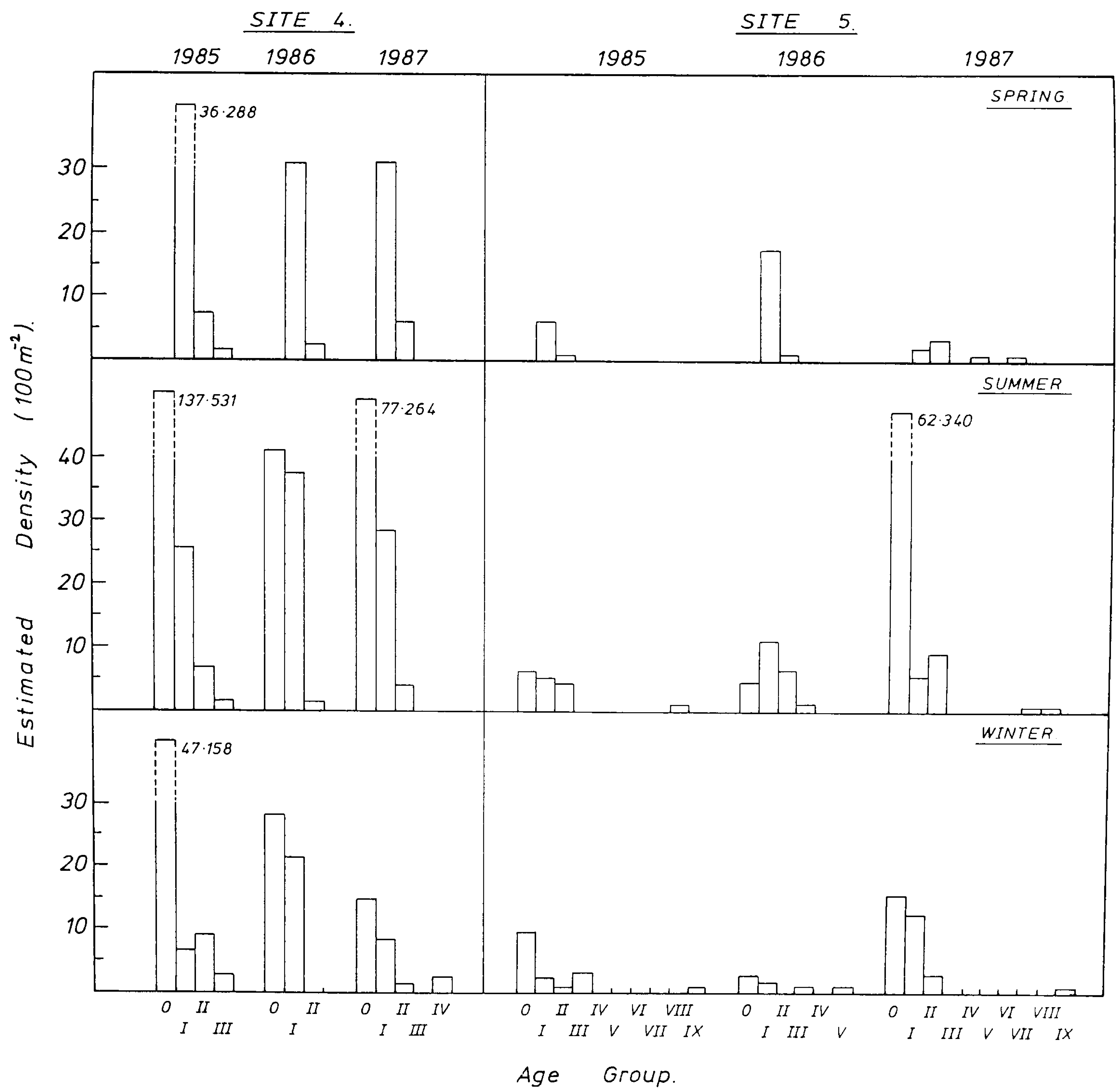


SPRING.
SUMMER.
WINTER.
n = 5
n = 10
n = 3
n = 6
n = 0
n = 1
n = 10
n = 12
n = 3
SITE 6.
SITE 7.
SITE 8.
Number of Fish.
Length Classes (mm).
25
50
75
100
1
2
3
4

Figure 11.

Histograms showing survey site brown trout age group density estimates ($100m^{-2}$).


SITE 1.
1985
1986
1987
SITE 2.
1985
1986
1987
SITE 3.
1985
1986
1987
SPRING.
SUMMER.
WINTER
Estimated Density (100 m⁻²).
Age Group.

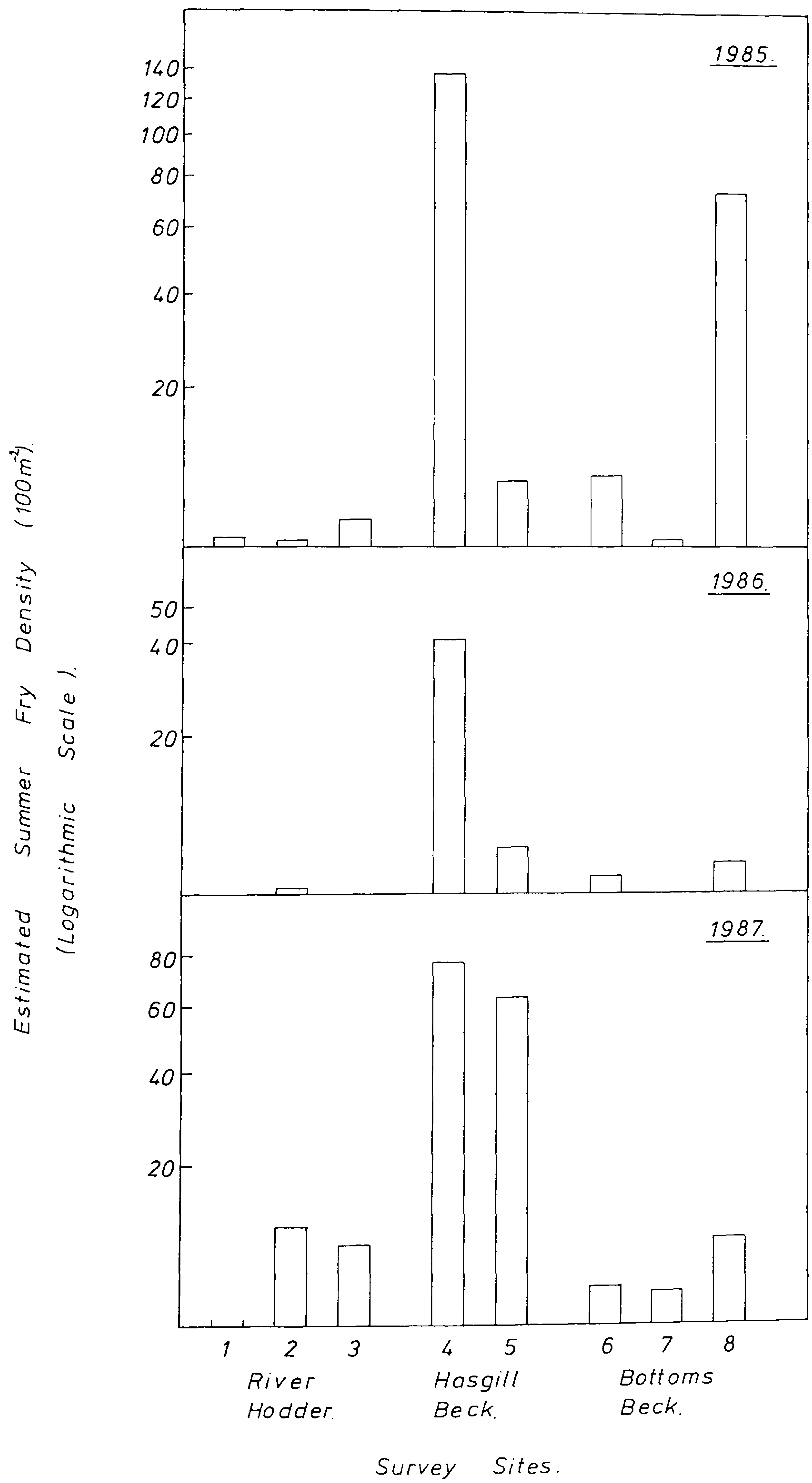


SITE 4.
SITE 5.
1985
1986
1987
1985
1986
1987
SPRING
SUMMER
WINTER
36·288
137·531
77·264
62·340
47·158
Estimated Density (100m-2).
Age Group.

SITE 6.
SITE 7.
SITE 8.
1985
1986
1987
SPRING
SUMMER
WINTER
11·500
75·171
14·389
14·576
Estimated Density (100 m⁻²)
Age Group.

Figure 12.

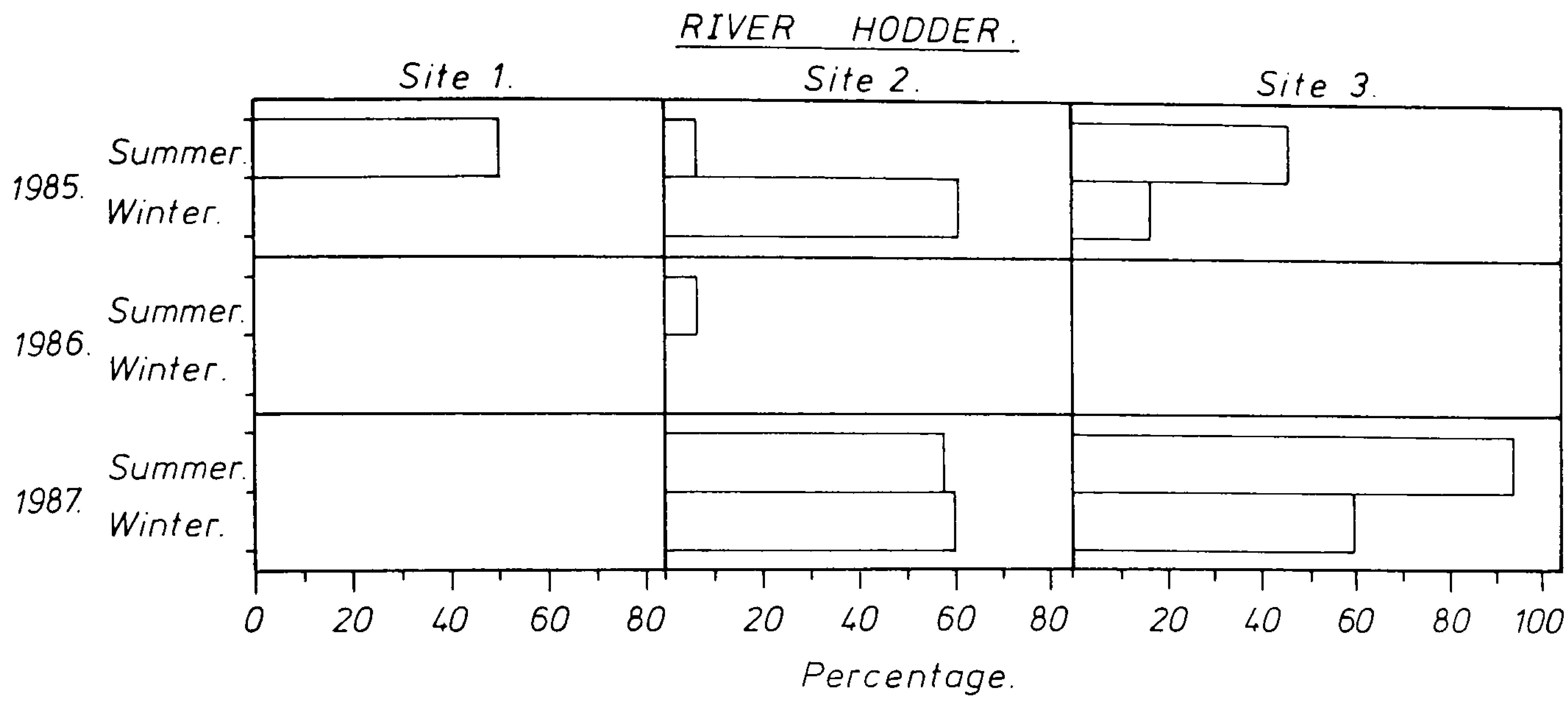
Histograms of survey site summer fry densities ($100m^{-2}$).

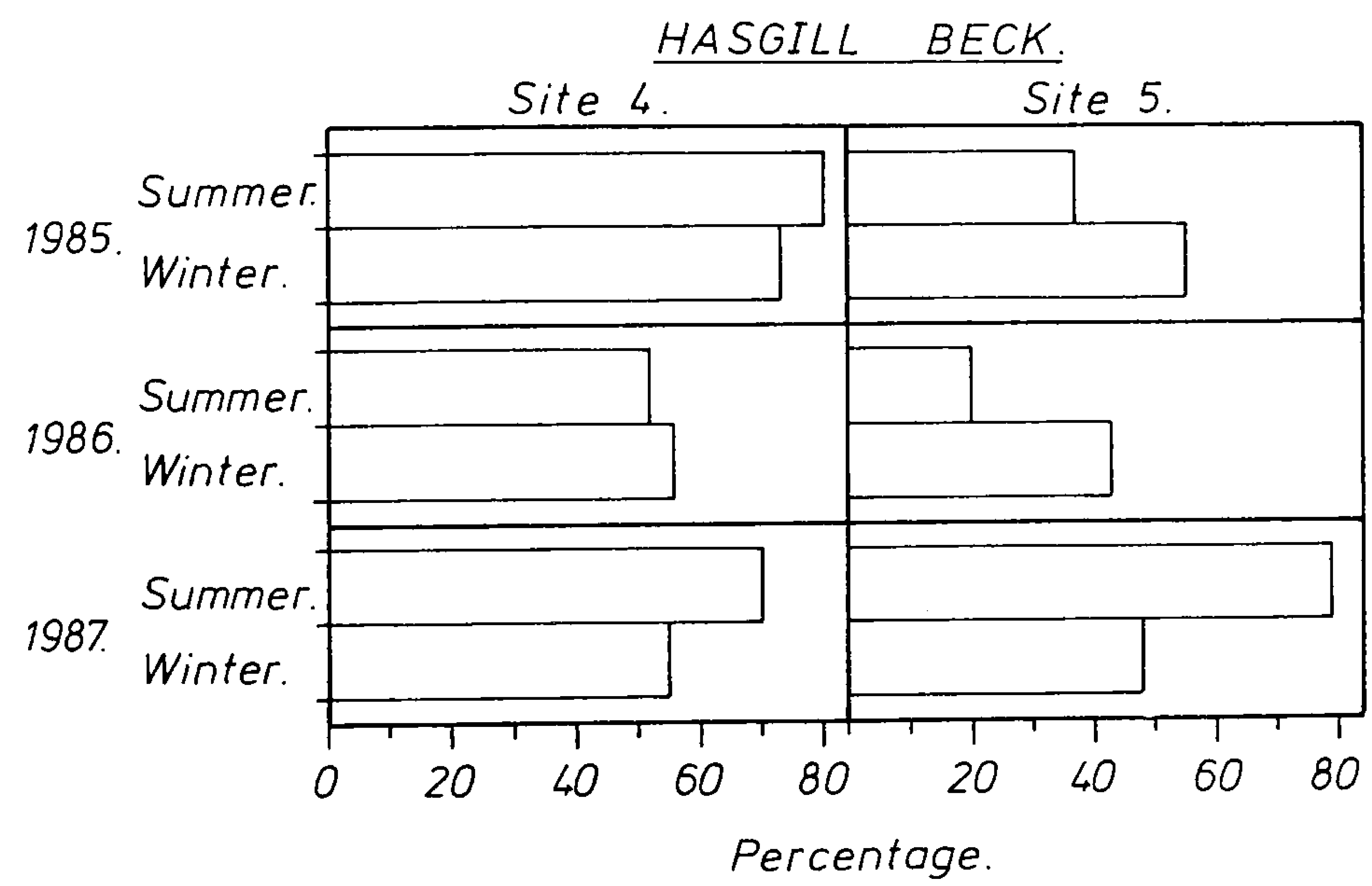


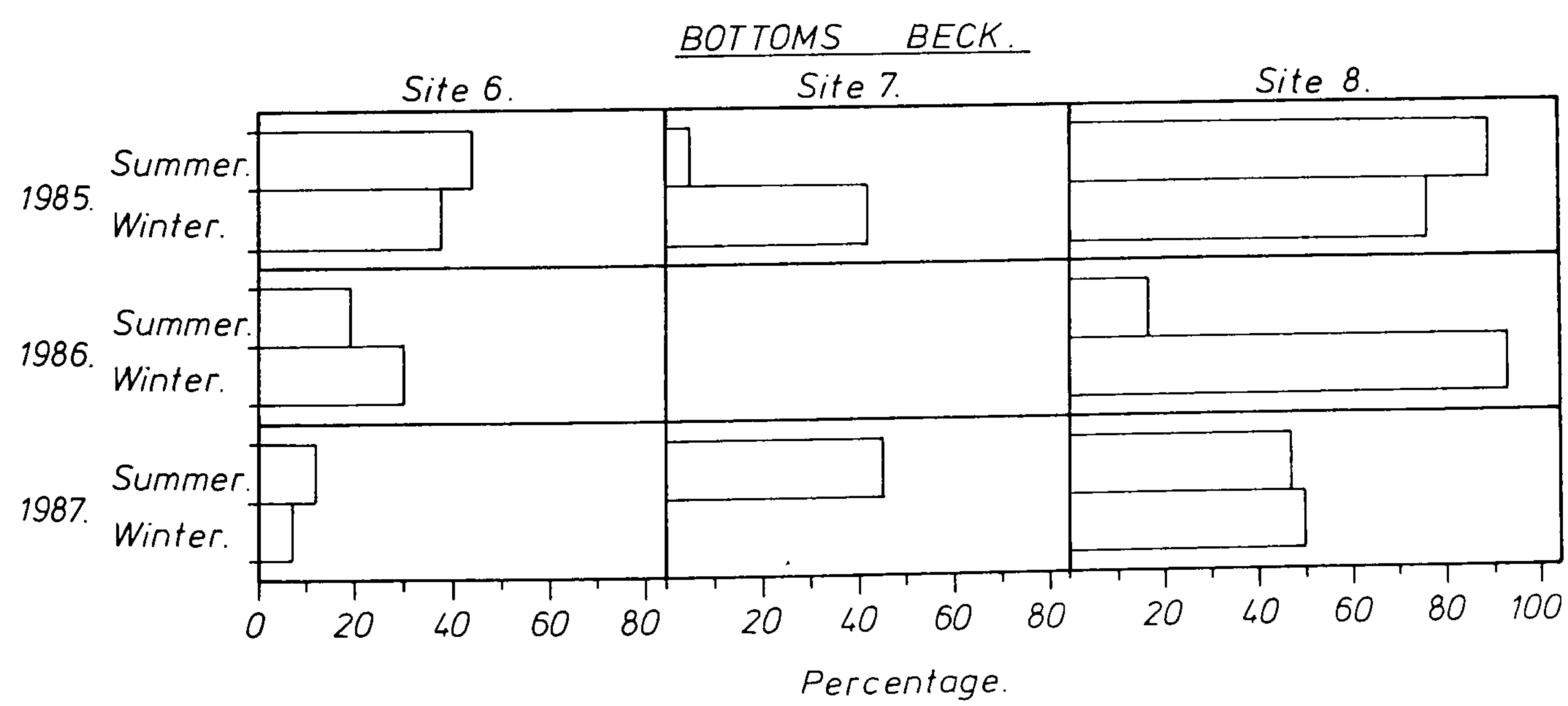
1985.
1986.
1987.
140
120
100
80
60
40
20
50
Estimated Summer Fry Density (100 m⁻²).
(Logarithmic Scale).
1
2
3
4
5
6
7
8
River Hodder.
Hasgill Beck.
Bottoms Beck.
Survey Sites.

Figure 13.

Bar charts depicting summer and winter survey site fry densities as percentages of the total brown trout population estimates.


RIVER HODDER.
Site 1.
Site 2.
Site 3.
1985.
1986.
1987.
Summer.
Winter.
0
20
40
60
80
100
Percentage.


HASGILL BECK.
Site 4.
Site 5.
1985.
1986.
1987.
Summer.
Winter.
0
20
40
60
80
Percentage.

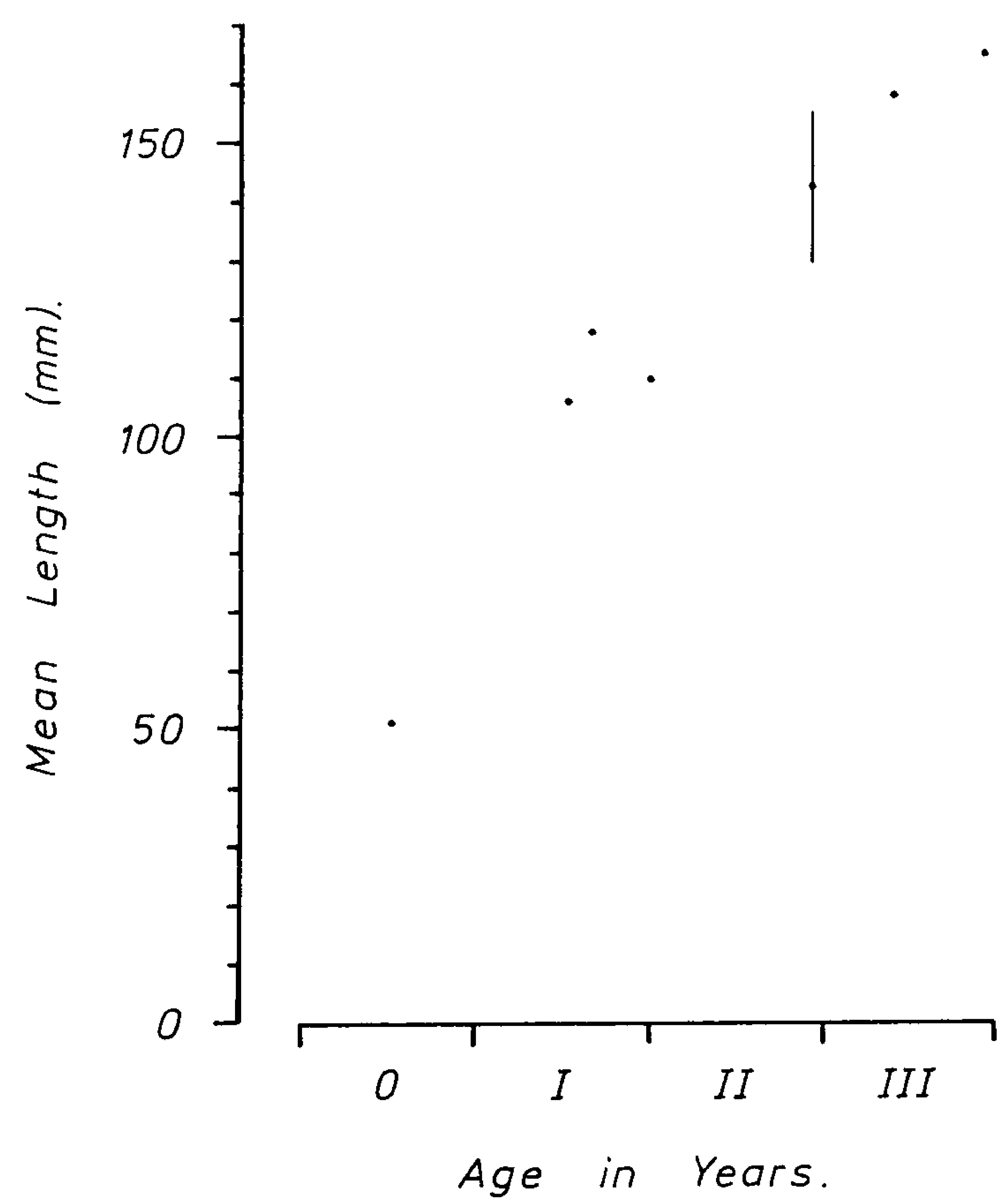

BOTTOMS BECK.
Site 6.
Site 7.
Site 8.
1985.
1986.
1987.
Summer.
Winter.
0
20
40
60
80
100
Percentage.

Curves of observed brown trout mean length for age, 1985 to 1987.

Figure 14. site 1.	
Figure 15. site 2.	River Hodder.
Figure 16. site 3.	
Figure 17. site 4.	Hasgill Beck.
Figure 18. site 5.	
Figure 19. site 6.	
Figure 20. site 7.	Bottoms Beck.
Figure 21. site 8.	

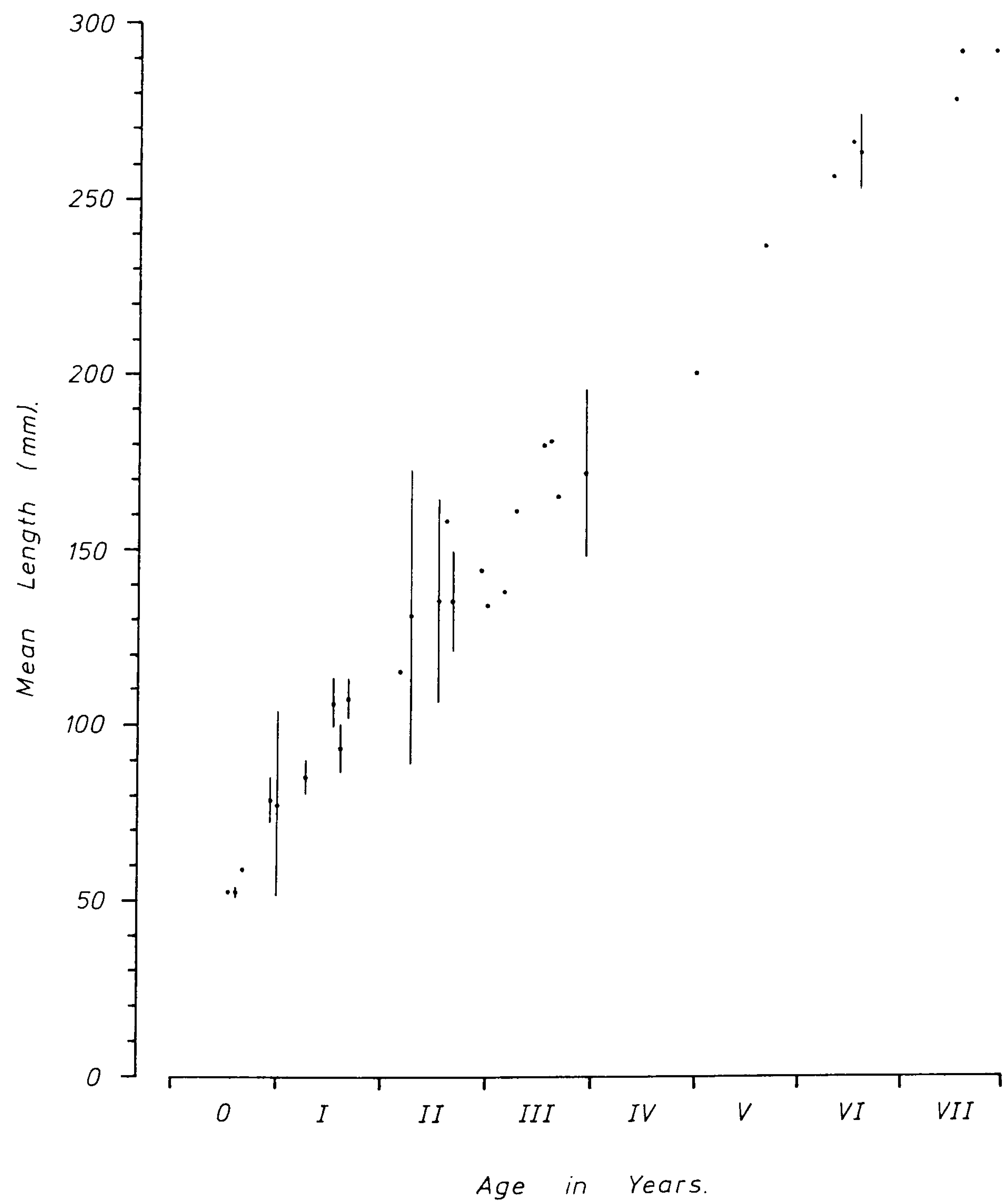
RIVER HODDER.

Figure 14. Site 1.



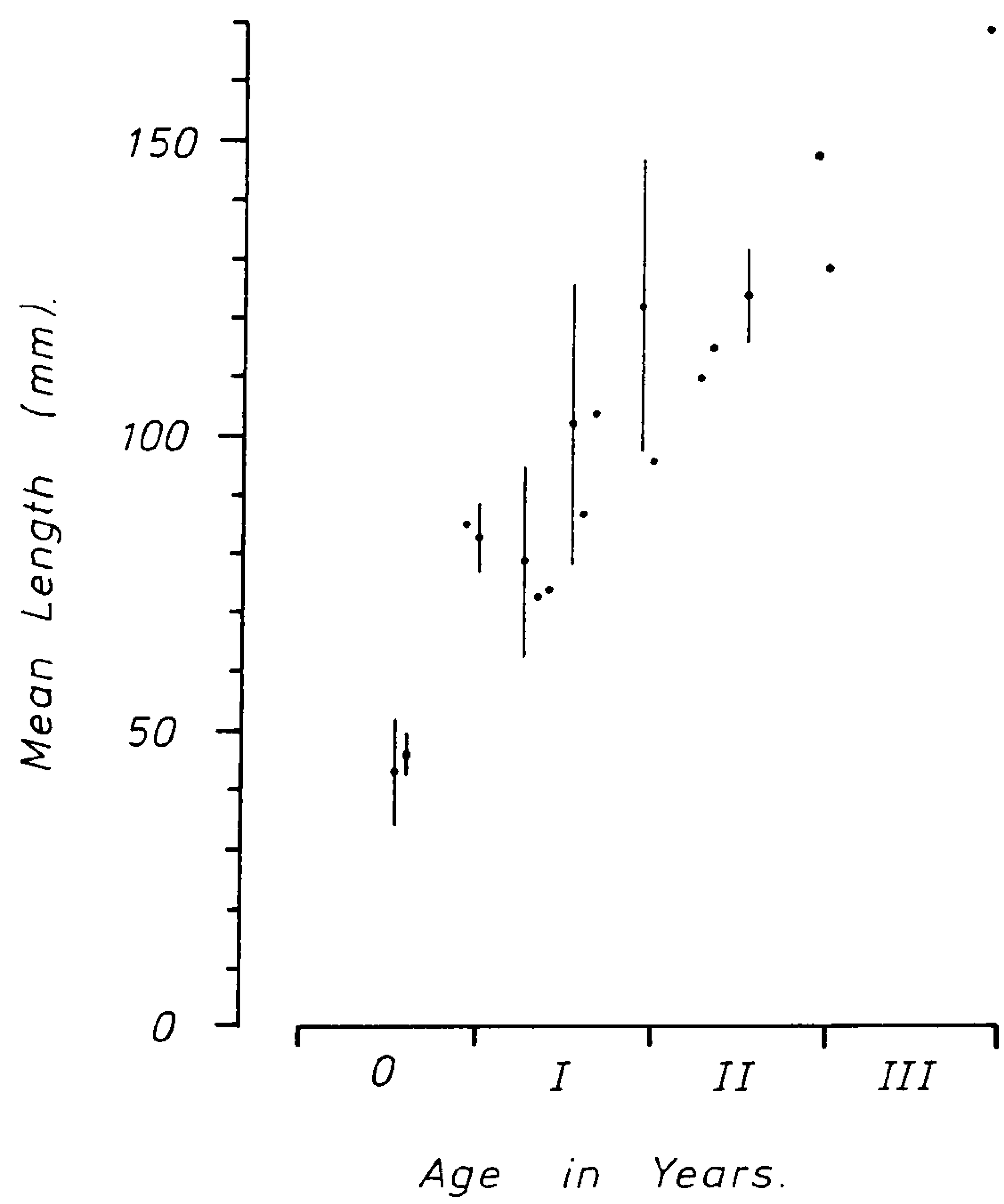
RIVER HODDER.

Figure 15. Site 2.



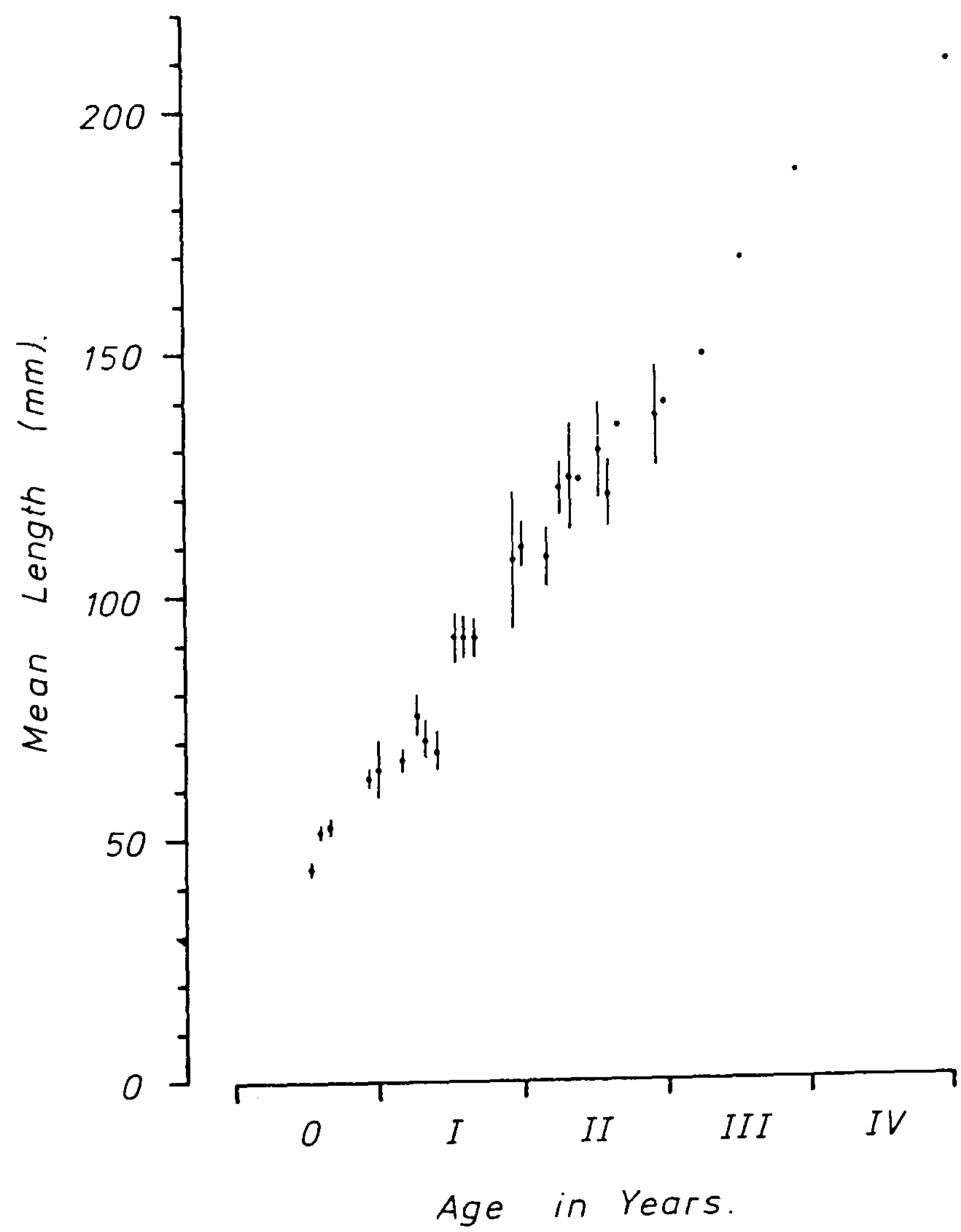
RIVER HODDER.

Figure 16. Site 3.



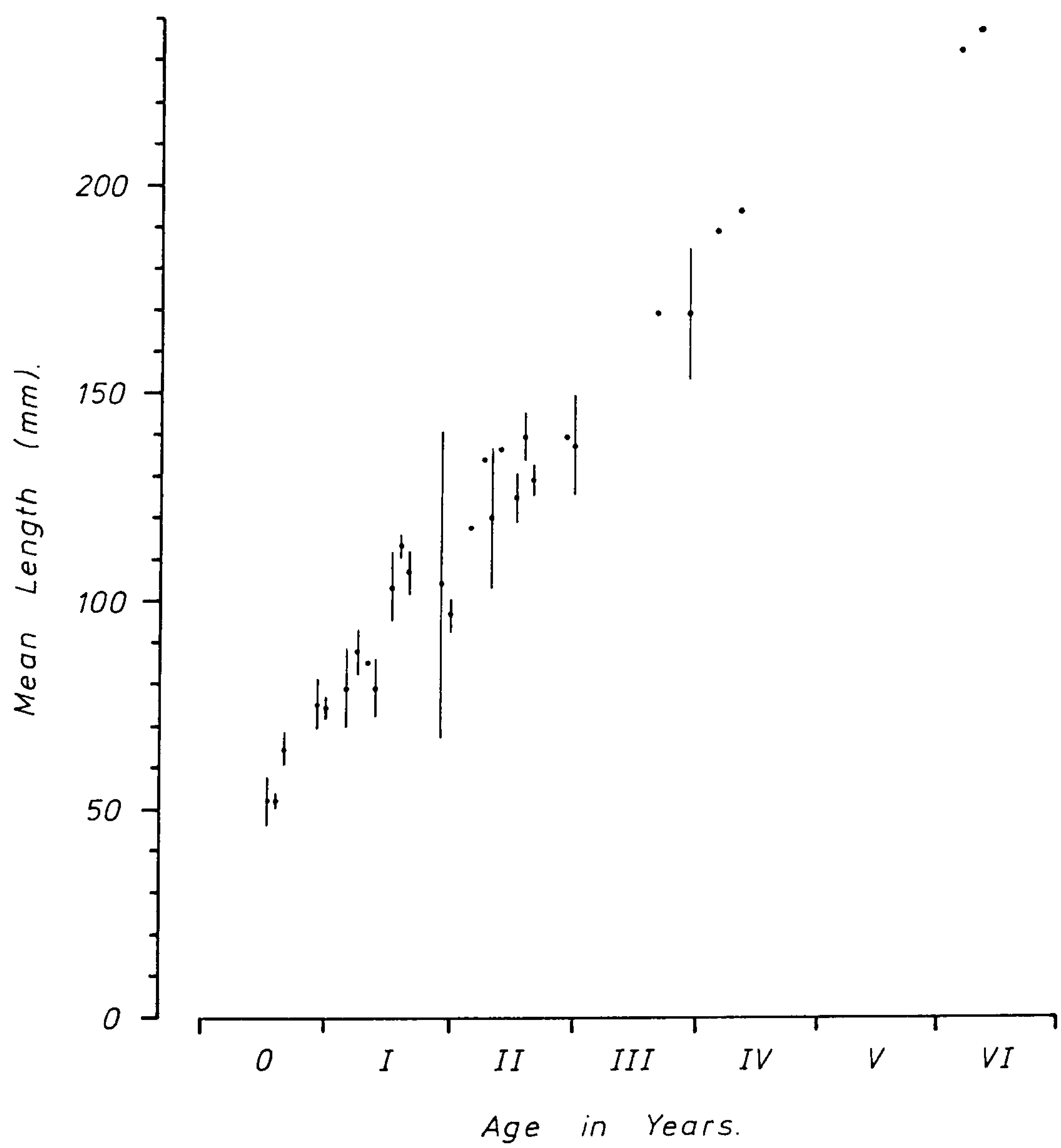
HASGILL BECK.

Figure 17. Site 4.



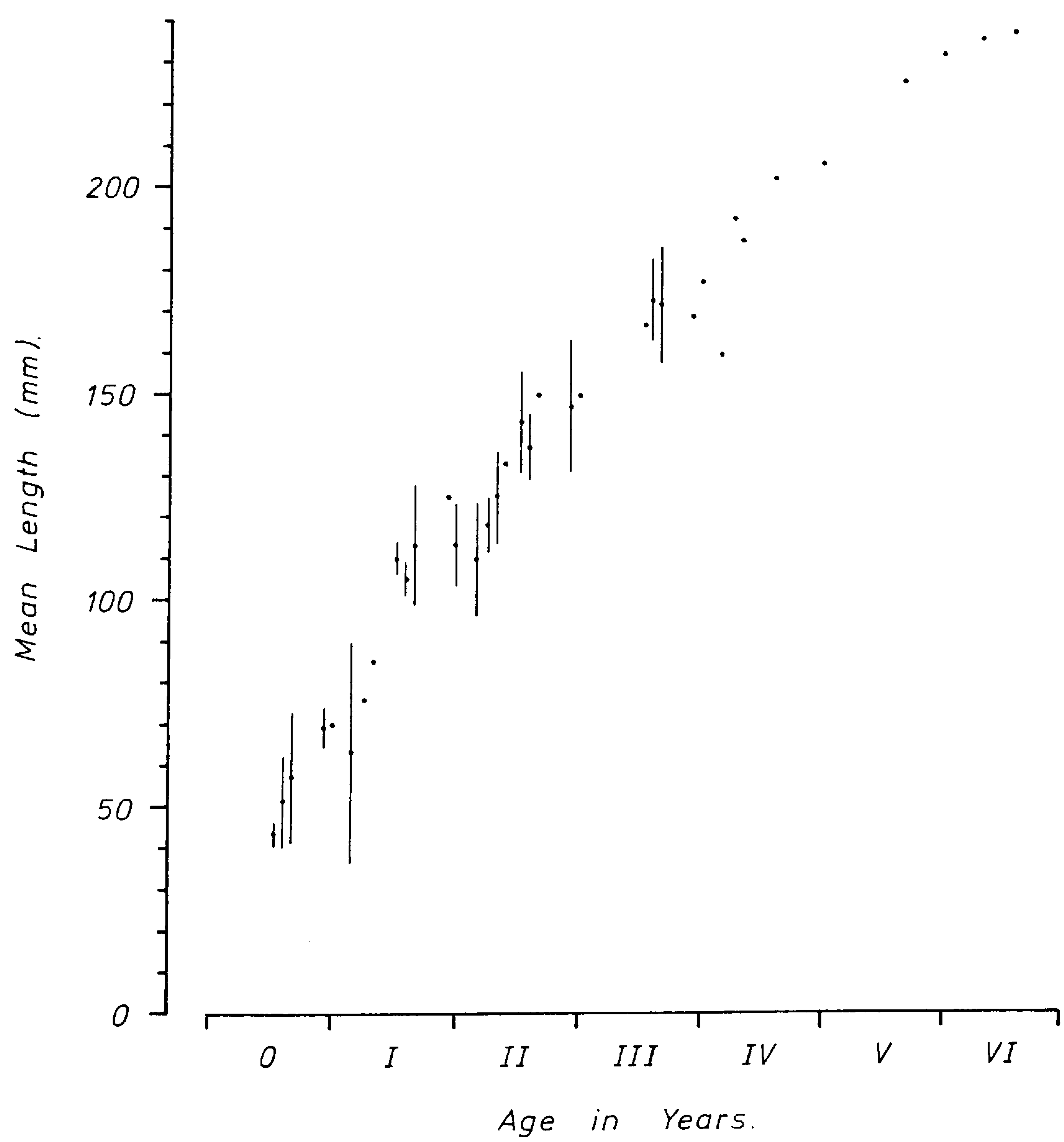
HASGILL BECK.

Figure 18. Site 5.



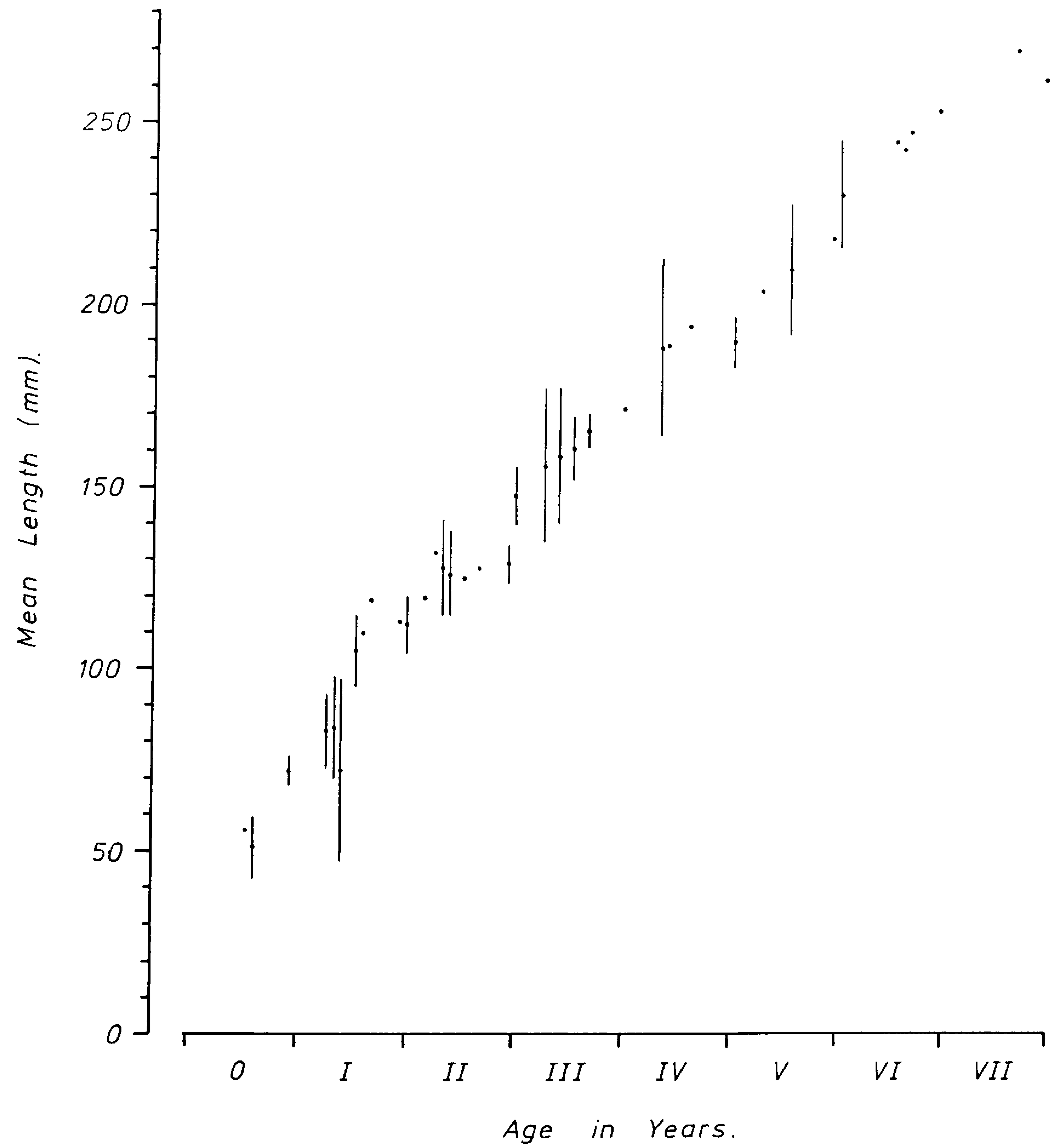
BOTTOMS BECK.

Figure 19. Site 6.



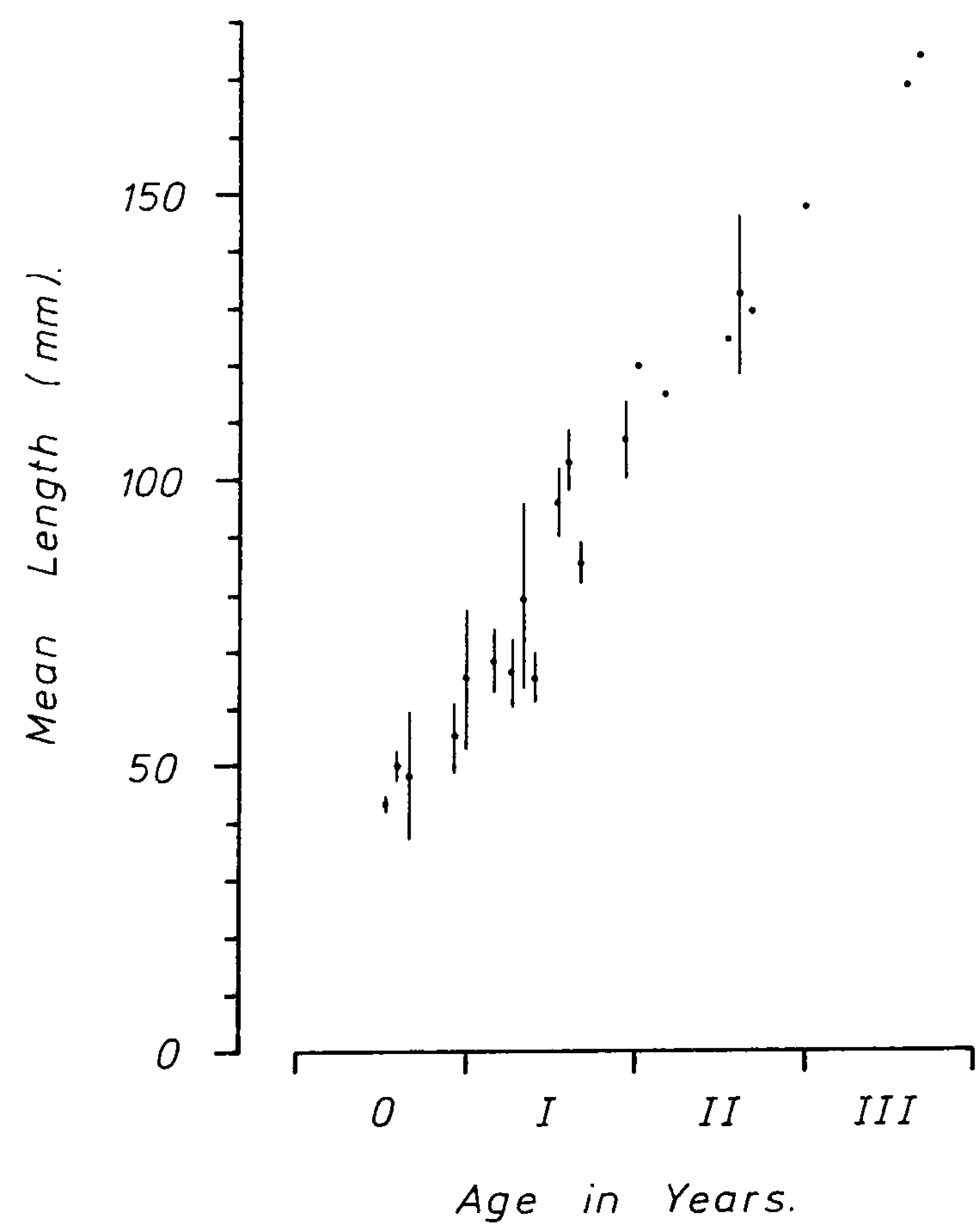
BOTTOMS BECK.

Figure 20. Site 7.



BOTTOMS BECK.

Figure 21. Site 8.



Comparative curves of length for age.

Figure 22. River Tees and Eden tributaries after Crisp *et al*. (1974, 1975) and Crisp and Cubby (1978).

Figure 23. Oligotrophic Welsh and Peak District streams the Teify, Rheidol and Pysgotwr, mid Wales and tributaries of the upper Wye. After Turnpenny (1985), Thomas (1964) and Milner *et al*. (1978).

Figure 22.


UPPER TEES TRIBUTARIES.
Durham Tributaries.
Westmorland Tributaries.
R. Tees (Reservoir Basin).
R. Tees (Below Impoundment).
Mean Length (mm).
250
200
150
100
50
0
0
I
II
III
IV
V
VI
VII
VIII
Age in Years.
UPPER TEES & EDEN TRIBUTARIES.
Trout Beck.
Great Dodgen Pot Sike.
Knock Ore Gill.
Swindale Beck.
Mean Length (mm).
250
200
150
100
50
0
0
I
II
III
IV
V
VI
VII
VIII
Age in Years.

Figure 23.

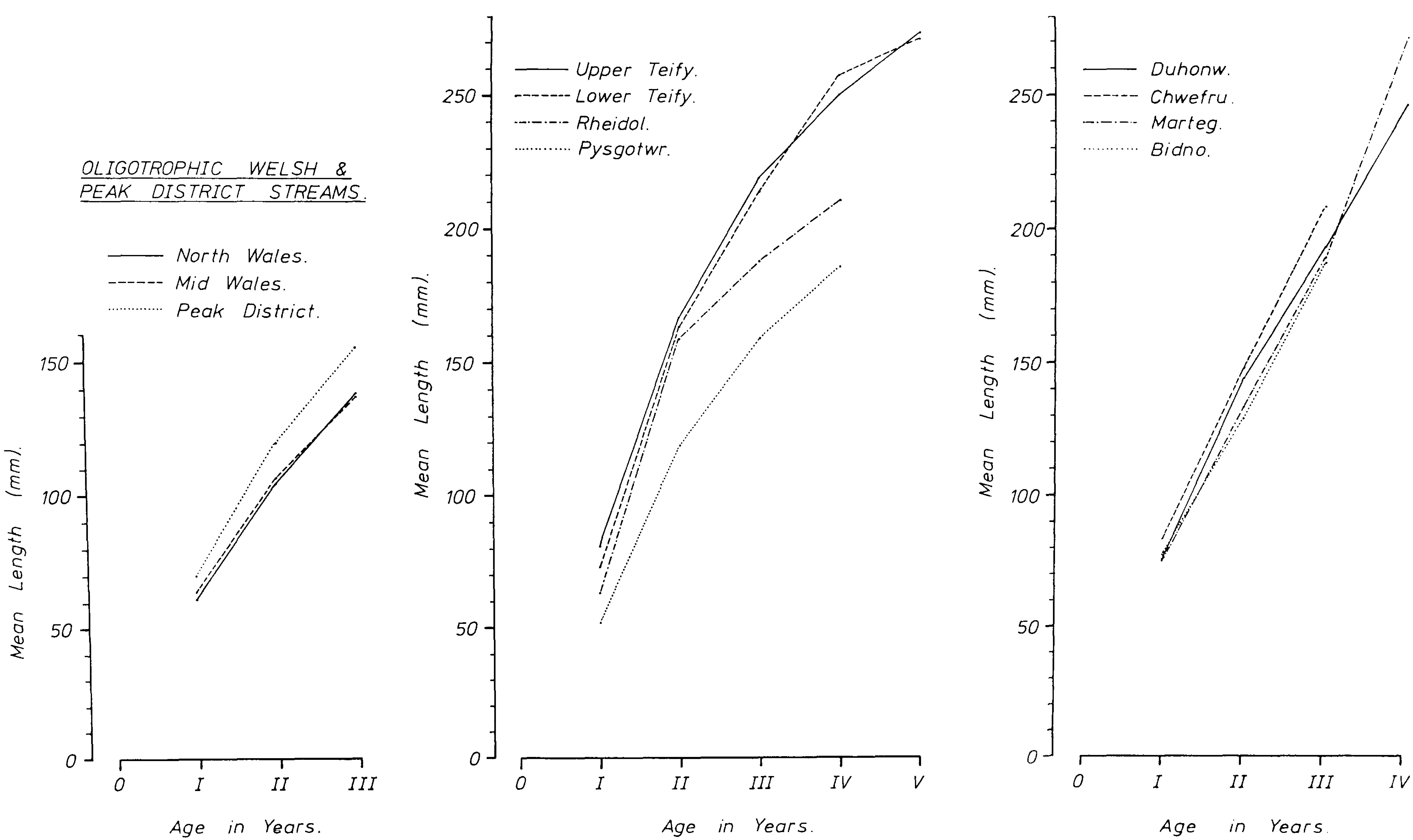

OLIGOTROPHIC WELSH & PEAK DISTRICT STREAMS.
North Wales.
Mid Wales.
Peak District.
Mean Length (mm).
150
100
50
0
0
I
II
III
Age in Years.
TEIFY, RHEIDOL & PYSGOTWR, MID WALES.
Upper Teify.
Lower Teify.
Rheidol.
Pysgotwr.
Mean Length (mm).
250
200
150
100
50
0
0
I
II
III
IV
V
Age in Years.
UPPER WYE TRIBUTARIES.
Duhonw.
Chwefru.
Marteg.
Bidno.
Mean Length (mm).
250
200
150
100
50
0
0
I
II
III
IV
Age in Years.

Figure 24. Map of Stocks Reservoir Exhibiting Relevant Fishery Information.

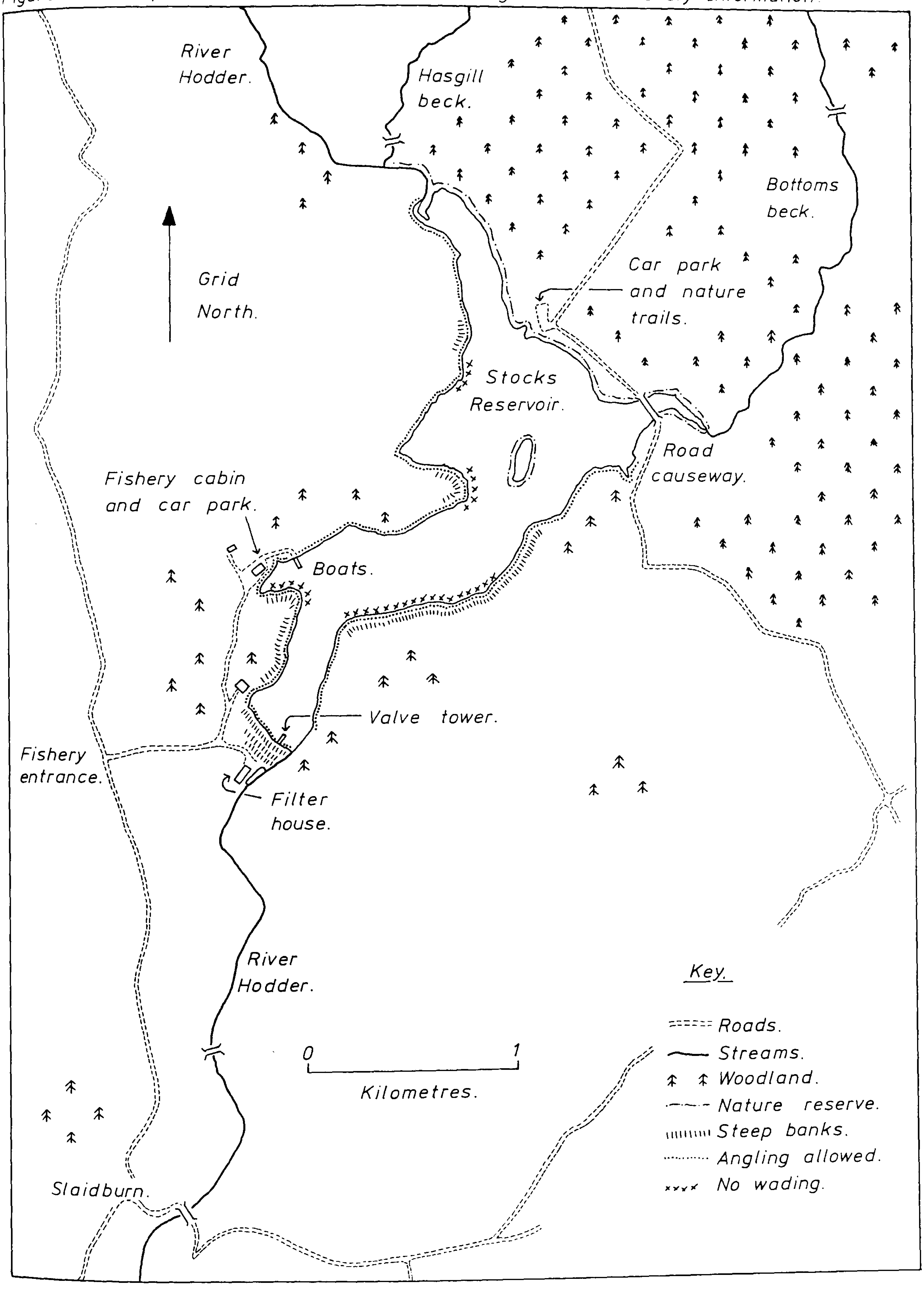
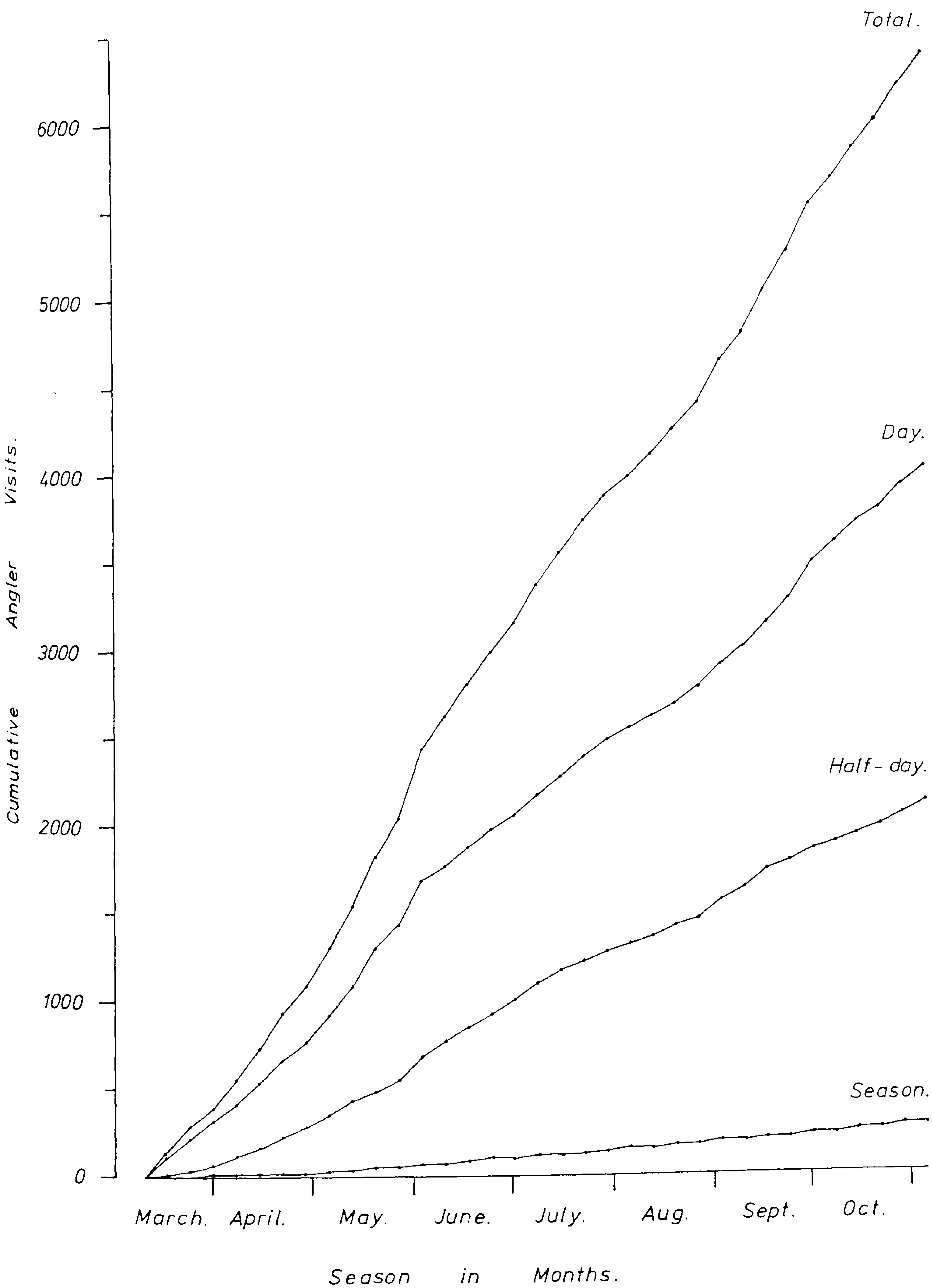


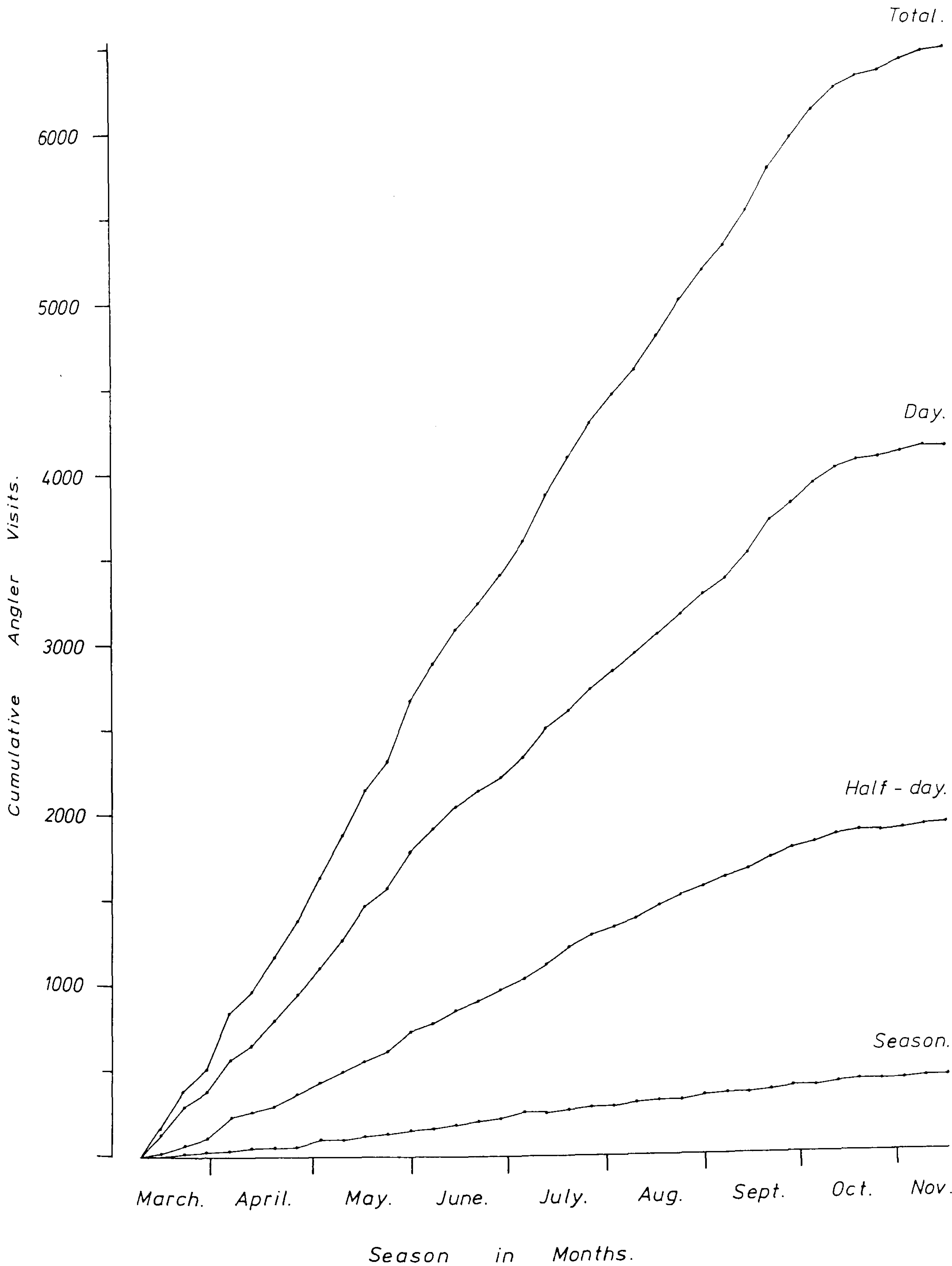
Figure 25.

Graphs of cumulative weekly permit visits for the seasons 1985 to 1987.

1985.

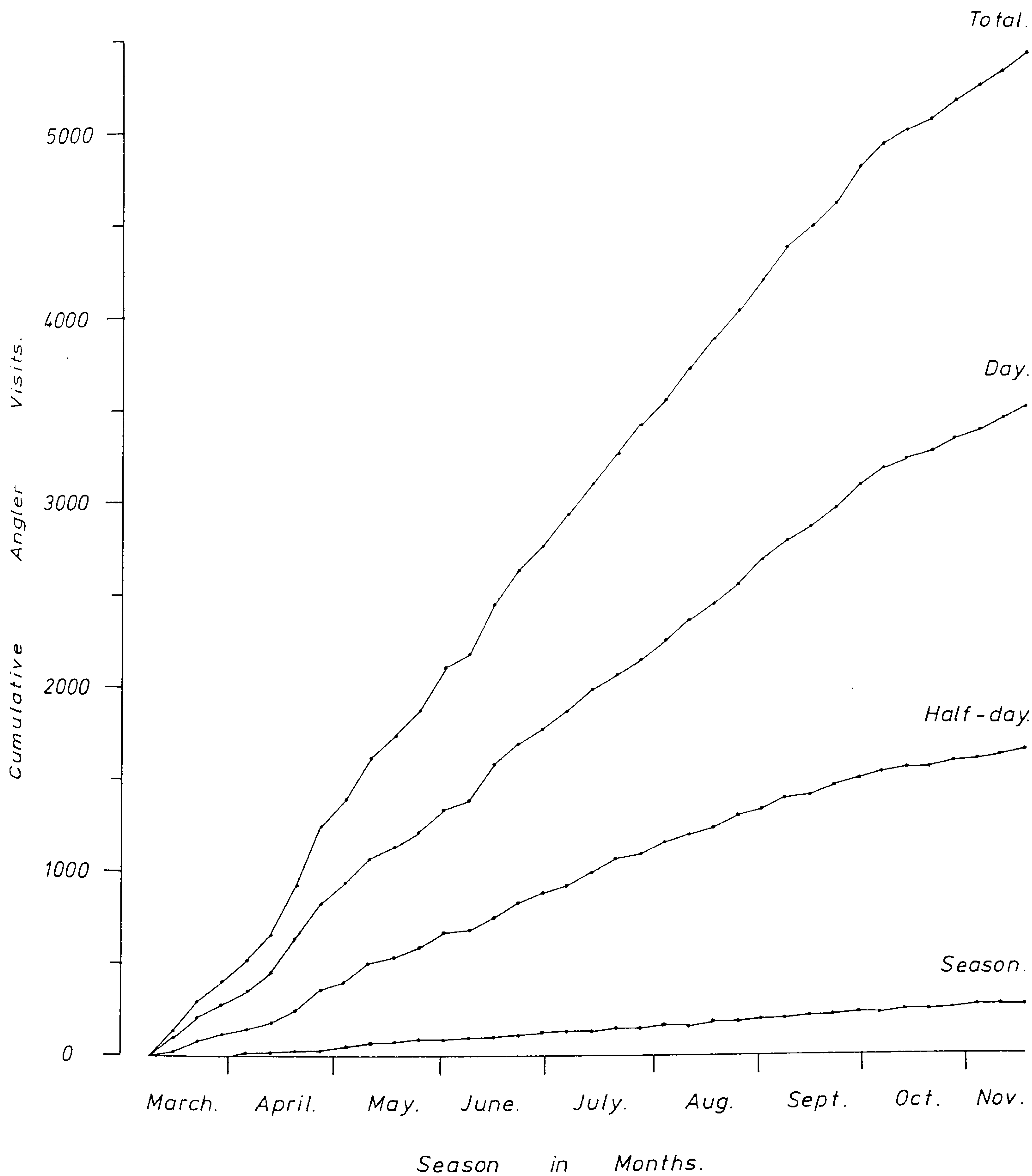

Total.
Day.
Half-day.
Season.
6000
5000
4000
3000
2000
1000
0
Cumulative Angler Visits.
March.
April.
May.
June.
July.
Aug.
Sept.
Oct.
Season in Months.

1986.



Total.
Day.
Half - day.
Season.
6000
5000
4000
3000
2000
1000
Cumulative Angler Visits.
March.
April.
May.
June.
July.
Aug.
Sept.
Oct.
Nov.
Season in Months.

<u>1987.</u>



Total.
Day.
Half-day.
Season.
5000
4000
3000
2000
1000
0
Cumulative Angler Visits.
March.
April.
May.
June.
July.
Aug.
Sept.
Oct.
Nov.
Season in Months.

Figure 26.

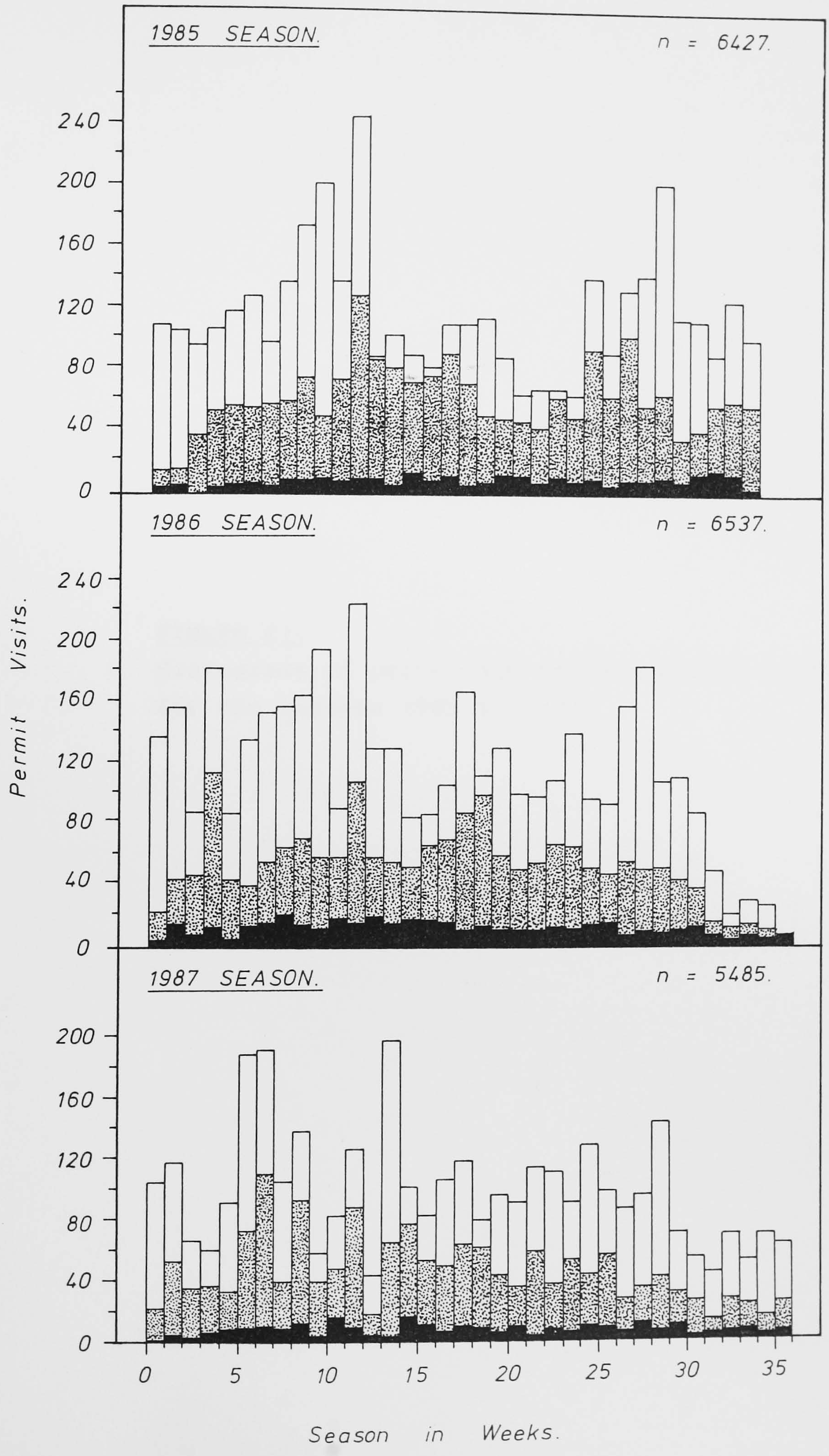
Histograms of weekly permit visits for the seasons 1985 to 1987.

Key.

Day permit visits.

Half-day permit visits.

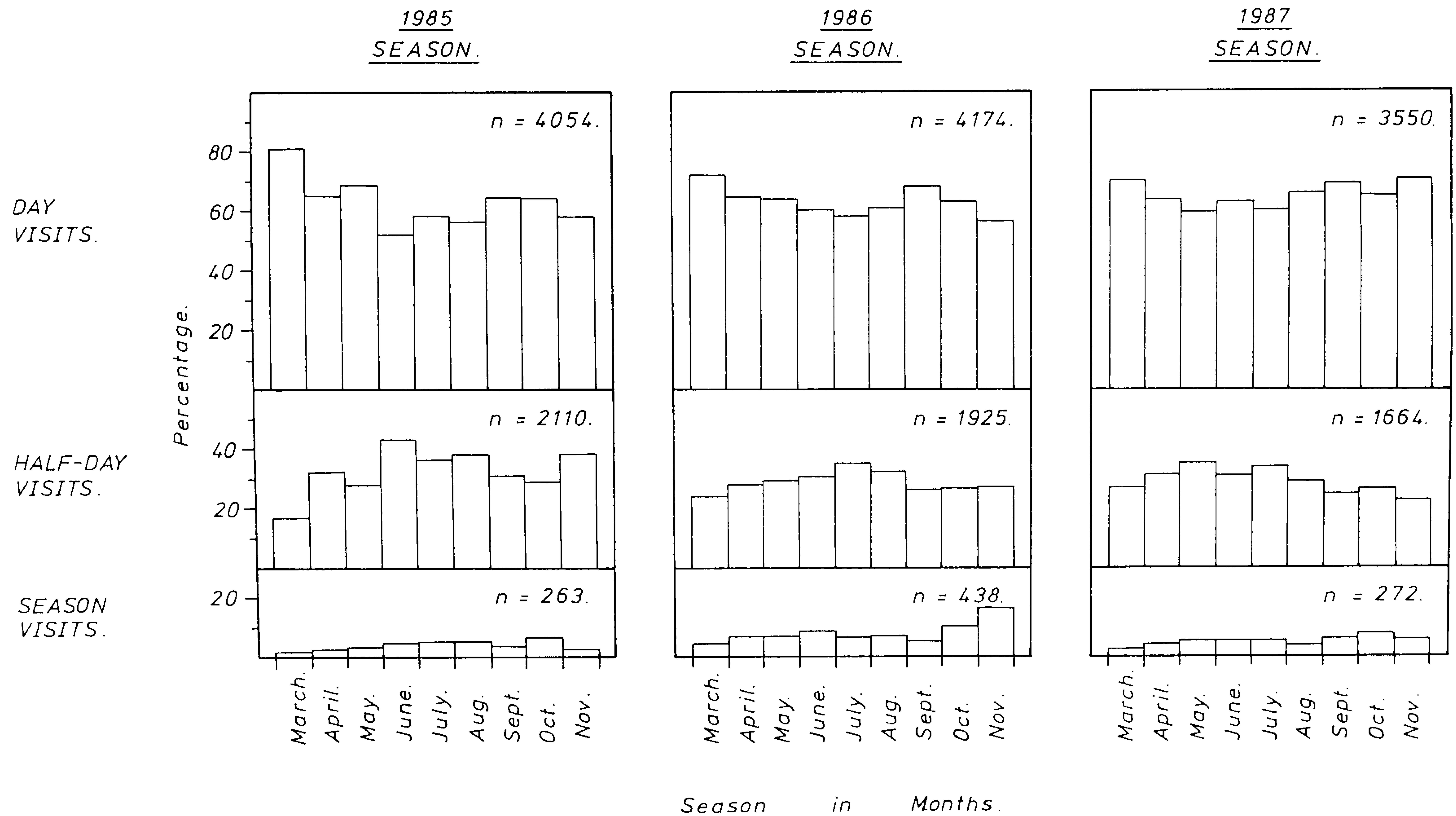
Season permit visits.



1985 SEASON.
n = 6427.
1986 SEASON.
n = 6537.
1987 SEASON.
n = 5485.
Permit Visits.
0
40
80
120
160
200
240
0
5
10
15
20
25
30
35
Season in Weeks.

Figure 27.

Histograms of percentage monthly permit visits for the seasons 1985 to 1987.



1985
SEASON.
1986
SEASON.
1987
SEASON.
DAY
VISITS.
HALF-DAY
VISITS.
SEASON
VISITS.
Percentage.
80
60
40
20
40
20
20
n = 4054.
n = 2110.
n = 263.
n = 4174.
n = 1925.
n = 438.
n = 3550.
n = 1664.
n = 272.
March.
April.
May.
June.
July.
Aug.
Sept.
Oct.
Nov.
Season in Months.

Figure 28.

Histograms of mean daily permit visits for the seasons 1985 to 1987.

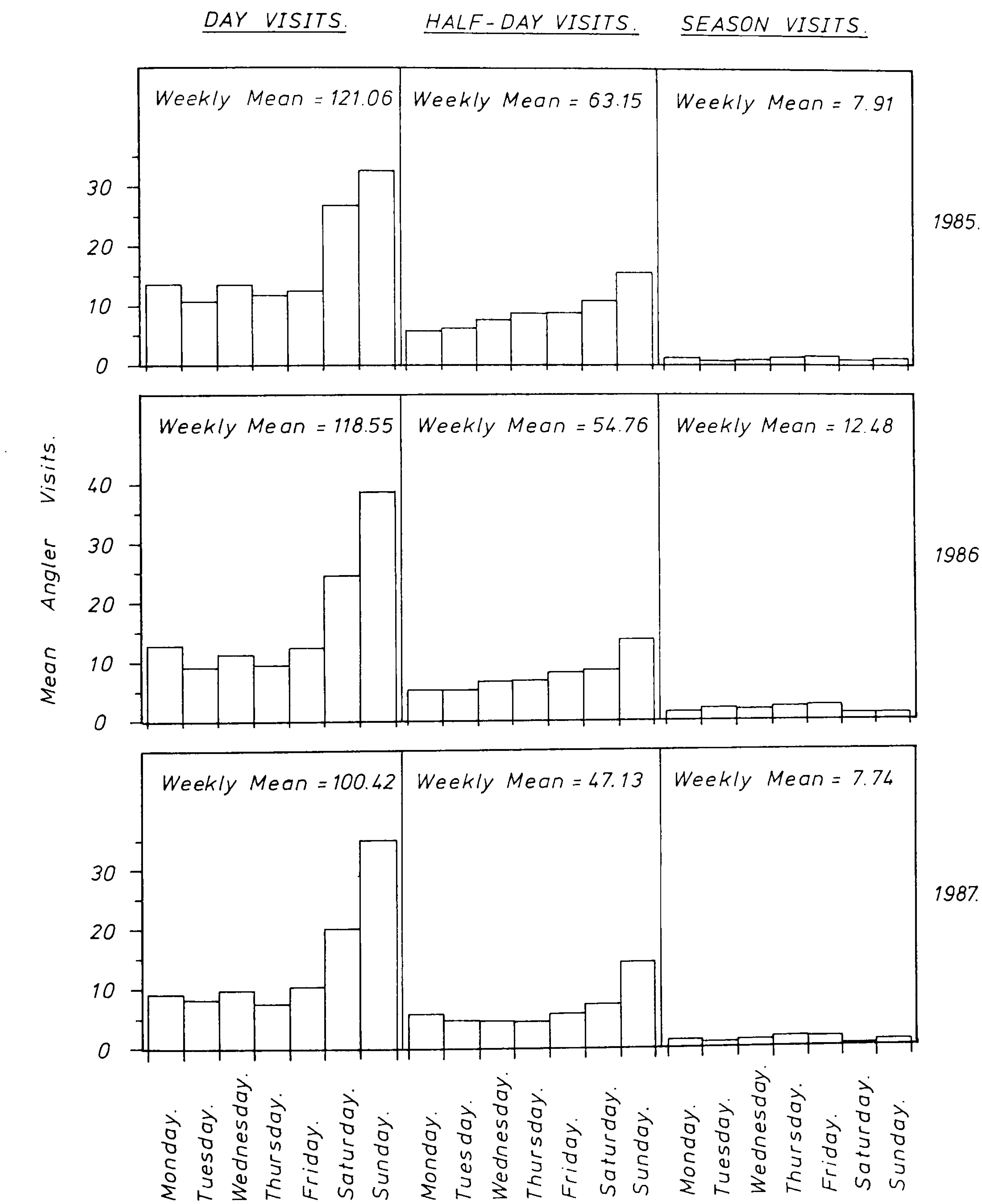
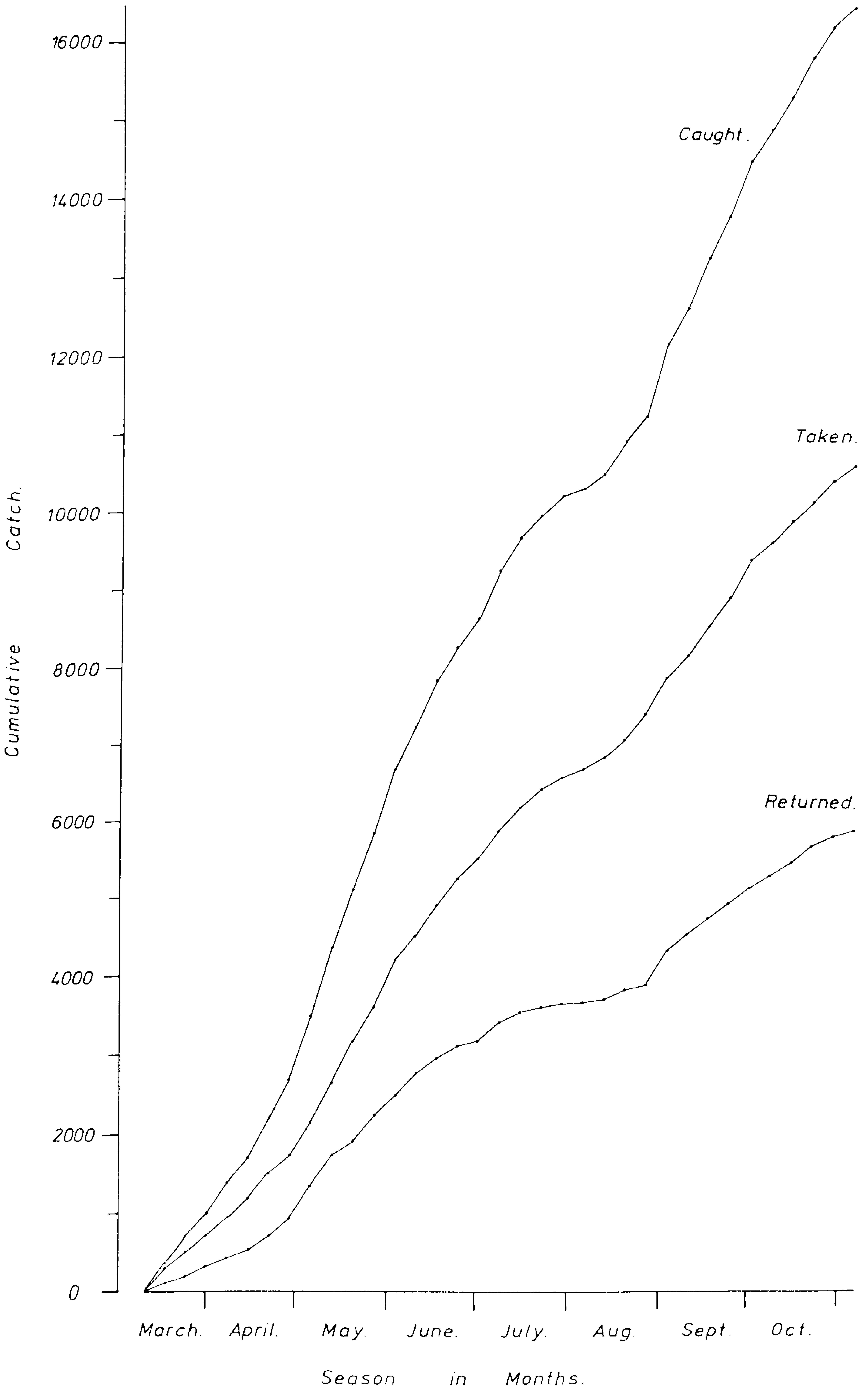

DAY VISITS.
HALF-DAY VISITS.
SEASON VISITS.
Weekly Mean = 121.06
Weekly Mean = 63.15
Weekly Mean = 7.91
1985.
Weekly Mean = 118.55
Weekly Mean = 54.76
Weekly Mean = 12.48
1986.
Weekly Mean = 100.42
Weekly Mean = 47.13
Weekly Mean = 7.74
1987.
Mean Angler Visits.
0
10
20
30
40
Monday.
Tuesday.
Wednesday.
Thursday.
Friday.
Saturday.
Sunday.

Figure 29.

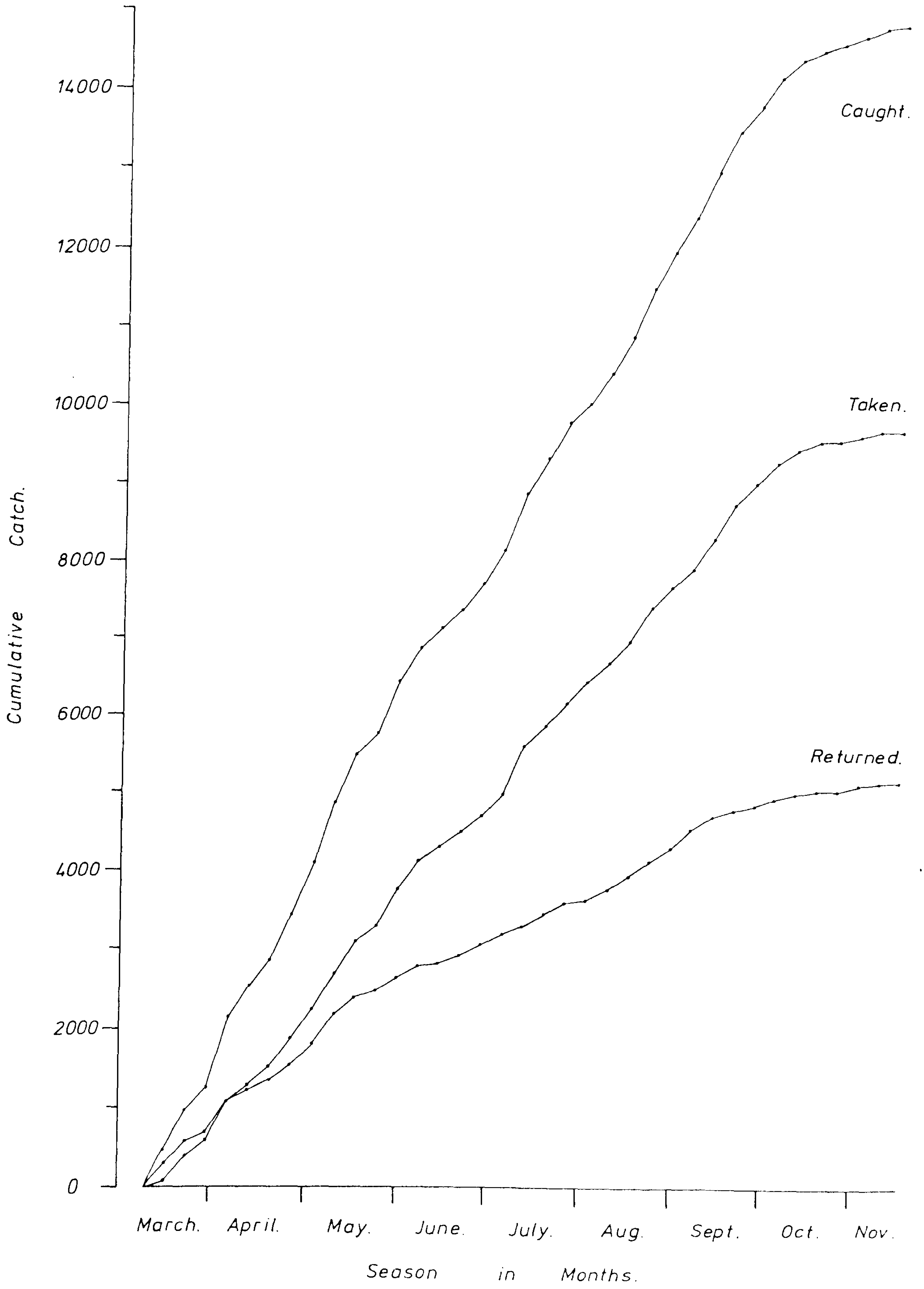
Cumulative weekly graphs of total fish caught, taken and returned for the seasons 1985 to 1987.

1985.



16000
14000
12000
10000
8000
6000
4000
2000
0
Cumulative Catch.
Caught.
Taken.
Returned.
March.
April.
May.
June.
July.
Aug.
Sept.
Oct.
Season in Months.

1986.



14000
12000
10000
8000
6000
4000
2000
0
Cumulative Catch.
Caught.
Taken.
Returned.
March.
April.
May.
June.
July.
Aug.
Sept.
Oct.
Nov.
Season in Months.

1987.

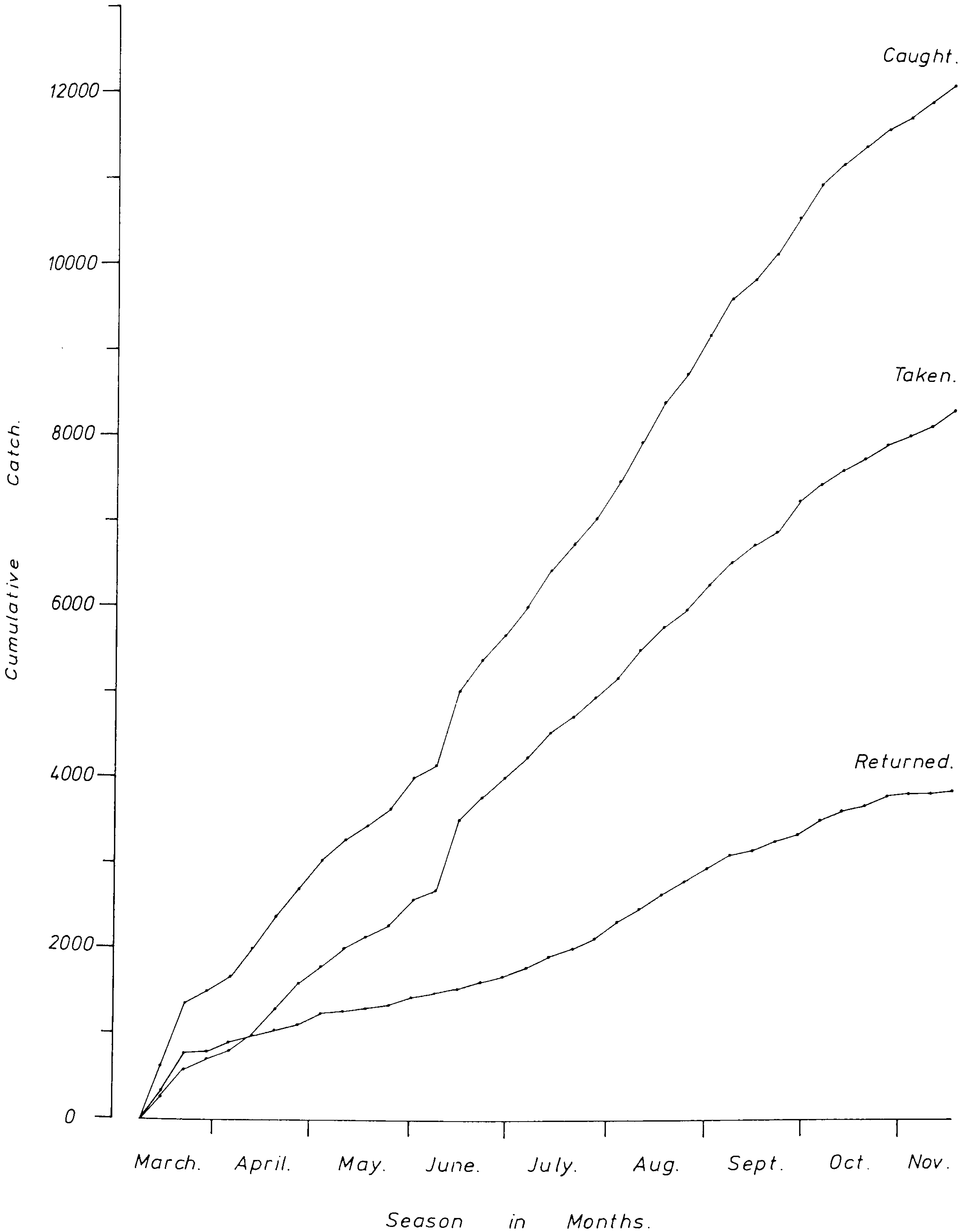
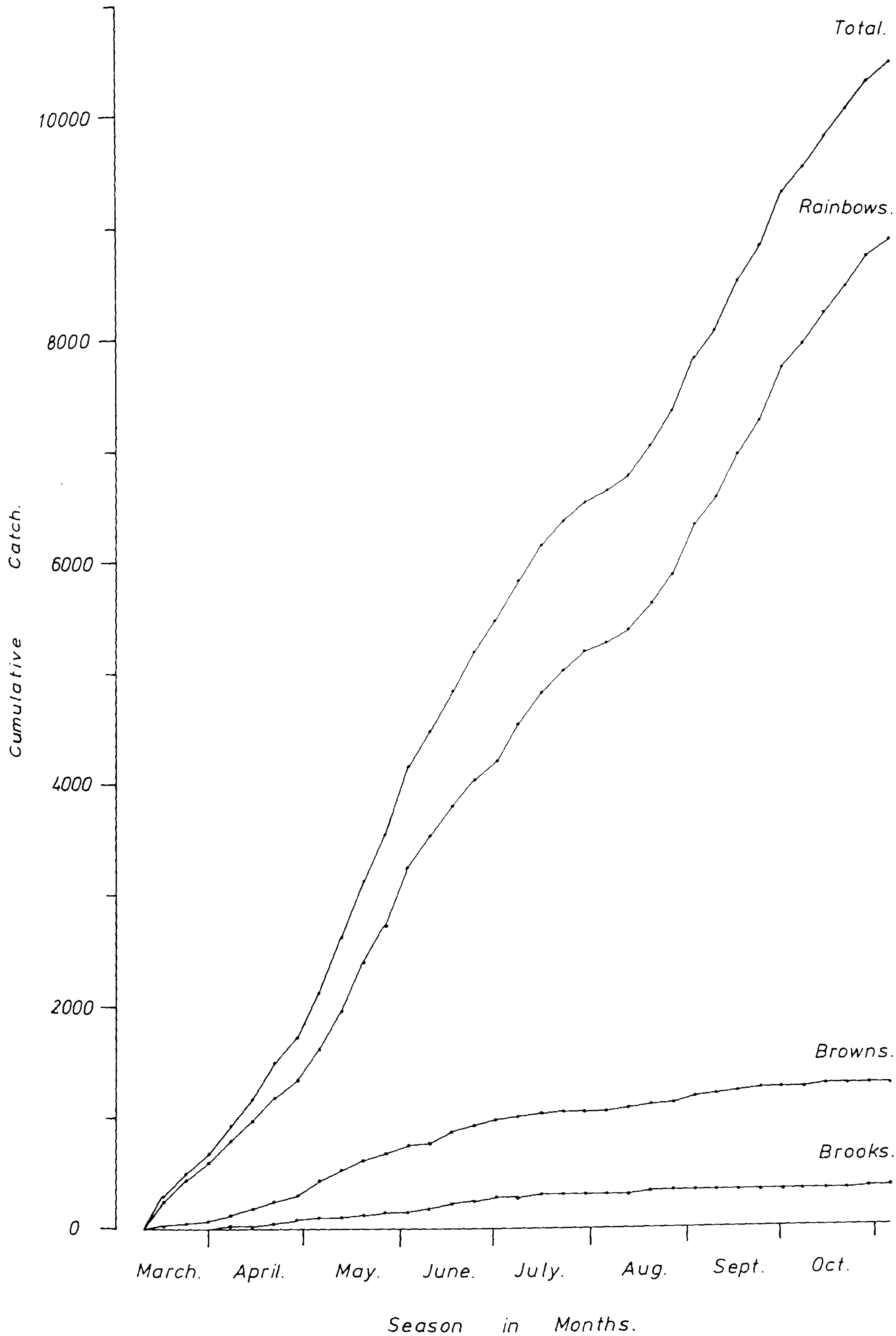

Caught.
Taken.
Returned.
Cumulative Catch.
12000
10000
8000
6000
4000
2000
0
March.
April.
May.
June.
July.
Aug.
Sept.
Oct.
Nov.
Season in Months.

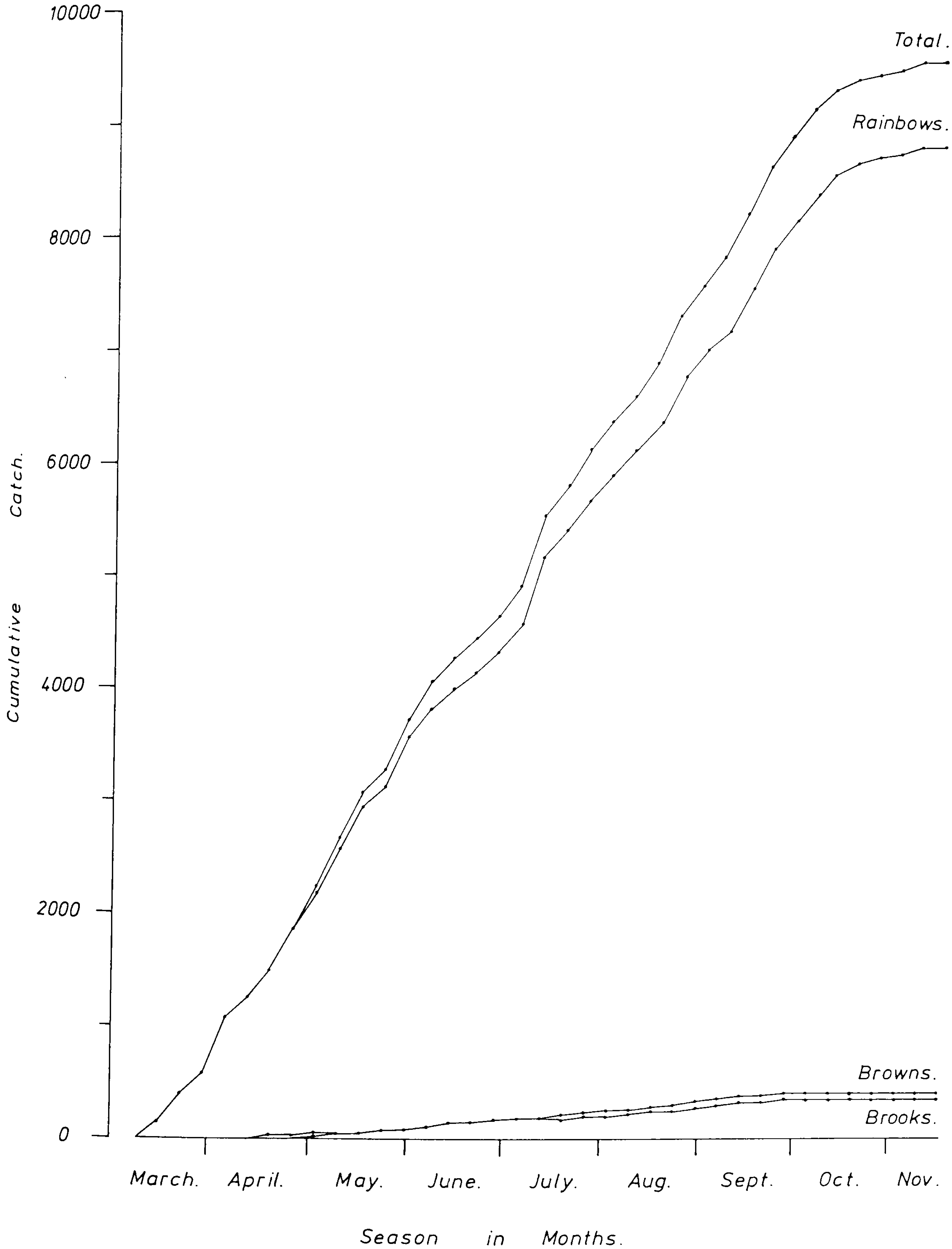
Figure 30.

Cumulative weekly graphs of rainbow trout, brook trout and brown trout taken for the seasons 1985 to 1987.

1985.

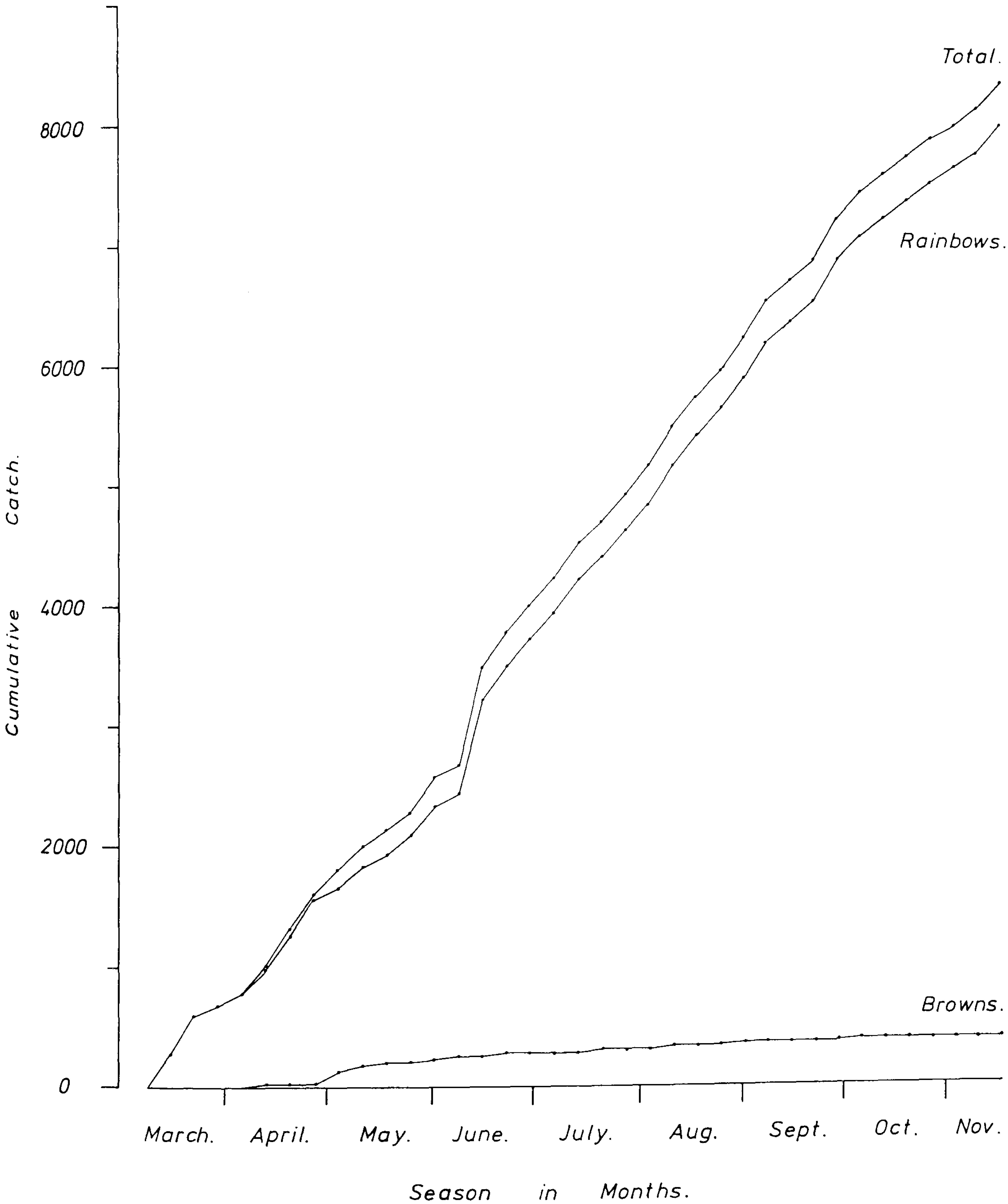

Total.
Rainbows.
Browns.
Brooks.
10000
8000
6000
4000
2000
0
Cumulative Catch.
March.
April.
May.
June.
July.
Aug.
Sept.
Oct.
Season in Months.

1986.



10000
8000
6000
4000
2000
0
Cumulative Catch.
Total.
Rainbows.
Browns.
Brooks.
March.
April.
May.
June.
July.
Aug.
Sept.
Oct.
Nov.
Season in Months.

1987.

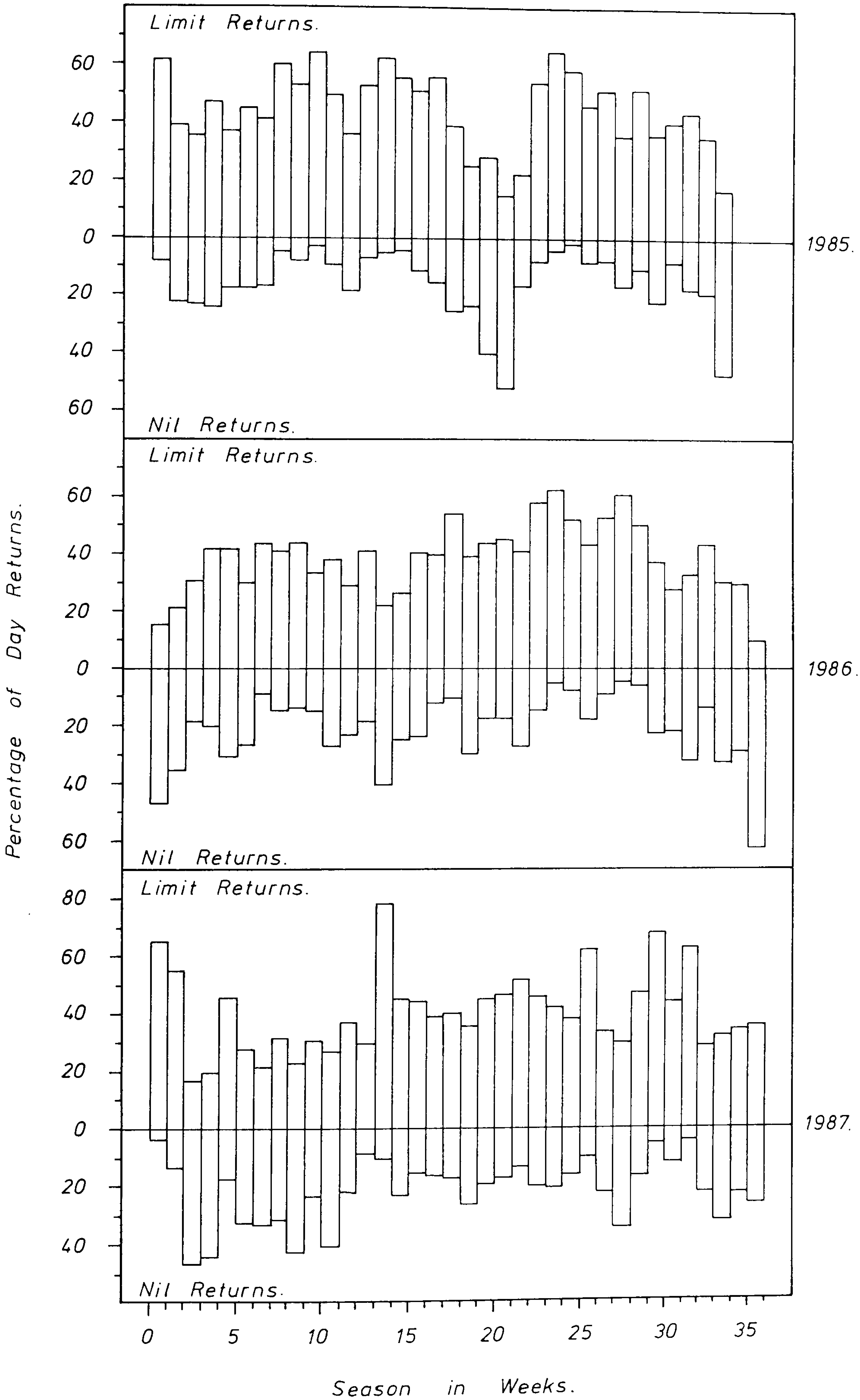


Total.
Rainbows.
Browns.
8000
6000
4000
2000
0
Cumulative Catch.
March.
April.
May.
June.
July.
Aug.
Sept.
Oct.
Nov.
Season in Months.

Figure 31.

Histograms of weekly percentage Limit and Nil returns for day permit visits and half day and season permit visits for the seasons 1985 to 1987.

DAY VISITS.



Limit Returns.
Nil Returns.
1985.
1986.
1987.
Percentage of Day Returns.
Season in Weeks.
0
20
40
60
80
5
10
15
25
30
35

HALF - DAY & SEASON VISITS.

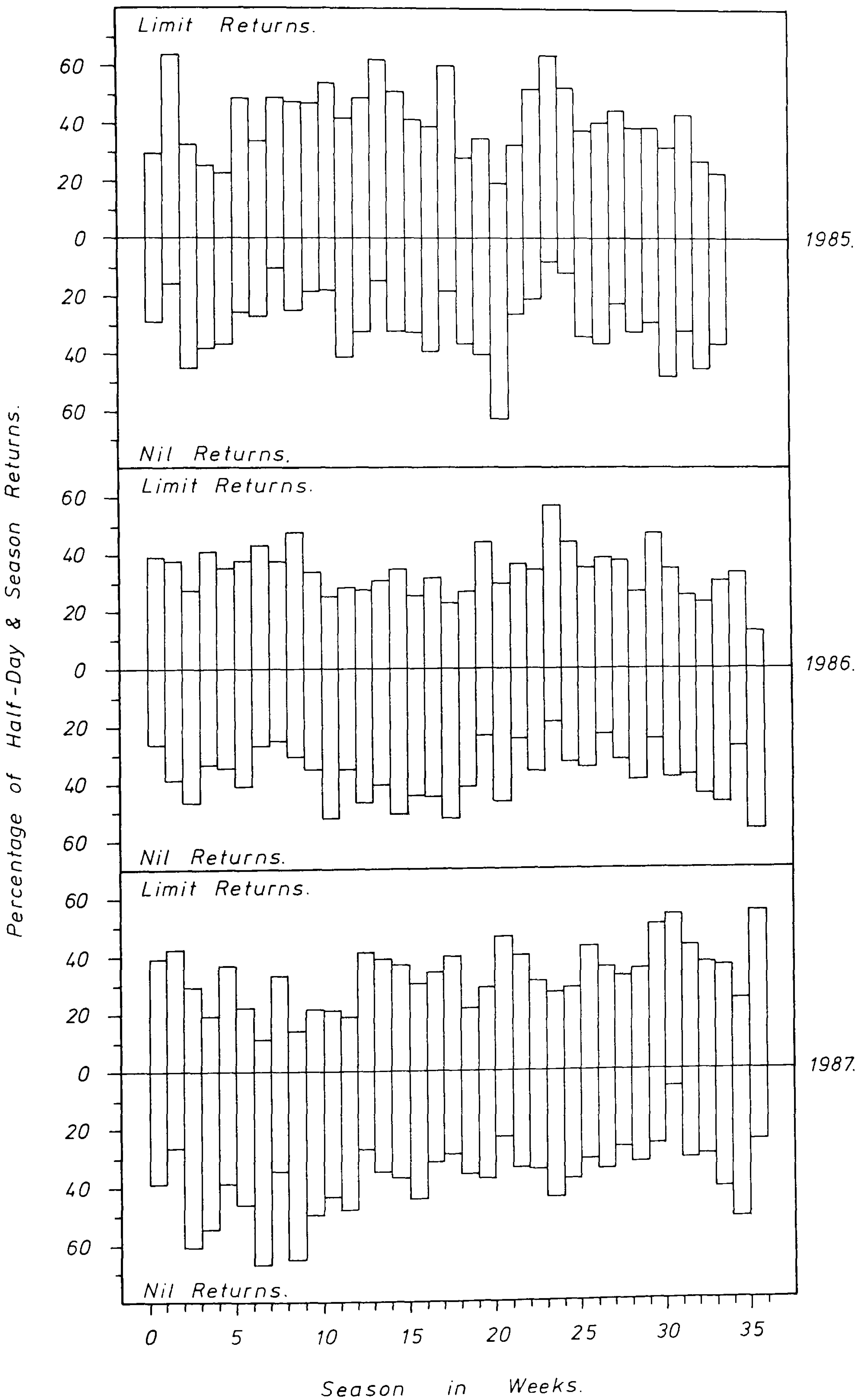
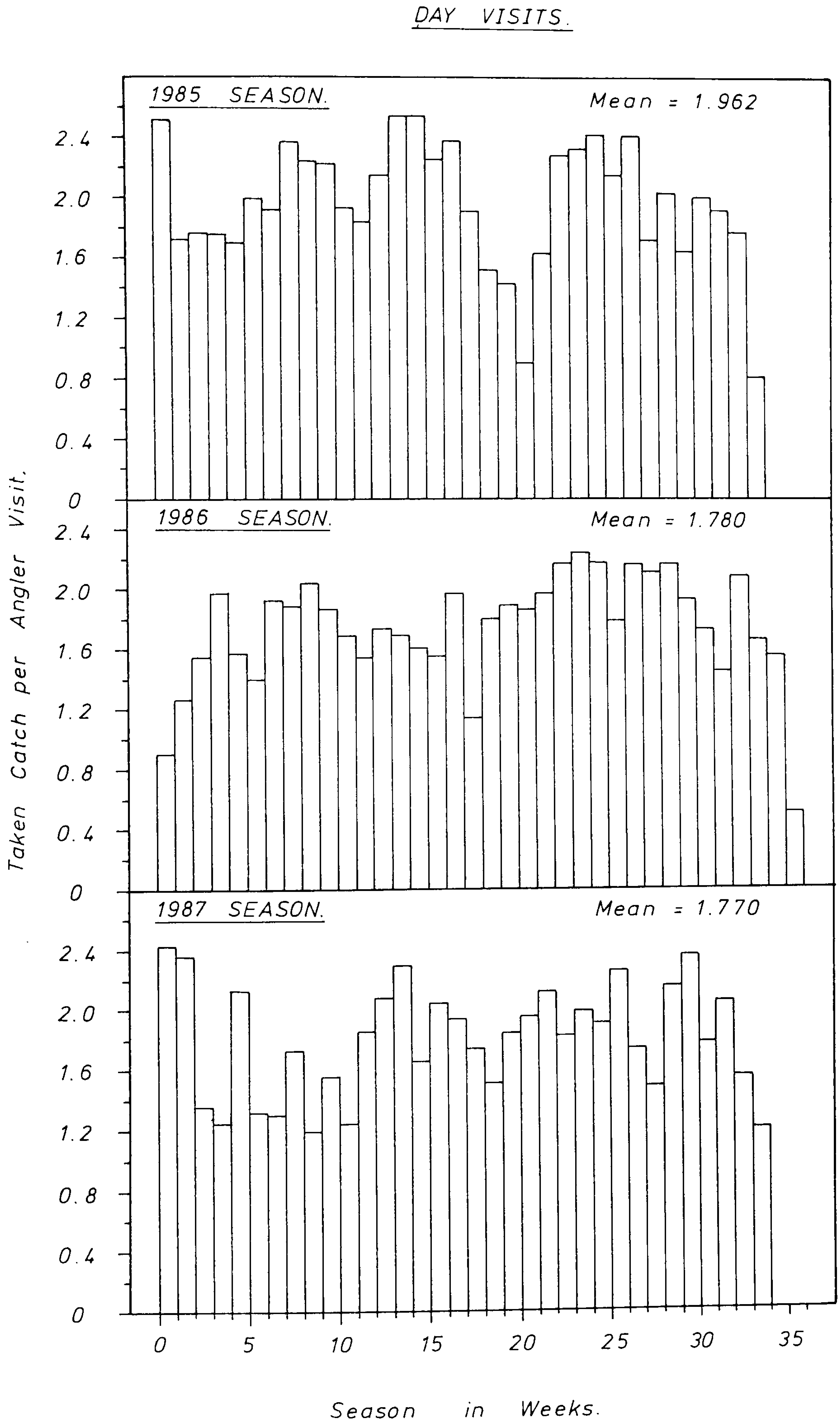


Figure 32.

Histograms of weekly fish taken per day permit visit and half day and season permit visits for the seasons 1985 to 1987.



DAY VISITS.
1985 SEASON.
Mean = 1.962
1986 SEASON.
Mean = 1.780
1987 SEASON.
Mean = 1.770
Taken Catch per Angler Visit.
0
0.4
0.8
1.2
1.6
2.0
2.4
0
5
10
15
20
25
30
35
Season in Weeks.

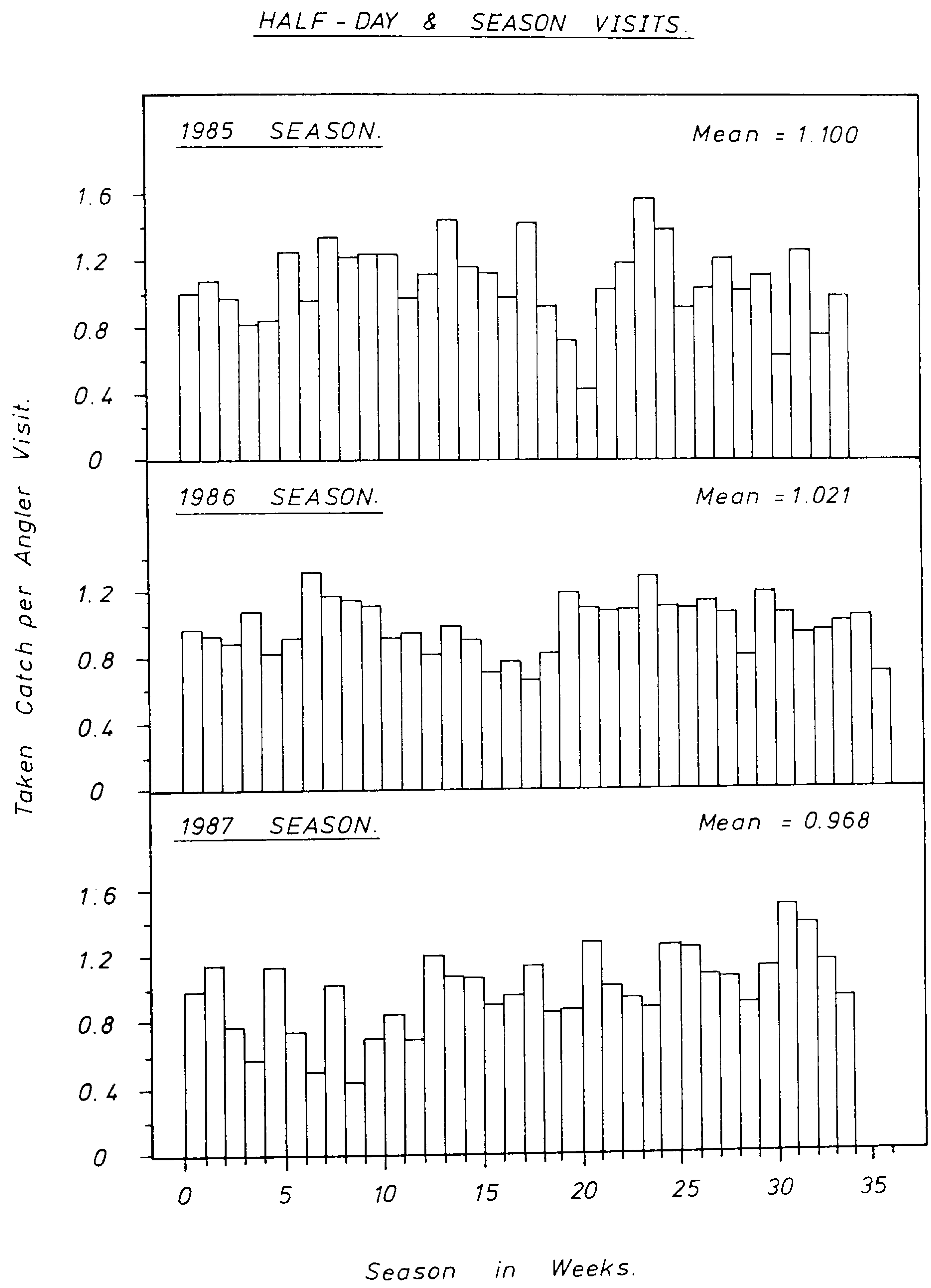
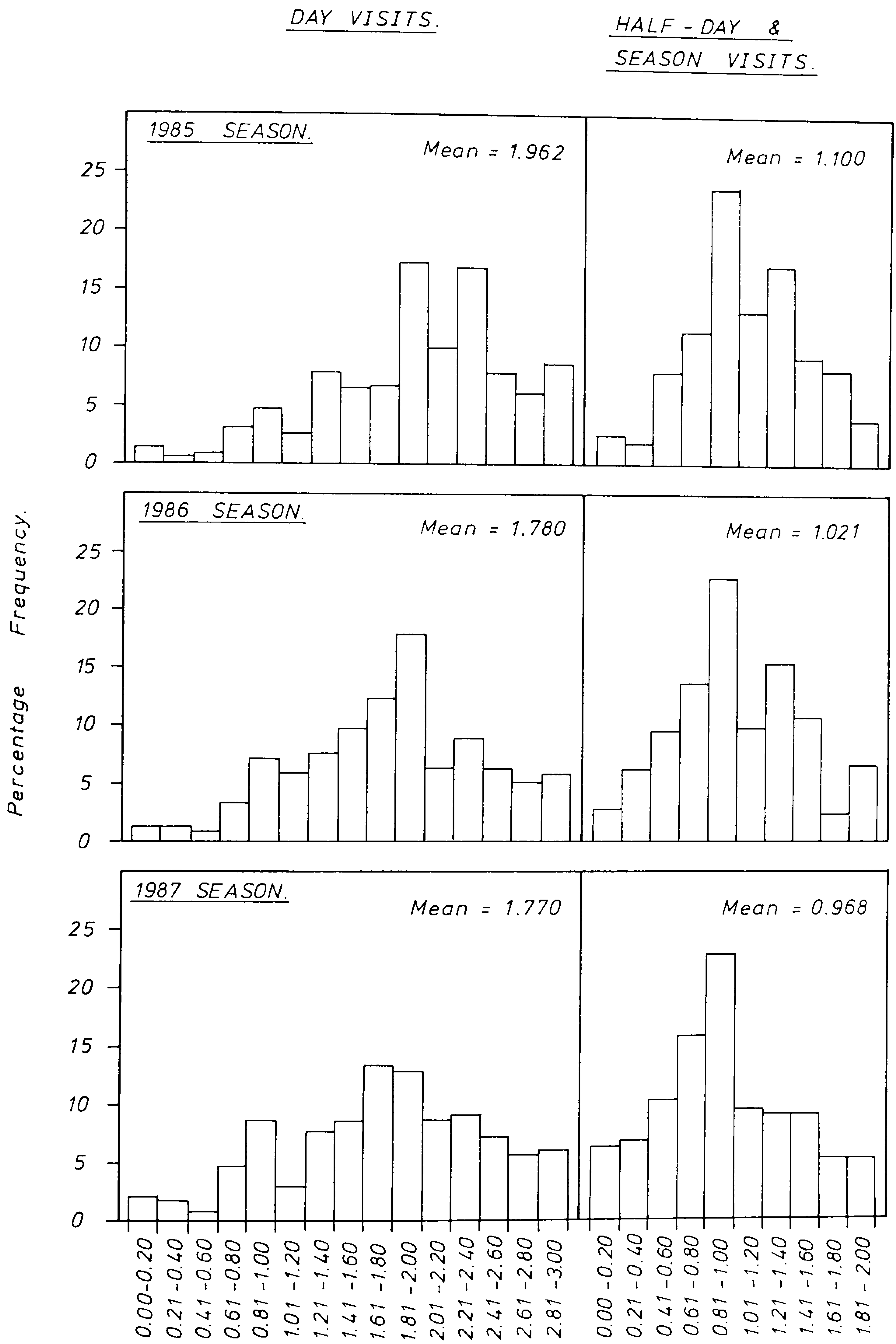

HALF - DAY & SEASON VISITS.
1985 SEASON.
Mean = 1.100
1986 SEASON.
Mean = 1.021
1987 SEASON.
Mean = 0.968
Taken Catch per Angler Visit.
0
0.4
0.8
1.2
1.6
0
5
10
15
20
25
30
35
Season in Weeks.

Figure 33.

Percentage frequency distributions for fish taken per day permit visit and half day and season permit visits for the seasons 1985 to 1987.



Taken per Angler Visit.

Figure 34.

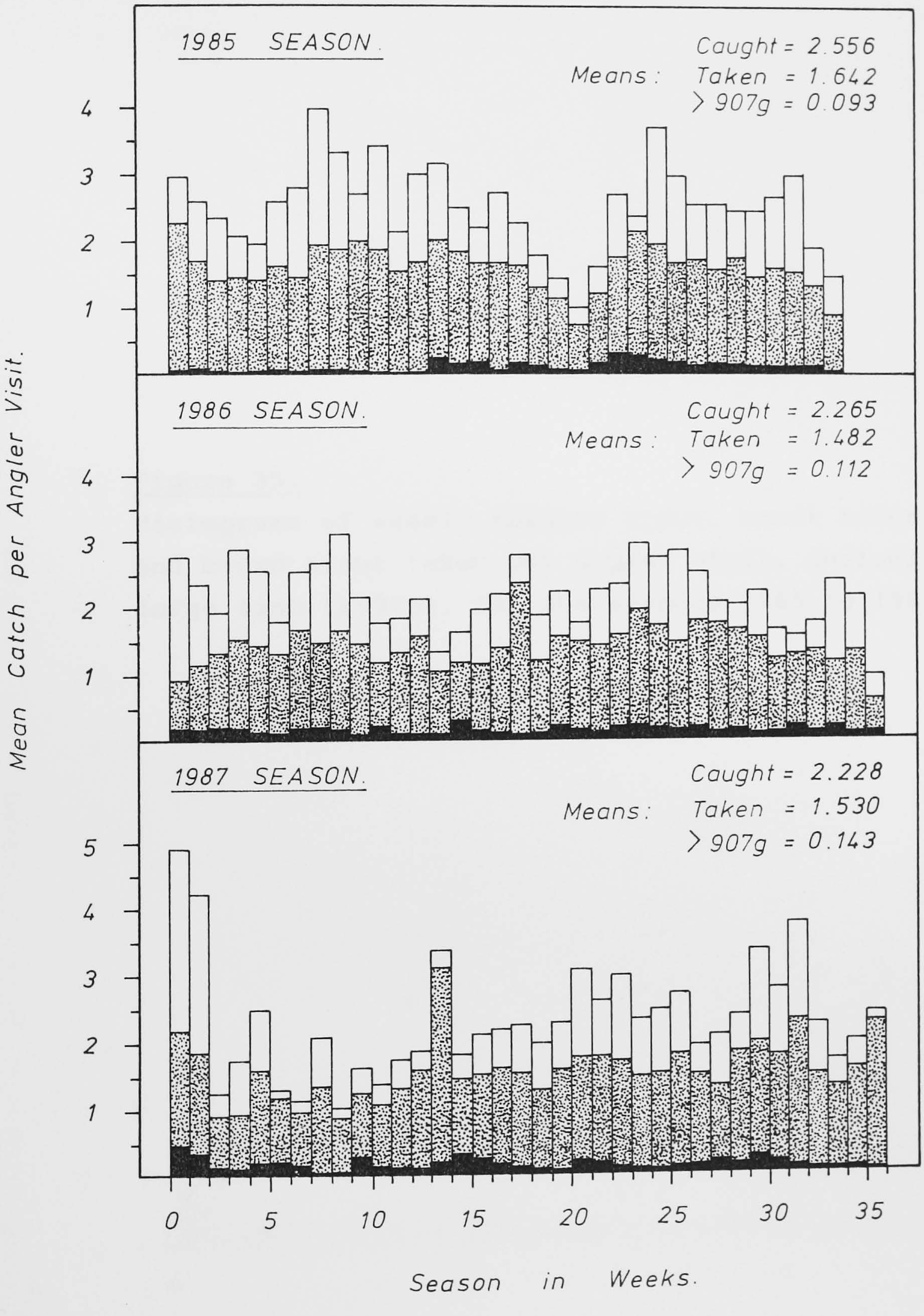
Histograms of weekly catch per angler visit, and taken per angler visit including large (>907g) fish for the seasons 1985 to 1987.

Key.

Catch per angler visit.

Taken per angler visit.

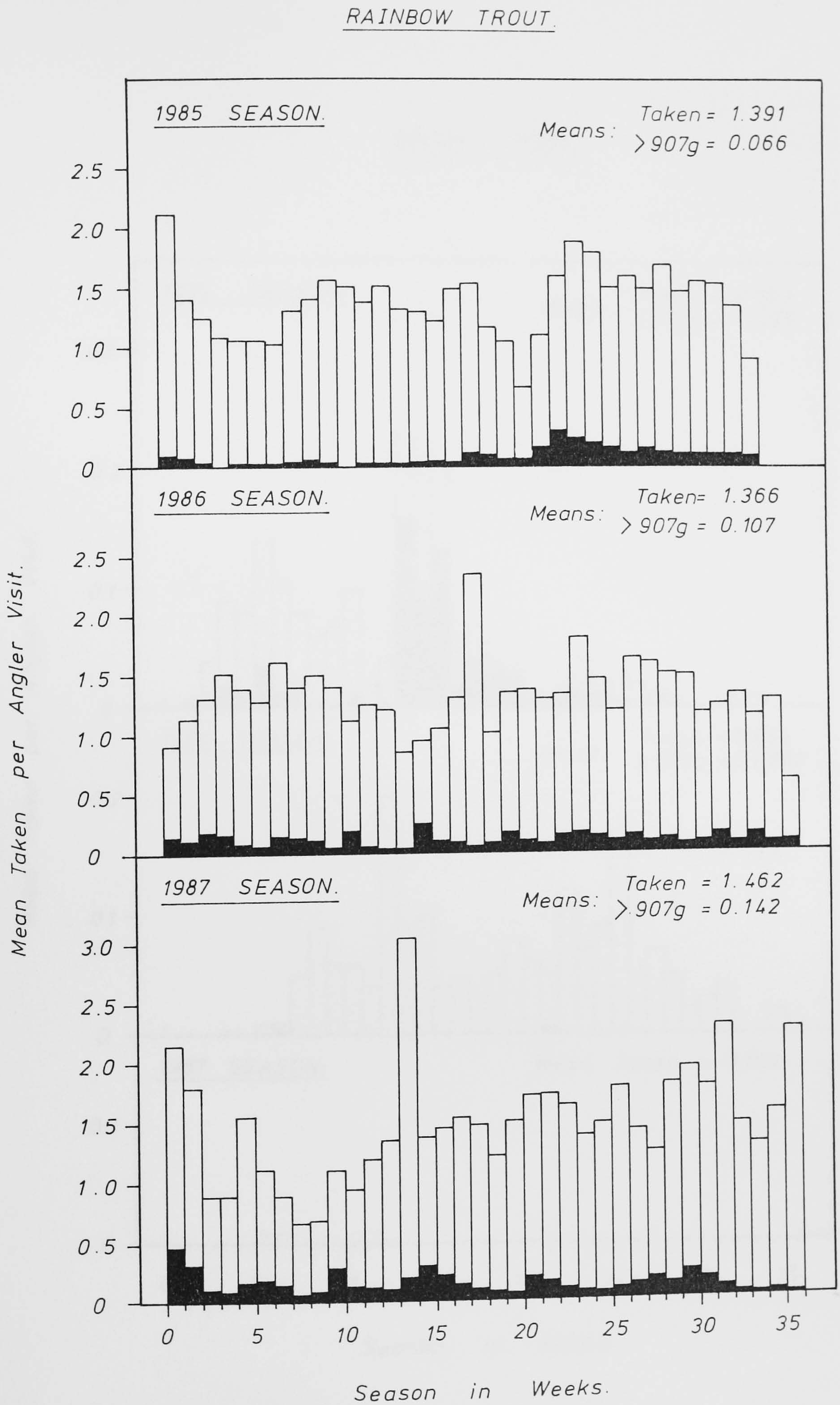
Large (>907g) fish taken per angler visit.



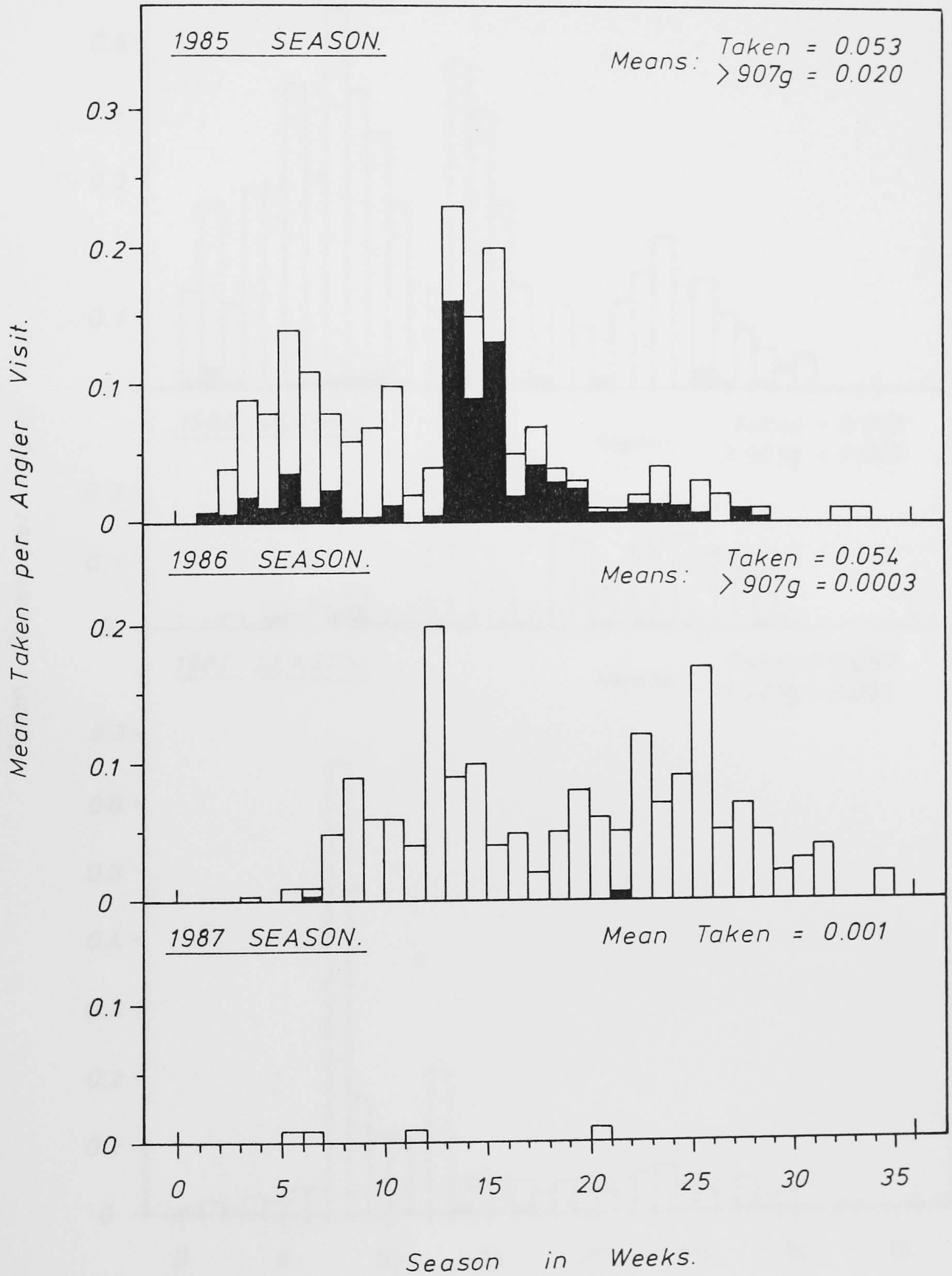
1985 SEASON.
Means: Caught = 2.556
Taken = 1.642
> 907g = 0.093
1986 SEASON.
Means: Caught = 2.265
Taken = 1.482
> 907g = 0.112
1987 SEASON.
Means: Caught = 2.228
Taken = 1.530
> 907g = 0.143
Mean Catch per Angler Visit.
Season in Weeks.

Figure 35.

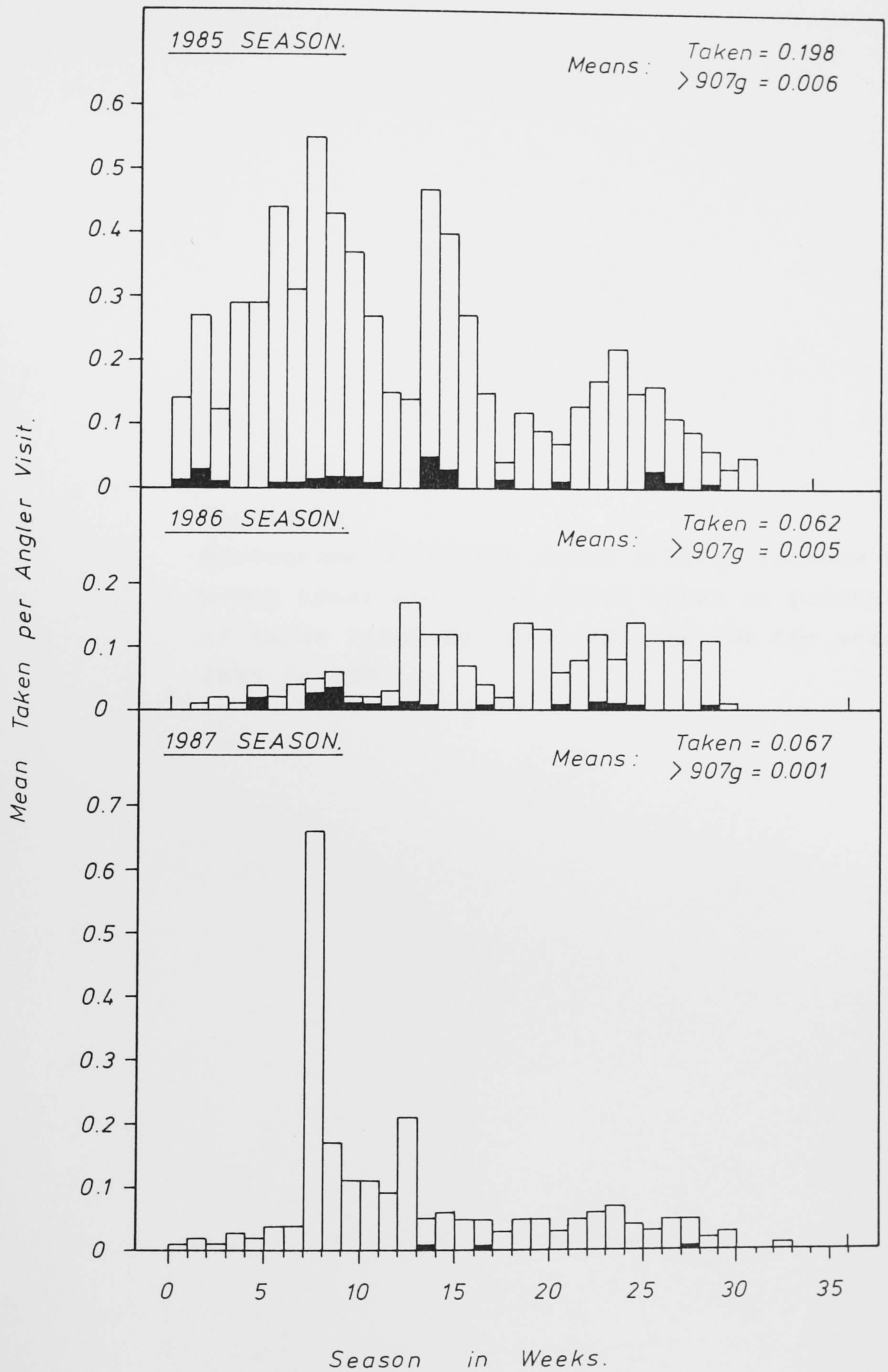
Histograms of weekly rainbow trout, brook trout and brown trout taken per angler visit, including large fish (>907g), for the seasons 1985 to 1987.


RAINBOW TROUT.
1985 SEASON.
Means: Taken = 1.391
>907g = 0.066
1986 SEASON.
Means: Taken= 1.366
> 907g = 0.107
1987 SEASON.
Means: Taken = 1.462
> 907g = 0.142
Mean Taken per Angler Visit.
Season in Weeks.
0
0.5
1.0
1.5
2.0
2.5
3.0
0
5
10
15
20
25
30
35

BROOK TROUT.


1985 SEASON.
Means: Taken = 0.053
> 907g = 0.020
0.3
0.2
0.1
0
1986 SEASON.
Means: Taken = 0.054
> 907g = 0.0003
0.2
0.1
0
1987 SEASON.
Mean Taken = 0.001
0.1
0
0
5
10
15
20
25
30
35
Mean Taken per Angler Visit.
Season in Weeks.

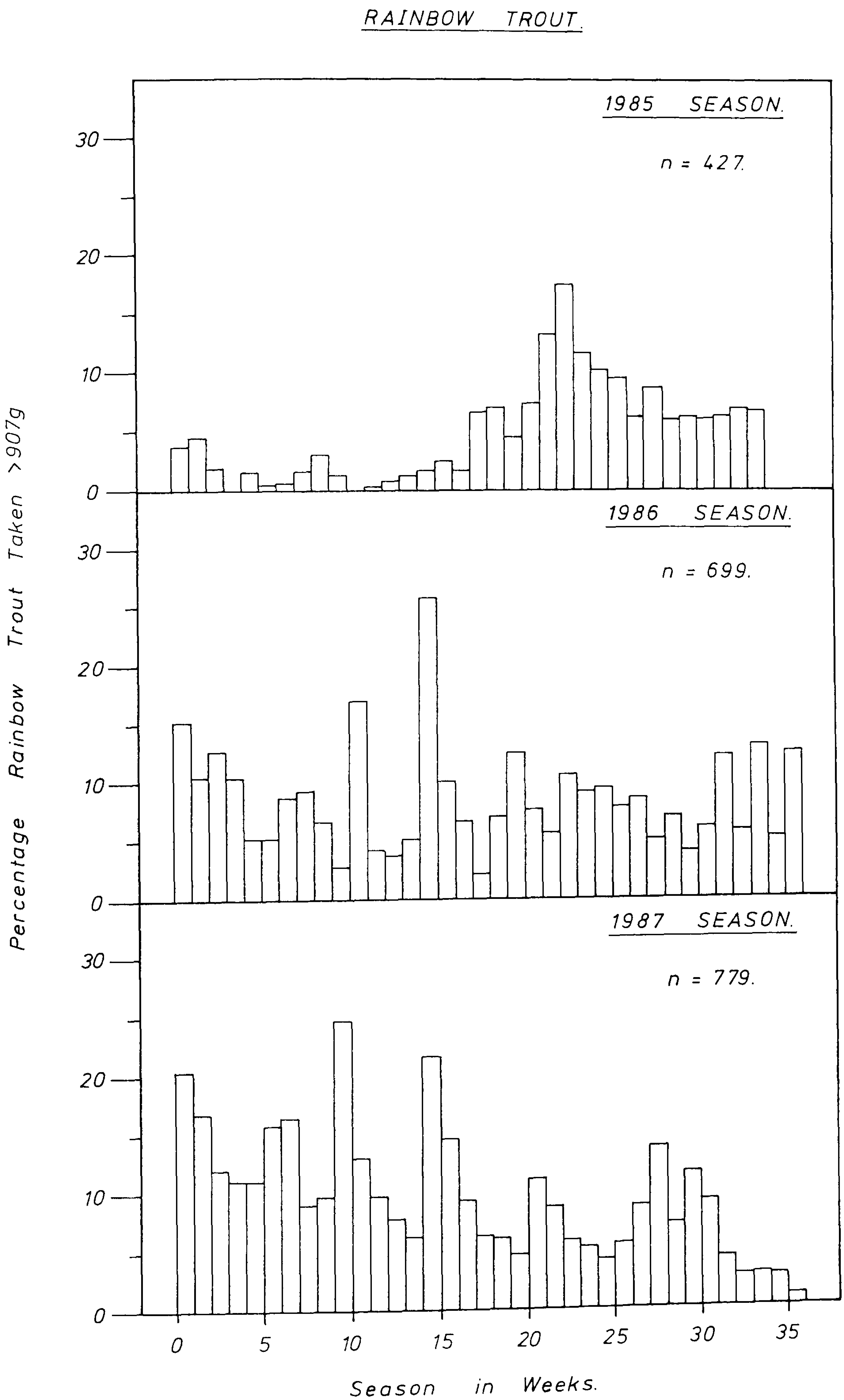
BROWN TROUT.

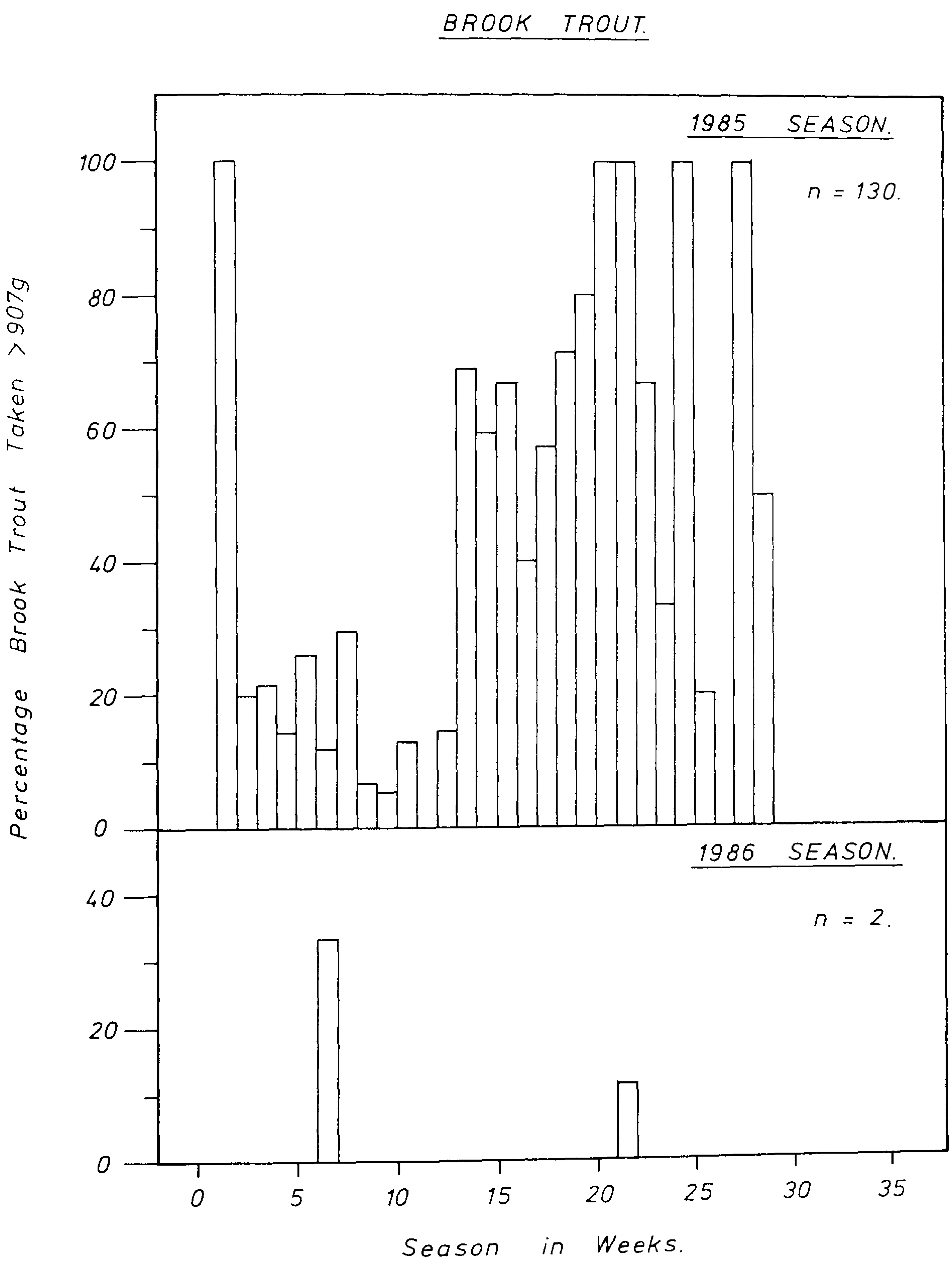


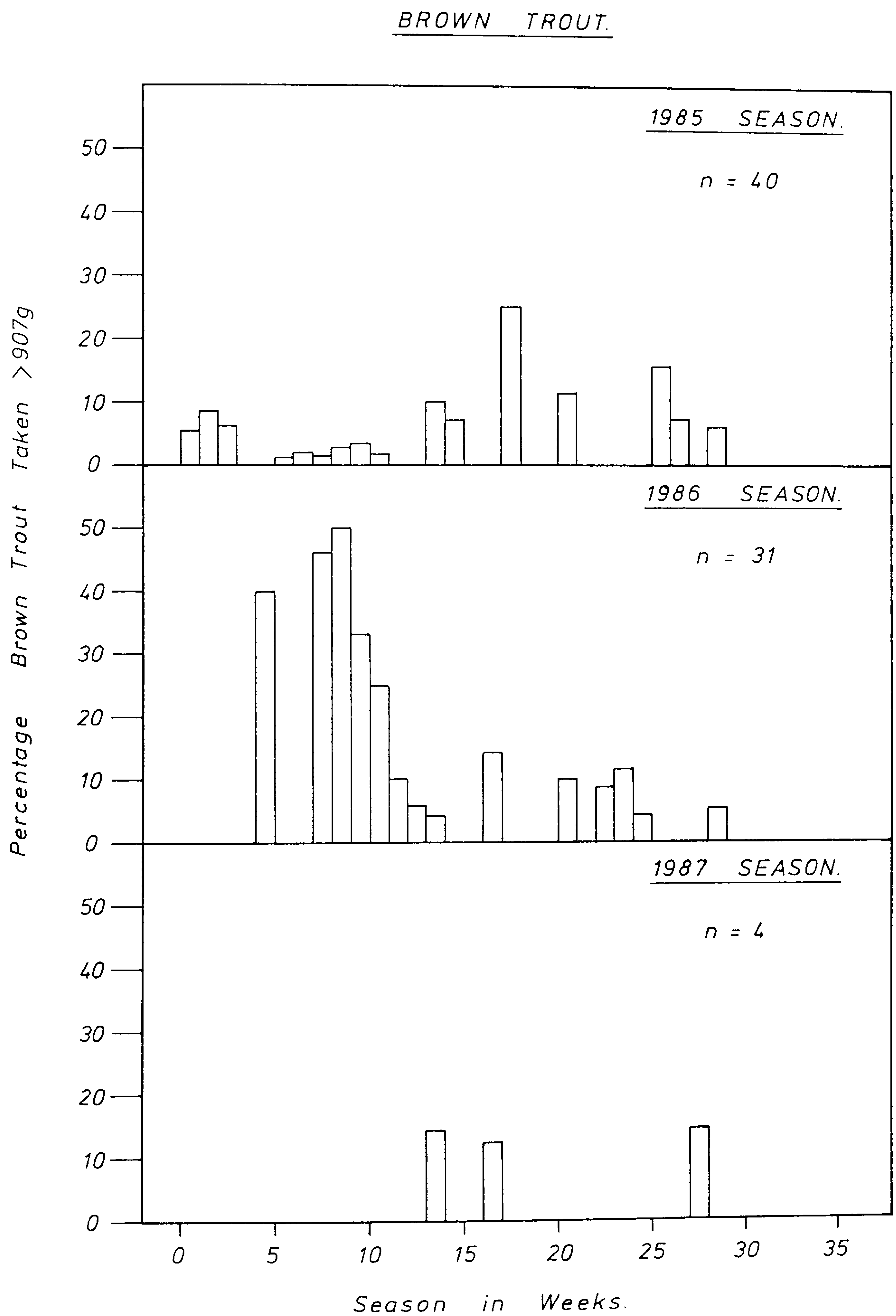
1985 SEASON.
Means : Taken = 0.198
> 907g = 0.006
1986 SEASON.
Means: Taken = 0.062
> 907g = 0.005
1987 SEASON.
Means : Taken = 0.067
> 907g = 0.001
Mean Taken per Angler Visit.
0.6
0.5
0.4
0.3
0.2
0.1
0
0.7
0
5
10
15
20
25
30
35
Season in Weeks.

Figure 36.

Histograms of weekly large (>907g) rainbow trout, brook trout and brown trout taken as percentages of those taken for each species for the seasons 1985 to 1987.


RAINBOW TROUT.
1985 SEASON.
n = 427.
1986 SEASON.
n = 699.
1987 SEASON.
n = 779.
0
10
20
30
0
5
10
15
20
25
30
35
Percentage Rainbow Trout Taken >907g
Season in Weeks.


BROOK TROUT.
1985 SEASON.
n = 130.
1986 SEASON.
n = 2.
Percentage Brook Trout Taken > 907g
100
80
60
40
20
0
40
20
0
0
5
10
15
20
25
30
35
Season in Weeks.



BROWN TROUT.
1985 SEASON.
n = 40
1986 SEASON.
n = 31
1987 SEASON.
n = 4
Percentage Brown Trout Taken > 907g
0
10
20
30
40
50
0
5
10
15
20
25
30
35
Season in Weeks.

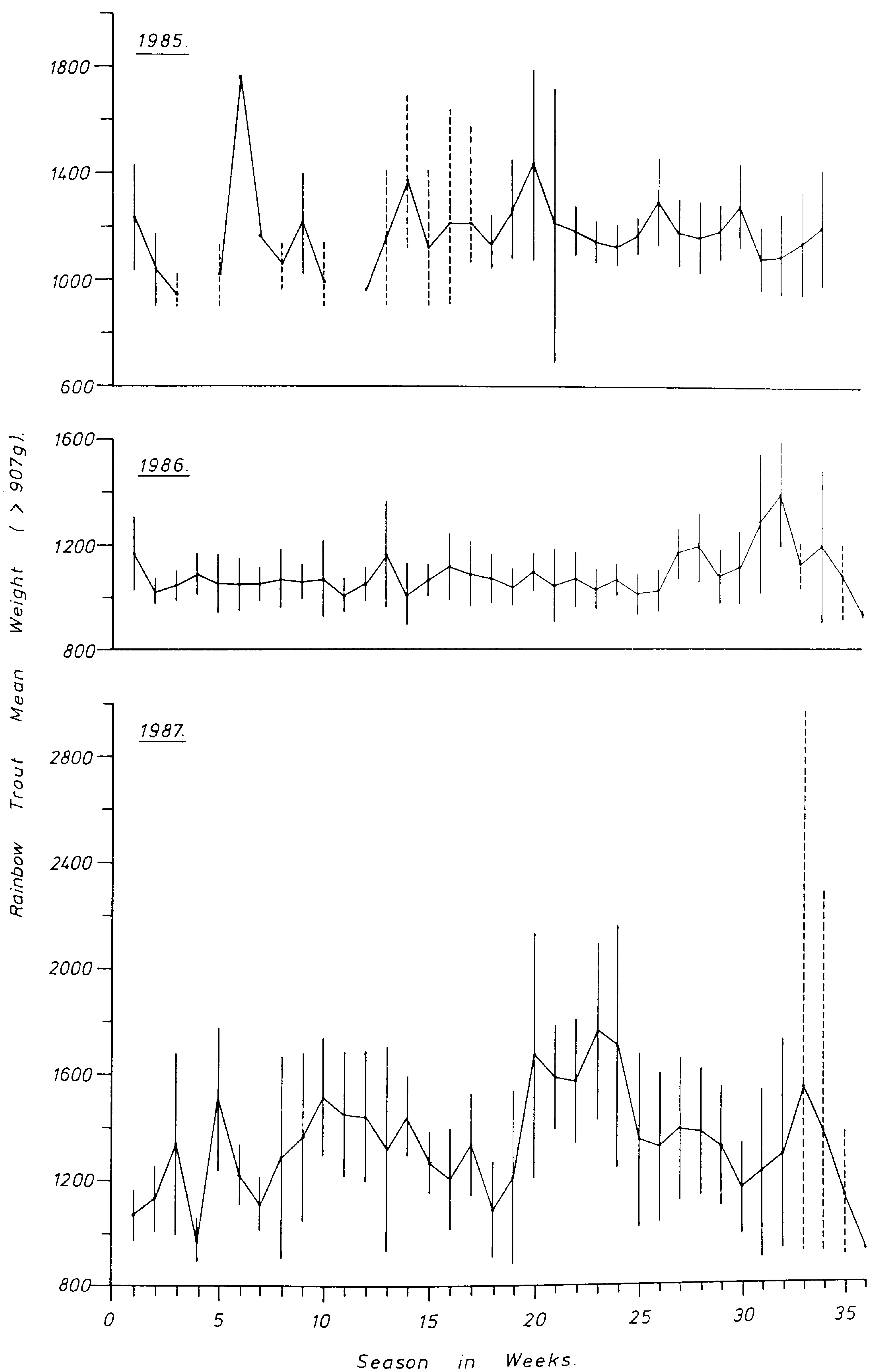
Figure 37.

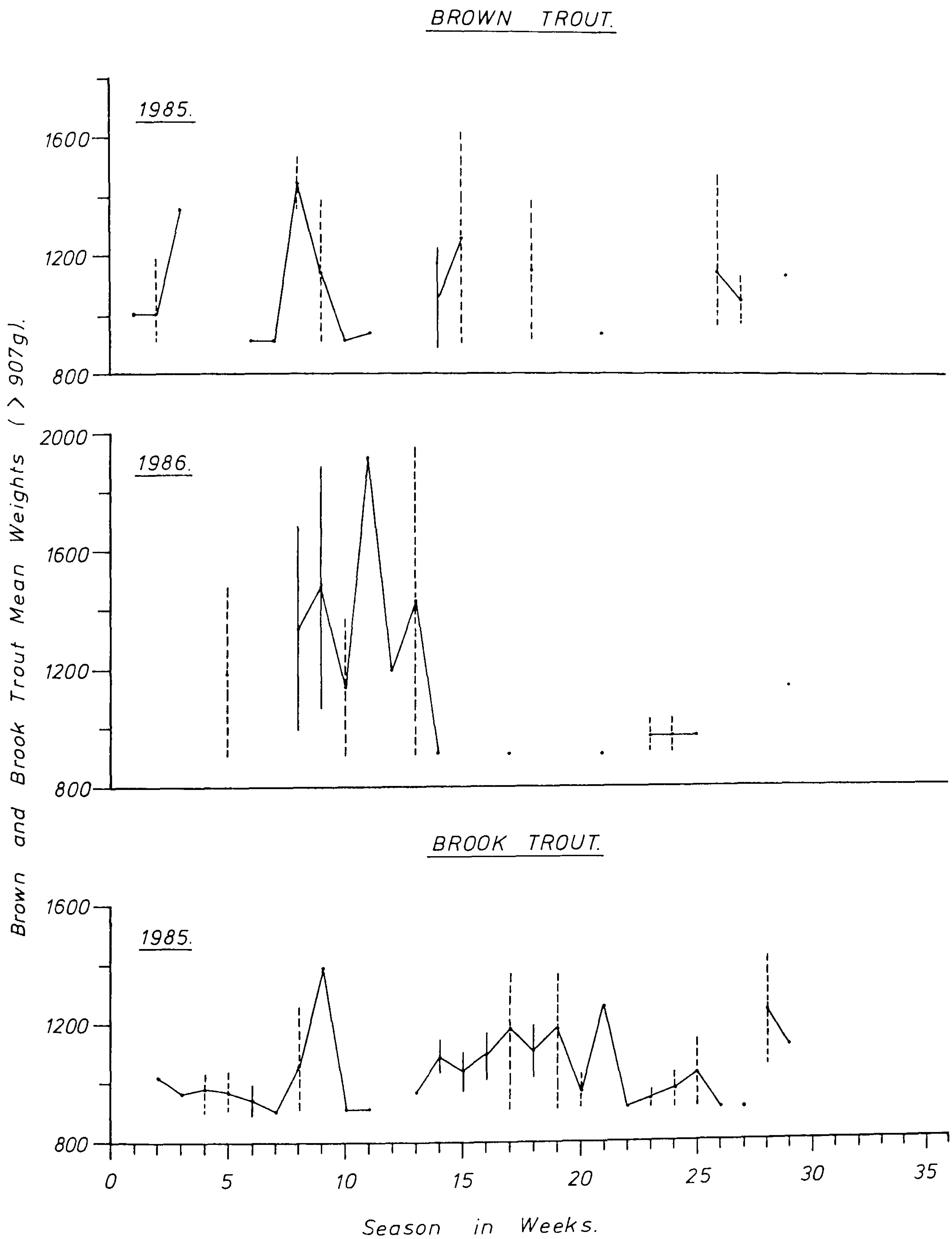
Graphical interpretation of mean weekly weights of large (>907g) rainbow trout, brook trout and brown trout taken, for the seasons 1985 to 1987.

——— 95% confidence limits.

----- range (less than 5 individuals).

RAINBOW TROUT.

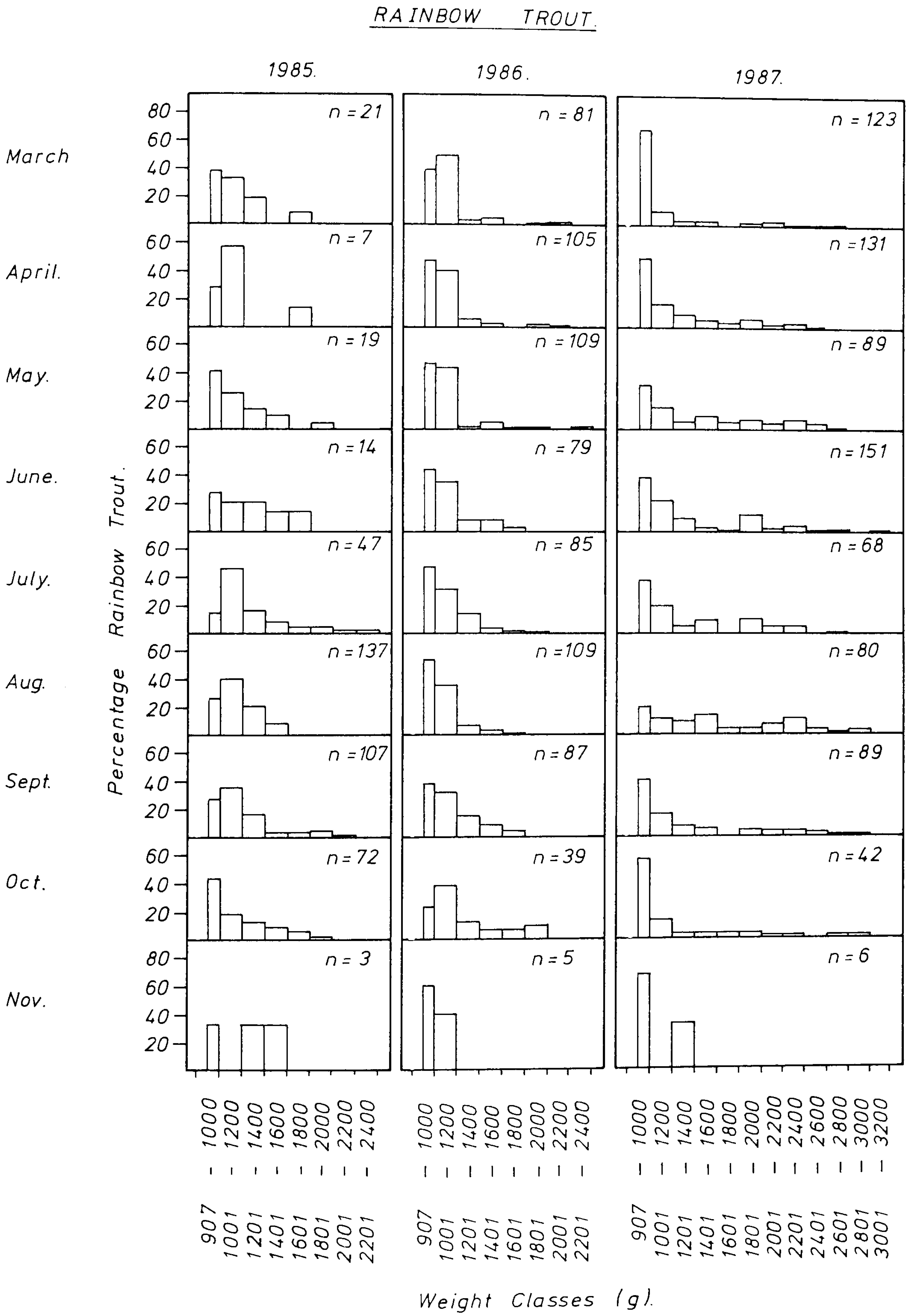




BROWN TROUT.
1985.
1986.
BROOK TROUT.
1985.
800
1200
1600
2000
0
5
10
15
20
25
30
35
Brown and Brook Trout Mean Weights (> 907g).
Season in Weeks.

Figure 38.

Monthly percentage frequency weight distributions of large (>907g) fish taken for the seasons 1985 to 1987.


RAINBOW TROUT.
1985.
1986.
1987.
March
April.
May.
June.
July.
Aug.
Sept.
Oct.
Nov.
Percentage Rainbow Trout.
n = 21
n = 81
n = 123
n = 7
n = 105
n = 131
n = 19
n = 109
n = 89
n = 14
n = 79
n = 151
n = 47
n = 85
n = 68
n = 137
n = 109
n = 80
n = 107
n = 87
n = 89
n = 72
n = 39
n = 42
n = 3
n = 5
n = 6
907 - 1000
1001 - 1200
1201 - 1400
1401 - 1600
1601 - 1800
1801 - 2000
2001 - 2200
2201 - 2400
2401 - 2600
2601 - 2800
2801 - 3000
3001 - 3200
Weight Classes (g).

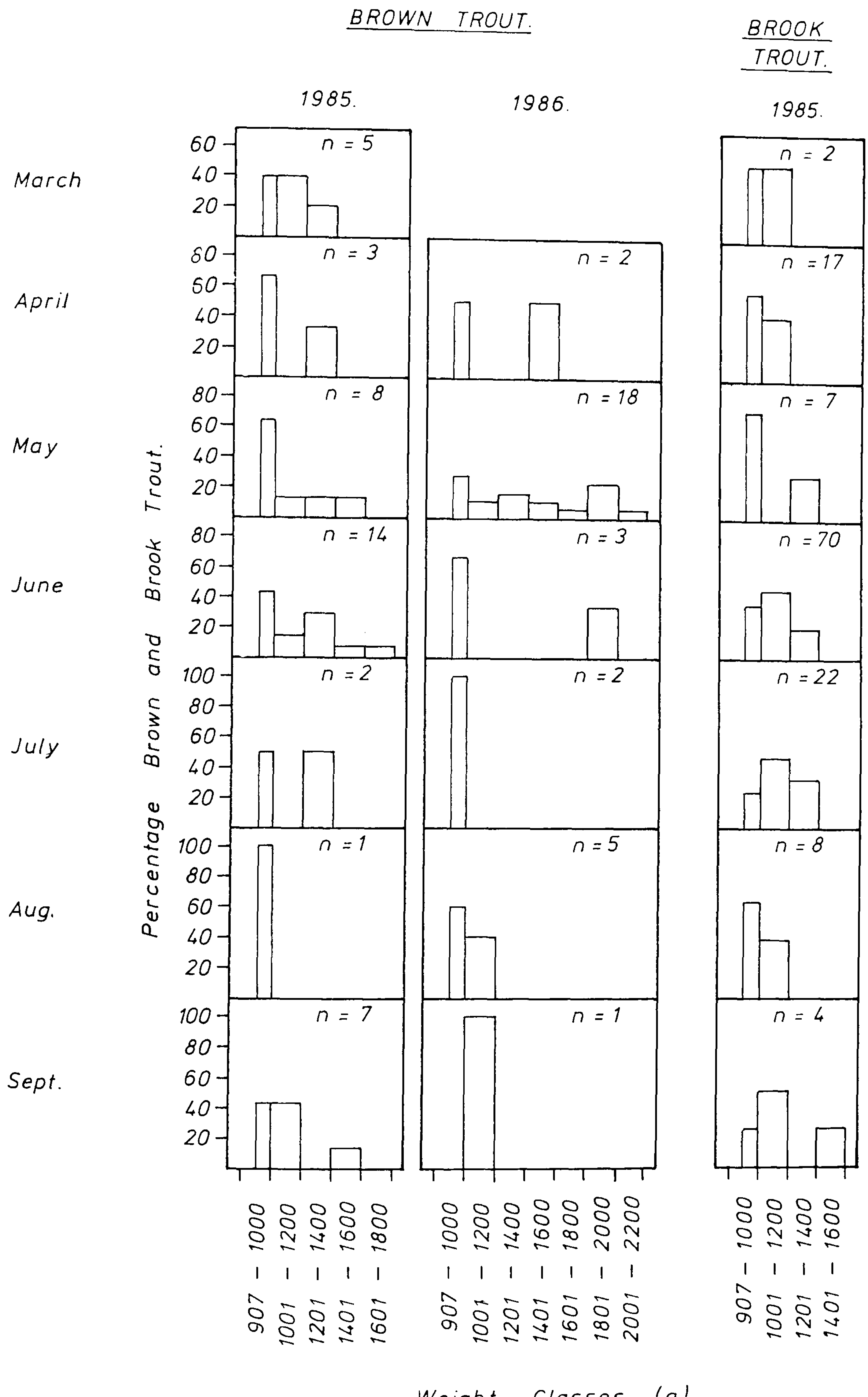
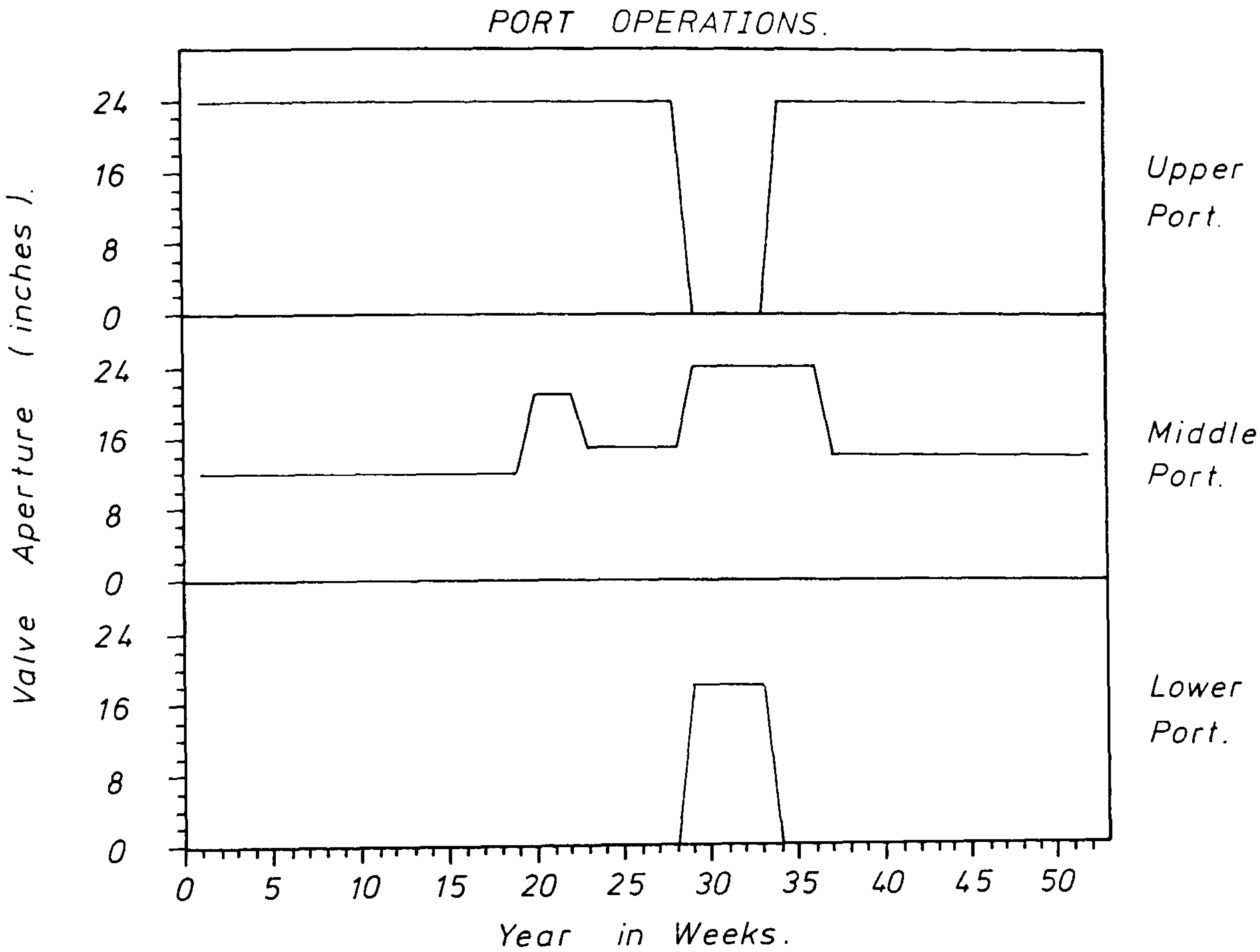
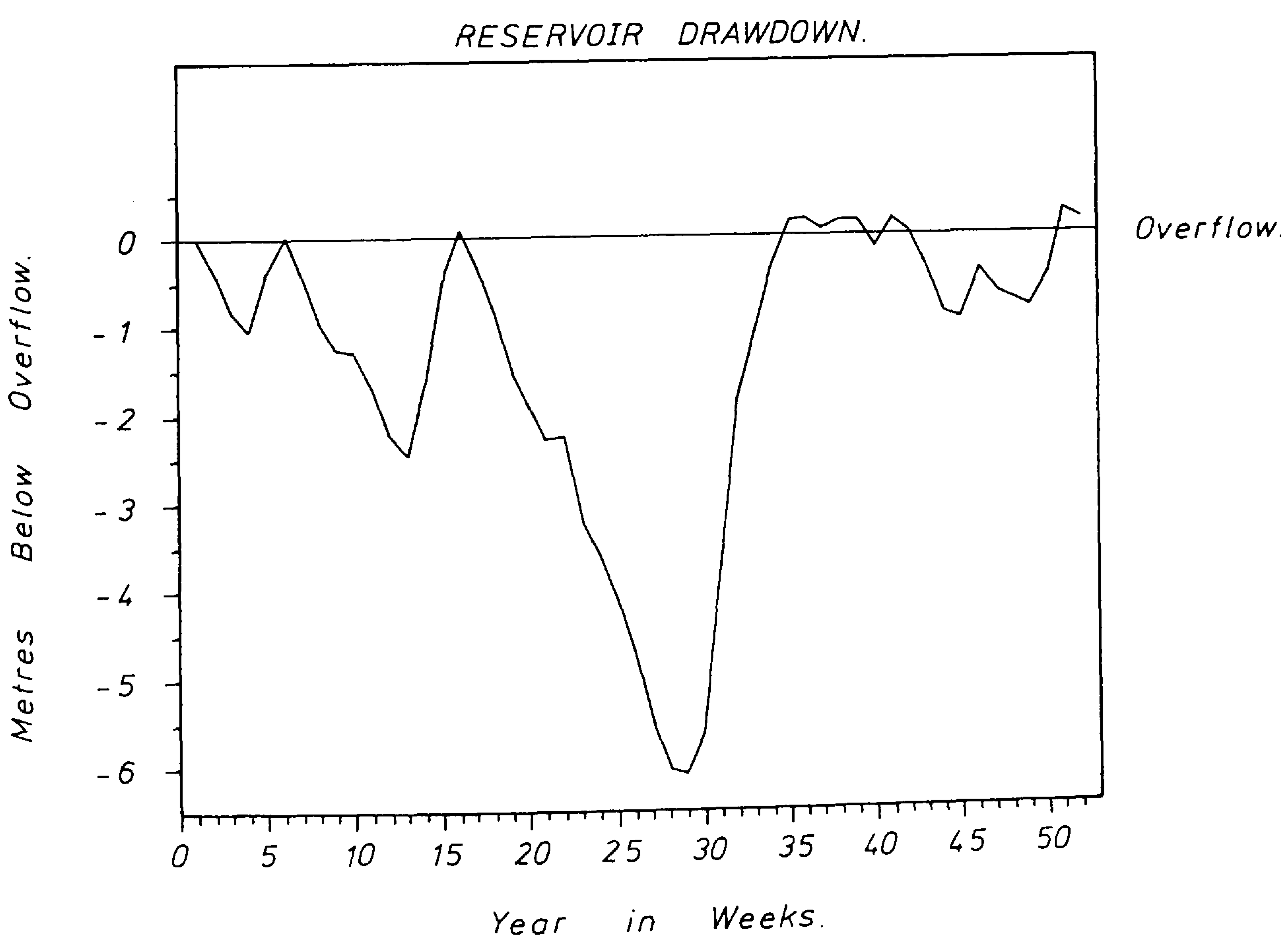

BROWN TROUT.
BROOK TROUT.
1985.
1986.
1985.
March
April
May
June
July
Aug.
Sept.
Percentage Brown and Brook Trout.
n = 5
n = 3
n = 8
n = 14
n = 2
n = 1
n = 7
n = 2
n = 18
n = 3
n = 2
n = 5
n = 1
n = 2
n = 17
n = 7
n = 70
n = 22
n = 8
n = 4
907 – 1000
1001 – 1200
1201 – 1400
1401 – 1600
1601 – 1800
1801 – 2000
2001 – 2200
Weight Classes (g).

Figure 39.

Graphical representation of draw-off port operations and reservoir draw-down for the years 1985 to 1987.

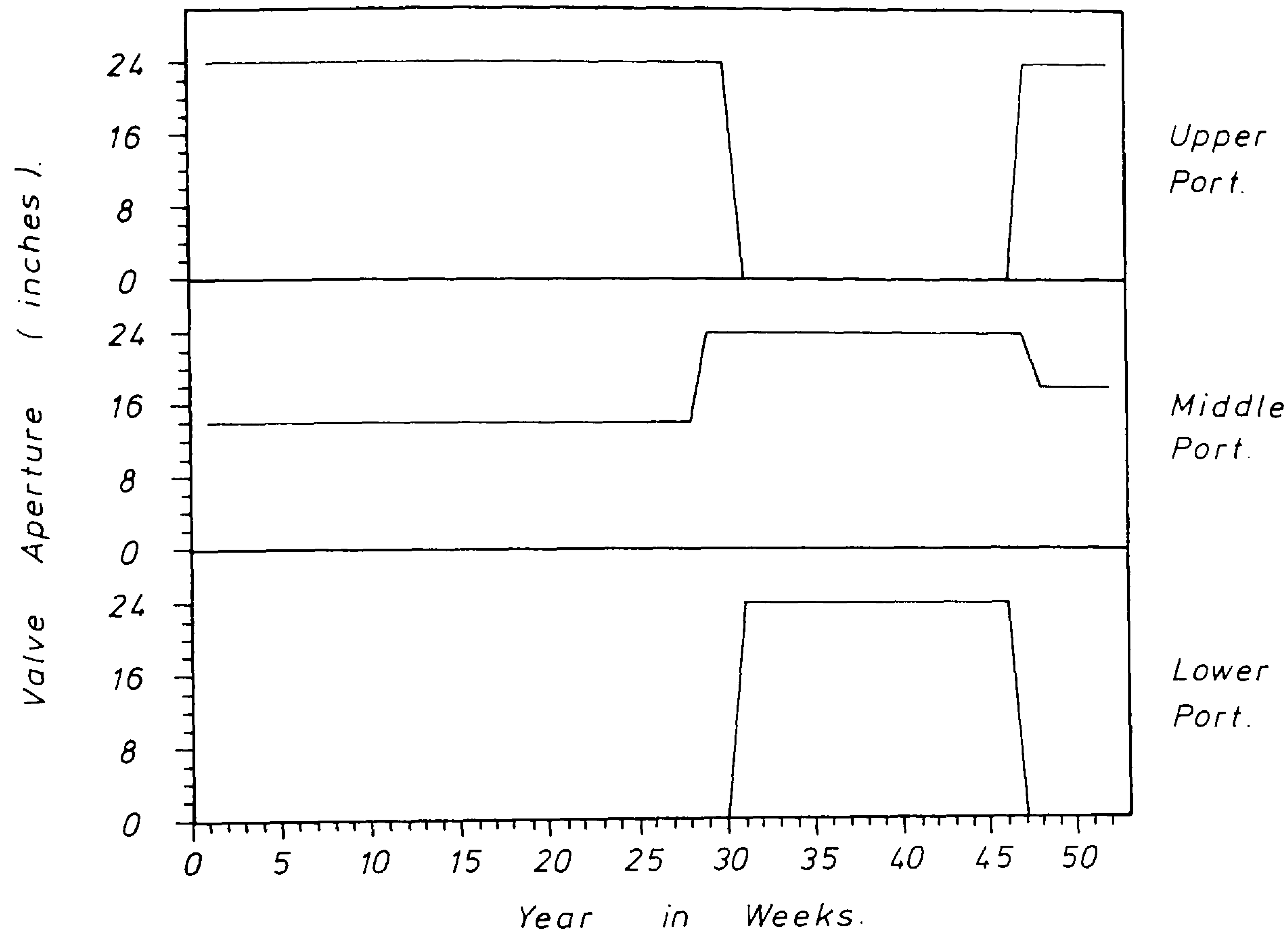
1985.


PORT OPERATIONS.
Valve Aperture (inches).
24
16
8
0
Upper Port.
Middle Port.
Lower Port.
0 5 10 15 20 25 30 35 40 45 50
Year in Weeks.

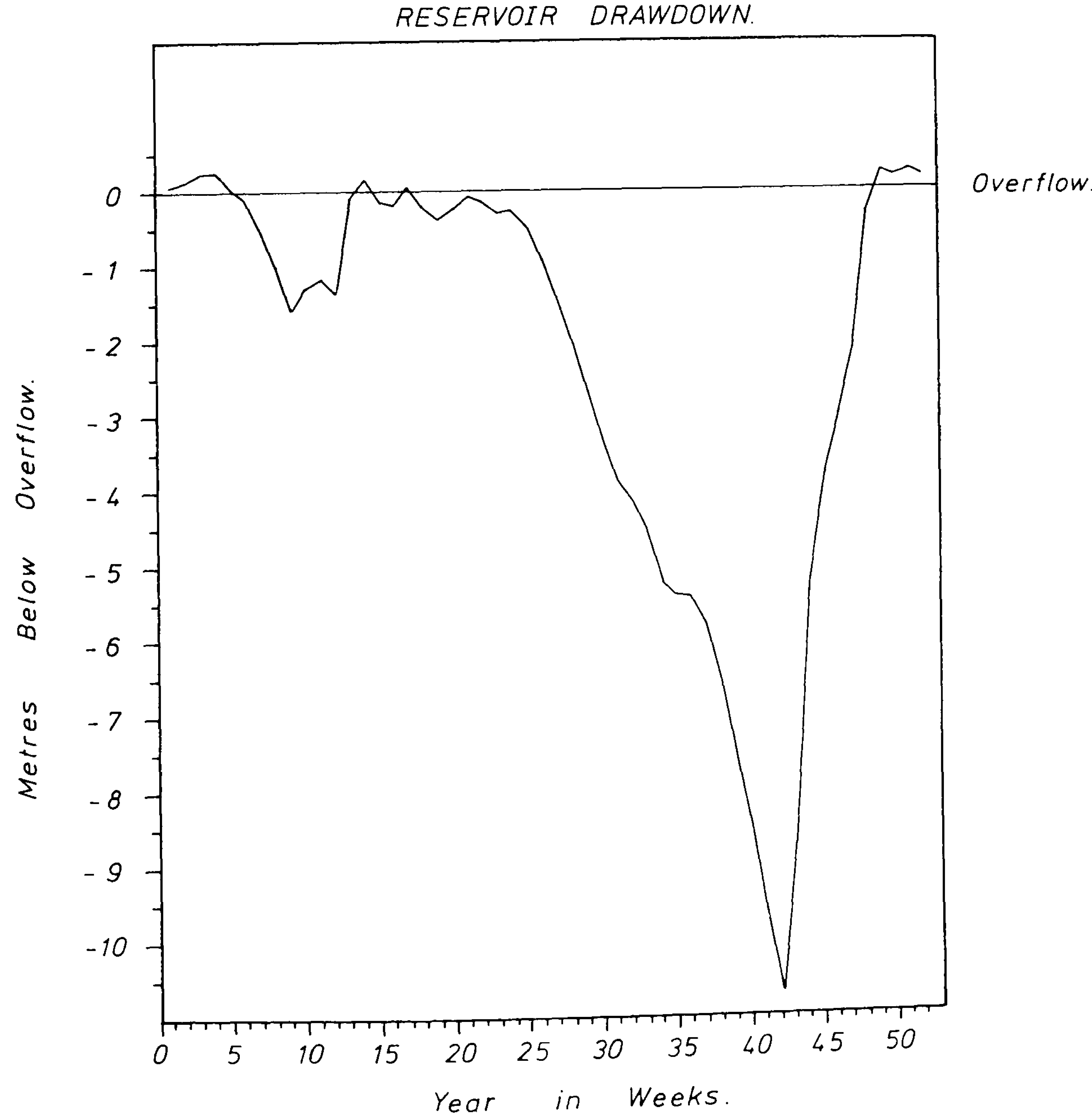

RESERVOIR DRAWDOWN.
Metres Below Overflow.
0
-1
-2
-3
-4
-5
-6
Overflow.
0 5 10 15 20 25 30 35 40 45 50
Year in Weeks.

1986.

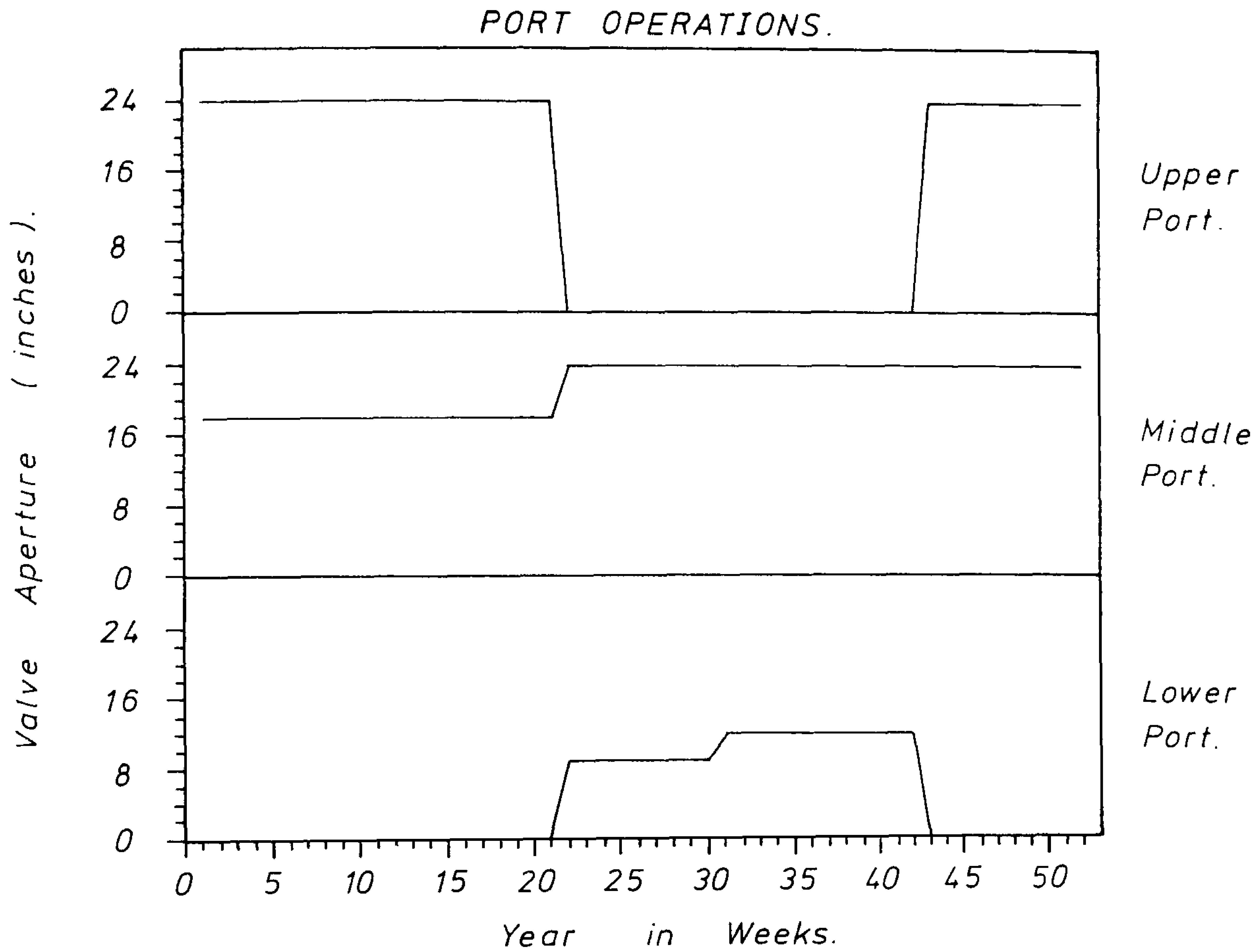
PORT OPERATIONS.



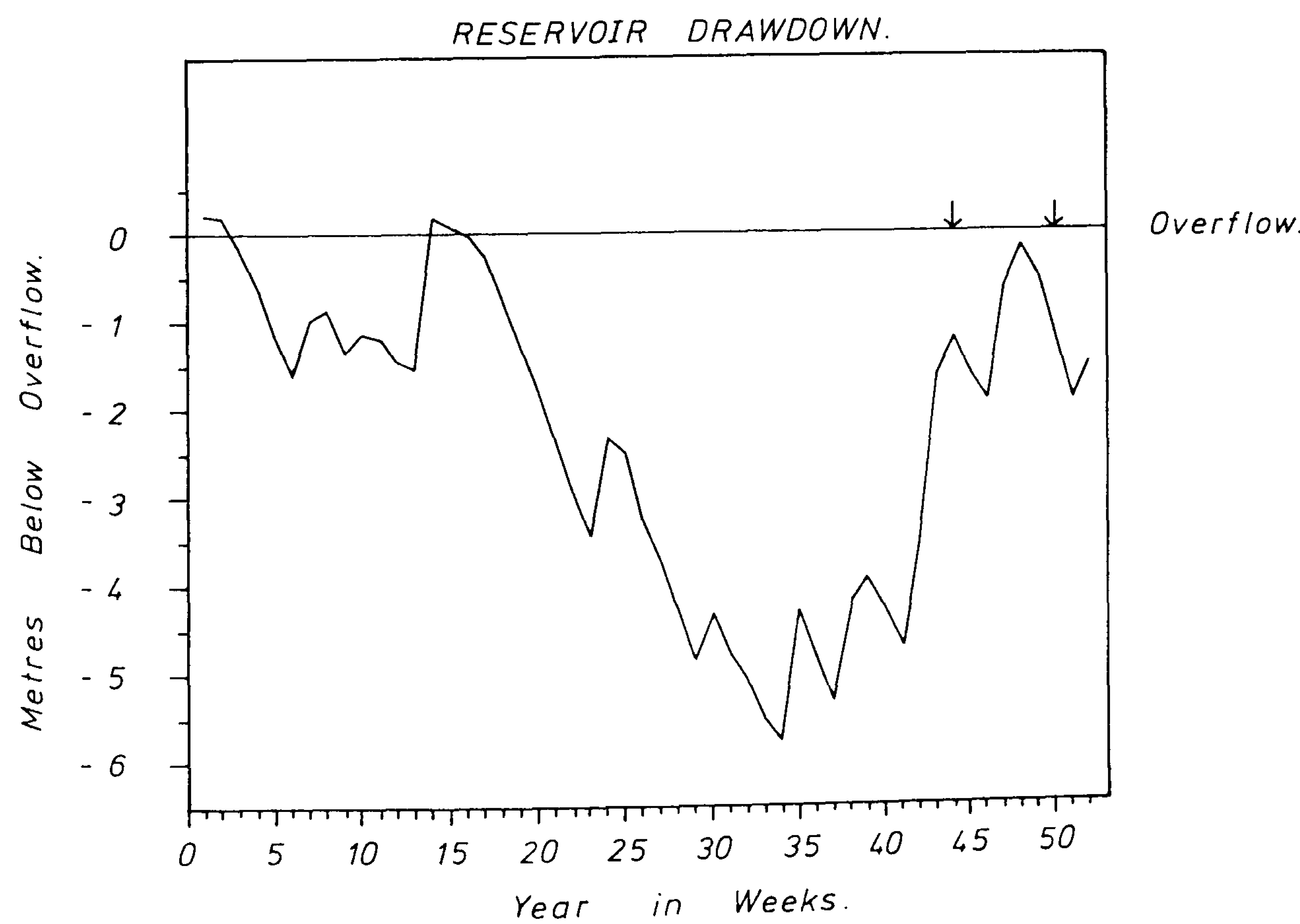
RESERVOIR DRAWDOWN.



1987.



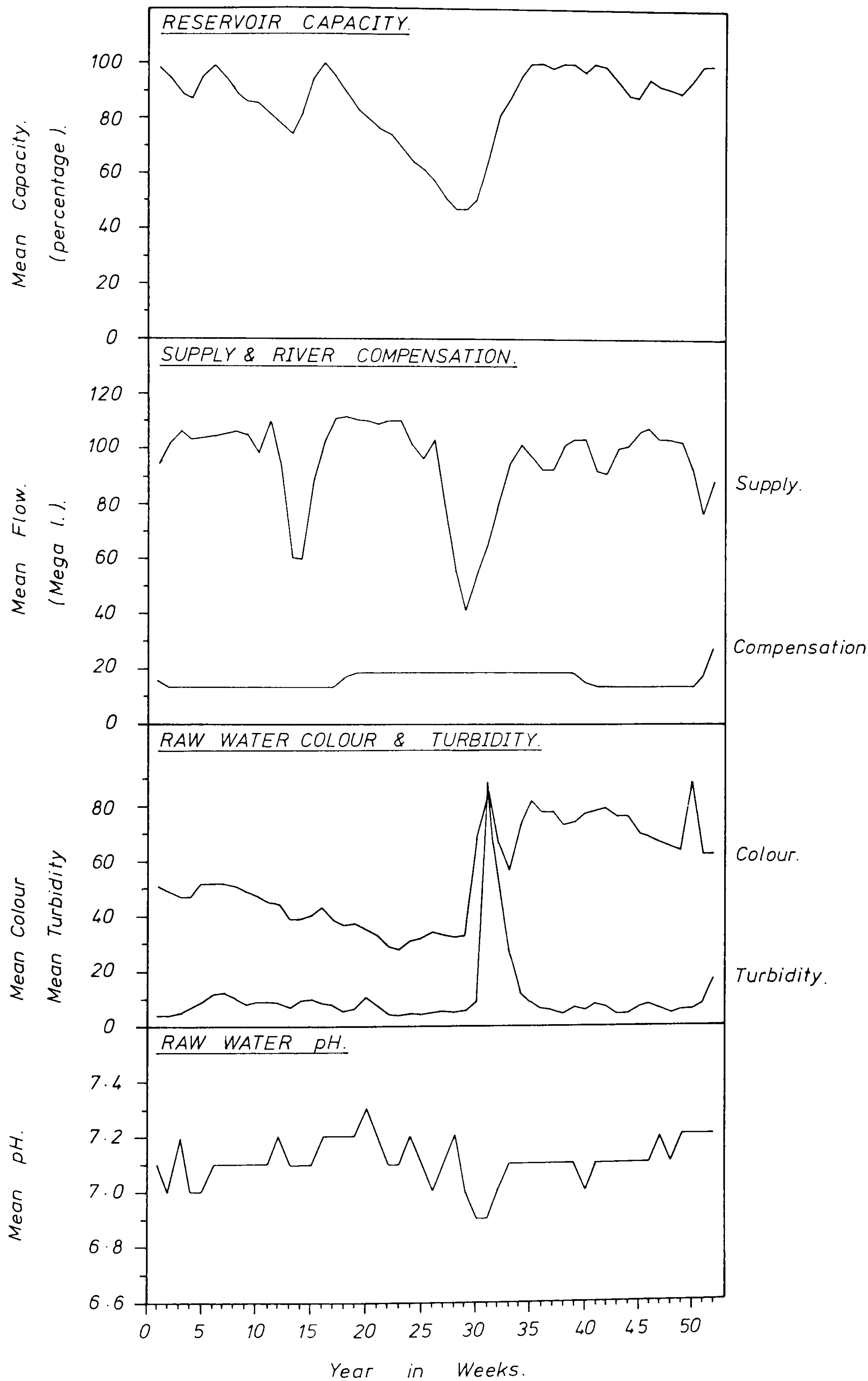
PORT OPERATIONS.
Valve Aperture (inches).
24
16
8
0
Upper Port.
Middle Port.
Lower Port.
0 5 10 15 20 25 30 35 40 45 50
Year in Weeks.



RESERVOIR DRAWDOWN.
Metres Below Overflow.
0
- 1
- 2
- 3
- 4
- 5
- 6
Overflow.
0 5 10 15 20 25 30 35 40 45 50
Year in Weeks.

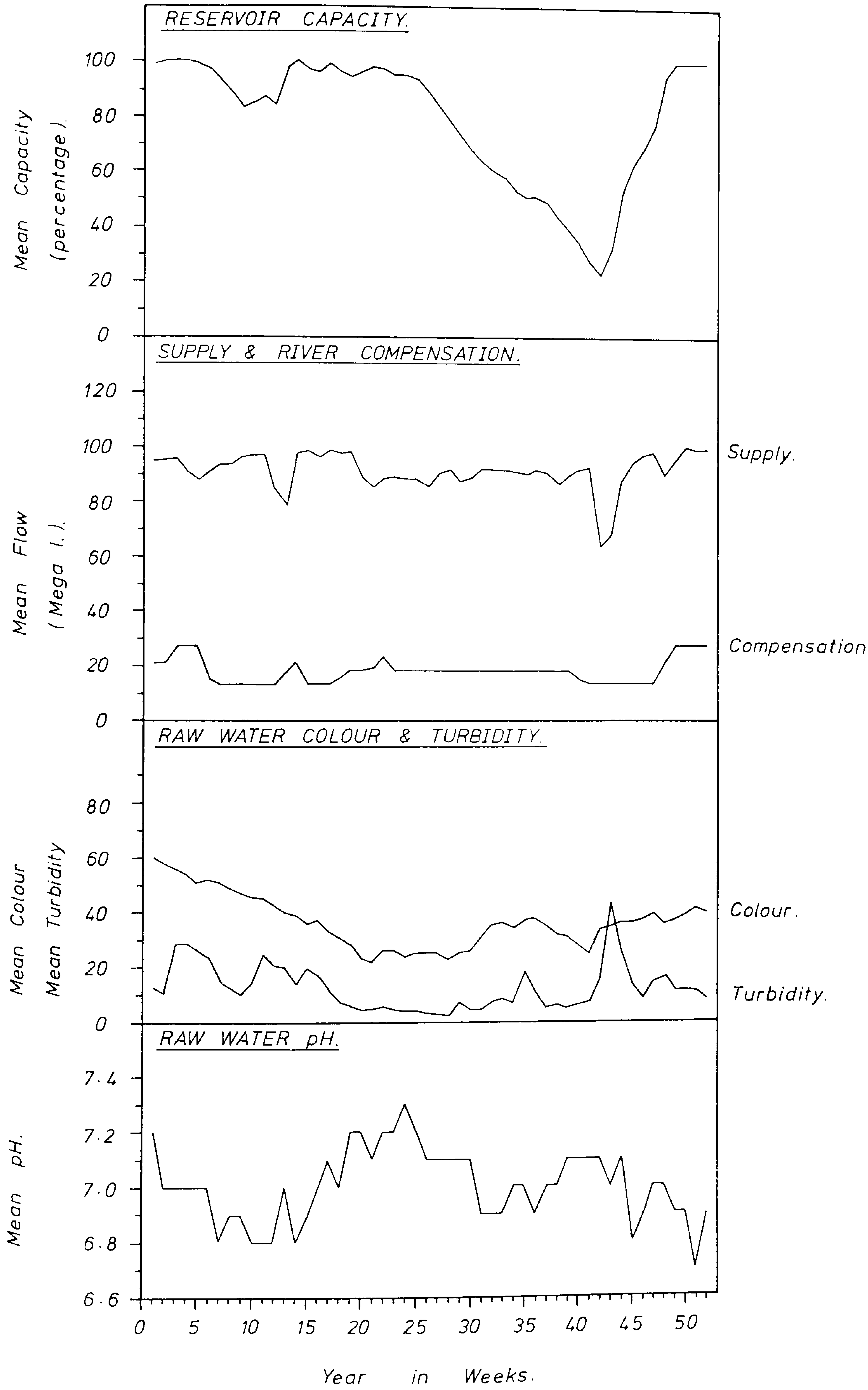
Figure 40.

Graphical representation of reservoir percentage capacity, supply and compensation flows, raw water colour, turbidity and pH for the years 1985 to 1987.

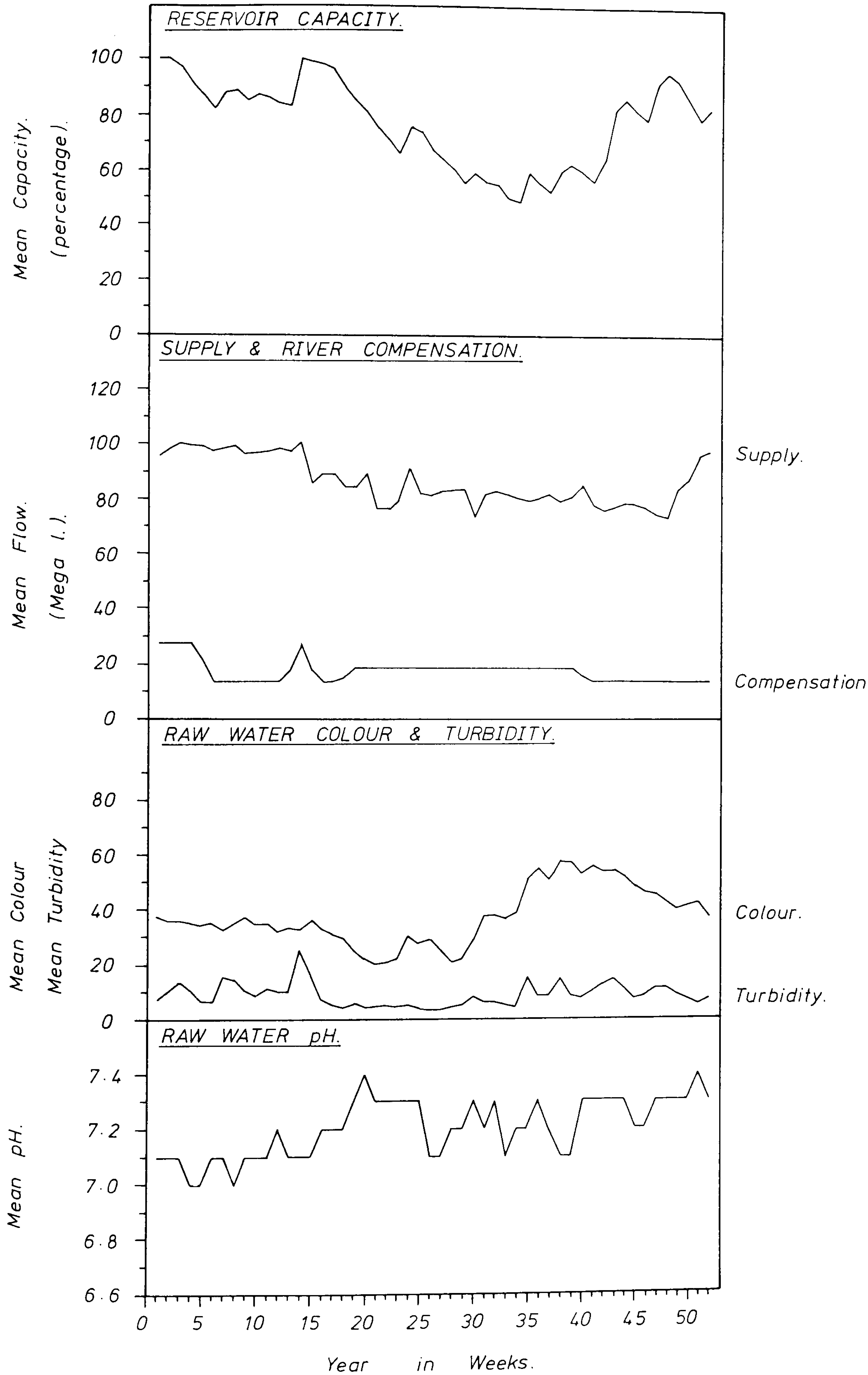


RESERVOIR CAPACITY.
Mean Capacity. (percentage).
0
20
40
60
80
100
SUPPLY & RIVER COMPENSATION.
Mean Flow. (Mega l.).
0
20
40
60
80
100
120
Supply.
Compensation.
RAW WATER COLOUR & TURBIDITY.
Mean Colour
Mean Turbidity
0
20
40
60
80
Colour.
Turbidity.
RAW WATER pH.
Mean pH.
6·6
6·8
7·0
7·2
7·4
0
5
10
15
20
25
30
35
40
45
50
Year in Weeks.

1986.


RESERVOIR CAPACITY.
Mean Capacity (percentage).
100
80
60
40
20
0
SUPPLY & RIVER COMPENSATION.
Mean Flow (Mega l.).
120
100
80
60
40
20
0
Supply.
Compensation.
RAW WATER COLOUR & TURBIDITY.
Mean Colour
Mean Turbidity
80
60
40
20
0
Colour.
Turbidity.
RAW WATER pH.
Mean pH.
7·4
7·2
7·0
6·8
6·6
0
5
10
15
20
25
30
35
40
45
50
Year in Weeks.

1987.

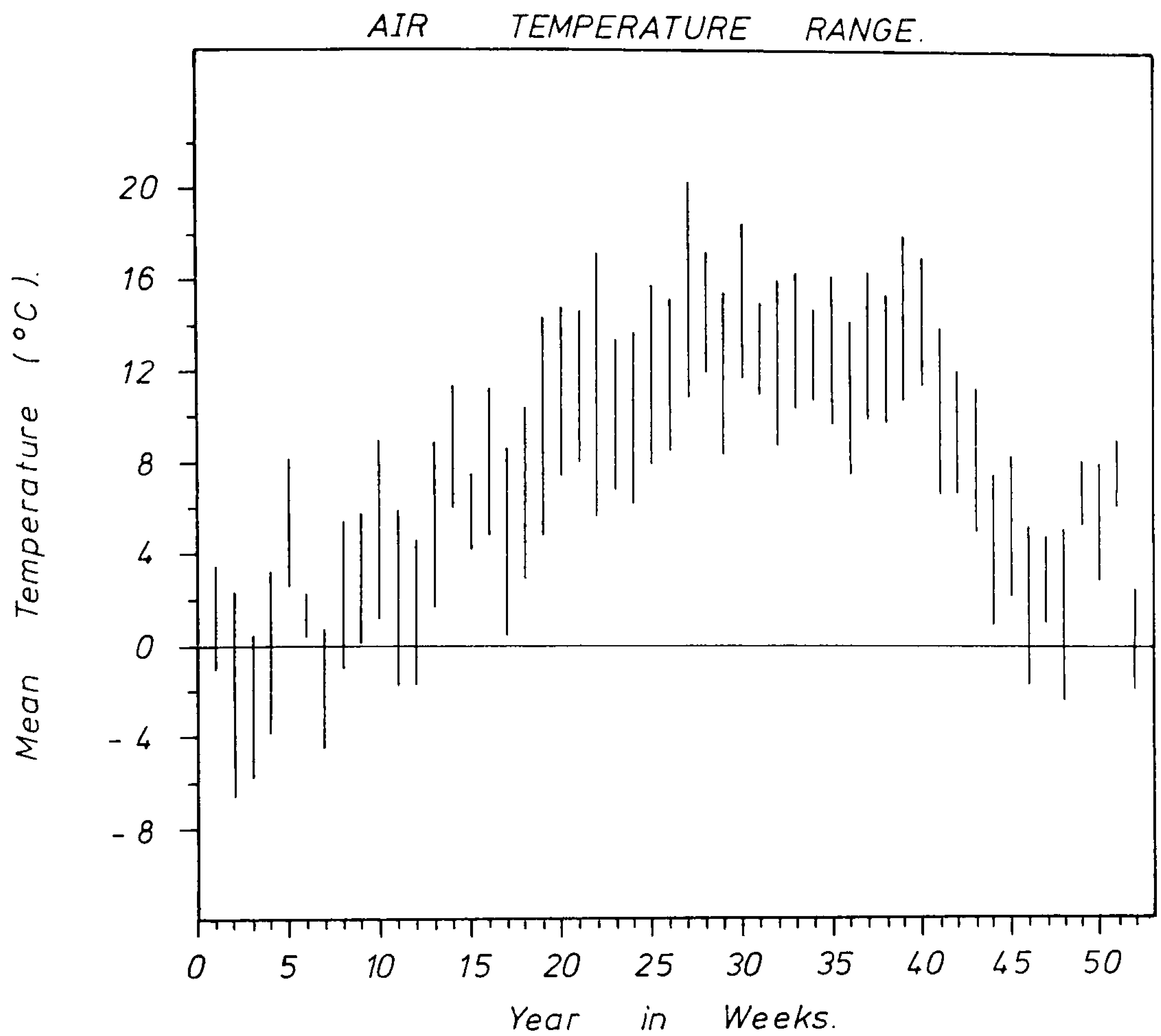


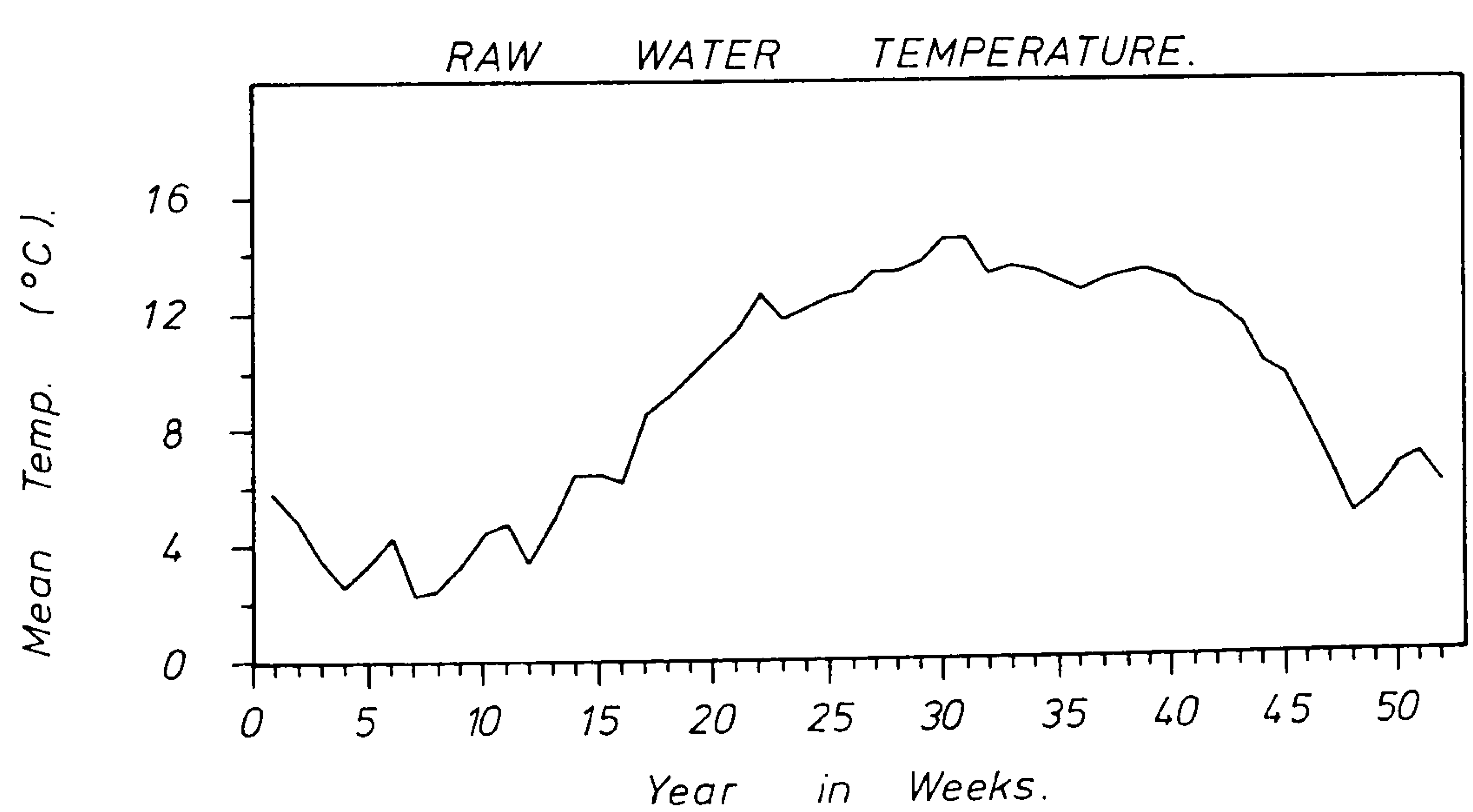
RESERVOIR CAPACITY.
Mean Capacity. (percentage).
100
80
60
40
20
0
SUPPLY & RIVER COMPENSATION.
Mean Flow. (Mega l.).
120
100
80
60
40
20
0
Supply.
Compensation.
RAW WATER COLOUR & TURBIDITY.
Mean Colour
Mean Turbidity
80
60
40
20
0
Colour.
Turbidity.
RAW WATER pH.
Mean pH.
7.4
7.2
7.0
6.8
6.6
0
5
10
15
20
25
30
35
40
45
50
Year in Weeks.

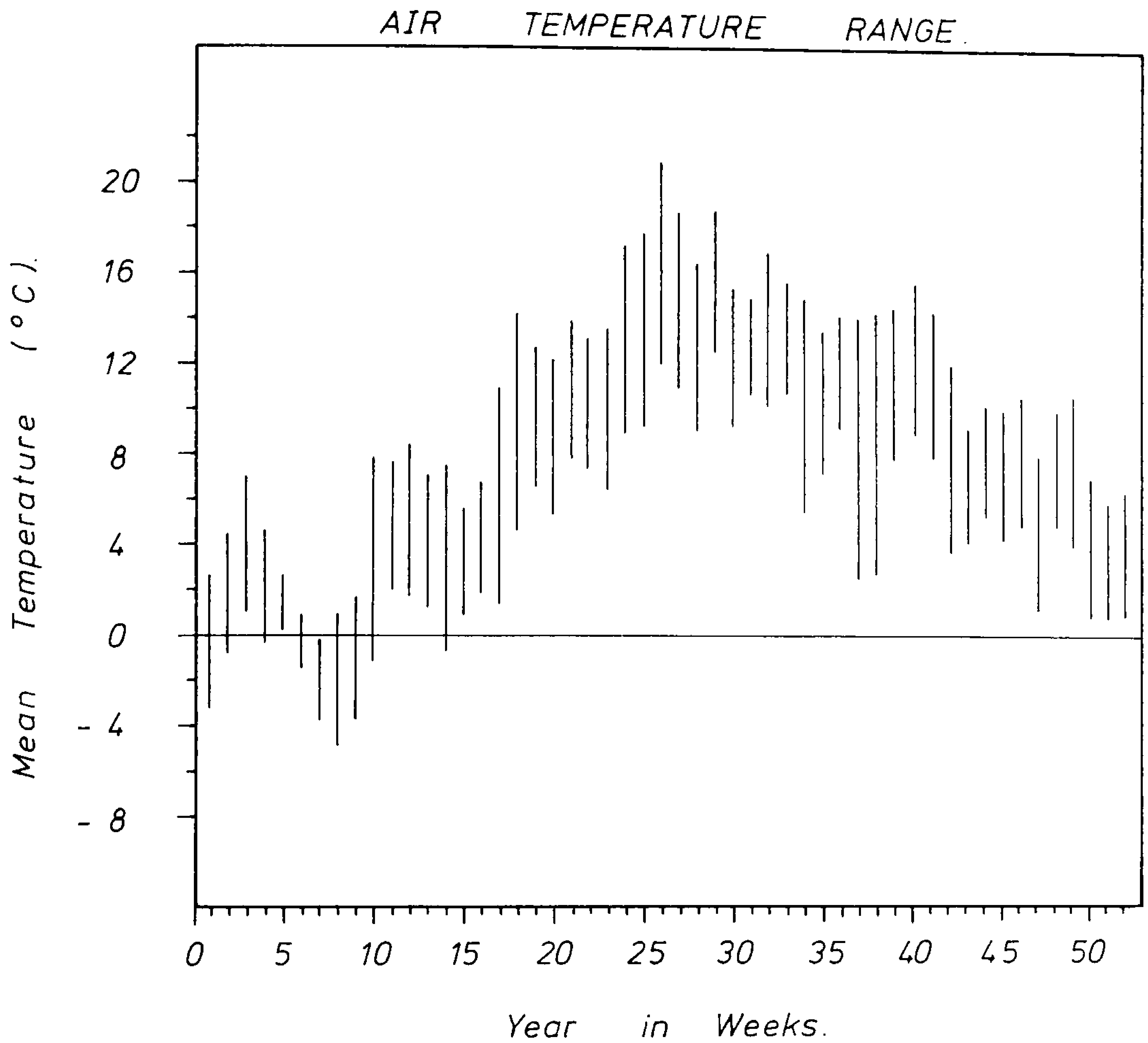
Figure 41.

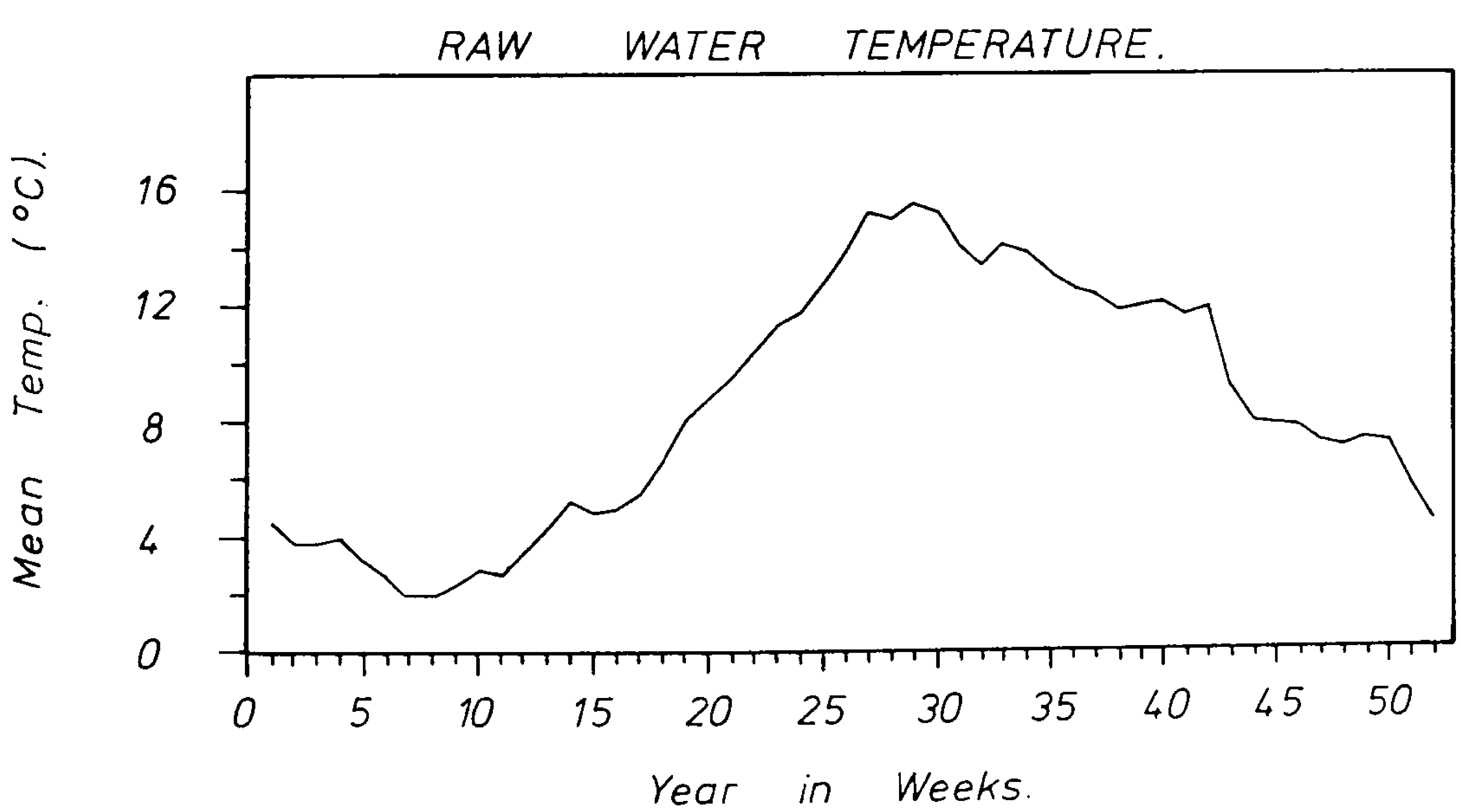
Graphical representation of maximum/minimum air temperature and raw water temperature for the years 1985 to 1987.

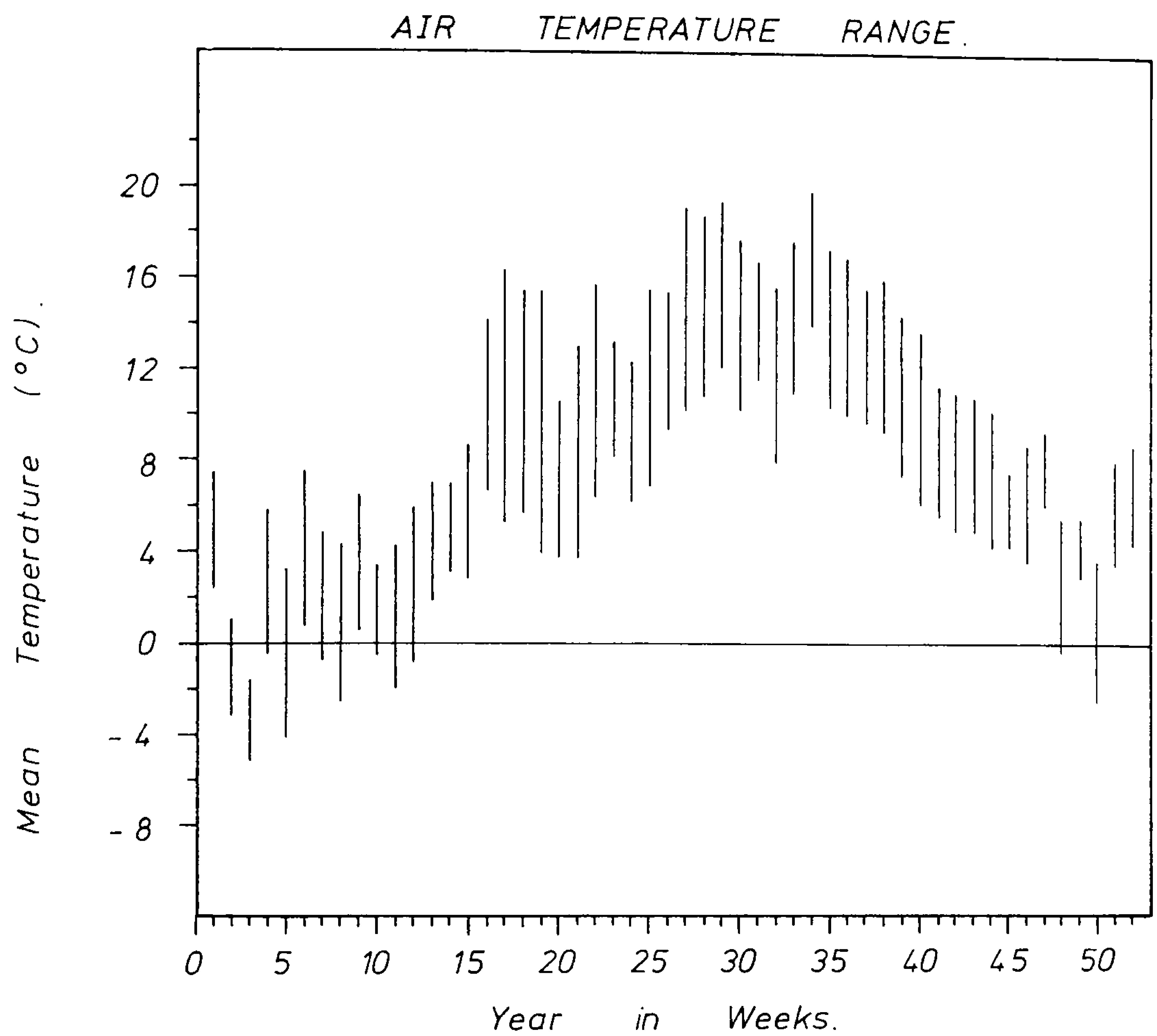
1985.

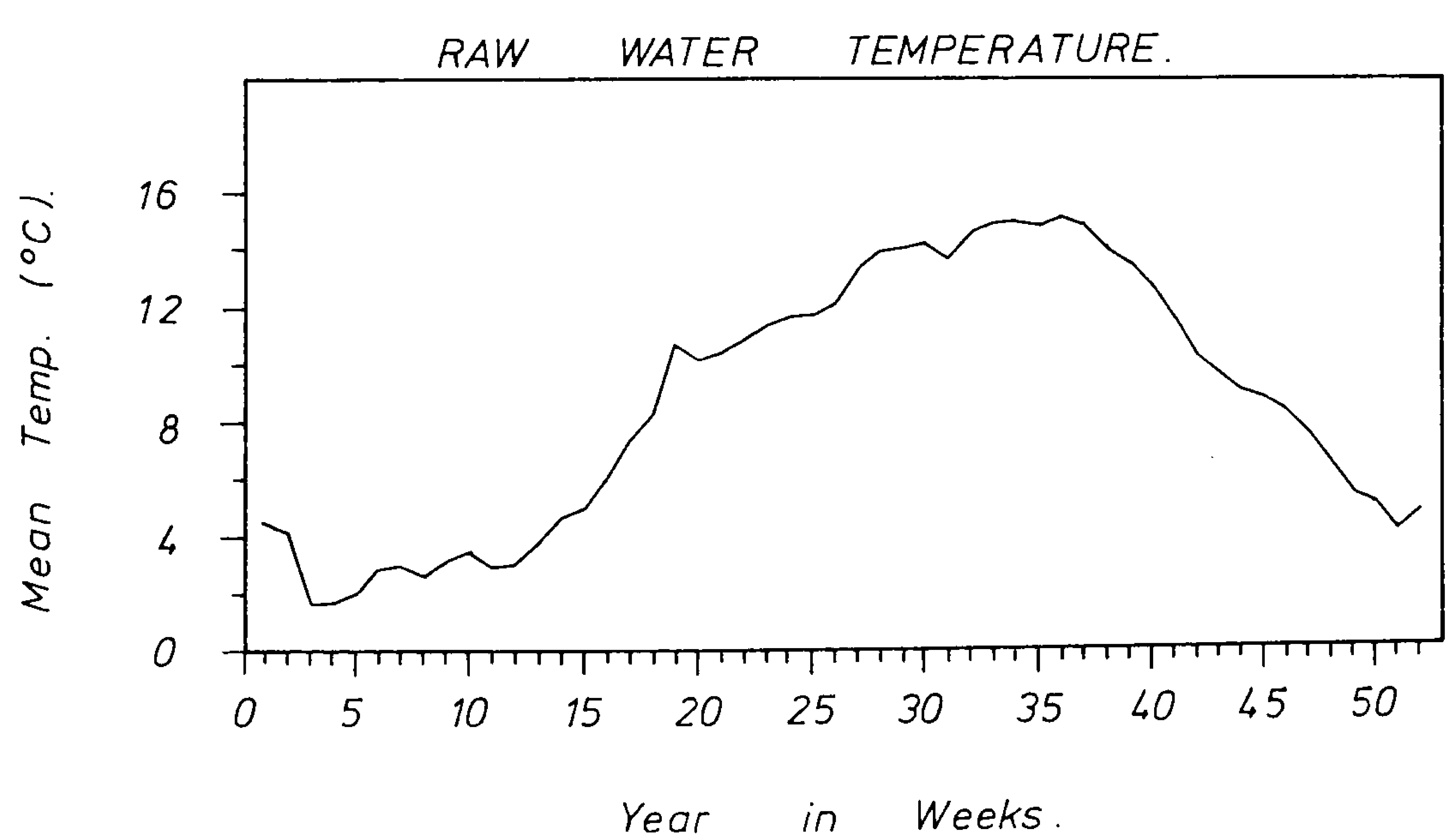

AIR TEMPERATURE RANGE.
Mean Temperature (°C).
20
16
12
8
4
0
-4
-8
0
5
10
15
20
25
30
35
40
45
50
Year in Weeks.


RAW WATER TEMPERATURE.
Mean Temp. (°C).
16
12
8
4
0
0
5
10
15
20
25
30
35
40
45
50
Year in Weeks.


AIR TEMPERATURE RANGE.
Mean Temperature (° C).
20
16
12
8
4
0
- 4
- 8
0 5 10 15 20 25 30 35 40 45 50
Year in Weeks.


RAW WATER TEMPERATURE.
Mean Temp. (°C).
16
12
8
4
0
0 5 10 15 20 25 30 35 40 45 50
Year in Weeks.

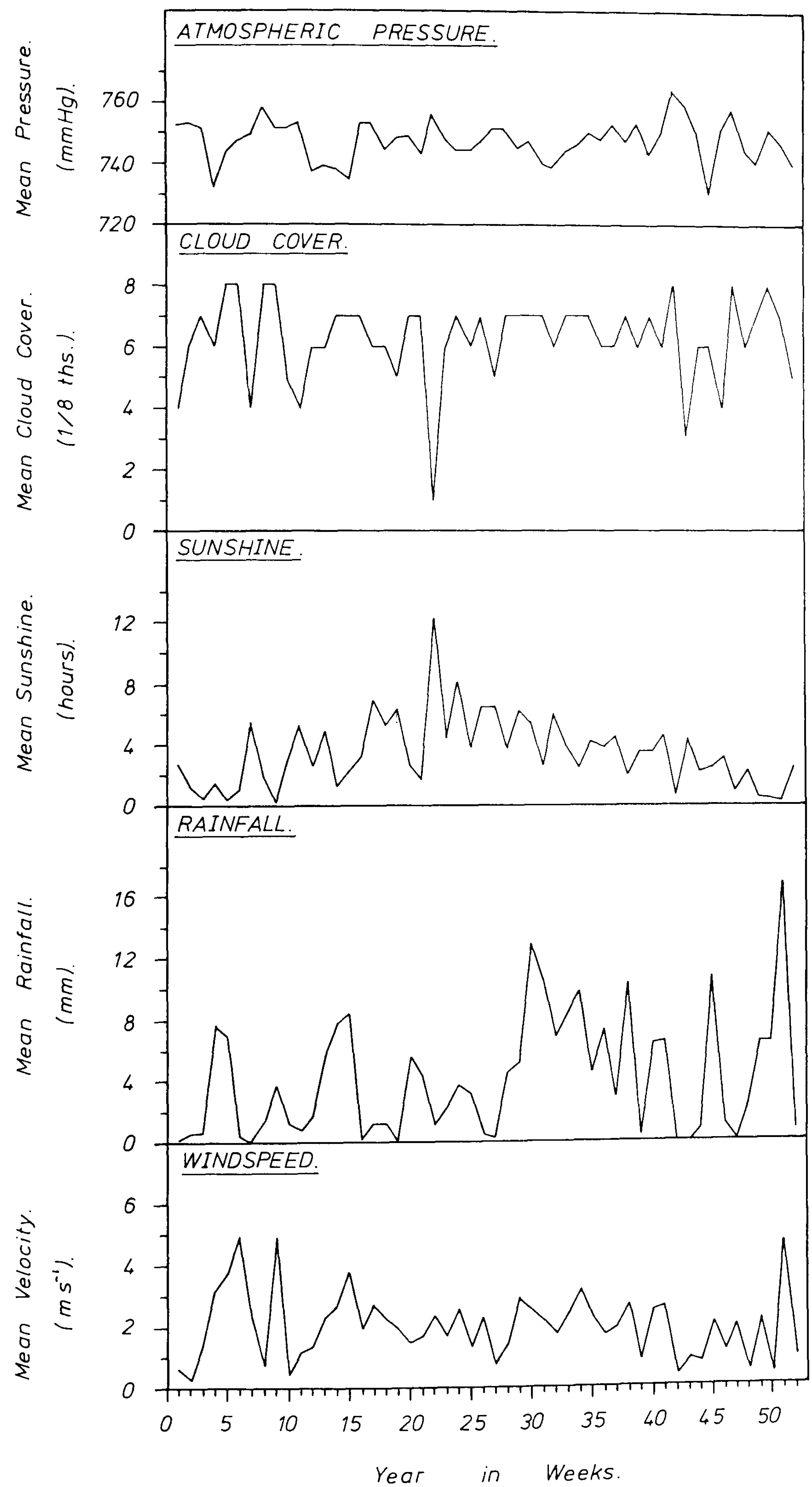

AIR TEMPERATURE RANGE.
Mean Temperature (°C).
20
16
12
8
4
0
-4
-8
0 5 10 15 20 25 30 35 40 45 50
Year in Weeks.


RAW WATER TEMPERATURE.
Mean Temp. (°C).
16
12
8
4
0
0 5 10 15 20 25 30 35 40 45 50
Year in Weeks.

<u>Figure 42.</u>

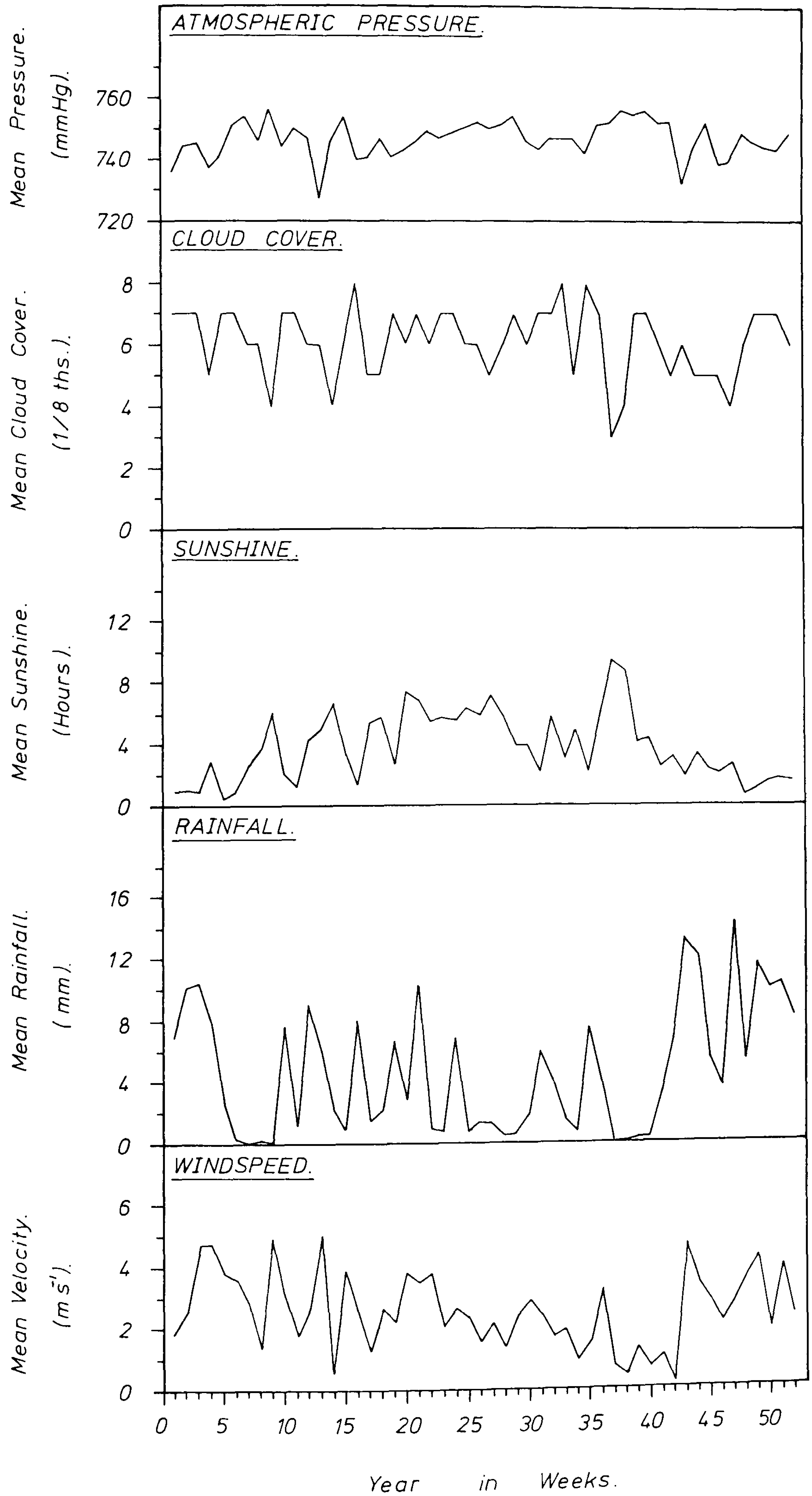
Graphical representation of atmospheric pressure, cloud cover, sunshine, rainfall and windspeed for the years 1985 to 1987.

1985.



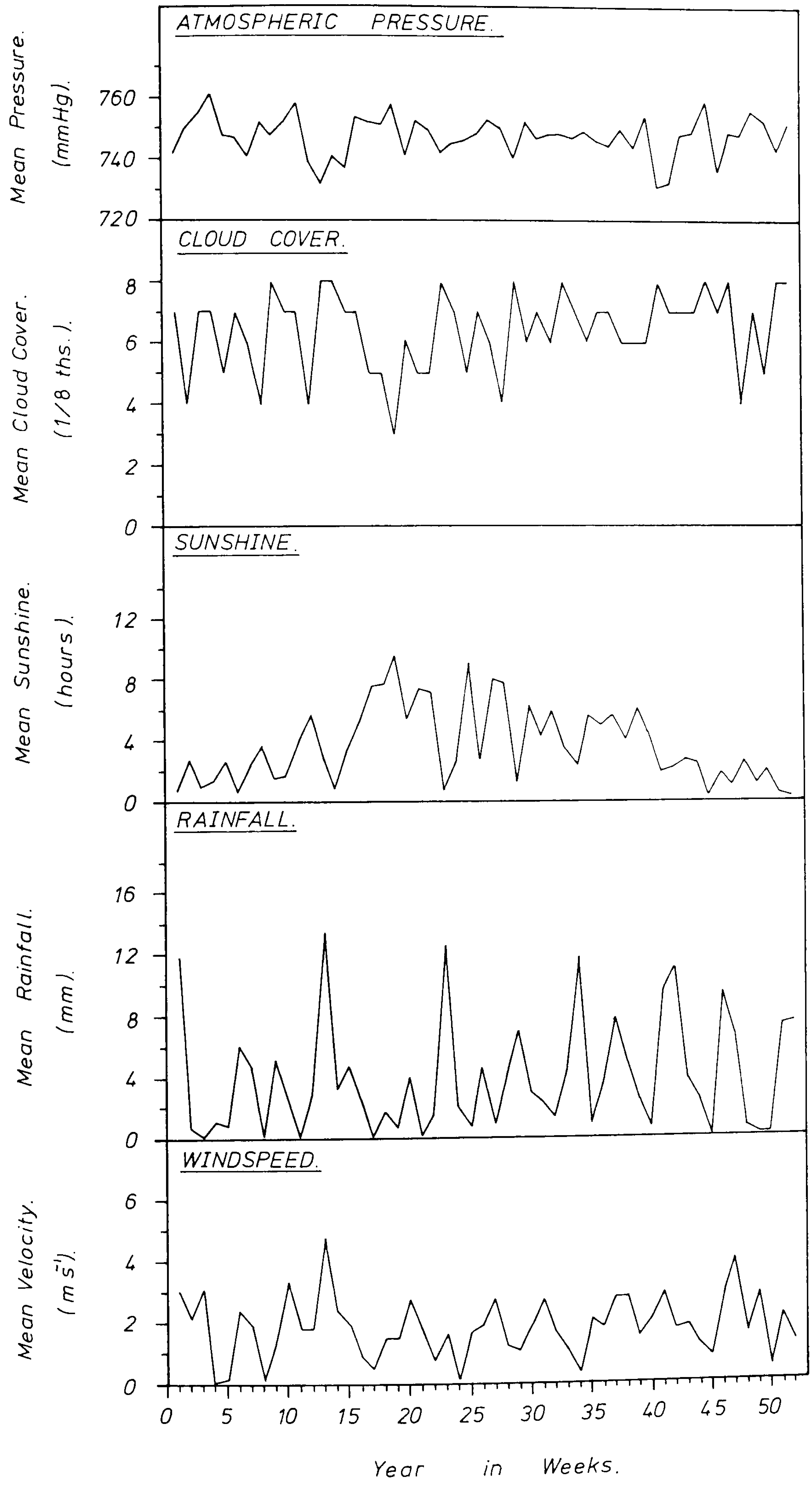
ATMOSPHERIC PRESSURE.
Mean Pressure. (mmHg).
760
740
720
CLOUD COVER.
Mean Cloud Cover. (1/8 ths.).
8
6
4
2
0
SUNSHINE.
Mean Sunshine. (hours).
12
8
4
0
RAINFALL.
Mean Rainfall. (mm).
16
12
8
4
0
WINDSPEED.
Mean Velocity. (m s⁻¹).
6
4
2
0
0 5 10 15 20 25 30 35 40 45 50
Year in Weeks.

1986.



ATMOSPHERIC PRESSURE.
Mean Pressure. (mmHg).
760
740
720
CLOUD COVER.
Mean Cloud Cover. (1/8 ths.).
8
6
4
2
0
SUNSHINE.
Mean Sunshine. (Hours).
12
8
4
0
RAINFALL.
Mean Rainfall. (mm).
16
12
8
4
0
WINDSPEED.
Mean Velocity. (m s⁻¹).
6
4
2
0
0 5 10 15 20 25 30 35 40 45 50
Year in Weeks.

1987.

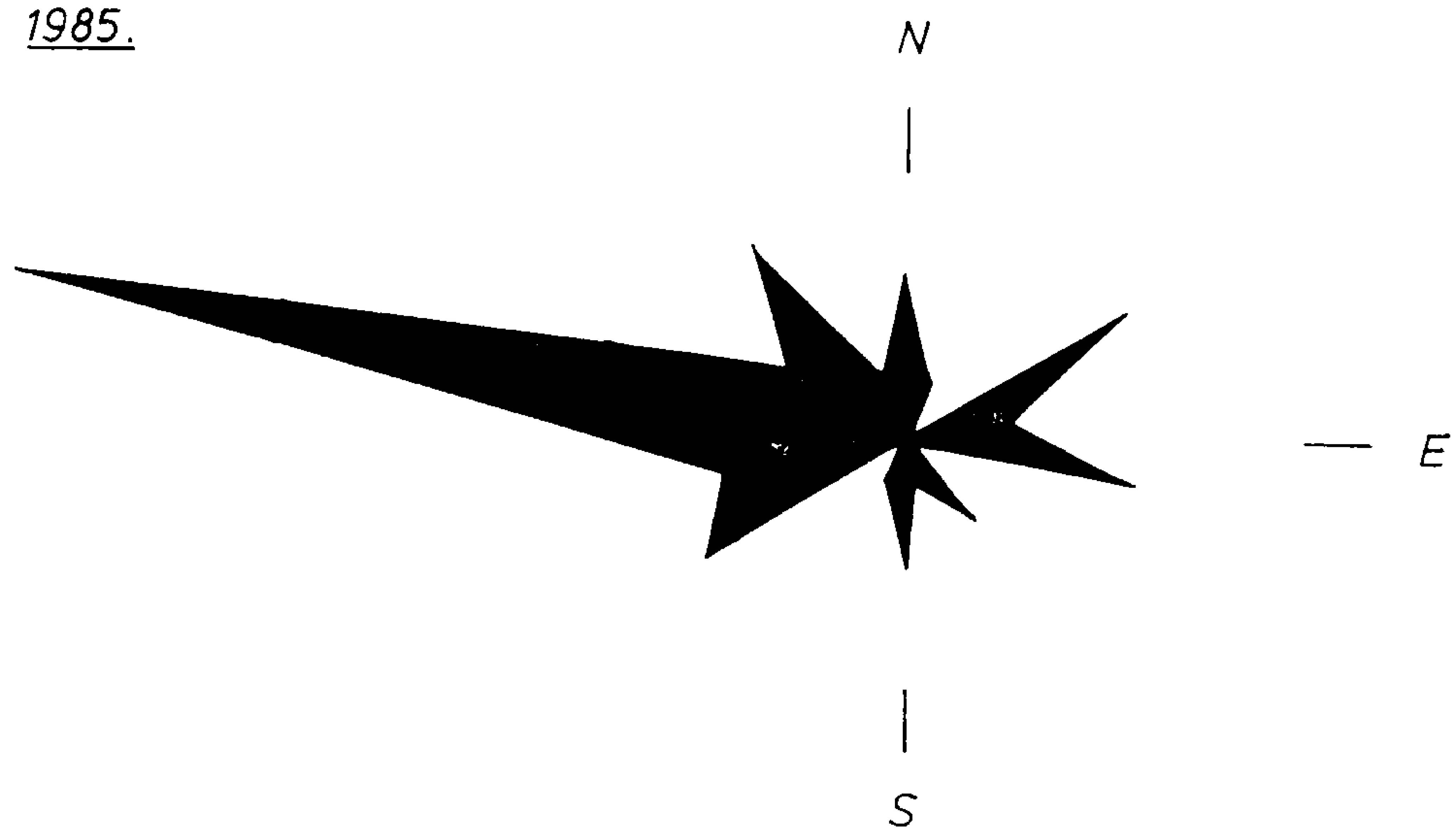


ATMOSPHERIC PRESSURE.
Mean Pressure. (mmHg).
760
740
720
CLOUD COVER.
Mean Cloud Cover. (1/8 ths.).
8
6
4
2
0
SUNSHINE.
Mean Sunshine. (hours).
12
8
4
0
RAINFALL.
Mean Rainfall. (mm).
16
12
8
4
0
WINDSPEED.
Mean Velocity. (m s⁻¹).
6
4
2
0
0 5 10 15 20 25 30 35 40 45 50
Year in Weeks.

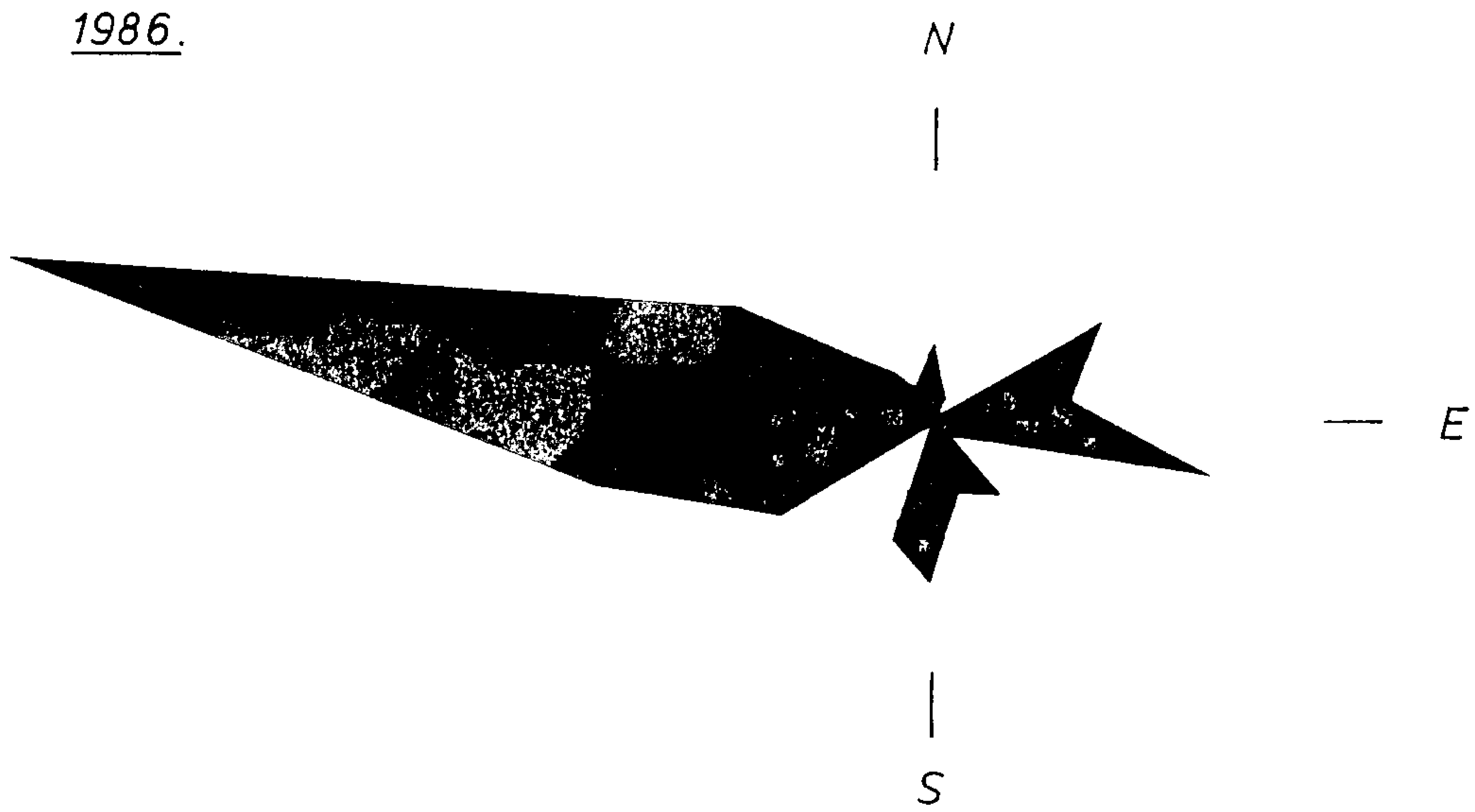
Figure 43.

Rose diagrams of annual daily wind direction for the years 1985 to 1987.

1985.



1986.



1987.

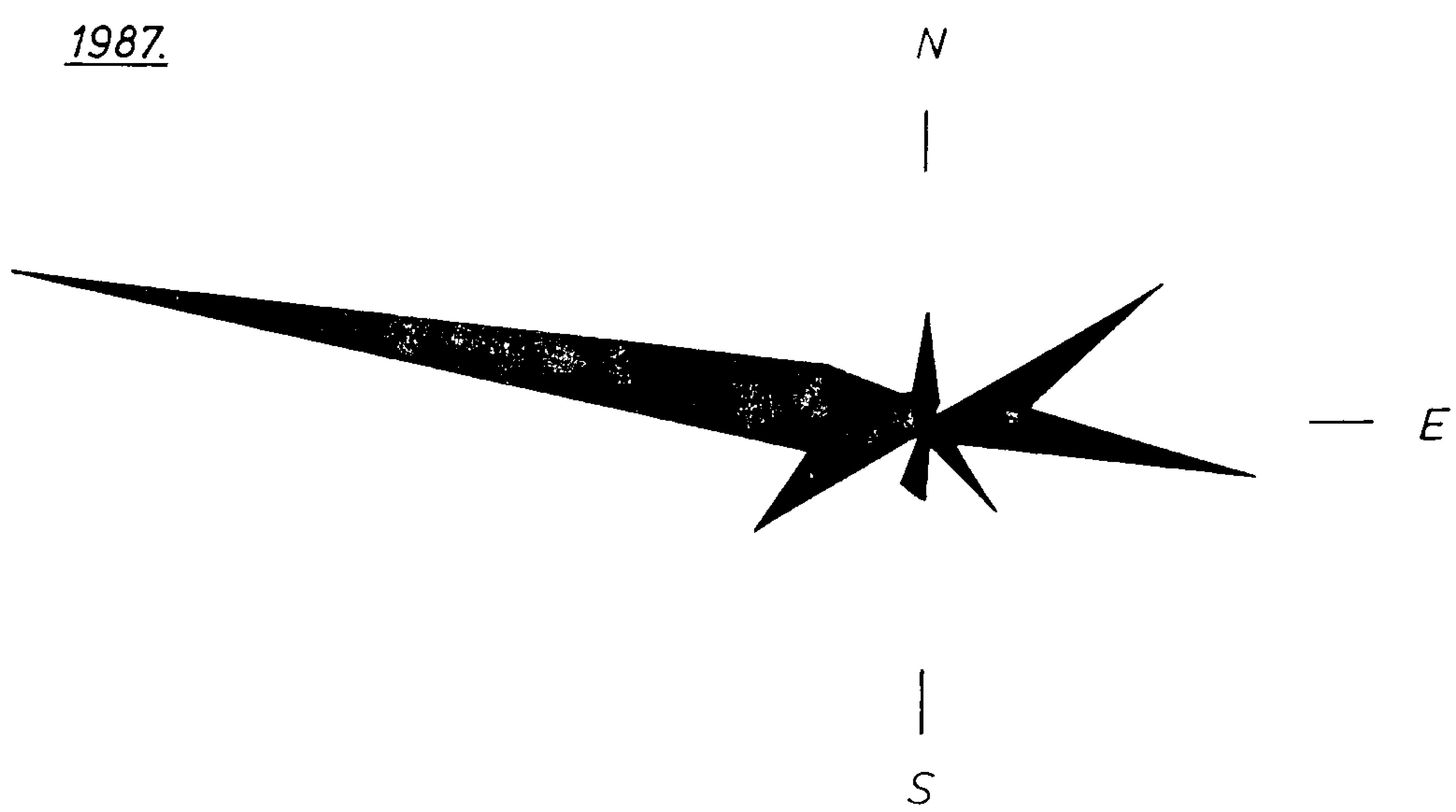
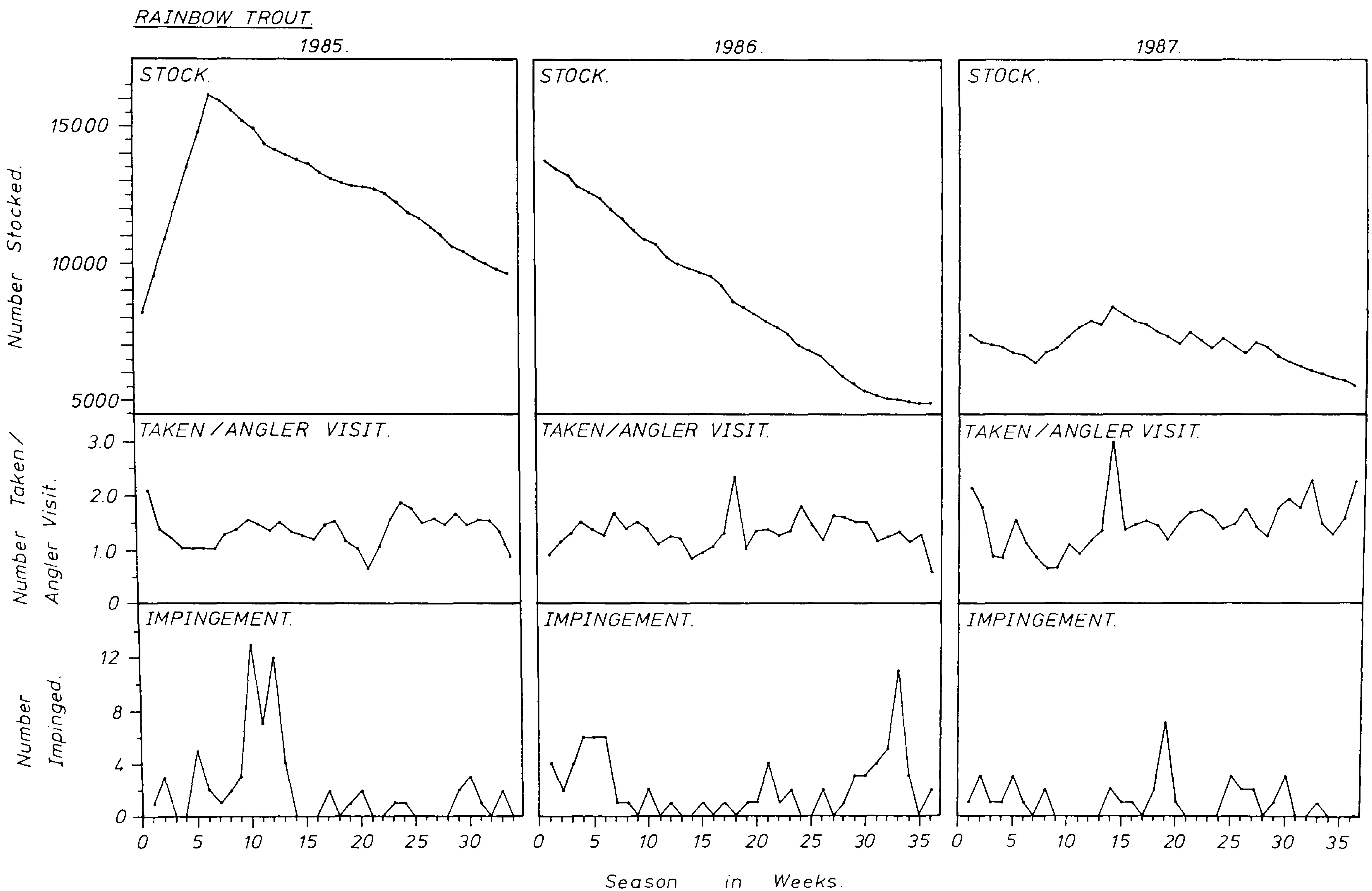
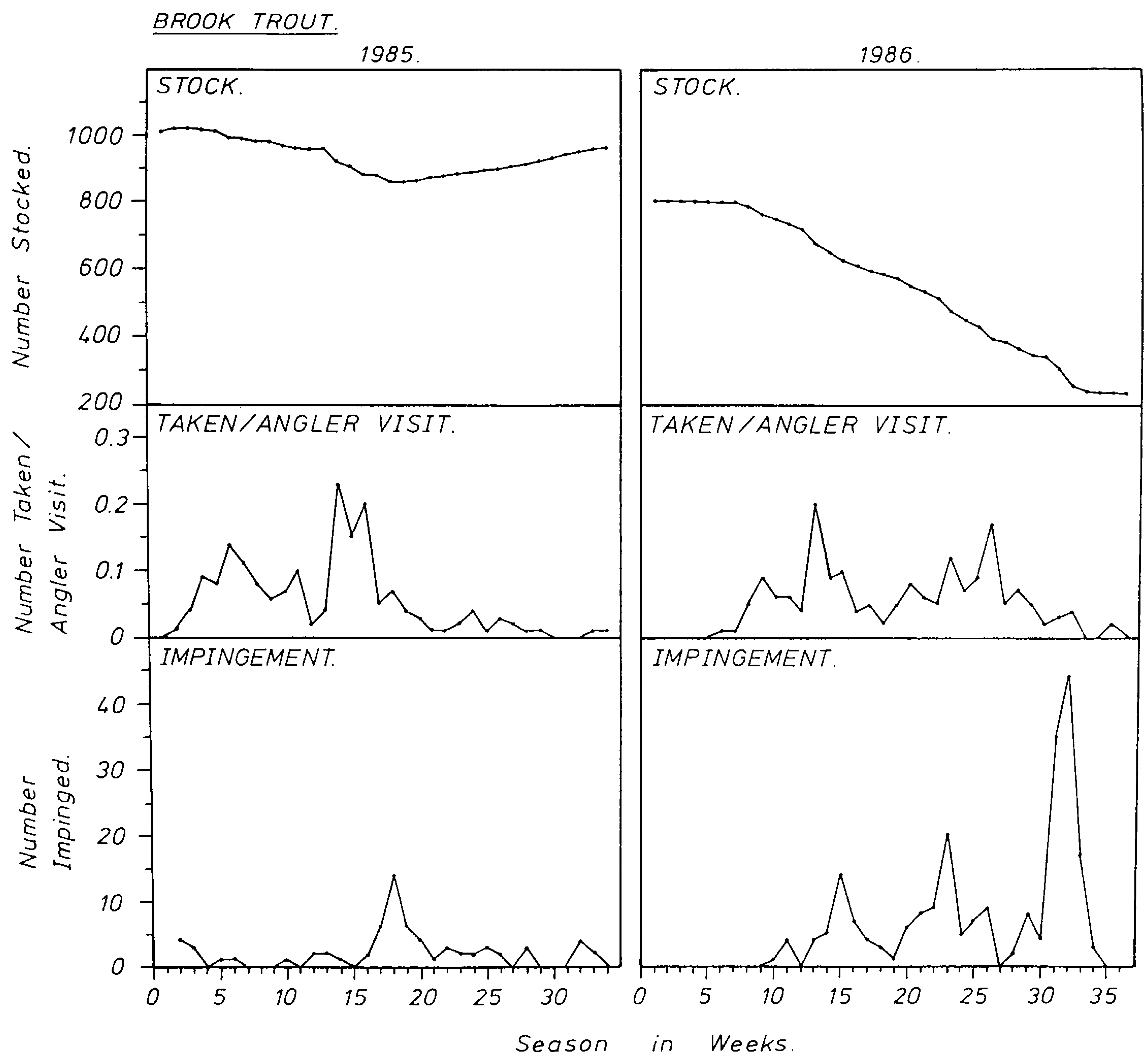


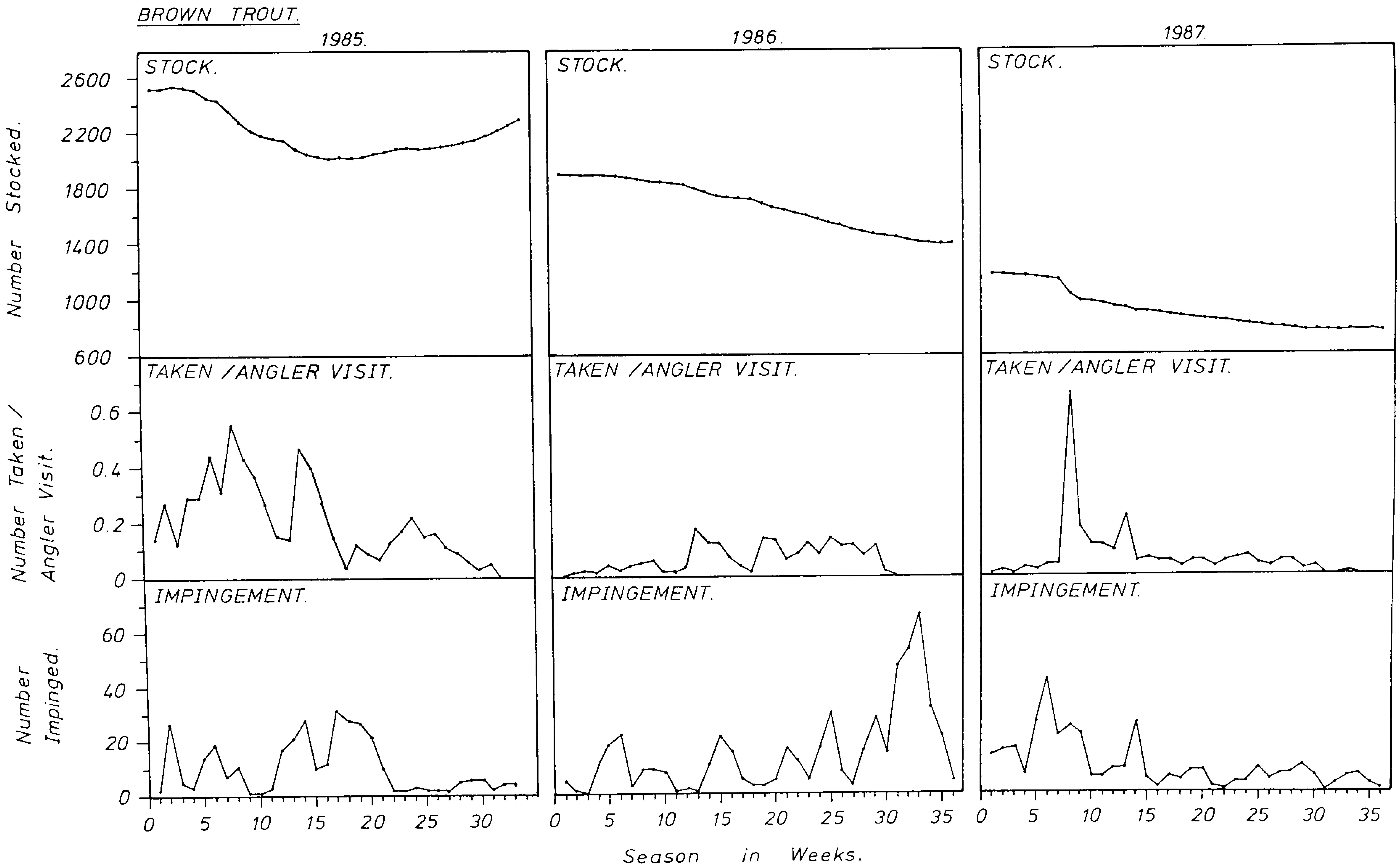
Figure 44.

Species graphs of estimated introduced stock, fish taken per angler visit and filter plate impingement for the seasons 1985 to 1987.



RAINBOW TROUT.
1985.
1986.
1987.
STOCK.
TAKEN/ANGLER VISIT.
IMPINGEMENT.
Number Stocked.
Number Taken/Angler Visit.
Number Impinged.
15000
10000
5000
3.0
2.0
1.0
0
12
8
4
0
0 5 10 15 20 25 30 35
Season in Weeks.


BROOK TROUT.
1985.
1986.
STOCK.
TAKEN/ANGLER VISIT.
IMPINGEMENT.
Number Stocked.
Number Taken / Angler Visit.
Number Impinged.
Season in Weeks.
1000
800
600
400
200
0.3
0.2
0.1
0
40
30
20
10
0
0 5 10 15 20 25 30
0 5 10 15 20 25 30 35



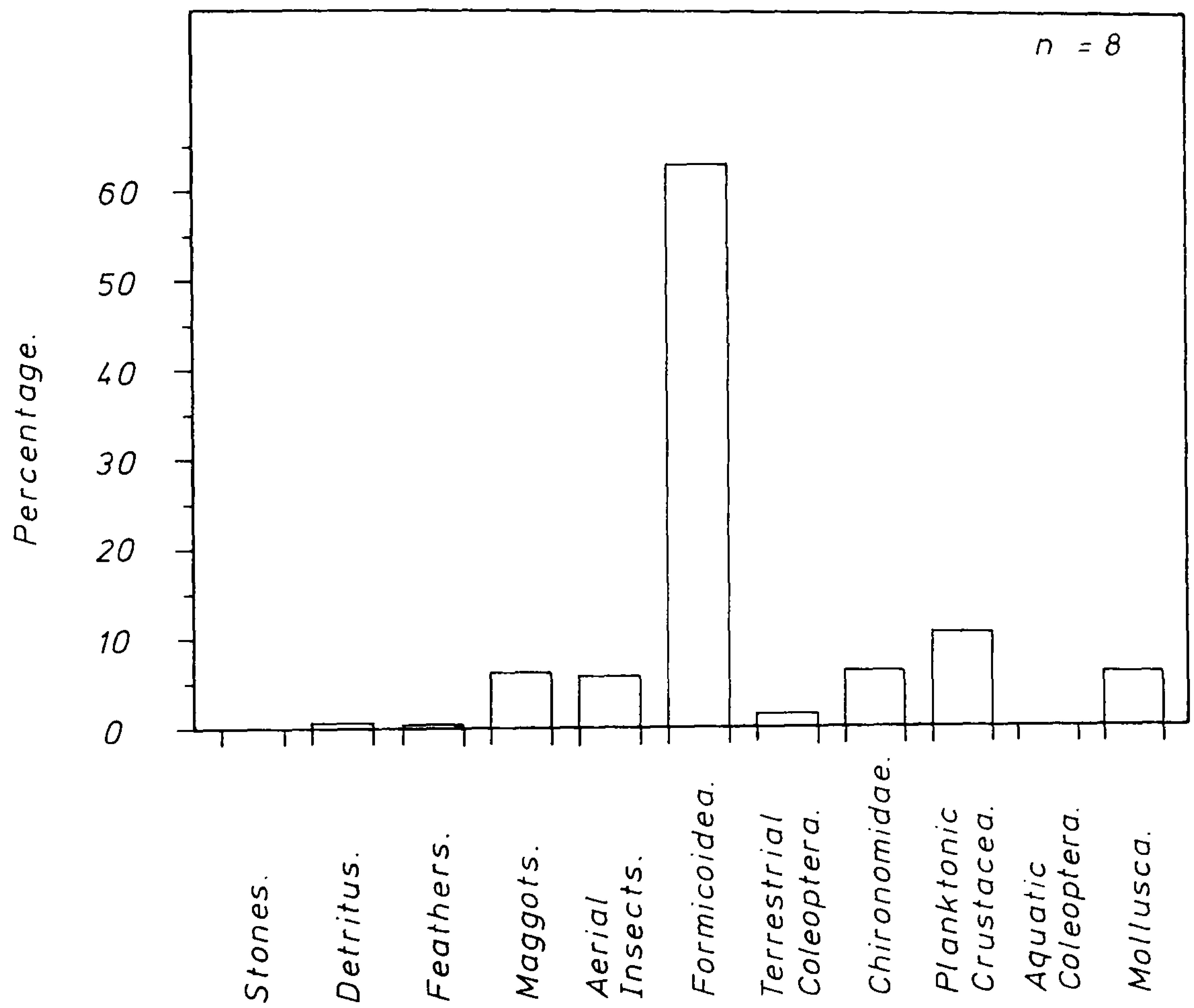
BROWN TROUT.
1985.
1986.
1987.
STOCK.
TAKEN / ANGLER VISIT.
IMPINGEMENT.
Number Stocked.
Number Taken / Angler Visit.
Number Impinged.
2600
2200
1800
1400
1000
600
0.6
0.4
0.2
0
60
40
20
0
0 5 10 15 20 25 30 35
Season in Weeks.

Figure 45.

Brown trout percentage stomach content composition and occurrence for the combined seasons 1985 and 1986.

BROWN TROUT.

COMPOSITION.



OCCURRENCE.

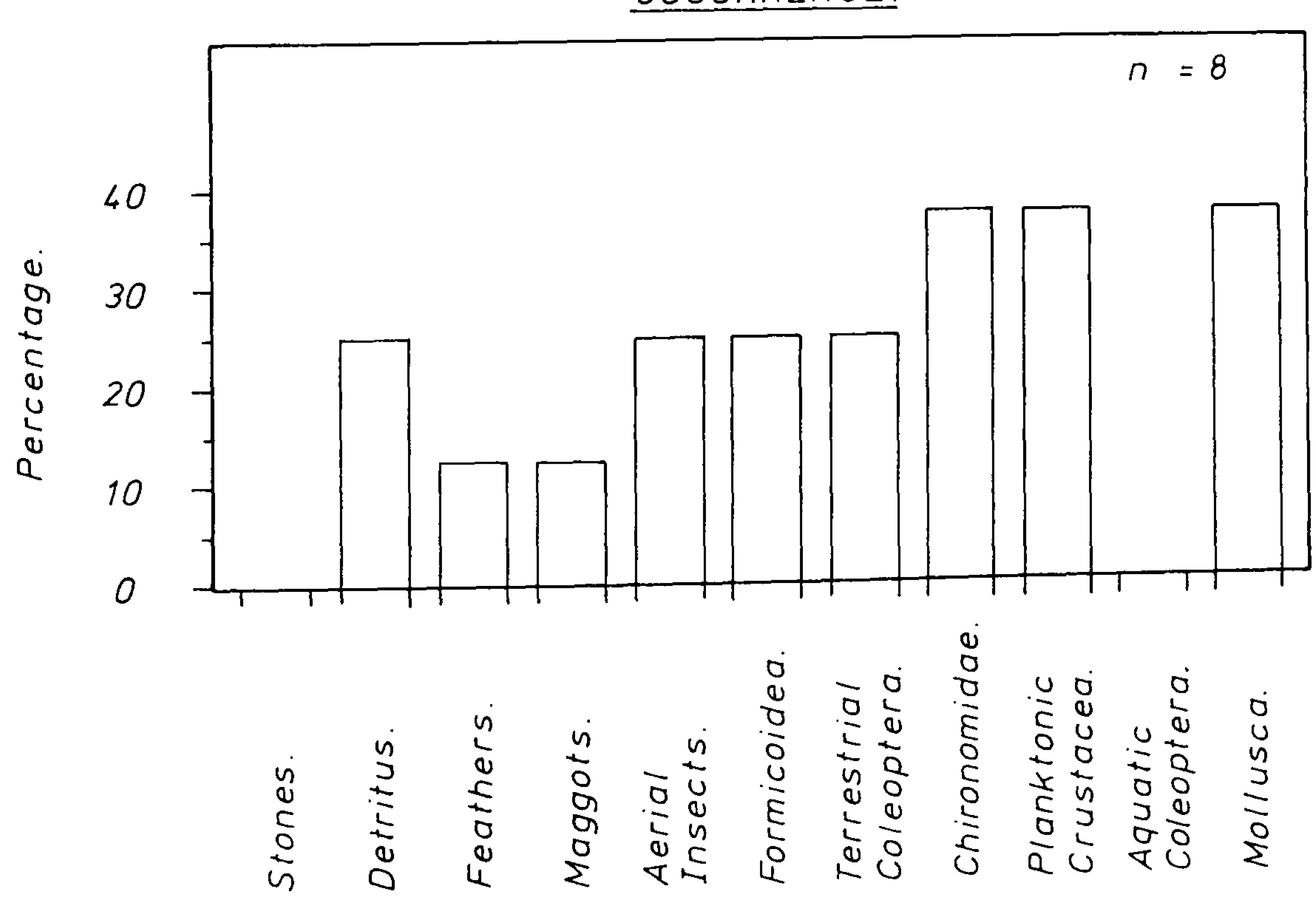


Figure 46.

Rainbow trout percentage stomach content composition and occurrence for the seasons 1985 and 1986.

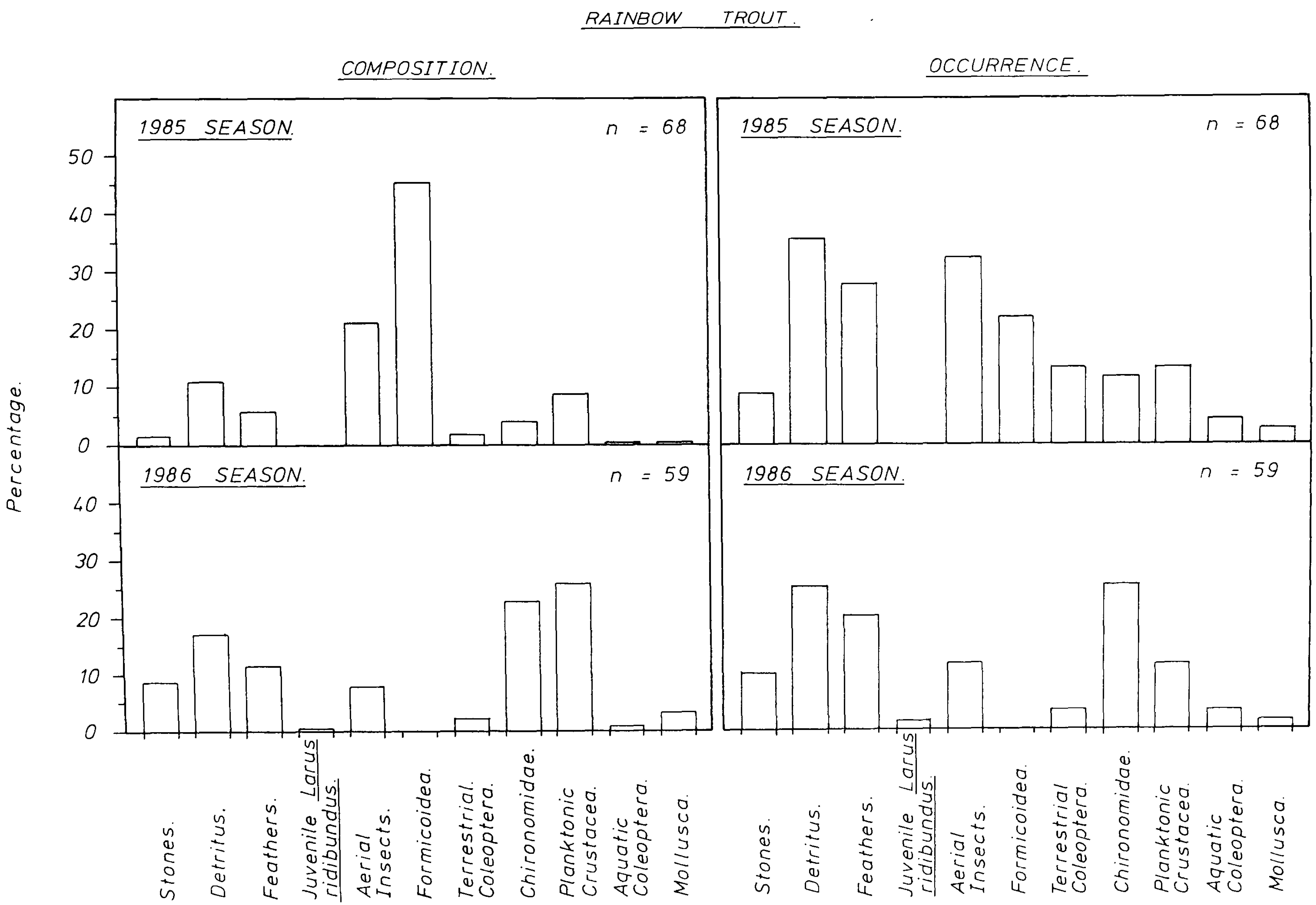

RAINBOW TROUT.
COMPOSITION.
OCCURRENCE.
1985 SEASON.
n = 68
1986 SEASON.
n = 59
Percentage.
0
10
20
30
40
50
Stones.
Detritus.
Feathers.
Juvenile Larus ridibundus.
Aerial Insects.
Formicoidea.
Terrestrial. Coleoptera.
Chironomidae.
Planktonic Crustacea.
Aquatic Coleoptera.
Mollusca.

Figure 47.

Rainbow trout percentage stomach content composition for early, mid and late season periods, based on combined seasonal data.

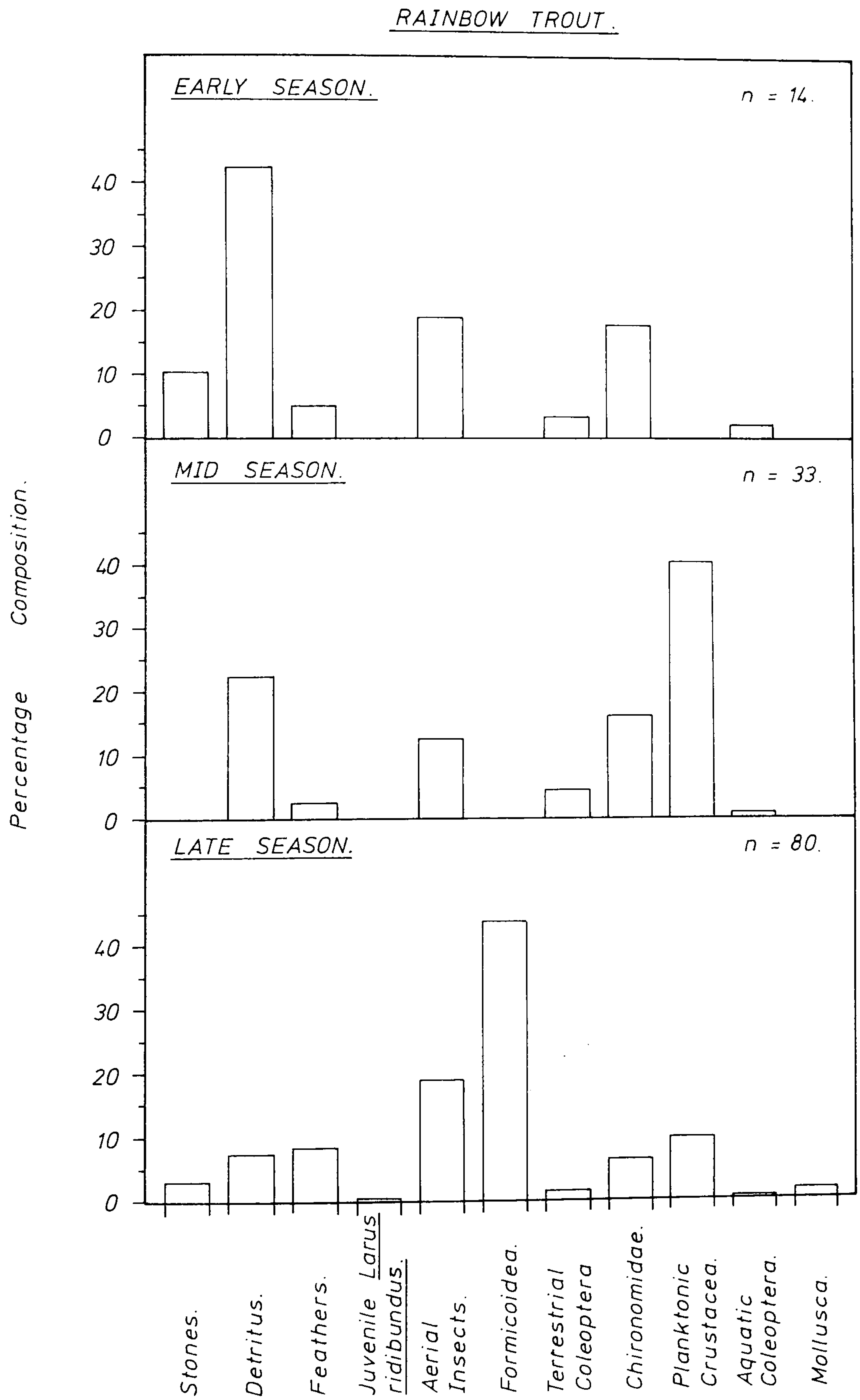

RAINBOW TROUT.
EARLY SEASON.
n = 14.
MID SEASON.
n = 33.
LATE SEASON.
n = 80.
Percentage Composition.
0
10
20
30
40
Stones.
Detritus.
Feathers.
Juvenile Larus ridibundus.
Aerial Insects.
Formicoidea.
Terrestrial Coleoptera
Chironomidae.
Planktonic Crustacea.
Aquatic Coleoptera.
Mollusca.

Figure 48.

Visual assessment of rainbow trout stomach and hind gut fullness for early, mid and late season periods, based on combined seasonal data.

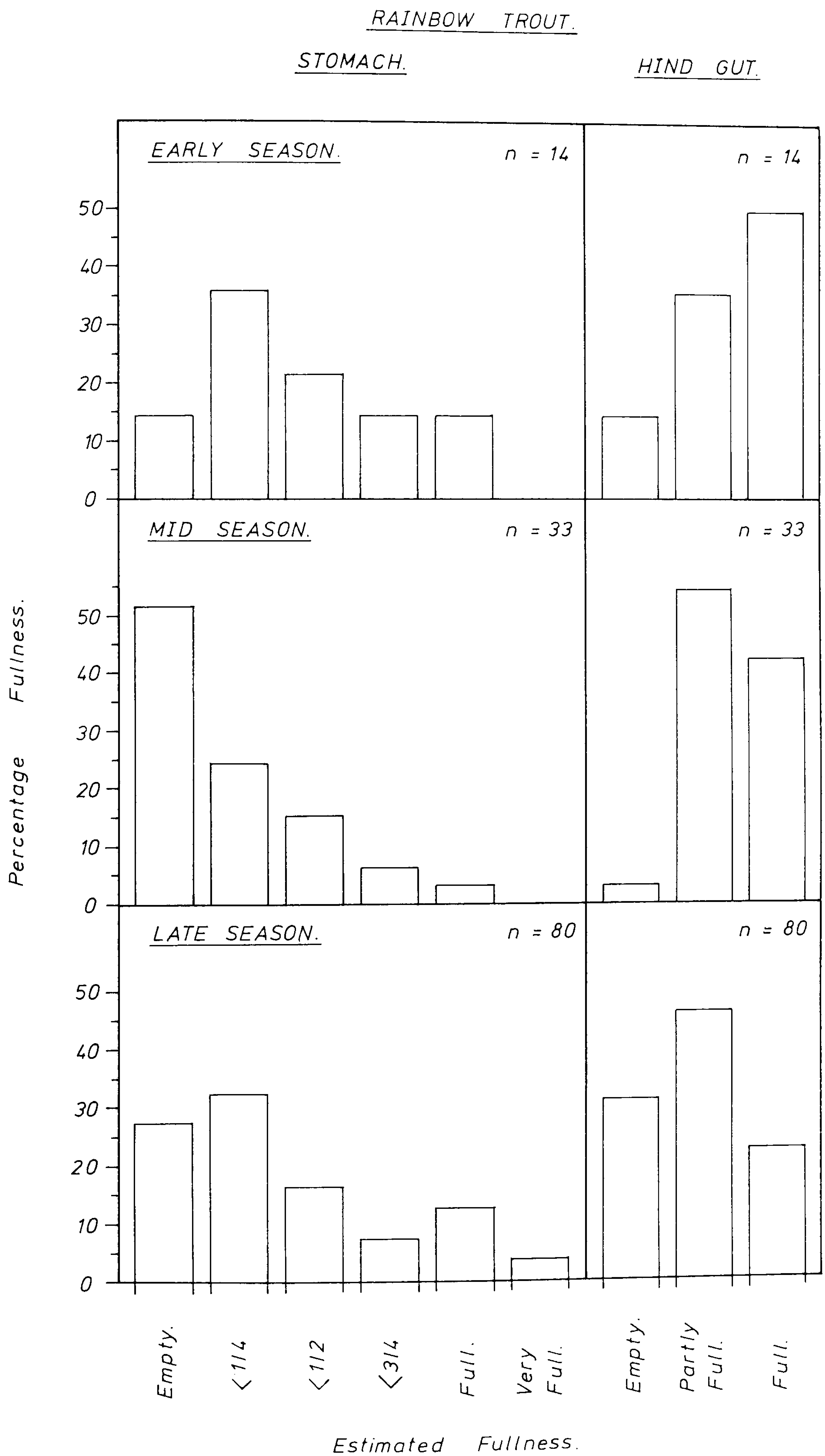
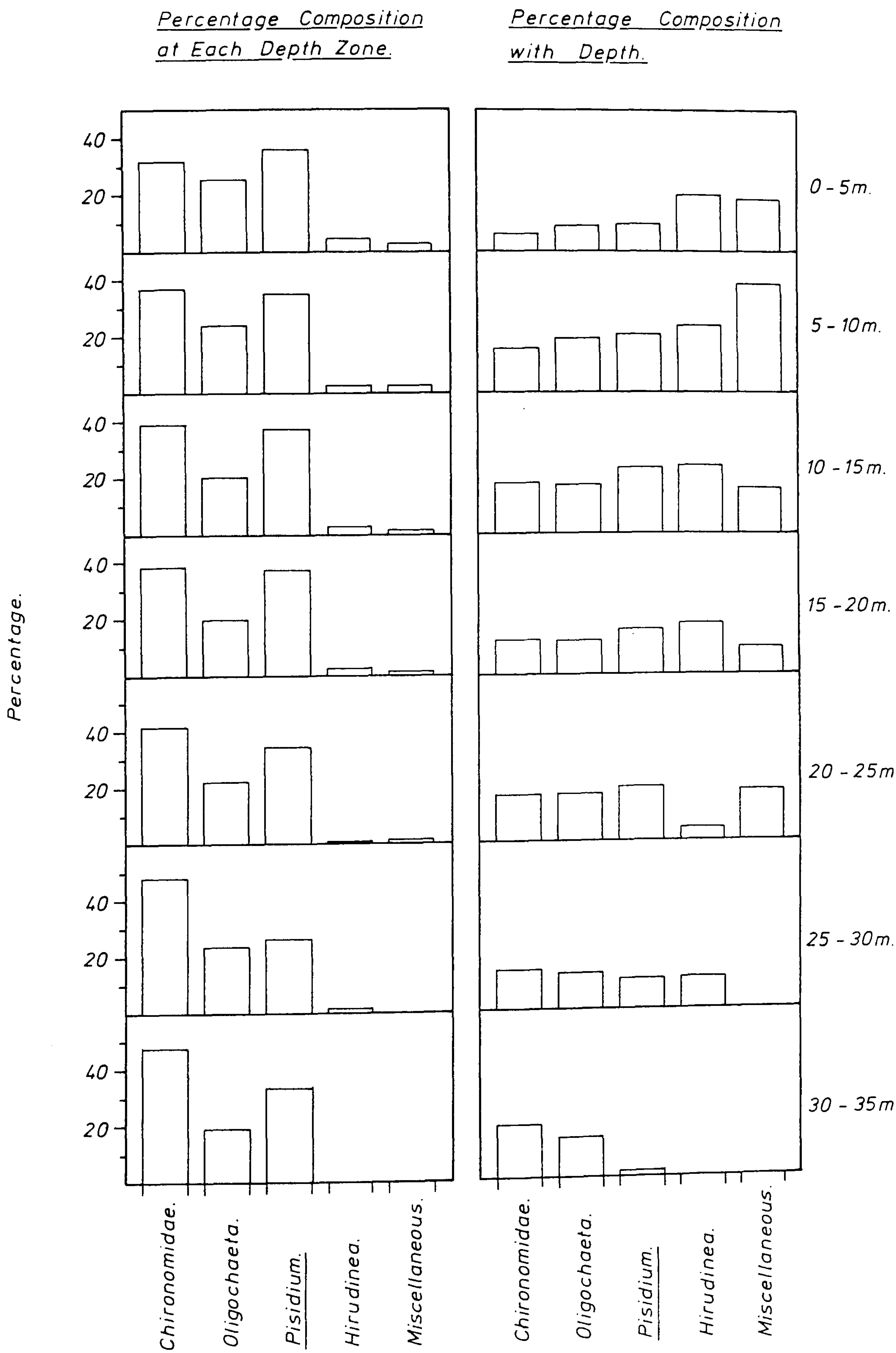

RAINBOW TROUT.
STOMACH.
HIND GUT.
EARLY SEASON.
n = 14
n = 14
MID SEASON.
n = 33
n = 33
LATE SEASON.
n = 80
n = 80
Percentage Fullness.
0
10
20
30
40
50
Empty.
<1/4
<1/2
<3/4
Full.
Very Full.
Empty.
Partly Full.
Full.
Estimated Fullness.

Figure 49.

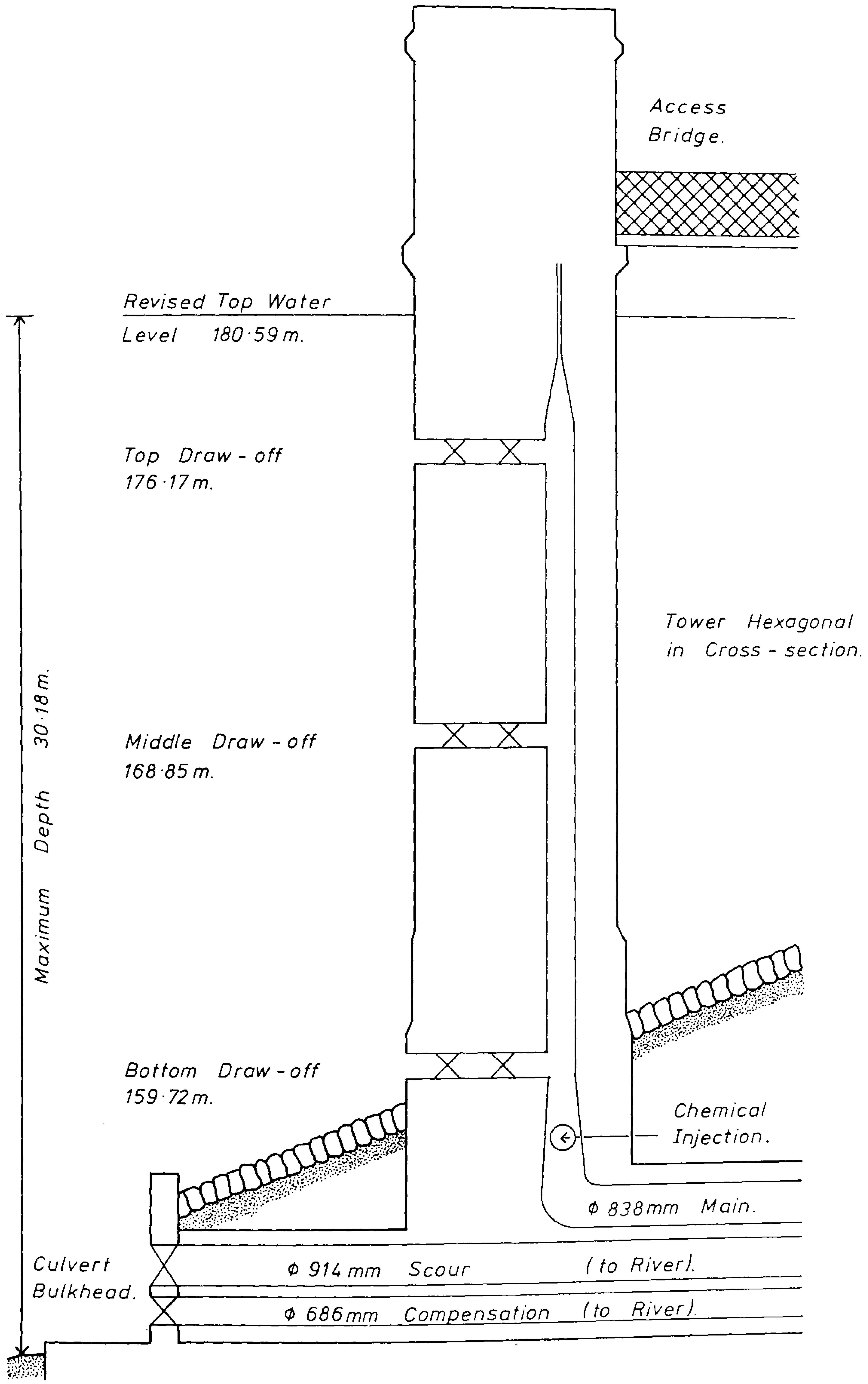
Histograms of Stocks Reservoir benthic invertebrate depth zone data, after Mills,M.L. (1971).



Percentage Composition at Each Depth Zone.
Percentage Composition with Depth.
Percentage.
40
20
0 - 5m.
5 - 10m.
10 - 15m.
15 - 20m.
20 - 25m.
25 - 30m.
30 - 35m.
Chironomidae.
Oligochaeta.
Pisidium.
Hirudinea.
Miscellaneous.

Figure 50.

Diagrammatic representation of Stocks Reservoir valve tower.



Access
Bridge.
Revised Top Water
Level 180·59 m.
Top Draw - off
176·17 m.
Tower Hexagonal
in Cross - section.
Middle Draw - off
168·85 m.
Maximum Depth 30·18 m.
Bottom Draw - off
159·72 m.
Chemical
Injection.
Φ 838mm Main.
Culvert
Bulkhead.
Φ 914 mm Scour (to River).
Φ 686 mm Compensation (to River).

Figure 51.

Diagrammatic representation of Stocks Reservoir water treatment works.

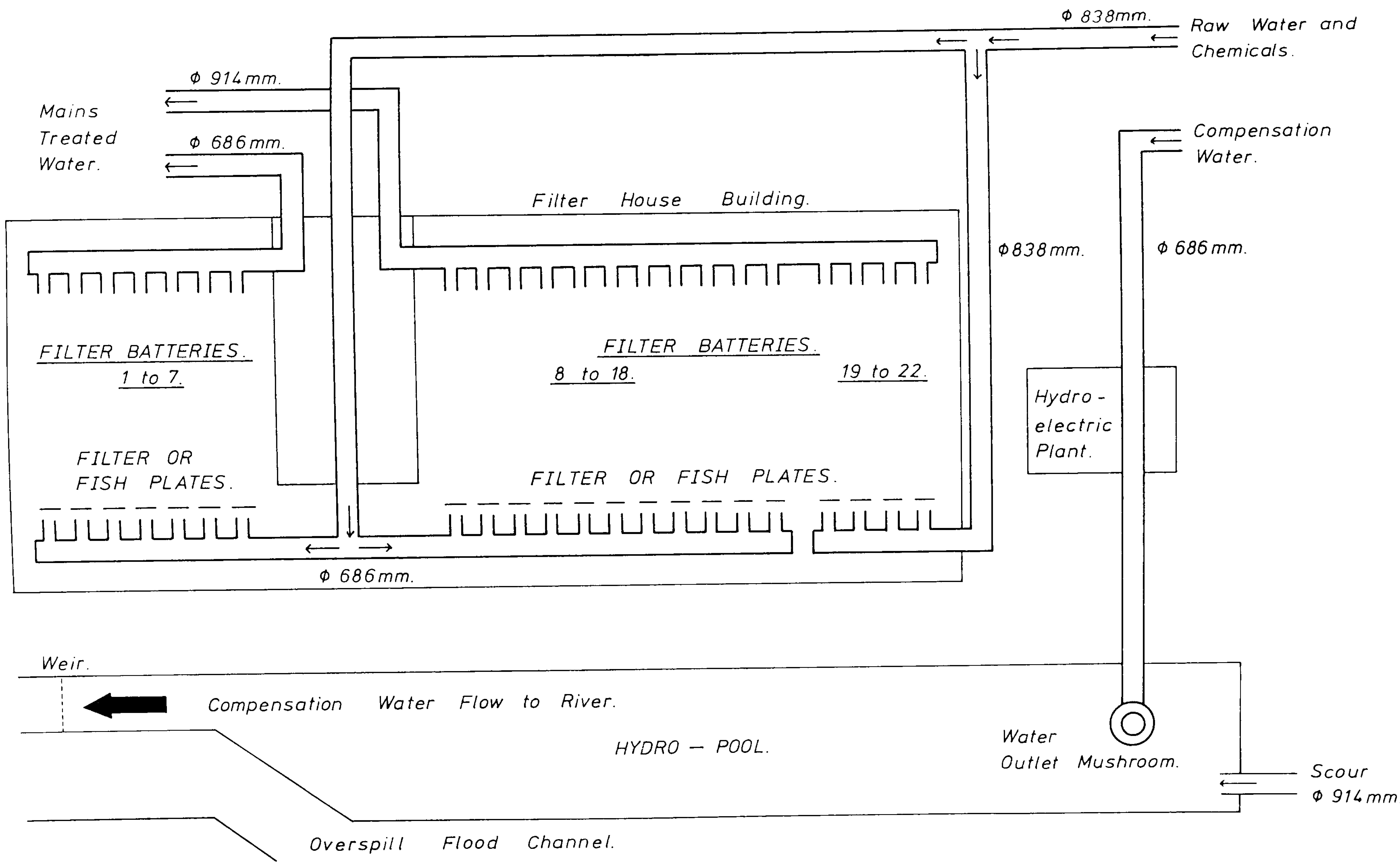

Φ 838mm.
Raw Water and Chemicals.
Φ 914mm.
Mains Treated Water.
Φ 686mm.
Compensation Water.
Filter House Building.
Φ838mm.
Φ 686mm.
FILTER BATTERIES.
1 to 7.
FILTER BATTERIES.
8 to 18.
19 to 22.
Hydro - electric Plant.
FILTER OR FISH PLATES.
FILTER OR FISH PLATES.
Φ 686mm.
Weir.
Compensation Water Flow to River.
HYDRO — POOL.
Water Outlet Mushroom.
Scour
Φ 914mm.
Overspill Flood Channel.

Figure 52.

Diagrammatic representation of filter plate location in a bifurcating rising main.

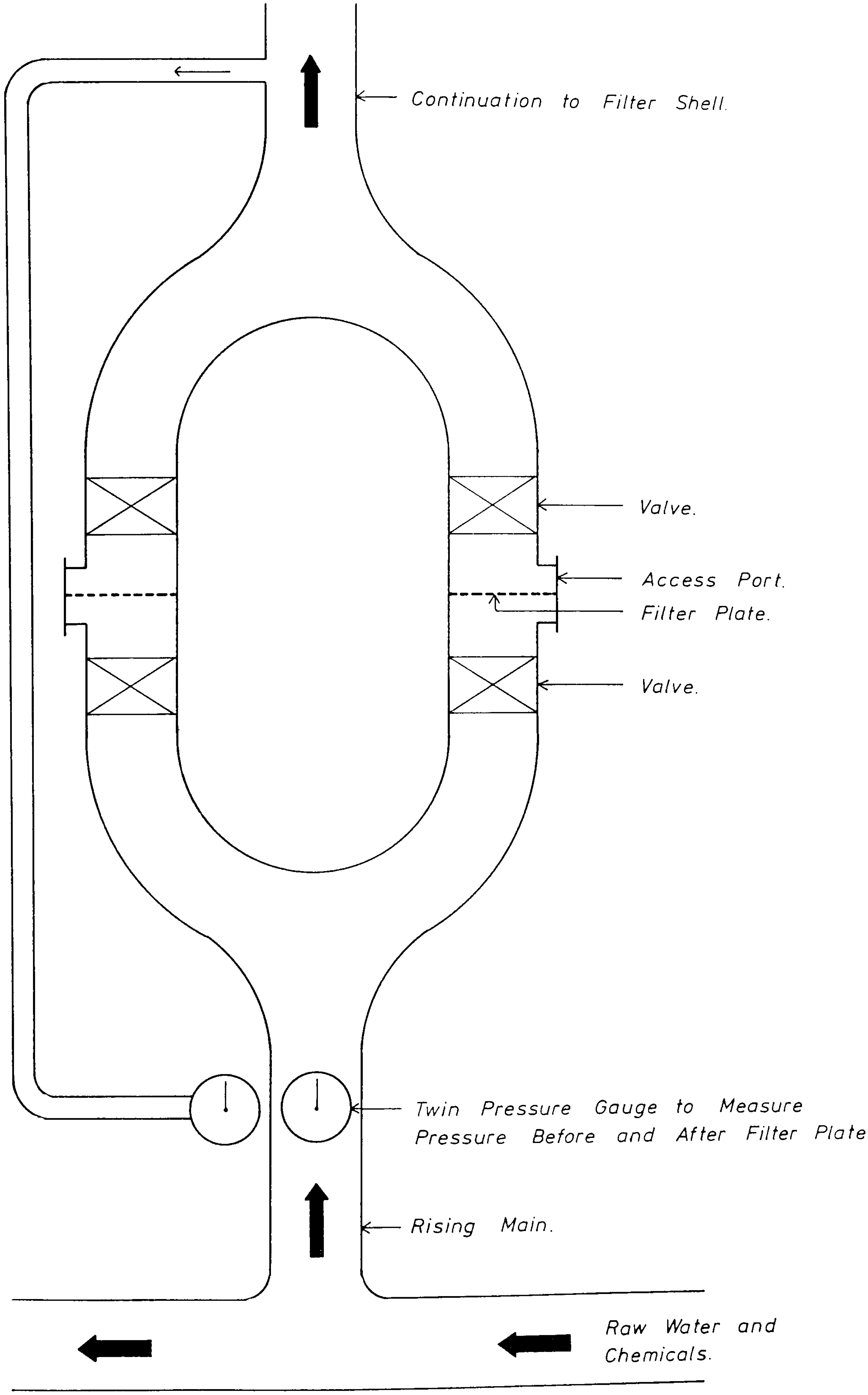
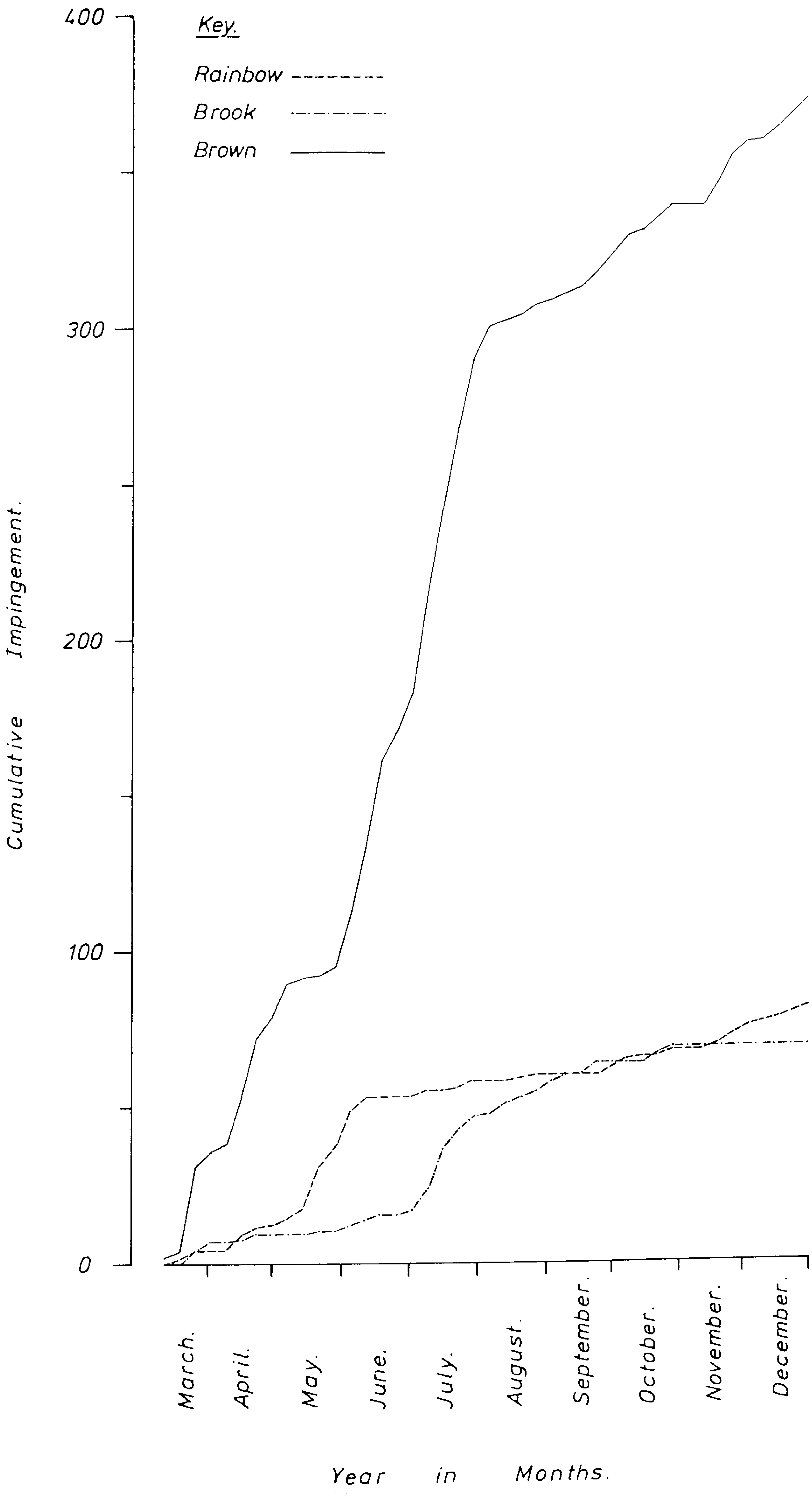

Continuation to Filter Shell.
Valve.
Access Port.
Filter Plate.
Valve.
Twin Pressure Gauge to Measure
Pressure Before and After Filter Plate.
Rising Main.
Raw Water and
Chemicals.

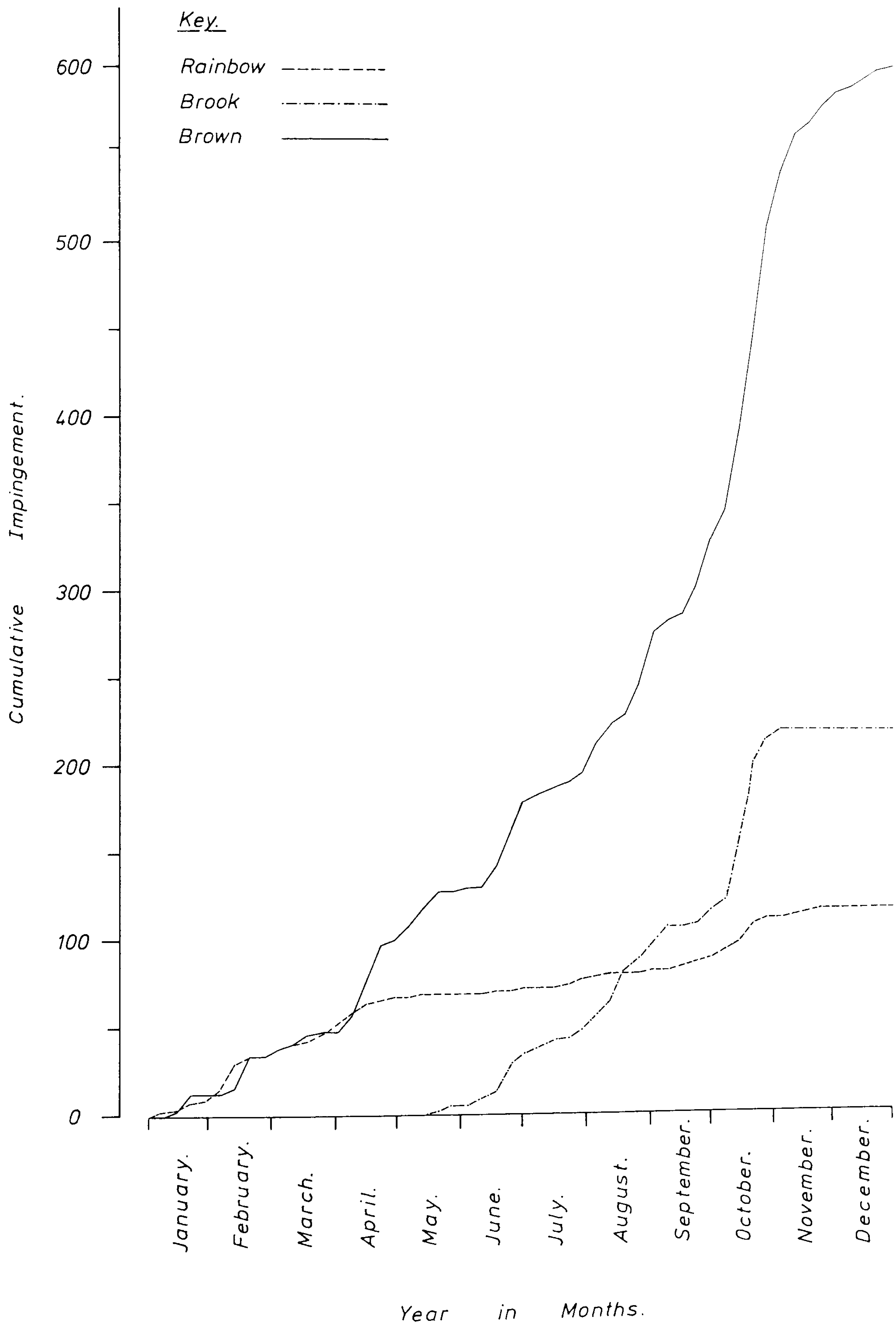
Figure 53.

Graphs of cumulative weekly species impingement for the years 1985 to 1987.

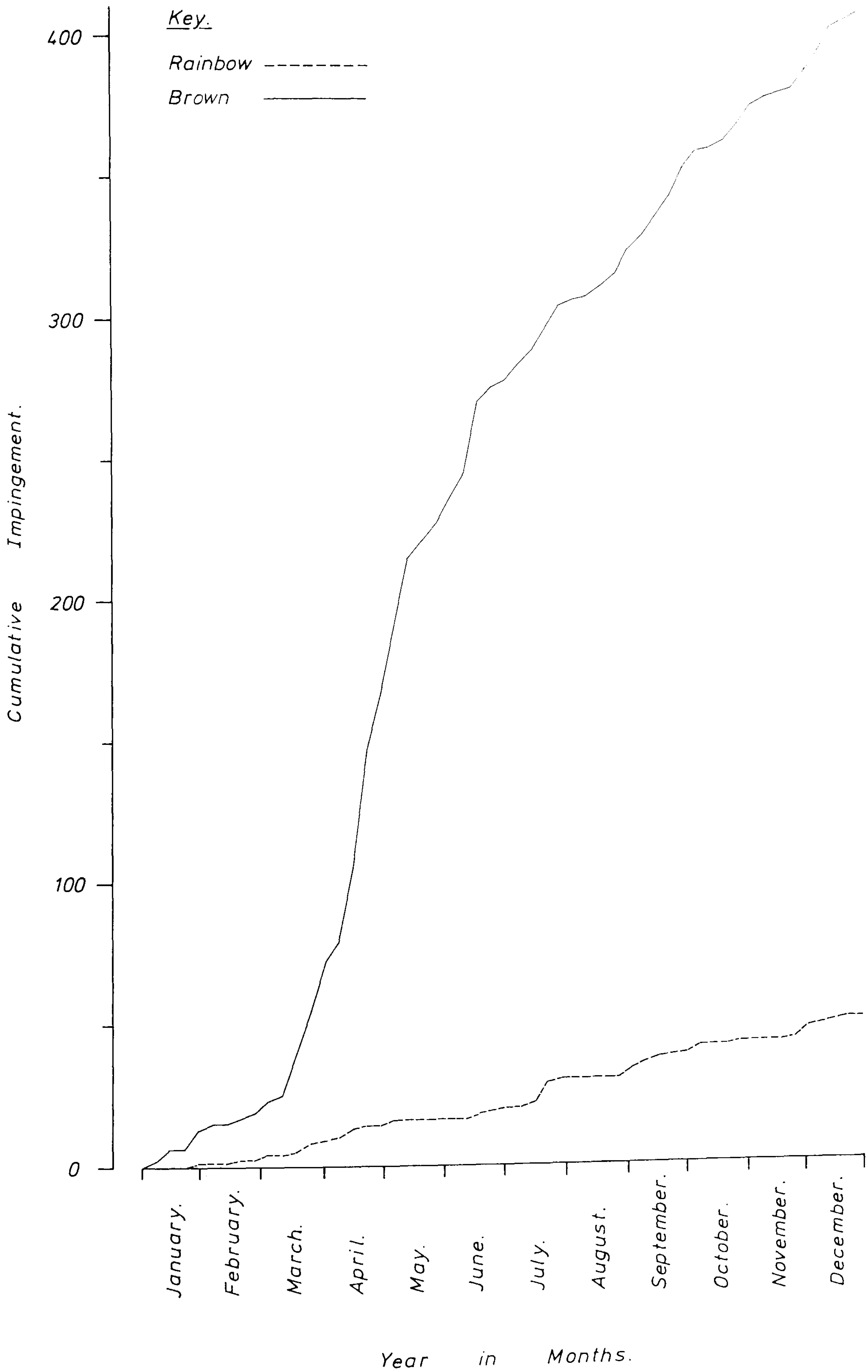
1985.


Key.
Rainbow
Brook
Brown
400
300
200
100
0
Cumulative Impingement.
March.
April.
May.
June.
July.
August.
September.
October.
November.
December.
Year in Months.

1986.


Key.
Rainbow
Brook
Brown
600
500
400
300
200
100
0
Cumulative Impingement.
January.
February.
March.
April.
May.
June.
July.
August.
September.
October.
November.
December.
Year in Months.

1987.



Key.
Rainbow
Brown
400
300
200
100
0
Cumulative Impingement.
January.
February.
March.
April.
May.
June.
July.
August.
September.
October.
November.
December.
Year in Months.

Figure 54.

Graph of combined cumulative weekly impingement for the years 1985 to 1987.

Totals - 1985 to 1987.

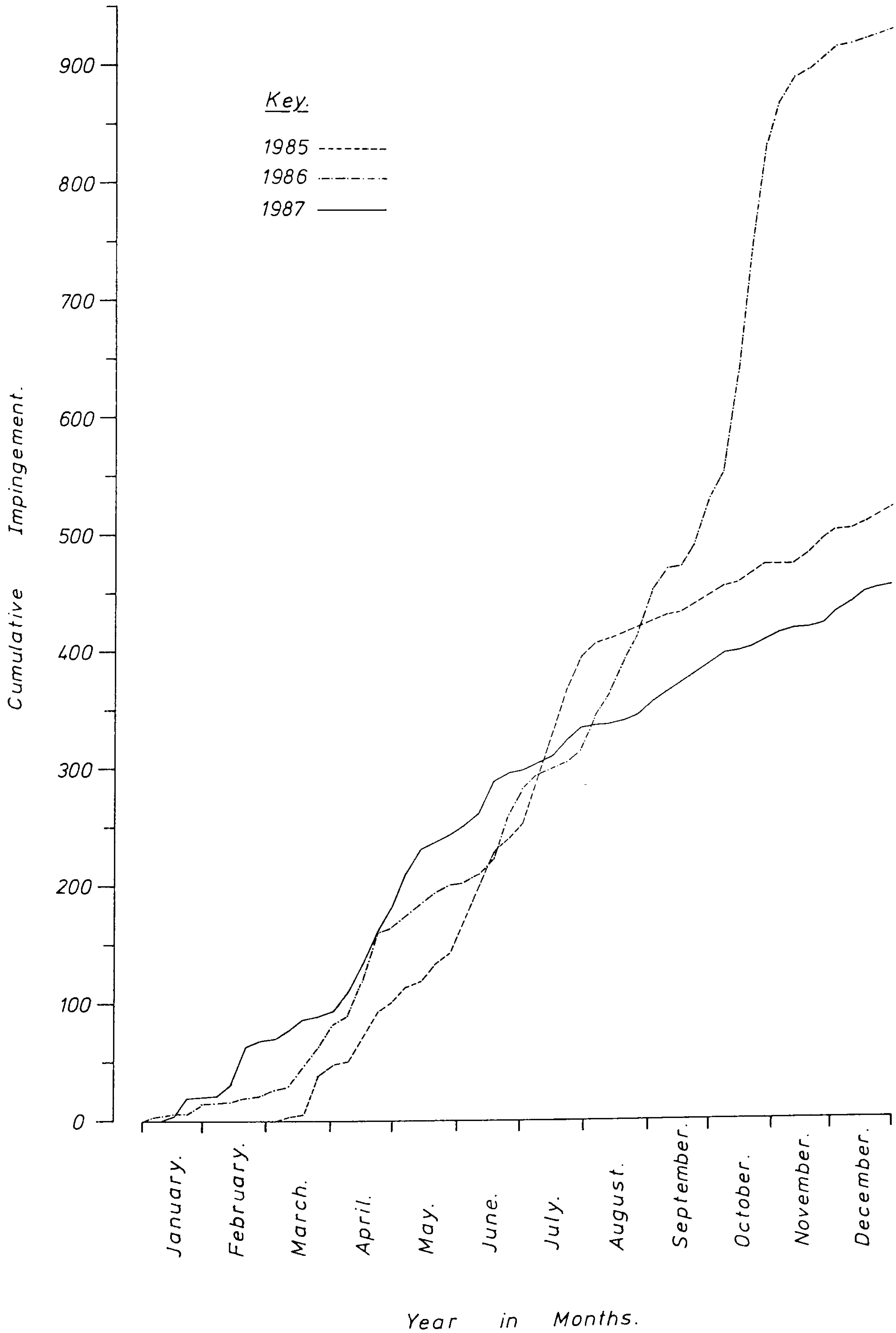
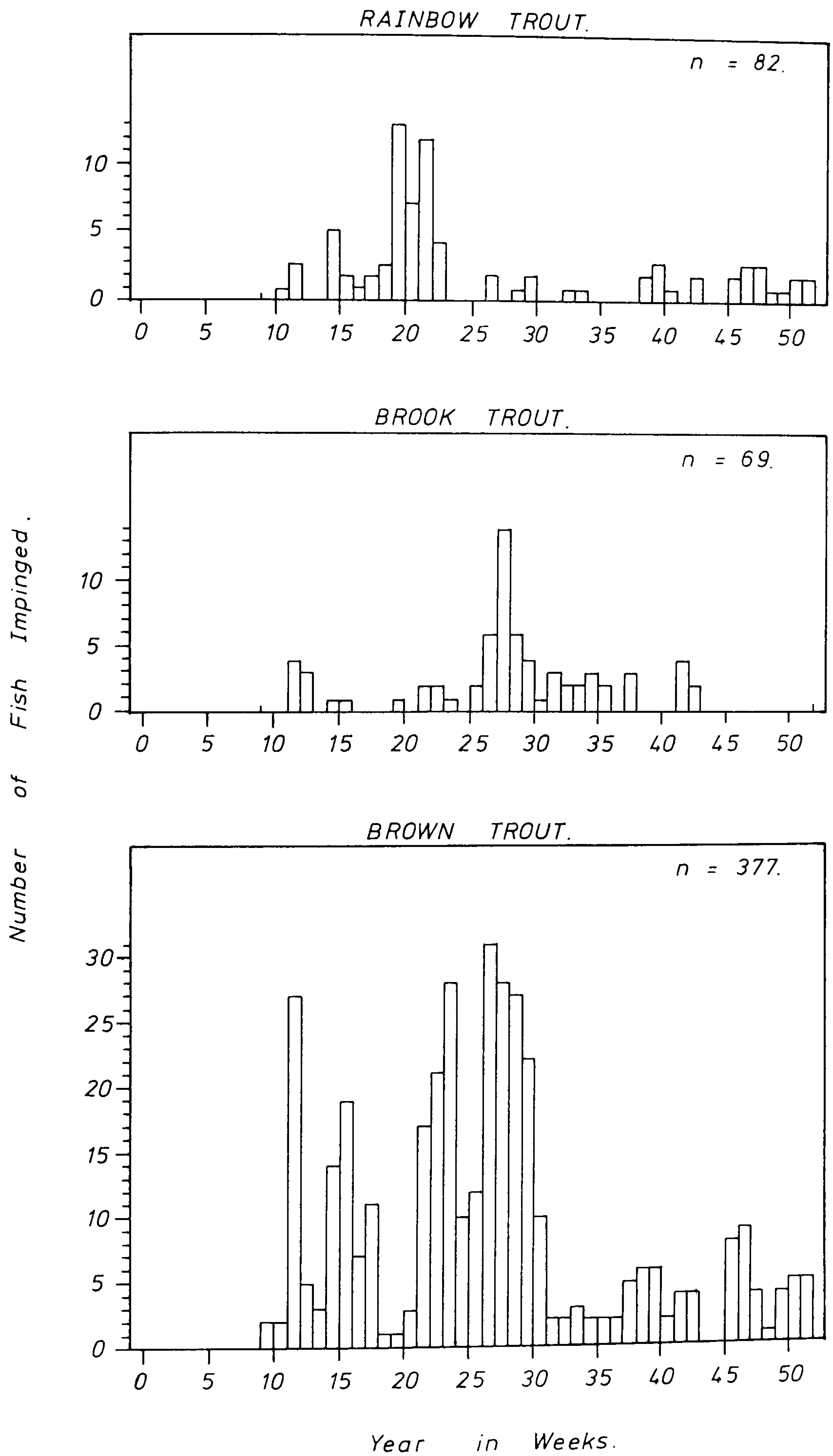


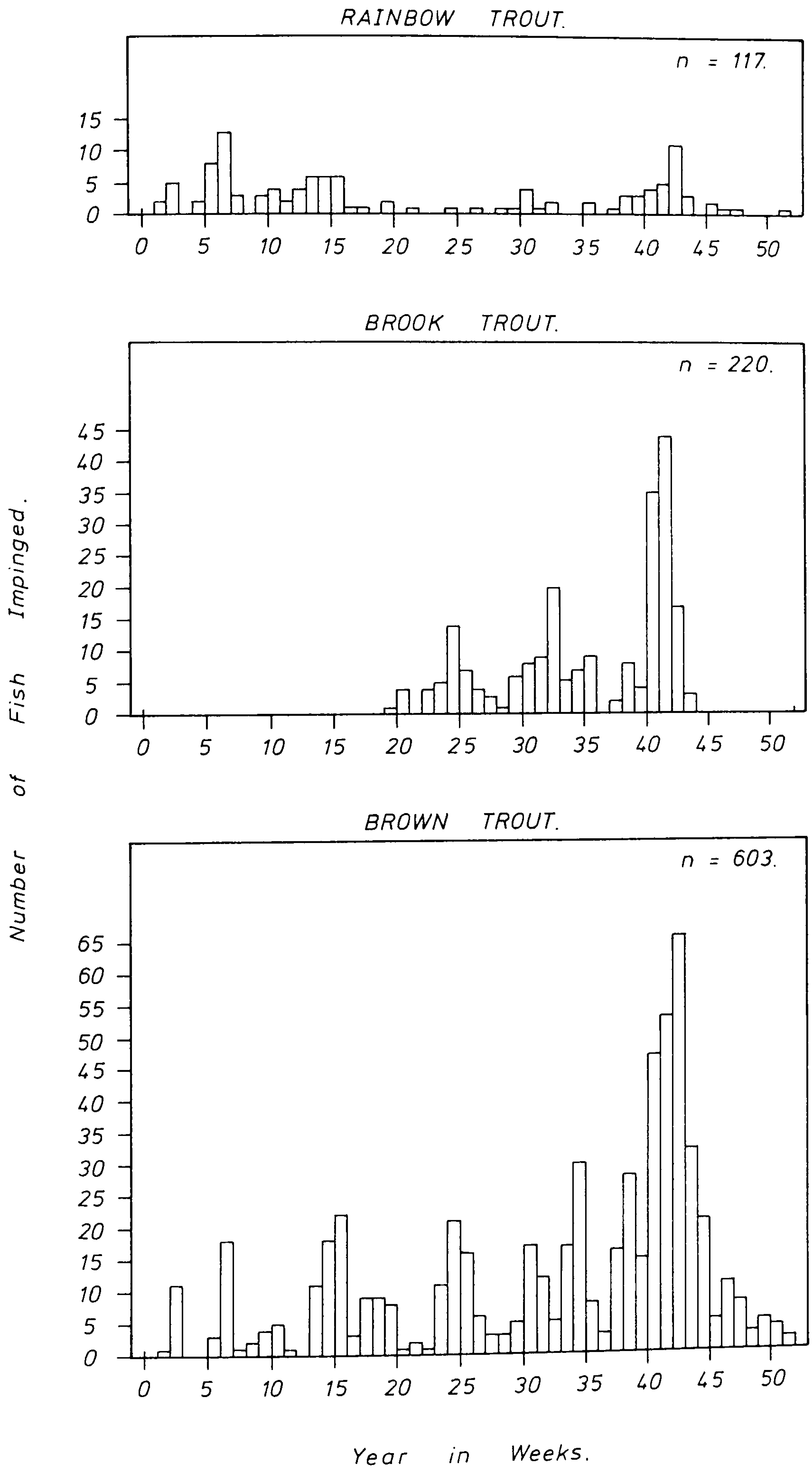
Figure 55.

Histograms of weekly species impingement for the years 1985 to 1987.

1985.


RAINBOW TROUT.
n = 82.
BROOK TROUT.
n = 69.
BROWN TROUT.
n = 377.
Number of Fish Impinged.
Year in Weeks.

1986.


RAINBOW TROUT.
n = 117.
15
10
5
0
0
5
10
15
20
25
30
35
40
45
50
BROOK TROUT.
n = 220.
45
40
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40
45
50
BROWN TROUT.
n = 603.
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40
45
50
Number of Fish Impinged.
Year in Weeks.

1987.

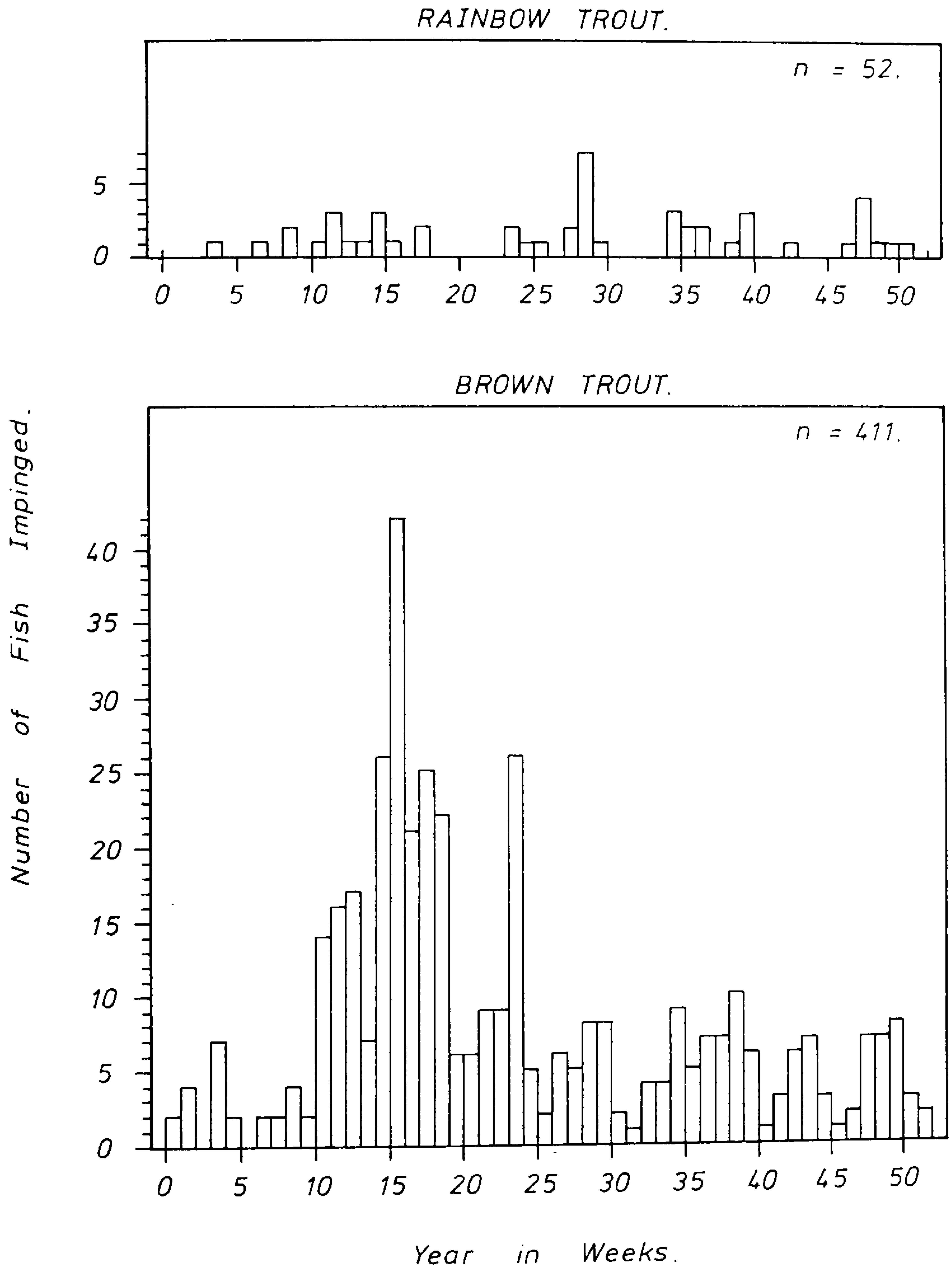
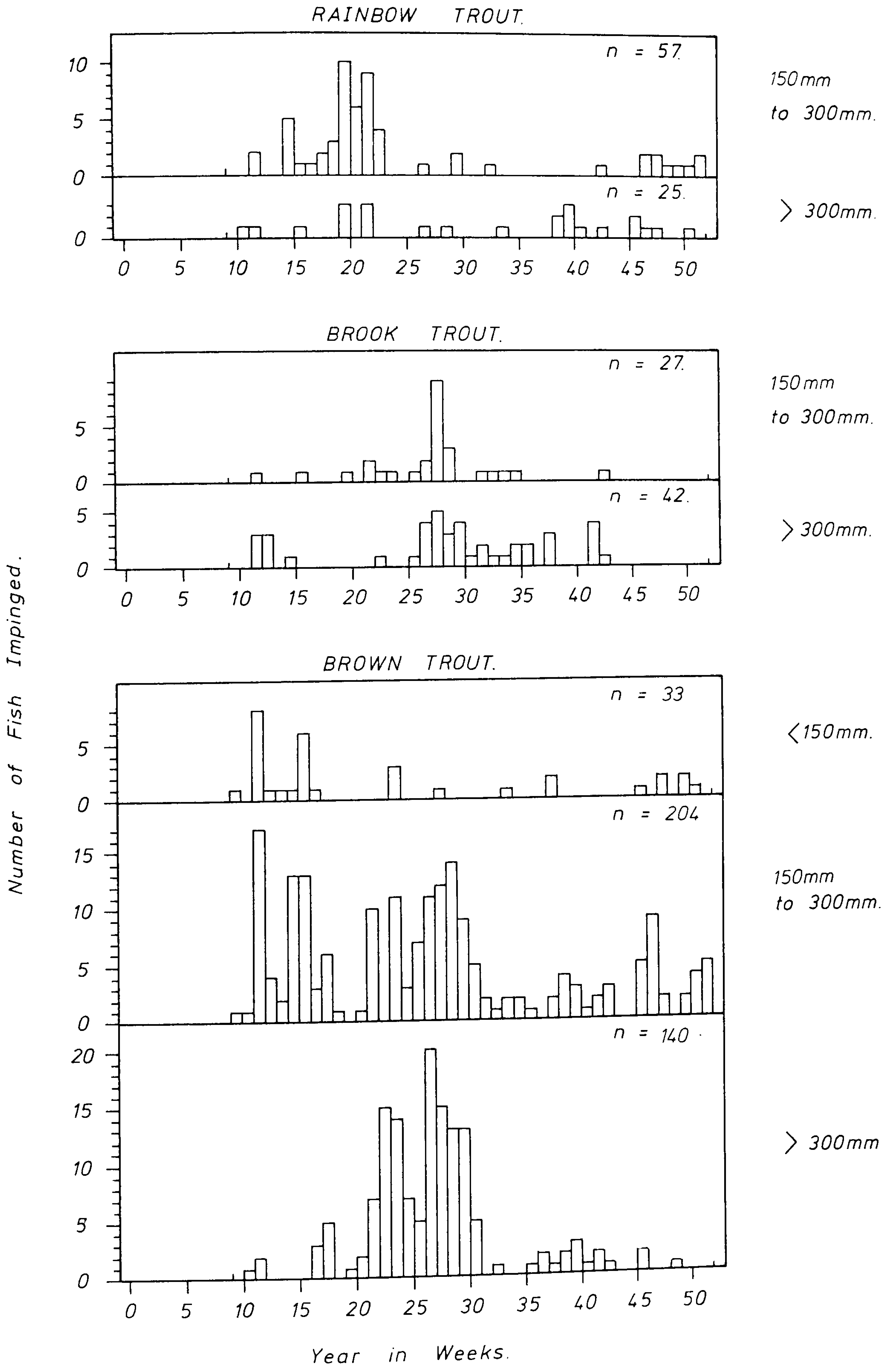

RAINBOW TROUT.
n = 52.
5
0
0 5 10 15 20 25 30 35 40 45 50
BROWN TROUT.
n = 411.
Number of Fish Impinged.
40
35
30
25
20
15
10
5
0
0 5 10 15 20 25 30 35 40 45 50
Year in Weeks.

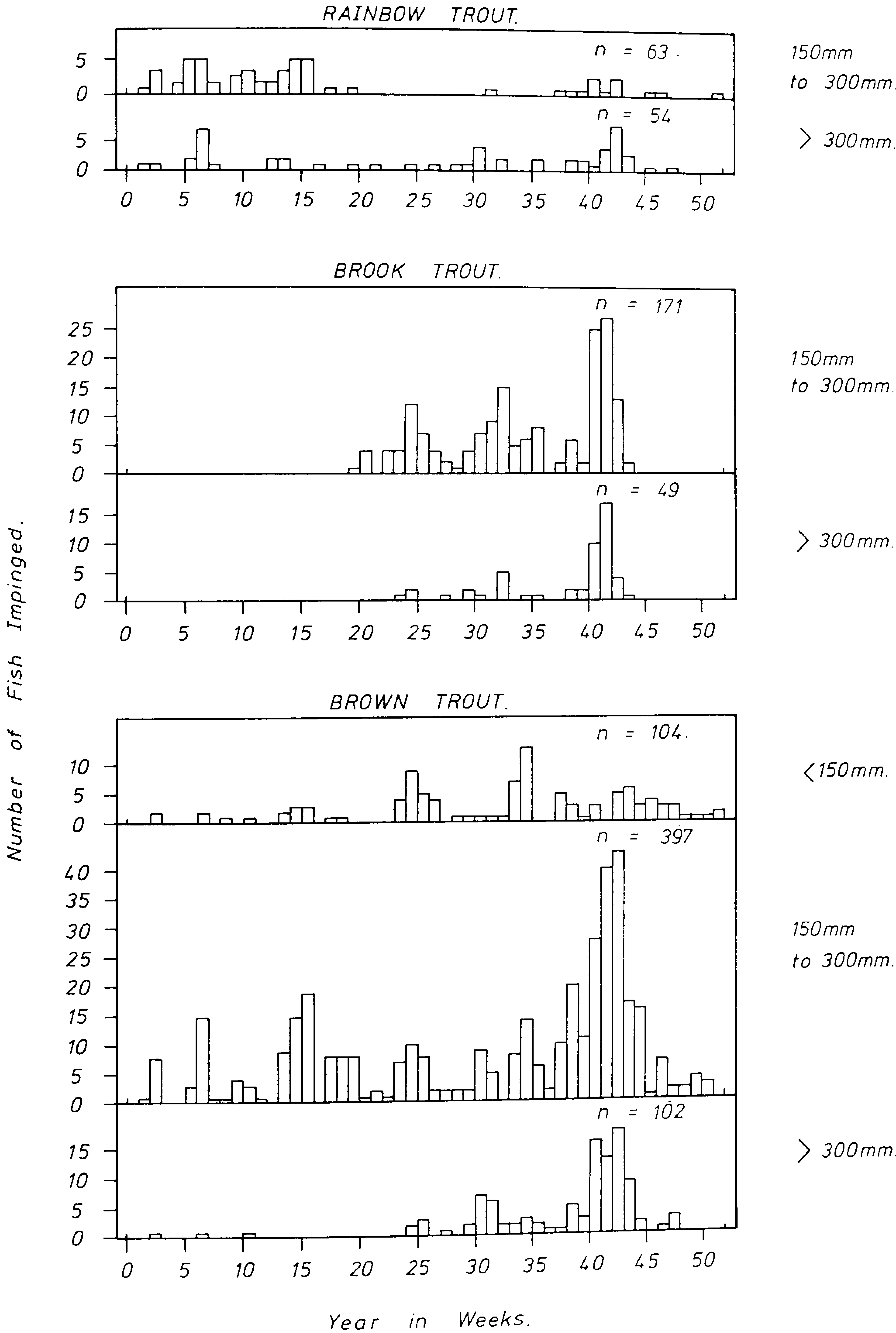
Figure 56.

Histograms of weekly species length category impingement for the years 1985 to 1987.

1985.


RAINBOW TROUT.
n = 57.
150mm to 300mm.
n = 25.
> 300mm.
BROOK TROUT.
n = 27.
150mm to 300mm.
n = 42.
> 300mm.
BROWN TROUT.
n = 33
< 150mm.
n = 204
150mm to 300mm.
n = 140
> 300mm.
Number of Fish Impinged.
Year in Weeks.

1986.


RAINBOW TROUT.
n = 63
150mm to 300mm.
n = 54
> 300mm.
BROOK TROUT.
n = 171
150mm to 300mm.
n = 49
> 300mm.
BROWN TROUT.
n = 104.
<150mm.
n = 397
150mm to 300mm.
n = 102
> 300mm.
Number of Fish Impinged.
Year in Weeks.

1987.

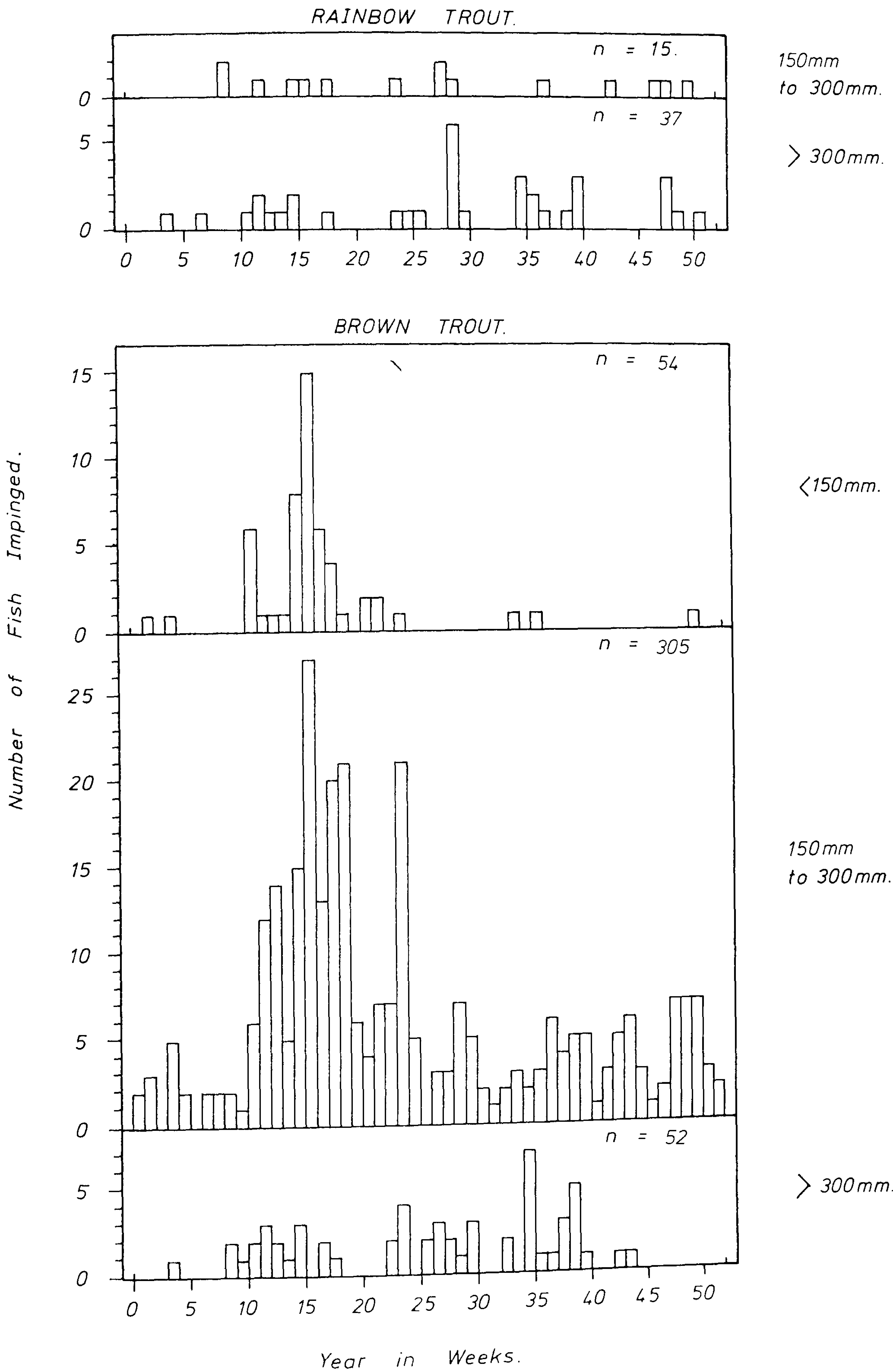
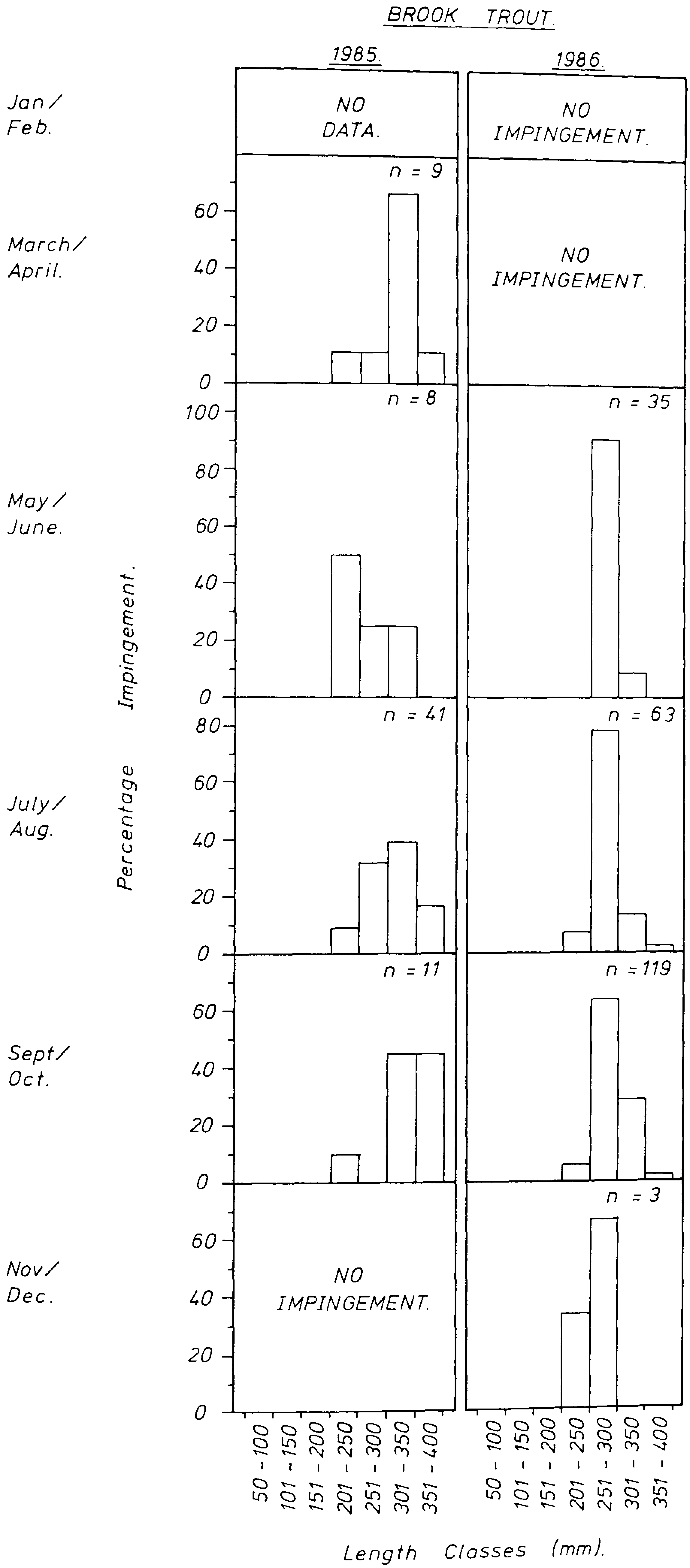

RAINBOW TROUT.
n = 15.
150mm to 300mm.
n = 37
> 300mm.
0
5
0
0 5 10 15 20 25 30 35 40 45 50
BROWN TROUT.
n = 54
<150mm.
15
10
5
0
n = 305
150mm to 300mm.
25
20
15
10
5
0
n = 52
> 300mm.
5
0
0 5 10 15 20 25 30 35 40 45 50
Number of Fish Impinged.
Year in Weeks.

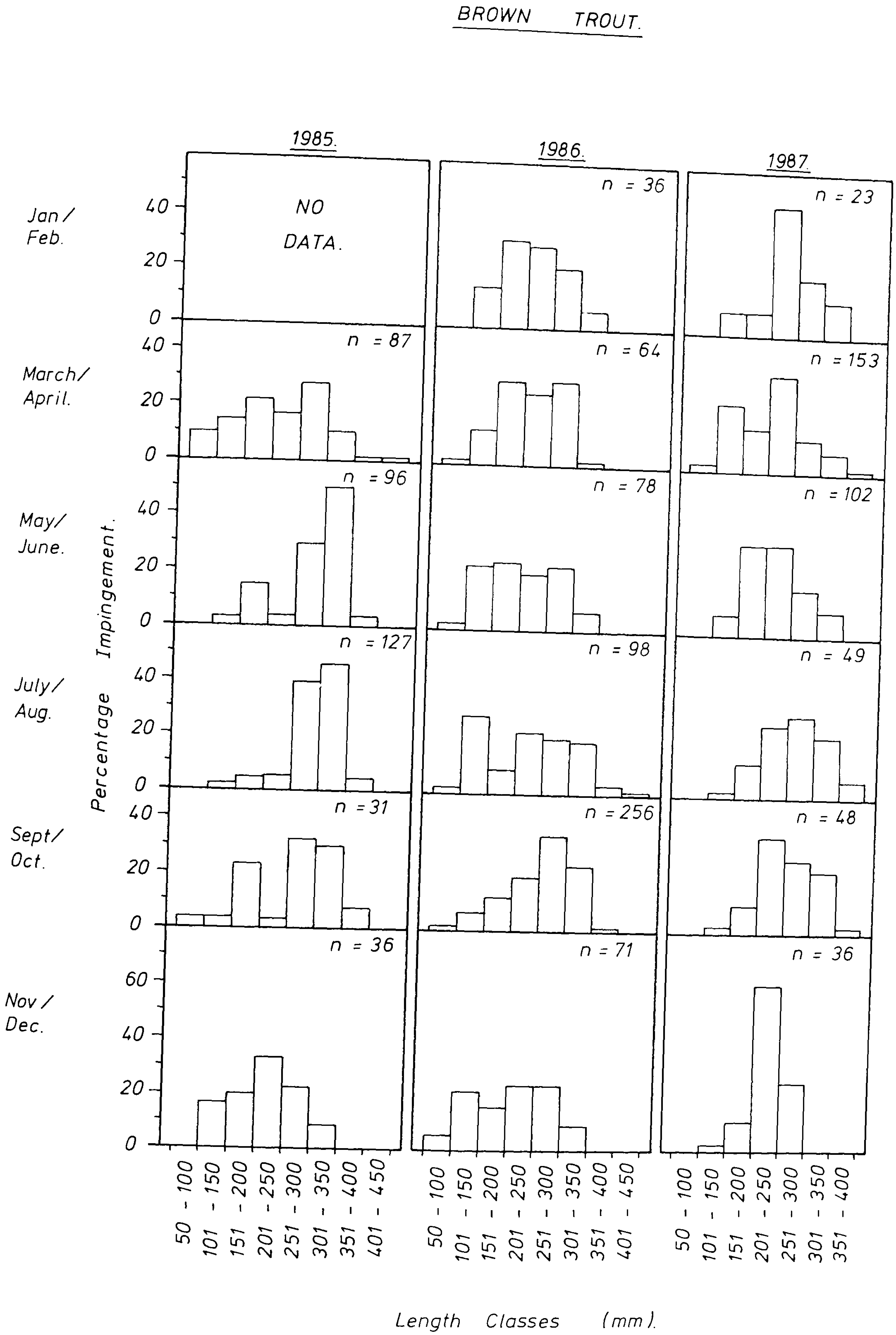
Figure 57.

Annual bi-monthly percentage frequency length class distributions for impinged rainbow trout, brook trout and brown trout, 1985 to 1987.


RAINBOW TROUT
1985
1986
1987
Jan/ Feb.
March/ April.
May/ June.
July/ Aug.
Sept/ Oct.
Nov/ Dec.
NO DATA.
n = 33
n = 4
n = 14
n = 32
n = 11
n = 39
n = 5
n = 5
n = 7
n = 10
n = 13
n = 8
n = 30
n = 9
n = 14
n = 7
n = 10
Percentage Impingement.
50 - 100
101 - 150
151 - 200
201 - 250
251 - 300
301 - 350
351 - 400
401 - 450
451 - 500
501 - 550
Length Classes (mm).



BROOK TROUT.
1985.
1986.
Jan/ Feb.
NO DATA.
NO IMPINGEMENT.
March/ April.
n = 9
NO IMPINGEMENT.
May/ June.
n = 8
n = 35
July/ Aug.
n = 41
n = 63
Sept/ Oct.
n = 11
n = 119
Nov/ Dec.
NO IMPINGEMENT.
n = 3
Percentage Impingement.
50 - 100
101 - 150
151 - 200
201 - 250
251 - 300
301 - 350
351 - 400
Length Classes (mm).


BROWN TROUT.
1985.
1986.
1987.
Jan / Feb.
March / April.
May / June.
July / Aug.
Sept / Oct.
Nov / Dec.
NO DATA.
n = 36
n = 23
n = 87
n = 64
n = 153
n = 96
n = 78
n = 102
n = 127
n = 98
n = 49
n = 31
n = 256
n = 48
n = 36
n = 71
n = 36
Percentage Impingement.
0
20
40
60
50 - 100
101 - 150
151 - 200
201 - 250
251 - 300
301 - 350
351 - 400
401 - 450
Length Classes (mm).

Appendix 1a.

A BASIC computer programme for Zippin's (1956) Removal Method of population estimation after Higgins (1985), with a worked example (Cowx, 1983).

(A typing error in line 400 of the original has been corrected).

```
10REM ZIPPIN
20DIM Y(50)
30LET Q$="NO"
40PRINT
50 PRINT"ESTIMATION OF FISH POPULATIONS BY ZIPPINS REMOVAL METHOD"
54 PRINT"P.J.HIGGINS: AQUACULTURE AND FISHERIES MANAGEMENT,1985.1,287-295"
55 PRINT"N.M.WALKER;1987" "
60 REM CALCULATION OF TOTAL CATCH (T) AND ZIPPINS"R-RATIO"
70PRINT
80PRINT
90PRINT"TYPE IN NAME OF SITE"
100INPUT S$
110PRINT
120 PRINT"TYPE IN DATE"
130INPUT D$
140PRINT
150PRINT"TYPE IN AREA FISHED (SQUARE METRES)"
160INPUT A
170PRINT
180PRINT"TYPE IN FISH SPECIES"
190INPUT F$
200PRINT
210PRINT"HOW MANY FISHING OPERATIONS?"
220INPUT K
230LET T=0
240LET S=0
250LET R=0
260LET U=0
270LET N=0
280PRINT
290PRINT"TYPE IN NUMBER OF FISH CAUGHT IN EACH OPERATION"
300FOR I=1 TO K
310INPUT Y(I)
320LET T=T+Y(I)
330LET S=S+(I-1)*Y(I)
340NEXT I
350LET R=S/T
360IF R>=(K-1)/2 THEN 480
370IF R=0 THEN 480
380REM SOLUTION OF EQN. OF GENERAL FORM TO EST. ZIPPINS "Q-VALUE"
390FOR Q=0 TO 1 STEP 0.01
400 LET U=R-(R+1)*Q+(K-R)*Q^K+(R+1-K)*(Q^(K+1))
410IF U>0 THEN 440
420 LET Q1=Q
430LET Q=1
440NEXT Q
450LET N=T/(1-(Q1^K))
460LET D=1-Q1
470LET E=2*SQR(N*(N-T)*T/((T*T)-N*(N-T)*((K*D)^2)/Q1))
480PRINT
490PRINT
500PRINT"RESULTS"
510PRINT"-------"
520IF Q$="YES"THEN 550
530PRINT
540PRINT S$,D$
550PRINT
```

```
   10REM ZIPPIN
   20DIM Y(50)
   30LET Q$="NO"
   40PRINT
   50  PRINT"ESTIMATION  OF  FISH  POPULATIONS  BY  ZIPPINS
REMOVAL METHOD"
   54   PRINT"P.J.HIGGINS:   AQUACULTURE   AND   FISHERIES
MANAGEMENT,1985.1,287-295"
   55 PRINT"N.M.WALKER;1987"  "
   60  REM  CALCULATION  OF  TOTAL  CATCH  (T)  AND
ZIPPINS"R-RATIO"
   70PRINT
   80PRINT
   90PRINT"TYPE IN NAME OF SITE"
  100INPUT S$
  110PRINT
  120 PRINT"TYPE IN DATE"
  130INPUT D$
  140PRINT
  150PRINT"TYPE IN AREA FISHED (SQUARE METRES)"
  160INPUT A
  170PRINT
  180PRINT"TYPE IN FISH SPECIES"
  190INPUT F$
  200PRINT
  210PRINT"HOW MANY FISHING OPERATIONS?"
  220INPUT K
  230LET T=0
  240LET S=0
  250LET R=0
  260LET U=0
  270LET N=0
  280PRINT
  290PRINT"TYPE IN NUMBER OF FISH CAUGHT IN EACH OPERATION"
  300FOR I=1 TO K
  310INPUT Y(I)
  320LET T=T+Y(I)
  330LET S=S+(I-1)*Y(I)
  340NEXT I
  350LET R=S/T
  360IF R>=(K-1)/2 THEN 480
  370IF R=0 THEN 480
  380REM SOLUTION  OF EQN. OF  GENERAL FORM TO  EST. ZIPPINS
"Q-VALUE"
  390FOR Q=0 TO 1 STEP 0.01
  400 LET U=R-(R+1)*Q+(K-R)*Q^K+(R+1-K)*(Q^(K+1))
  410IF U>0 THEN 440
  420 LET Q1=Q
  430LET Q=1
  440NEXT Q
  450LET N=T/(1-(Q1^K))
  460LET D=1-Q1
  470LET E=2*SQR(N*(N-T)*T/((T*T)-N*(N-T)*((K*D)^2)/Q1))
  480PRINT
  490PRINT
  500PRINT"RESULTS"
  510PRINT"-------"
  520IF Q$="YES"THEN 550
  530PRINT
  [illegible]
```

```
560PRINT"FISH SPECIES:";F$
570PRINT"-------------"
580PRINT
590PRINT"NO. OF FISH CAUGHT IN EACH OPERATION"
600PRINT"-----------------------------------"
610FOR I=1 TO K
620PRINT"        ",Y(I)
630NEXT I
640PRINT
650IF Q$="YES" THEN 680
660PRINT"TOTAL AREA FISHED (SQUARE METRES)=";A
670PRINT
680PRINT"NUMBER OF FISHING OPERATIONS=";K
690PRINT
700PRINT"TOTAL NUMBER OF FISH CAUGHT=";T
710PRINT
720IF R=0 THEN 740
730IF R<(K-1)/2 THEN 790
740PRINT"NO  ZIPPIN POPN.  EST. POSSIBLE  WITH THIS  CATCH
COMBINATION"
750PRINT
760PRINT"MINIMUM POPN. DENSITY PER SQUARE METRE=";T/A
770IF R=0 THEN 860
780IF R>=(K-1)/2 then 860
790PRINT"POPULATION ESTIMATE BY ZIPPIN METHOD=";N
800PRINT
810PRINT"ESTIMATED 95% CONFIDENCE LIMITS=+,-";E
820PRINT
830PRINT"ESTIMATED    POPULATION    DENSITY    PER    SQUARE
METRE=";N/A
840PRINT
850PRINT"ESTIMATED   95%   CONFIDENCE  LIMITS   TO   POPN.
DENSITY=";E/A
860PRINT
870 PRINT"----------------------------"
880PRINT
890PRINT"DO YOU WISH TO RE-RUN THE PROGRAM?"
900PRINT"TYPE YES OR NO"
910INPUT Q$
920PRINT
930PRINT
940IF Q$="YES" THEN 180
950END
```

```
>RUN

ESTIMATION OF FISH POPULATIONS BY ZIPPINS REMOVAL METHOD
P.J.HIGGINS: AQUACULTURE AND FISHERIES MANAGEMENT
MANAGEMENT,1985.1,287-295
N.M.WALKER;1987.


TYPE IN NAME OF SITE
?AFON DULAS

TYPE IN DATE
?19/6/79

TYPE IN AREA FISHED (SQUARE METRES)
?100

TYPE IN FISH SPECIES
?TROUT

HOW MANY FISHING OPERATIONS?
?5

TYPE IN NUMBER OF FISH CAUGHT IN EACH OPERATION
?72
?56
?46
?30
?24
```

```
RESULTS
-------

AFON DULAS19/6/79

FISH SPECIES:TROUT
-------------

NO. OF FISH CAUGHT IN EACH OPERATION
------------------------------------
                  72
                  56
                  46
                  30
                  24

TOTAL AREA FISHED (SQUARE METRES)=100

NUMBER OF FISHING OPERATIONS=5
TOTAL NUMBER OF FISH CAUGHT=228

POPULATION ESTIMATE BY ZIPPIN METHOD=305.446815

ESTIMATED 95% CONFIDENCE LIMITS=+,-54.8832641

ESTIMATED POPULATION DENSITY PER SQUARE METRE=3.05446815

ESTIMATED 95% CONFIDENCE LIMITS TO POPN.DENSITY=0.548832641


----------------------------

DO YOU WISH TO RE-RUN THE PROGRAM?
TYPE YES OR NO
?NO
```

Appendix 1b.

A BASIC computer programme for Carle and Strub's (1978) Maximum Weighted Likelihood Method of population estimation, with a worked example (Cowx, 1983).

```
 10 DIM C(10)
 20 LET Q$="NO"
 30  PRINT"----------------------------------------------"
 40 PRINT"ESTIMATION OF FISH POPULATIONS BY"
 50 PRINT"MAXIMUM WEIGHTED LIKELIHOOD METHOD-"
 60 PRINT"CARLE & STRUB,1978"
 70 PRINT"(N.M.WALKER, 1987)"
 80 PRINT"---------------------------------------------"
 90 PRINT"TYPE IN NAME OF SITE"
100 INPUT S$
110 PRINT
120 PRINT"TYPE IN DATE"
130 INPUT D$
140 PRINT
150 PRINT"TYPE IN AREA FISHED (SQUARE METRES)"
160 INPUT A
170 PRINT
180 PRINT"TYPE IN FISH SPECIES"
190 INPUT F$
200 PRINT
210 PRINT"HOW MANY FISHING OPERATIONS?"
220 INPUT K
230 PRINT
240 M=0:T=0
250 PRINT"TYPE IN NUMBER OF FISH CAUGHT IN EACH   OPERATION"
260 FOR I=1 TO K
270 INPUT C(I)
280M=M+(K-I)*C(I)
290T=T+C(I)
300NEXT I
310 FOR N0=T TO 1000
320 X=(N0+1)/(N0-T+1)
330 X=X*((K*N0-M-T+0.5*K)/(K*N0-M+1+0.5*K))^K
340 IF X<=1 GOTO 390
350NEXT N0
360 PRINT "SOLUTION NOT FOUND ":PRINT"CHECK INPUT DATA"
370VDU7:VDU7:PRINT:PRINT
380 GOTO 240
390 P=T/(K*N0-M)
400 IF P=1 THEN S=0: GOTO 420
410 S=SQR((N0*(N0-T)*T)/((T)^2-(N0*(N0-T)*((K*P)^2/(1-P)))))
420 R=1.96*S
430 PRINT
440 PRINT
450 PRINT"RESULTS"
460 PRINT"-------"
470 PRINT
480 PRINT S$,D$
490 PRINT"FISH SPECIES:";F$
500 PRINT"---------------------------------------"
510 PRINT"NUMBER OF FISH CAUGHT IN EACH OPERATION"
520 FOR I=1 TO K
530 PRINT"   ",C(I)
540 NEXT I
```

```
550 PRINT"TOTAL AREA FISHED (SQUARE METRES)             =";A
560 PRINT"NUMBER OF FISHING OPERATIONS                  =";K
570 PRINT"TOTAL NUMBER OF FISH CAUGHT                   =";T
580 PRINT"CATCHABILITY(P)                               =";P
590 PRINT
600 IF P=1 PRINT"MWL IMPOSSIBLE-ASSUMED POPULATION   =";T:GOTO 620
610PRINT"POPULATION EST.BY CARLE & STRUB METHOD  =";N0
620PRINT"EST.95% CONFIDENCE LIMITS                      =+,-";R
630 PRINT
640PRINT"EST.POPULATION DENSITY PER SQUARE METRE =";N0/A
650PRINT"EST.95% CONFIDENCE LIMITS                      =+,-";R/A
660 PRINT"---------------------------------------"
670 PRINT"DO YOU WISH TO RE-RUN THE PROGRAM?"
680 PRINT"TYPE YES OR NO"
690 INPUT Q$
700 IF Q$="YES" THEN 180
710 END
```

```
>RUN
-----------------------------------------
ESTIMATION OF FISH POPULATIONS BY
MAXIMUM WEIGHTED LIKELIHOOD METHOD-
CARLE & STRUB,1978
(N.M.WALKER,1987)
-----------------------------------------
TYPE IN NAME OF SITE
?AFON DULAS

TYPE IN DATE
?19/6/79

TYPE IN AREA FISHED (SQUARE METRES)
?100

TYPE IN FISH SPECIES
?TROUT

HOW MANY FISHING OPERATIONS?
?5

TYPE IN NUMBER OF FISH CAUGHT IN EACH   OPERATION
?72
?56
?46
?30
?24
```

```
RESULTS
-------

AFON DULAS19/6/79
FISH SPECIES:TROUT
----------------------------------------
NUMBER OF FISH CAUGHT IN EACH OPERATION
                  72
                  56
                  46
                  30
                  24
TOTAL AREA FISHED (SQUARE METRES)       =100
NUMBER OF FISHING OPERATIONS            =5
TOTAL NUMBER OF FISH CAUGHT             =228
CATCHABILITY(P)                         =0.25

POPULATION EST.BY CARLE & STRUB METHOD  =298
EST.95% CONFIDENCE LIMITS               =+,-46.2931222

EST.POPULATION DENSITY PER SQUARE METRE =2.98
EST.95% CONFIDENCE LIMITS               =+,-0.462931222
----------------------------------------
DO YOU WISH TO RE-RUN THE PROGRAM?
TYPE YES OR NO
?NO
```

Appendix 2.

Species fork length data (mm) for electric fishing site surveys, 1985 to 1987.

2a. Brown trout.
2b. Stone loach.
2c. Bullhead.
2d. Rainbow trout.

APPENDIX 2a.

SITE 1. (RIVER HODDER, SD 702 590)
BROWN TROUT.

SM85	W85	SP86	SM86	W87
106	166	166	120	120
51	147	152	115	
	145			
	137			

SITE 2.(RIVER HODDER, SD 715 583)
BROWN TROUT.

SP85	SM85	W85	SP86	SM86	W86
161	316	295	375	238	140
145	281	295		165	135
136	270	183		151	115
112	265	167		138	
98	180	165		136	
96	142	148		126	
93	141	140		123	
91	121	93		118	
89	116	88		117	
87	112	86		115	
86	105	83		106	
81	104	82		104	
79	103	80		103	
78	96	77		101	
78	52	75		100	
77		71		98	
76		70		59	
		56			

SP87	SM87		W87
258	295	57	201
	275	55	134
	264	55	88
	260	55	76
	260	54	66
	181	54	
	163	53	
	152	53	
	113	52	
	112	52	
	110	51	
	105	50	
	100	50	
	97	49	
	92	48	
	92	48	
	60	47	
	59	46	
	58	45	

SITE 3.(RIVER HODDER, SD 724 572)
BROWN TROUT.

SP85	SM85	W85	SP86	SM86	SP87
110	126	170	74	116	115
87	125	148		92	75
76	120	132			70
75	116	123			
	106	112			
	104	85			
	80				
	54				
	46				
	46				
	46				
	32				
	31				

SM87	W87
87	129
54	96
52	85
52	84
52	80
52	
50	
50	
49	
48	
48	
45	
44	
40	
40	
38	
38	
24	

SITE 4. (HASGILL BECK, SD 733 586)
BROWN TROUT.

SP85	SM85			W85	SP86	SM86		W86
150	170	47	39	190	130	135	50	127
127	140	47	38	185	117	110	50	124
125	135	47	38	158	86	110	50	120
122	130	47	38	142	82	110	50	120
120	122	46	37	140	80	105	50	118
115	121	46	37	132	76	100	50	112
95	111	46	36	131	76	100	50	111
93	108	46	35	128	75	100	50	111
88	105	46	35	125	73	100	49	110
85	100	46	35	120	72	98	45	110
84	98	45	35	113	72	97	45	106
82	97	45	35	108	70	94		103
82	93	45	34	105	65	94		98
77	92	45	34	90	65	93		96
77	90	45	34	77	65	92		93
76	88	45	34	73	65	92		92
74	87	45	34	72	64	90		88
74	87	45	34	71	64	90		78
74	87	45	32	71	62	85		72
73	86	45	32	70	61	85		72
70	84	45	32	70	60	85		70
70	83	44	30	70	60	85		68
70	80	44	30	69	59	83		68
68	75	44	28	69	57	83		66
68	75	43	25	69	53	81		66
67	55	43		68		80		66
65	54	42		64		80		66
65	53	42		64		78		65
64	51	42		63		75		65
64	51	42		62		70		65
61	51	42		62		64		64
	50	42		62		64		64
	50	42		62		60		64
	50	42		61		55		63
	50	41		60		55		62
	50	41		60		55		62
	50	41		59		55		61
	50	41		58		55		60
	50	41		57		54		56
	50	41		56		52		
	49	40		56		52		
	49	40		55		52		
	49	40		55		52		
	49	40		55		52		
	49	40		53		52		
	48	40		52		50		
	48	40		52		50		
	48	40		52		50		
	48	39		50		50		
	47	39		50		50		
	47	39		48		50		

SITE 4, cont.

SP87	SM87		W87
135	124	53	212
130	120	52	210
125	118	52	140
118	112	52	119
112	110	52	115
98	104	52	110
97	103	52	108
92	95	51	107
75	94	51	105
75	92	51	103
74	92	50	76
74	92	50	76
72	90	50	72
70	90	50	71
69	89	50	69
67	88	49	67
66	87	49	61
66	87	49	57
65	86	49	55
65	85	49	54
65	83	49	53
64	83	48	52
64	82	48	
64	75	47	
63	75	47	
60	67	47	
60	62	47	
60	62	46	
60	61	45	
57	59	44	
	58	44	
	58	43	
	58	43	
	58	43	
	57	42	
	57	42	
	57	41	
	56	38	
	56		
	56		
	56		
	55		
	55		
	55		
	54		
	53		

SITE 5. (HASGILL BECK, SD 724 574)
BROWN TROUT.

SP85	SM85	W85	SP86	SM86		W86
134	312	338	137	170	66	235
100	133	180	104	135	66	190
90	125	177	103	135	66	125
86	125	163	95	131	61	110
85	120	160	94	129	60	83
85	120	140	90	126		80
85	113	121	90	125		75
85	108	95	89	124		
	106	95	87	119		
	100	87	80	116		
	96	85	77	113		
	92	84	75	111		
	61	83	74	110		
	56	78	72	109		
	55	73	64	107		
	55	71	64	106		
	51	71	63	101		
	49	68	62	100		
	39	63	61	100		
		59	55	95		

SP87	SM87			W87	
240	305	57	51	325	70
195	280	57	50	144	70
136	152	56	50	136	67
115	150	56	50	135	66
115	140	56	49	108	
115	139	56	48	105	
90	139	55	48	104	
80	137	55	48	99	
	134	55	48	98	
	133	55	48	97	
	132	55	47	97	
	123	55	47	97	
	115	55	47	93	
	115	55	47	92	
	115	54	46	92	
	111	54	45	90	
	110	54	45	89	
	110	54	45	85	
	66	54	45	84	
	65	53	44	82	
	63	53	44	77	
	62	53	44	76	
	60	52	43	75	
	60	52	43	74	
	60	52	41	73	
	60	52	41	72	
	58	52	37	72	
	57	52		72	
	57	51		70	

SITE 6. (BOTTOMS BECK, SD 746 575)
BROWN TROUT.

SP85	SM85		W85	SP86	SM86	W86
193	169	50	278	278	228	160
120	162	46	175	132	225	125
119	150	43	162	130	195	115
115	145	43	160		180	115
78	144	42	148		170	110
73	131	42	145		165	110
	116	41	136		160	85
	114	41	125		160	70
	113	40	75		150	68
	112	38	69		120	50
	110	38	67		115	
	110		67		115	
	108		65		100	
	105				63	
	100				58	
	52				50	

SP87	SM87		W87
238	240	115	290
188	203	114	236
145	195	112	231
145	190	111	207
127	190	110	184
120	180	110	172
118	173	110	155
116	172	108	145
115	170	105	121
112	161	104	119
85	160	104	118
85	158	100	106
	155	100	103
	150	100	70
	150	100	
	150	100	
	145	100	
	135	92	
	133	90	
	130	85	
	130	70	
	122	52	
	120	50	
	120	50	
	116	45	
	115	40	

SITE 7. (BOTTOMS BECK, SD 745 567)
BROWN TROUT.

SP85	SM85		W85	SP86	SM86	W86
337	355	110	265	190	273	120
205	247	106	256	160	250	
175	222	106	220	157	168	
153	219	91	131	136	165	
150	205	56	130	135	164	
145	198		127	125	128	
132	169		113	122	119	
131	168		76	114		
94	157		73	74		
92	155		70	70		
85	155		70			
82	127		69			
72	122					
72	113					

SP87	SM87	W87	
200	290	288	155
185	245	243	152
182	205	233	152
140	185	232	150
135	110	220	145
130	110	200	135
120	58	192	117
115	55	188	115
93	52	188	112
90	50	185	105
77	40	175	
75		168	

SITE 8. (BOTTOMS BECK, SD 745 565)
BROWN TROUT.

SP85	SM85			W85	SP86	SM86	W86
92	125	47	40	310	81	175	115
90	125	46	40	111	73	130	86
84	115	46	40	108	72	105	78
82	110	46	40	107	70	100	78
75	110	45	40	100	68	95	72
75	110	45	40	89	68	95	72
74	105	45	40	83	68	95	71
72	97	45	40	79	68	95	70
65	95	45	40	77	65	91	70
63	95	45	40	70	63	91	67
62	92	45	40	66	61	90	60
61	92	45	40	64	58	90	56
60	90	45	40	63	58	90	54
59	90	45	40	63	51	90	54
58	85	44	40	60	50	90	
57	82	44	39	60		90	
55	78	44	39	58		85	
55	55	44	39	57		85	
55	55	44	39	55		80	
52	55	44	38	53		80	
49	54	44	38	46		80	
	53	44	38			80	
	53	44	38			75	
	53	44	38			75	
	52	44	38			75	
	52	43	38			75	
	52	43	37			70	
	52	43	37			70	
	52	43	36			70	
	52	43	36			70	
	52	42	36			65	
	52	42	36			55	
	51	42	35			45	
	51	42	35			45	
	51	42	35			45	
	51	42	35			35	
	50	42	35				
	50	42	35				
	50	42	35				
	50	42	35				
	50	42	35				
	50	42	35				
	50	41	35				
	49	41	35				
	48	41	35				
	48	41	34				
	48	41	33				
	47	41	32				
	47	40	30				
	47	40	25				
	47	40					
	47	40					

SITE 8, cont.

SP87	SM87	W87
100	170	355
78	150	350
76	143	148
76	142	125
63	125	115
	120	76
	120	70
	113	68
	113	58
	111	53
	110	
	100	
	100	
	100	
	95	
	95	
	94	
	93	
	56	
	54	
	54	
	54	
	53	
	53	
	51	
	50	
	50	
	50	
	50	
	50	
	45	
	45	
	40	
	40	

APPENDIX 2b.

SITE 2. (RIVER HODDER, SD 715 583)
STONE LOACH.

SP85		SM85	W85	SP86	SM86	W86
119	84	110	100	82	102	95
114	82	110	100	71	98	80
111	81	97	97	70	96	30
107	81	93	96	66	95	25
106	81	88	96	64	94	
105	78	88	94		92	
102	77	87	93		92	
100	75	87	92		90	
99	75	86	91		81	
99	72	81	90		80	
98	71	80	90		70	
98	70	73	90		66	
96	66	56	86		43	
95	43	56	80		40	
94	42	50	75		33	
93	42		70			
92	42		65			
92	41		64			
91	41		58			
91	40		55			
91	39					
90	37					
88	33					
86	32					
86						

SP87	SM87		W87
100	109	94	111
100	103	93	111
98	98	92	105
95	98	90	105
95	97	90	103
95	96	90	98
95	96	90	98
90	96	90	98
90	95	85	96
	95	83	92
	95	70	80
	94	55	72

SITE 3. (RIVER HODDER, SD 724 572)
STONE LOACH.

SP85	SM85		W85	SP86	SM86	W86
107	99	80	104	94	92	95
100	95	80	85	92	91	
97	94	80	85	90	90	
95	93	79	84	90	85	
94	92	78	83	89	84	
90	91	78	74	85	81	
88	91	78	61	85	80	
85	91	78		83	80	
77	90	78		83	78	
75	90	78		83	77	
75	89	77		82	75	
75	88	77		82	75	
75	88	77		81	65	
74	87	76		80	64	
73	86	76		80	62	
70	86	76		80	55	
70	86	76		80		
59	85	75		78		
58	84	75		77		
	84	74		75		
	83	74		75		
	83	74		75		
	83	69		75		
	82	68		74		
	82	65		70		
	82	64		65		
	81	64		60		
	81	62		60		
	80	61		58		
	80	55		57		
	80	49		55		

SP87			SM87			W87
114	85	80	91	78	60	90
100	85	80	90	77	59	87
98	85	78	90	76	57	85
97	85	75	86	76	56	80
95	85	75	86	76	52	76
95	85	70	85	75	52	75
95	84	70	85	75		67
95	84	67	84	75		65
90	83	66	83	71		58
90	82		83	71		
90	82		82	71		
90	80		81	70		
90	80		81	64		
85	80		80	61		
85	80		79	60		

SITE 4. (HASGILL BECK, SD 733 586)
STONE LOACH.

SP85	SM85	W85	SM86	SP87	SM87
100	95	110	108	105	120
100		107	100	100	106
		100			
		100			
		82			

SITE 5. (HASGILL BECK, SD 724 574)
STONE LOACH.

SP85		SM85		W85	SP86		SM86		W86
104	71	111	79	107	110	75	108	77	105
100	70	104	78	95	101	74	105	76	90
95	70	103	77	91	97	68	104	75	90
92	70	96	77	91	95	68	104	75	90
90	70	96	77	90	95	62	96	73	85
89	69	90	76	90	94		92	71	85
84	67	89	75	86	93		90	70	80
84	66	88	75	85	92		90	68	80
82	60	87	75	84	92		89	66	75
82	60	86	74	83	89		87	65	75
80		86	73	83	87		85	65	72
80		84	73	83	85		84	51	65
80		84	73	82	85		84	50	
80		84	73	78	85		84	50	
80		83	72	76	84		83	48	
78		83	71	72	84		83	48	
78		82	70	72	83		82		
75		82	68	66	82		81		
75		82	66	65	82		81		
75		82	66	60	78		80		
75		80	64	56	77		80		
72		80	51	53	76		79		
72		80	48		76		77		

SP87		SM87		W87	
110	85	97	82	105	90
110	85	96	82	102	87
100	85	90	82	101	86
100	85	90	81	101	85
100	85	90	80	97	85
95	80	90	80	95	85
95	80	89	78	95	75
95	80	89	77	95	70
95	80	89	77	94	69
93	80	88	54	94	68
90	80	87	52	93	65
90	70	87	48	92	
90		87	44	91	
90		86	42	90	
90		85	40	90	
90		84		90	
90		84		90	

SITE 6. (BOTTOMS BECK, SD 746 575)
STONE LOACH.

SP85	SM85	W85	SM86	W86	SP87	SM87
117	115	110	110	117	118	120
100	102	100			115	115
92	96					110
	94					
	91					
	90					

SITE 7. (BOTTOMS BECK, SD 745 567)
STONE LOACH.

SP85	W87
120	108
90	
85	
85	
75	
36	

SITE 8. (BOTTOMS BECK, SD 745 565)
STONE LOACH.

SP85	SM85	SM86	W86	SP87	SM87	W87
90	98	95	89	100	100	100
75	90	75		100	100	90
		70		95	96	
				95	95	
				94	95	
				80	90	
				80	90	
				76		

APPENDIX 2c.

SITE 2. (RIVER HODDER, SD 715 583)
BULLHEAD.

SP85	SM85	W85	SP86	SM86	W86
93	69	91	94	80	65
88		85	88	78	
87		83	84	64	
84		82	81	61	
83			80	60	
80			73	58	
73			70	55	
68			45	51	
53			45		
45			43		

SP87	SM87		W87
80	85	60	80
73	80	60	77
	78	58	72
	63	56	65
	62	56	60
	61	55	60
	60	51	
	60		

SITE 3. (RIVER HODDER, SD 724 572)
BULLHEAD.

SP85	SM85	SP86	SP87	SM87
50	81	81	68	55
43	71		60	53
			55	48
			50	

SITE 4. (HASGILL BECK, SD 733 586)
BULLHEAD.

SP85	SM85	W85	SP86	W86	SP87
70	90	85	86	89	95
			85	50	45
			45	45	45
				45	40
				45	35
				45	

SM87	W87
70	35
62	
60	
60	
59	
58	
58	
58	
57	
53	
52	

SITE 5. (HASGILL BECK, SD 724 574)
BULLHEAD.

SP85	SM85	SM86	W86	SP87	SM87	W87
85	72	83	75	75	83	95
80		81	75	75	60	
80		73	75	65	56	
72		60	67	50		
65		45	65	50		
60			60	50		
50				40		

SITE 6. (BOTTOMS BECK, SD 746 575)
BULLHEAD.

SP85	SM85		W85	SP86	SM86	W86
90	99	63	87	95	85	90
84	91	62	83	90	65	85
81	88	62	82	86	50	80
81	88	62	80	81	50	72
78	86	61	80	80	50	72
78	82	60	78	80	45	55
75	80	58	75	71	40	50
74	80	57	70	70		50
74	80	57	68	60		45
72	80	57	68			
70	79	56	66			
69	79	56	61			
68	78	56	61			
66	78	55	61			
65	77	54	60			
56	76	53	32			
52	76	53	30			
46	75	53				
40	74	53				
40	72	52				
	71	52				
	70	52				
	69	52				
	68	51				
	68	51				
	68	50				
	67	50				
	66	49				
	64	47				
	64					

SP87	SM87	W87
65	80	50
	70	
	70	
	65	
	50	
	50	
	50	
	50	
	50	
	40	

SITE 7. (BOTTOMS BECK, SD 745 567)
BULLHEAD.

SP85	SM85	W85	SP86	SM86	W86
90 66	53	90	86	70	80
84 59		87	66	54	60
83		85	66	51	
80		84	65		
78		77	64		
76		76	61		
75		75			
75		65			
74		65			
68		35			
67		30			

SP87	SM87	W87
90	70	72
70	70	67
60	60	
60	51	
	50	

SITE 8. (BOTTOMS BECK, SD 745 565)
BULLHEAD.

SP85	SM85	W85	SP86	SM86	W86
80	90 55	77	84	65	66
79	70 55	40	74	60	65
72	63 47	35	65	55	56
65	62 45	23	63		52
63	62		62		47
51	60		60		40
38	59				
36	58				
35	58				

SP87	SM87	W87
80	55	73
40	52	65
	50	
	50	
	50	
	50	

APPENDIX 2d.

SITE 2. (RIVER HODDER, SD 715 583)
RAINBOW TROUT.

W85	W86	SP87
330	355	388
	335	353

SITE 3. (RIVER HODDER, SD 724 572)
RAINBOW TROUT.

SP85	W85	SP87
460	335	343
460		343
330		

SITE 5. (HASGILL BECK, SD 724 574)
RAINBOW TROUT.

W87
315

SITE 8. (BOTTOMS BECK, SD 745 565)
RAINBOW TROUT.

SP87
350
345

Appendix 3.

Weekly fishery data, 1985 to 1987.

3a. Permit visits.

3b. Catches.

3c. Limit and Nil returns.

3d. Catches per angler visit.

3e. Numbers and weights of large fish taken (>907g).

APPENDIX 3a.

1985 Season.

SEASON IN WEEKS.	ANGLER VISITS.	DAY VISITS.	1/2 DAY VISITS.	SEASON VISITS.	NO DATA.
11	128	111	14	3	0
12	126	107	15	4	0
13	134	97	37	0	3
14	164	108	53	3	10
15	182	120	57	5	9
16	192	130	56	6	6
17	161	99	58	4	9
18	207	139	60	8	13
19	261	177	76	8	9
20	263	204	50	9	4
21	223	140	75	8	5
22	388	249	130	9	3
23	188	90	89	9	1
24	192	105	82	5	0
25	177	91	73	13	0
26	168	83	77	8	1
27	215	112	92	11	0
28	189	112	72	5	0
29	173	116	51	6	3
30	151	90	49	12	6
31	123	65	47	11	1
32	118	69	43	6	11
33	142	69	63	10	2
34	153	95	50	8	3
35	247	143	95	9	11
36	161	92	64	5	3
37	246	134	104	8	4
38	210	145	57	8	8
39	282	207	65	10	16
40	160	116	36	8	4
41	169	115	41	13	2
42	166	92	59	15	2
43	203	129	61	13	6
44	165	103	59	3	12

1986 Season.

SEASON IN WEEKS.	ANGLER VISITS.	DAY VISITS.	1/2 DAY VISITS.	SEASON VISITS.	NO DATA.
11	164	138	22	4	16
12	217	158	44	15	4
13	143	88	47	8	4
14	311	184	114	13	8
15	136	87	44	5	1
16	190	137	40	13	8
17	225	155	55	15	21
18	245	159	65	21	29
19	252	166	71	15	8
20	267	196	59	12	17
21	169	91	59	19	2
22	352	227	109	16	21
23	210	131	59	20	15
24	202	131	56	15	3
25	155	85	52	18	7
26	170	87	66	17	12
27	193	107	70	16	16
28	267	168	88	11	23
29	226	113	100	13	6
30	202	131	60	11	14
31	163	101	51	11	3
32	165	99	55	11	12
33	190	110	67	13	10
34	219	141	66	12	12
35	164	98	52	14	6
36	157	94	48	15	2
37	222	159	56	7	13
38	246	185	51	10	7
39	170	109	52	9	7
40	167	112	44	11	5
41	141	89	39	13	10
42	73	49	16	8	0
43	39	21	13	5	2
44	53	30	15	8	0
45	45	27	12	6	0
46	27	11	8	8	0

1987 Season.

SEASON IN WEEKS.	ANGLER VISITS.	DAY VISITS.	1/2 DAY VISITS.	SEASON VISITS.	NO DATA.
11	128	105	22	1	6
12	175	118	53	4	5
13	104	66	35	3	2
14	103	61	36	6	1
15	133	92	33	8	7
16	271	189	73	9	16
17	312	192	110	10	4
18	154	105	40	9	0
19	244	139	93	12	1
20	103	59	40	4	1
21	147	83	48	16	0
22	224	127	88	9	1
23	66	44	18	4	2
24	267	199	65	3	4
25	196	102	78	16	1
26	148	83	54	11	2
27	153	97	50	6	7
28	193	119	64	10	11
29	151	80	62	9	6
30	146	96	44	6	1
31	138	92	36	10	0
32	179	115	60	4	1
33	158	112	38	8	2
34	153	92	54	7	1
35	183	129	44	10	1
36	165	99	57	9	2
37	121	87	28	6	0
38	143	96	35	12	0
39	193	144	42	7	14
40	113	71	32	10	2
41	85	55	26	4	4
42	64	45	14	5	0
43	103	70	27	6	3
44	84	53	24	7	0
45	91	70	16	5	3
46	95	64	25	6	1

APPENDIX 3b.

1985 Season.

SEASON IN WEEKS.	TOTAL CAUGHT.	TOTAL TAKEN.	TOTAL RETURNED.	RAINBOWS TAKEN.	BROWNS TAKEN.	BROOKS TAKEN.
11	380	289	91	271	18	0
12	326	211	115	176	34	1
13	311	187	124	166	16	5
14	338	237	101	175	48	14
15	354	258	96	192	52	14
16	498	314	184	202	85	27
17	447	231	216	164	50	17
18	820	399	421	269	113	17
19	865	492	373	364	113	15
20	709	526	183	409	98	19
21	760	418	342	335	60	23
22	828	598	230	531	58	9
23	564	317	247	283	27	7
24	606	387	219	251	91	45
25	441	326	115	229	70	27
26	370	282	88	203	46	33
27	581	362	219	320	32	10
28	435	312	123	290	8	14
29	308	228	80	201	20	7
30	215	175	40	157	13	5
31	123	91	32	81	9	1
32	189	145	44	129	15	1
33	383	253	130	226	24	3
34	366	327	39	288	33	6
35	918	482	436	442	37	3
36	480	272	208	241	26	5
37	628	423	205	391	28	4
38	536	331	205	311	18	2
39	691	496	195	477	17	2
40	391	238	153	234	4	0
41	451	271	180	262	9	0
42	497	255	242	255	0	0
43	382	273	109	271	0	2
44	239	148	91	147	0	1

1986 Season.

SEASON IN WEEKS.	TOTAL CAUGHT.	TOTAL TAKEN.	TOTAL RETURNED.	RAINBOWS TAKEN.	BROWNS TAKEN.	BROOKS TAKEN.
11	457	150	307	150	0	0
12	514	249	265	247	2	0
13	278	190	88	187	3	0
14	900	477	423	473	3	1
15	347	193	154	188	5	0
16	341	248	93	243	4	1
17	571	376	195	364	9	3
18	654	366	288	341	13	12
19	783	419	364	380	16	23
20	579	395	184	373	6	16
21	303	202	101	188	4	10
22	657	470	187	445	10	15
23	442	330	112	254	35	41
24	268	215	53	172	25	18
25	252	181	71	147	19	15
26	336	197	139	178	12	7
27	419	269	150	252	7	10
28	741	635	106	624	6	5
29	428	272	156	228	32	12
30	448	315	133	273	26	16
31	285	242	43	223	10	9
32	375	236	139	213	14	9
33	444	301	143	255	23	23
34	648	429	219	396	17	16
35	447	279	168	241	23	15
36	446	233	213	189	17	27
37	560	397	163	361	25	11
38	508	429	79	393	20	16
39	339	283	56	256	18	9
40	370	256	114	251	1	4
41	233	169	64	165	0	4
42	113	94	19	91	0	3
43	69	52	17	52	0	0
44	127	61	66	61	0	0
45	97	59	38	58	0	1
46	26	16	10	16	0	0

1987 Season.

SEASON IN WEEKS.	TOTAL CAUGHT.	TOTAL TAKEN.	TOTAL RETURNED.	RAINBOWS TAKEN.	BROWNS TAKEN.
11	627	277	350	275	2
12	734	318	416	314	4
13	136	92	44	91	1
14	180	94	86	91	3
15	330	210	120	207	3
16	345	312	33	301	10
17	350	289	61	275	12
18	317	201	116	100	101
19	240	205	35	163	42
20	166	125	41	113	12
21	197	154	43	138	16
22	385	288	97	267	20
23	120	103	17	89	14
24	892	822	70	808	14
25	349	281	68	269	12
26	307	220	87	213	7
27	329	242	87	234	8
28	426	289	137	283	6
29	291	189	102	181	8
30	326	226	100	219	7
31	421	239	182	234	4
32	460	316	144	308	8
33	466	266	200	256	10
34	352	220	132	210	10
35	446	277	169	270	7
36	443	295	148	291	4
37	230	178	52	172	6
38	294	184	110	177	7
39	453	348	105	344	4
40	374	222	152	218	4
41	234	150	84	150	0
42	238	146	92	146	0
43	226	151	75	150	1
44	140	108	32	108	0
45	174	142	32	142	0
46	223	213	10	213	0

APPENDIX 3c.

1985 Season.

SEASON IN WEEKS.	DAY NIL.	DAY LIMIT.	1/2 DAY, SEASON NIL.	1/2 DAY, SEASON LIMIT.
11	9	68	5	5
12	24	41	3	12
13	23	34	17	12
14	26	50	22	14
15	21	44	23	14
16	23	58	16	30
17	17	40	17	21
18	7	83	7	33
19	14	93	21	40
20	7	130	11	28
21	14	69	15	45
22	47	88	58	58
23	7	47	32	48
24	6	65	13	54
25	5	50	28	44
26	10	42	28	35
27	18	62	41	41
28	29	43	14	46
29	28	28	21	16
30	37	25	25	21
31	34	9	37	11
32	12	15	13	16
33	6	37	16	38
34	5	61	5	37
35	4	83	13	53
36	8	42	24	26
37	11	68	42	45
38	25	51	15	29
39	24	107	25	29
40	26	41	13	17
41	10	46	26	17
42	17	40	24	32
43	25	45	34	20
44	42	17	23	14

1986 Season.

SEASON IN WEEKS.	DAY NIL.	DAY LIMIT.	1/2 DAY, SEASON NIL.	1/2 DAY, SEASON LIMIT.
11	65	20	7	10
12	56	33	23	22
13	17	27	26	15
14	37	76	43	52
15	27	36	17	17
16	37	41	22	20
17	15	67	19	30
18	24	64	22	32
19	23	72	27	41
20	30	64	25	24
21	25	34	41	19
22	53	65	44	35
23	25	53	37	22
24	54	28	29	22
25	21	22	36	24
26	21	33	37	21
27	13	40	39	27
28	19	90	52	22
29	34	44	47	30
30	23	57	17	31
31	18	45	29	18
32	27	40	16	24
33	17	63	29	27
34	8	87	15	44
35	8	50	22	29
36	17	40	22	22
37	15	83	15	24
38	9	111	20	23
39	9	54	24	16
40	26	41	14	26
41	20	24	20	18
42	16	16	9	6
43	3	9	8	4
44	10	9	11	7
45	8	8	5	6
46	7	1	9	2

1987 Season.

SEASON IN WEEKS.	DAY NIL.	DAY LIMIT.	1/2 DAY, SEASON NIL.	1/2 DAY, SEASON LIMIT.
11	4	68	9	9
12	16	64	15	24
13	31	11	23	11
14	27	12	23	8
15	16	42	16	15
16	61	52	38	18
17	64	40	81	13
18	33	33	17	16
19	60	31	69	14
20	14	18	22	9
21	34	22	28	13
22	28	46	47	18
23	4	13	6	9
24	21	154	24	26
25	24	45	35	34
26	13	36	29	20
27	16	37	18	19
28	21	47	22	29
29	21	28	26	15
30	19	43	19	14
31	16	43	11	21
32	16	59	22	25
33	23	51	16	14
34	19	38	27	16
35	21	48	21	15
36	10	61	21	28
37	20	29	12	12
38	33	28	13	15
39	24	67	16	17
40	4	48	11	21
41	7	24	2	16
42	2	28	6	8
43	16	20	10	12
44	17	17	13	11
45	16	24	11	5
46	17	23	8	17

APPENDIX 3d.

1985 Season.

SEASON IN WEEKS.	CAUGHT/ ANGLER VISIT.	TAKEN/ ANGLER VISIT.	RETURNED/ ANGLER VISIT.	RAINBOWS/ ANGLER VISIT.	BROWNS/ ANGLER VISIT.	BROOKS/ ANGLER VISIT.
11	2.97	2.26	0.71	2.12	0.14	0.00
12	2.58	1.67	0.91	1.40	0.27	0.00
13	2.33	1.40	0.93	1.24	0.12	0.04
14	2.07	1.45	0.62	1.07	0.29	0.09
15	1.95	1.42	0.53	1.05	0.29	0.08
16	2.59	1.63	0.96	1.05	0.44	0.14
17	2.78	1.44	1.34	1.02	0.31	0.11
18	3.96	1.93	2.03	1.30	0.55	0.08
19	3.31	1.88	1.43	1.39	0.43	0.06
20	2.70	2.00	0.70	1.56	0.37	0.07
21	3.40	1.87	1.53	1.50	0.27	0.10
22	2.13	1.54	0.59	1.37	0.15	0.02
23	3.00	1.69	1.31	1.51	0.14	0.04
24	3.15	2.01	1.14	1.31	0.47	0.23
25	2.49	1.84	0.65	1.29	0.40	0.15
26	2.20	1.68	0.52	1.21	0.27	0.20
27	2.71	1.69	1.02	1.49	0.15	0.05
28	2.29	1.64	0.65	1.53	0.04	0.07
29	1.78	1.32	0.46	1.16	0.12	0.04
30	1.42	1.16	0.26	1.04	0.09	0.03
31	1.00	0.74	0.26	0.66	0.07	0.01
32	1.60	1.23	0.37	1.09	0.13	0.01
33	2.70	1.78	0.92	1.59	0.17	0.02
34	2.39	2.14	0.25	1.88	0.22	0.04
35	3.72	1.95	1.77	1.79	0.15	0.01
36	2.98	1.69	1.29	1.50	0.16	0.03
37	2.55	1.72	0.83	1.59	0.11	0.02
38	2.56	1.58	0.98	1.48	0.09	0.01
39	2.45	1.76	0.69	1.69	0.06	0.01
40	2.45	1.49	0.96	1.46	0.03	0.00
41	2.67	1.60	1.07	1.55	0.05	0.00
42	3.00	1.54	1.46	1.54	0.00	0.00
43	1.88	1.34	0.54	1.33	0.00	0.01
44	1.45	0.90	0.55	0.89	0.00	0.01

1986 Season.

SEASON IN WEEKS.	CAUGHT/ ANGLER VISIT.	TAKEN/ ANGLER VISIT.	RETURNED/ ANGLER VISIT.	RAINBOWS/ ANGLER VISIT.	BROWNS/ ANGLER VISIT.	BROOKS/ ANGLER VISIT.
11	2.78	0.91	1.87	0.91	0.00	0.00
12	2.37	1.15	1.22	1.14	0.01	0.00
13	1.95	1.33	0.62	1.31	0.02	0.00
14	2.89	1.53	1.36	1.52	0.01	0.00
15	2.55	1.42	1.13	1.38	0.04	0.00
16	1.80	1.31	0.49	1.28	0.02	0.01
17	2.54	1.67	0.87	1.62	0.04	0.01
18	2.67	1.49	1.18	1.39	0.05	0.05
19	3.10	1.66	1.44	1.51	0.06	0.09
20	2.17	1.48	0.69	1.40	0.02	0.06
21	1.79	1.19	0.60	1.11	0.02	0.06
22	1.86	1.33	0.53	1.26	0.03	0.04
23	2.11	1.58	0.53	1.21	0.17	0.20
24	1.32	1.06	0.26	0.85	0.12	0.09
25	1.63	1.17	0.46	0.95	0.12	0.10
26	1.98	1.16	0.82	1.05	0.07	0.04
27	2.18	1.40	0.78	1.31	0.04	0.05
28	2.78	2.38	0.40	2.34	0.02	0.02
29	1.89	1.20	0.69	1.01	0.14	0.05
30	2.22	1.56	0.66	1.35	0.13	0.08
31	1.75	1.49	0.26	1.37	0.06	0.06
32	2.26	1.42	0.84	1.29	0.08	0.05
33	2.33	1.58	0.75	1.34	0.12	0.12
34	2.96	1.96	1.00	1.81	0.08	0.07
35	2.72	1.70	1.02	1.47	0.14	0.09
36	2.84	1.48	1.36	1.20	0.11	0.17
37	2.52	1.79	0.73	1.63	0.11	0.05
38	2.07	1.75	0.32	1.60	0.08	0.07
39	2.00	1.67	0.33	1.51	0.11	0.05
40	2.21	1.53	0.68	1.50	0.01	0.02
41	1.65	1.20	0.45	1.17	0.00	0.03
42	1.55	1.29	0.26	1.25	0.00	0.04
43	1.77	1.33	0.44	1.33	0.00	0.00
44	2.40	1.15	1.25	1.15	0.00	0.00
45	2.15	1.31	0.84	1.29	0.00	0.02
46	0.96	0.59	0.37	0.59	0.00	0.00

1987 Season.

YEAR IN WEEKS.	CAUGHT/ ANGLER VISIT.	TAKEN/ ANGLER VISIT.	RETURNED/ ANGLER VISIT.	RAINBOWS/ ANGLER VISIT.	BROWNS/ ANGLER VISIT.
11	4.89	2.16	2.73	2.15	0.01
12	4.19	1.81	2.38	1.79	0.02
13	1.31	0.89	0.42	0.88	0.01
14	1.74	0.91	0.83	0.88	0.03
15	2.48	1.58	0.90	1.56	0.02
16	1.28	1.16	0.12	1.11	0.04
17	1.13	0.93	0.20	0.88	0.04
18	2.06	1.31	0.75	0.65	0.66
19	0.98	0.84	0.14	0.67	0.17
20	1.61	1.21	0.40	1.10	0.11
21	1.34	1.05	0.29	0.94	0.11
22	1.72	1.29	0.43	1.19	0.09
23	1.82	1.56	0.26	1.35	0.21
24	3.34	3.08	0.26	3.03	0.05
25	1.78	1.43	0.35	1.37	0.06
26	2.08	1.49	0.59	1.44	0.05
27	2.15	1.58	0.57	1.53	0.05
28	2.21	1.50	0.71	1.47	0.03
29	1.93	1.25	0.68	1.20	0.05
30	2.23	1.55	0.68	1.50	0.05
31	3.05	1.73	1.32	1.69	0.03
32	2.57	1.77	0.80	1.72	0.05
33	2.95	1.68	1.27	1.62	0.06
34	2.30	1.44	0.86	1.37	0.07
35	2.43	1.51	0.92	1.47	0.04
36	2.69	1.79	0.90	1.76	0.03
37	1.90	1.47	0.43	1.42	0.05
38	2.06	1.29	0.77	1.24	0.05
39	2.35	1.80	0.55	1.78	0.02
40	3.31	1.96	1.35	1.93	0.03
41	2.75	1.76	0.99	1.76	0.00
42	3.72	2.28	1.44	2.28	0.00
43	2.20	1.47	0.73	1.46	0.01
44	1.67	1.29	0.38	1.29	0.00
45	1.91	1.56	0.35	1.56	0.00
46	2.35	2.24	0.11	2.24	0.00

APPENDIX 3e.

1985 Season.

SEASON IN WEEKS.	NUMBER OF RAINBOWS.	MEAN WEIGHT RAINBOWS.	NUMBER OF BROWNS.	MEAN WEIGHT BROWNS.	NUMBER OF BROOKS.	MEAN WEIGHT BROOKS.
11	10	1235	1	1006	0	0
12	8	1042	3	1002	1	1021
13	3	955	1	1361	1	964
14	0	0	0	0	3	983
15	3	1021	0	0	2	964
16	1	1758	1	907	7	940
17	1	1134	1	907	2	907
18	4	1063	2	1446	5	1054
19	11	1214	3	1143	1	1389
20	5	998	3	907	1	907
21	0	0	1	936	3	907
22	1	964	0	0	0	0
23	2	1163	0	0	1	964
24	3	1380	9	1061	31	1086
25	4	1120	5	1259	16	1033
26	5	1213	0	0	22	1082
27	5	1213	0	0	4	1177
28	19	1140	2	1148	8	1102
29	14	1272	0	0	5	1179
30	7	1442	0	0	4	964
31	6	1214	1	936	1	1247
32	17	1194	0	0	1	907
33	40	1152	0	0	2	936
34	34	1137	0	0	2	964
35	45	1171	0	0	3	1021
36	23	1307	4	1141	1	907
37	24	1188	2	1049	0	0
38	27	1173	0	0	2	1234
39	29	1196	1	1134	1	1113
40	15	1295	0	0	0	0
41	16	1090	0	0	0	0
42	16	1102	0	0	0	0
43	19	1150	0	0	0	0
44	10	1210	0	0	0	0

1986 Season.

SEASON IN WEEKS.	NUMBER OF RAINBOWS.	MEAN WEIGHT RAINBOWS.	NUMBER OF BROWNS.	MEAN WEIGHT BROWNS.	NUMBER OF BROOKS.	MEAN WEIGHT BROOKS.
11	23	1163	0	0	0	0
12	26	1021	0	0	0	0
13	24	1043	0	0	0	0
14	49	1088	0	0	0	0
15	10	1049	2	1191	0	0
16	13	1042	0	0	0	0
17	32	1048	0	0	1	907
18	32	1067	6	1337	0	0
19	26	1053	8	1474	0	0
20	11	1067	2	1134	0	0
21	32	1006	1	1814	0	0
22	19	1045	1	1191	0	0
23	10	1157	2	1432	0	0
24	9	1002	1	907	0	0
25	38	1059	0	0	0	0
26	18	1107	0	0	0	0
27	17	1084	1	907	0	0
28	14	1069	0	0	0	0
29	16	1033	0	0	0	0
30	34	1089	0	0	0	0
31	17	1034	1	907	0	0
32	12	1063	0	0	1	1191
33	27	1029	2	964	0	0
34	36	1057	2	964	0	0
35	23	1008	1	964	0	0
36	15	1015	0	0	0	0
37	31	1161	0	0	0	0
38	20	1186	0	0	0	0
39	18	1072	1	1134	0	0
40	10	1106	0	0	0	0
41	10	1279	0	0	0	0
42	11	1389	0	0	0	0
43	3	1115	0	0	0	0
44	8	1184	0	0	0	0
45	3	1077	0	0	0	0
46	2	922	0	0	0	0

1987 Season.

SEASON IN WEEKS.	NUMBER OF RAINBOWS.	MEAN WEIGHT RAINBOWS.	NUMBER OF BROWNS.	MEAN WEIGHT BROWNS.
11	56	1097	0	0
12	53	1129	0	0
13	11	1340	0	0
14	10	970	0	0
15	23	1505	0	0
16	48	1217	0	0
17	45	1109	0	0
18	9	1288	0	0
19	16	1361	0	0
20	28	1510	0	0
21	18	1443	0	0
22	26	1438	0	0
23	7	1312	0	0
24	51	1432	2	907
25	58	1259	0	0
26	31	1197	0	0
27	22	1326	1	1247
28	18	1085	0	0
29	11	1206	0	0
30	10	1661	0	0
31	26	1576	0	0
32	27	1566	0	0
33	15	1748	0	0
34	11	1691	0	0
35	11	1335	0	0
36	16	1308	0	0
37	15	1376	0	0
38	24	1366	1	1588
39	25	1310	0	0
40	25	1151	0	0
41	14	1209	0	0
42	6	1276	0	0
43	4	1531	0	0
44	3	1361	0	0
45	4	1120	0	0
46	2	907	0	0

Appendix 4.

Weekly environmental parameters, 1985 to 1987.

4a. Reservoir level, percentage capacity, supply, hydro and total flows.
4b. Raw water pH, temperature, colour and turbidity.
4c. Compensation water pH, temperature, colour and turbidity.
4d. Atmospheric pressure, maximum and minimum temperatures.
4e. Sunshine, cloud cover, rainfall and wind speed.

1985.

YEAR IN WEEKS.	RES. LEVEL. (m)	%AGE CAPACITY.	SUPPLY. (mega.l)	HYDRO. (mega.l)	TOTAL FLOW. (mega.l)
1	30.16	98	94.481	15.911	110.392
2	29.80	94	102.146	13.638	115.784
3	29.31	89	106.304	13.638	119.942
4	29.10	87	103.884	13.638	117.522
5	29.82	95	104.459	13.638	118.097
6	30.20	99	104.895	13.638	118.533
7	29.77	94	105.545	13.638	119.183
8	29.25	89	106.279	13.638	119.917
9	28.92	86	104.792	13.638	118.430
10	28.89	85	98.295	13.638	111.933
11	28.48	81	110.045	13.638	123.683
12	27.97	77	95.008	13.638	108.646
13	27.70	74	60.467	13.638	74.105
14	28.55	82	60.090	13.638	73.728
15	29.74	94	89.283	13.638	102.921
16	30.28	100	102.975	13.638	116.613
17	29.85	95	111.133	13.638	124.771
18	29.29	89	111.546	16.885	128.431
19	28.64	83	110.755	18.184	128.939
20	28.27	79	110.145	18.184	128.329
21	27.88	76	109.156	18.184	127.340
22	27.90	74	110.016	18.184	128.200
23	26.94	68	109.753	18.184	127.937
24	26.50	64	101.016	18.184	119.200
25	26.07	61	96.090	18.184	114.274
26	25.47	57	103.730	18.184	121.914
27	24.66	51	79.415	18.184	97.599
28	24.12	47	54.847	18.184	73.031
29	24.09	47	41.366	18.184	59.550
30	24.53	50	54.604	18.184	72.788
31	26.56	65	65.427	18.184	83.611
32	28.41	81	84.356	18.184	102.540
33	29.10	87	95.149	18.184	113.333
34	29.81	95	102.014	18.184	120.198
35	30.35	100	96.778	18.184	114.962
36	30.37	100	92.007	18.184	110.191
37	30.27	99	92.481	18.184	110.665
38	30.31	100	101.780	18.184	119.964
39	30.32	100	103.311	18.184	121.495
40	30.01	97	103.373	14.937	118.310
41	30.37	100	91.854	13.638	105.492
42	30.22	99	90.925	13.638	104.563
43	29.79	94	100.642	13.638	114.280
44	29.28	89	101.364	13.638	115.002
45	29.21	88	106.400	13.638	120.038
46	29.82	95	107.486	13.638	121.124
47	29.55	92	103.944	13.638	117.582
48	29.45	91	103.250	13.638	116.888
49	29.36	90	102.596	13.638	116.234
50	29.74	94	92.808	13.638	106.446
51	30.43	100	76.209	17.535	93.744
52	30.33	100	88.254	27.276	115.530

1986.

YEAR IN WEEKS.	RES. LEVEL. (m)	%AGE CAPA-CITY.	SUPPLY. (mega.l)	HYDRO. (mega.l)	TOTAL FLOW. (mega.l)
1	30.25	99	94.749	21.431	116.180
2	30.29	100	94.982	21.431	116.403
3	30.40	100	95.311	27.276	122.587
4	30.42	100	90.463	27.276	117.739
5	30.24	99	88.106	27.276	115.382
6	30.08	97	90.562	15.586	106.148
7	29.68	93	93.070	13.638	106.708
8	29.20	88	93.600	13.638	107.238
9	28.67	83	96.033	13.638	109.671
10	28.90	85	96.769	13.638	110.407
11	29.03	87	96.733	13.638	110.371
12	28.79	84	84.220	13.638	97.858
13	30.09	98	79.155	17.535	96.690
14	30.33	100	97.998	21.431	119.429
15	30.03	97	98.249	13.638	111.887
16	29.99	96	96.117	13.638	109.755
17	30.25	99	98.131	13.638	111.769
18	29.93	96	97.394	15.586	112.980
19	29.79	94	97.536	18.184	115.720
20	29.93	96	88.492	18.184	106.676
21	30.10	98	85.694	19.483	105.177
22	30.04	97	88.494	23.379	111.873
23	29.88	95	89.018	18.184	107.202
24	29.90	95	88.603	18.184	106.787
25	29.70	93	88.169	18.184	106.353
26	29.24	89	85.754	18.184	103.938
27	28.71	84	90.247	18.184	108.431
28	28.11	78	91.446	18.184	109.630
29	27.47	72	87.589	18.184	105.773
30	26.84	67	88.705	18.184	106.889
31	26.28	63	91.959	18.184	110.143
32	26.01	60	91.581	18.184	109.765
33	25.61	58	91.374	18.184	109.558
34	24.92	53	90.966	18.184	109.150
35	24.76	51	89.977	18.184	108.161
36	24.75	51	91.115	18.184	109.299
37	24.35	49	90.589	18.184	108.773
38	23.53	43	86.711	18.184	104.895
39	22.63	38	89.071	18.184	107.255
40	21.60	33	91.437	14.937	106.374
41	20.48	27	92.007	13.638	105.645
42	19.47	23	63.746	13.638	77.384
43	21.39	32	68.019	13.638	81.657
44	24.94	53	87.390	13.638	101.028
45	26.32	63	94.108	13.638	107.746
46	27.09	69	96.879	13.638	110.517
47	27.99	77	97.678	13.638	111.316
48	29.83	95	89.486	21.431	110.917
49	30.42	100	95.528	27.276	122.804
50	30.37	100	100.037	27.276	127.313
51	30.42	100	99.195	27.276	126.471
52	30.37	100	99.053	27.276	126.329

1987.

YEAR IN WEEKS.	RES. LEVEL. (m)	%AGE CAPA-CITY.	SUPPLY. (mega.l)	HYDRO. (mega.l)	TOTAL FLOW (mega.l)
1	30.39	100	95.751	27.276	123.027
2	30.35	100	98.685	27.276	125.961
3	30.01	97	100.521	27.276	127.797
4	29.49	91	99.905	27.276	127.181
5	29.06	87	99.345	21.431	120.776
6	28.57	82	97.978	13.638	111.616
7	29.20	88	98.505	13.638	112.143
8	29.29	89	99.089	13.638	112.727
9	28.82	85	96.756	13.638	110.394
10	29.06	87	96.752	13.638	110.390
11	28.99	86	97.739	13.638	111.377
12	28.73	84	98.733	13.638	112.371
13	28.61	83	97.981	17.535	115.516
14	30.35	100	100.924	27.276	128.200
15	30.25	99	86.178	17.535	103.713
16	30.14	98	89.661	13.638	103.299
17	29.91	96	89.398	13.638	103.036
18	29.40	90	84.639	14.937	99.576
19	28.88	85	84.559	18.184	102.743
20	28.40	81	89.733	18.184	107.917
21	27.79	75	76.382	18.184	94.566
22	27.27	71	76.689	18.184	94.873
23	26.73	66	79.566	18.184	97.750
24	27.86	76	91.613	18.184	109.797
25	27.68	74	82.129	18.184	100.313
26	26.88	67	81.587	18.184	99.771
27	26.43	64	82.403	18.184	100.587
28	25.88	60	83.193	18.184	101.377
29	25.31	55	83.827	18.184	102.011
30	25.84	59	73.595	18.184	91.779
31	25.38	56	81.456	18.184	99.640
32	25.11	54	82.910	18.184	101.094
33	24.61	50	81.352	18.184	99.536
34	24.38	49	80.216	18.184	98.400
35	25.87	59	79.410	18.184	97.594
36	25.30	55	80.220	18.184	98.404
37	24.83	52	81.596	18.184	99.780
38	25.97	60	79.443	18.184	97.627
39	26.20	62	81.189	18.184	99.373
40	25.88	60	85.340	15.586	100.926
41	25.45	56	77.978	13.638	91.616
42	26.64	65	75.941	13.638	89.579
43	28.55	82	77.069	13.638	90.707
44	28.96	86	78.419	13.638	92.057
45	28.52	82	78.175	13.638	91.813
46	28.21	79	77.006	13.638	90.644
47	29.52	92	74.346	13.638	87.984
48	29.99	96	73.496	13.638	87.134
49	29.67	93	83.362	13.638	97.000
50	28.99	86	87.219	13.638	100.857
51	28.25	79	96.176	13.638	109.814
52	28.64	83	97.496	13.638	111.134

APPENDIX 4b.

1985.

YEAR IN WEEKS.	pH.	TEMP. (°C)	COLOUR.	TURBIDITY.
1	7.1	5.8	51	4.0
2	7.0	4.9	49	3.9
3	7.2	3.5	47	4.9
4	7.0	2.6	47	6.9
5	7.0	3.3	52	9.0
6	7.1	4.4	52	11.5
7	7.1	2.3	52	11.9
8	7.1	2.5	51	10.5
9	7.1	3.3	49	8.3
10	7.1	4.4	47	8.7
11	7.1	4.8	45	8.7
12	7.2	3.5	44	8.5
13	7.1	4.9	39	7.0
14	7.1	6.4	39	9.3
15	7.1	6.4	40	9.8
16	7.2	6.2	43	8.9
17	7.2	8.5	39	7.7
18	7.2	9.1	37	5.4
19	7.2	9.9	37	6.1
20	7.3	10.6	35	10.3
21	7.2	11.4	33	7.2
22	7.1	12.6	29	4.1
23	7.1	11.8	28	3.9
24	7.2	12.1	31	4.2
25	7.1	12.5	32	3.9
26	7.0	12.7	34	4.6
27	7.1	13.4	33	5.1
28	7.2	13.4	32	4.7
29	7.0	13.7	33	5.2
30	6.9	14.5	69	9.2
31	6.9	14.5	85	88.0
32	7.0	13.3	66	52.3
33	7.1	13.5	56	26.9
34	7.1	13.4	73	11.6
35	7.1	13.1	82	8.1
36	7.1	12.8	78	6.3
37	7.1	13.1	78	5.7
38	7.1	13.3	73	4.4
39	7.1	13.4	74	6.4
40	7.0	13.1	77	5.5
41	7.1	12.5	78	7.8
42	7.1	12.2	79	6.6
43	7.1	11.6	76	4.2
44	7.1	10.3	76	4.0
45	7.1	9.7	70	6.2
46	7.1	8.1	69	7.4
47	7.2	6.6	67	6.1
48	7.1	4.9	65	4.4
49	7.2	5.5	64	5.5
50	7.2	6.5	89	5.7
51	7.2	6.9	62	7.8
		6.0	62	17.0

1986.

YEAR IN WEEKS.	pH.	TEMP. (°C)	COLOUR.	TURBIDITY.
1	7.2	4.5	60	12.4
2	7.0	3.8	58	10.7
3	7.0	3.8	56	28.4
4	7.0	4.0	54	28.9
5	7.0	3.2	51	26.8
6	7.0	2.6	52	23.5
7	6.8	2.0	51	15.9
8	6.9	1.9	49	12.4
9	6.9	2.3	47	10.4
10	6.8	2.8	46	14.4
11	6.8	2.6	45	24.7
12	6.8	3.5	43	20.5
13	7.0	4.3	40	19.4
14	6.8	5.2	39	13.9
15	6.9	4.8	36	19.7
16	7.0	5.0	37	16.9
17	7.1	5.4	33	11.9
18	7.0	6.5	31	7.5
19	7.2	8.0	28	6.0
20	7.2	8.6	23	4.7
21	7.1	9.4	22	4.6
22	7.2	10.3	26	5.5
23	7.2	11.3	26	4.3
24	7.3	11.6	24	3.8
25	7.2	12.7	25	3.9
26	7.1	13.8	25	2.9
27	7.1	15.1	25	2.6
28	7.1	14.9	23	2.2
29	7.1	15.4	25	6.9
30	7.1	15.1	26	4.4
31	6.9	14.0	31	4.4
32	6.9	13.3	35	6.9
33	6.9	14.0	36	8.2
34	7.0	13.7	34	7.2
35	7.0	13.0	37	18.1
36	6.9	12.5	38	10.1
37	7.0	12.3	35	5.2
38	7.0	11.7	32	6.5
39	7.1	11.9	31	5.1
40	7.1	12.0	28	6.2
41	7.1	11.6	25	7.2
42	7.1	11.8	33	15.9
43	7.0	9.0	34	43.1
44	7.1	7.8	36	25.1
45	6.8	7.7	36	13.6
46	6.9	7.6	37	8.5
47	7.0	7.1	39	14.4
48	7.0	6.9	36	16.1
49	6.9	7.1	37	11.2
50	6.9	7.0	39	11.8
51	6.7	5.6	41	11.5
		4.2	40	8.5

1987.

YEAR IN WEEKS.	pH.	TEMP. (°C)	COLOUR.	TURBIDITY.
1	7.1	4.6	38	7.3
2	7.1	4.2	36	10.3
3	7.1	1.8	36	13.9
4	7.0	1.8	35	10.7
5	7.0	2.1	34	6.5
6	7.1	2.9	35	6.4
7	7.1	3.0	33	15.6
8	7.0	2.7	35	14.6
9	7.1	3.2	37	10.7
10	7.1	3.5	35	9.2
11	7.1	3.0	35	11.3
12	7.2	3.1	32	10.5
13	7.1	3.9	33	10.5
14	7.1	4.7	33	25.3
15	7.1	5.0	36	16.4
16	7.2	6.1	33	7.7
17	7.2	7.4	31	5.8
18	7.2	8.3	30	4.4
19	7.3	10.7	25	5.6
20	7.4	10.2	22	4.4
21	7.3	10.4	20	4.8
22	7.3	10.9	21	4.9
23	7.3	11.4	22	4.1
24	7.3	11.7	30	4.8
25	7.3	11.7	28	3.7
26	7.1	12.1	29	3.0
27	7.1	13.4	25	3.1
28	7.2	14.0	21	4.2
29	7.2	14.1	22	5.0
30	7.3	14.2	29	8.1
31	7.2	13.7	38	6.1
32	7.3	14.6	38	6.1
33	7.1	14.9	37	5.3
34	7.2	15.0	39	4.9
35	7.2	14.8	51	15.1
36	7.3	15.1	55	8.5
37	7.2	14.9	51	8.8
38	7.1	14.1	57	15.1
39	7.1	13.6	57	8.8
40	7.3	12.7	53	7.6
41	7.3	11.6	56	9.9
42	7.3	10.2	54	12.6
43	7.3	9.6	54	14.3
44	7.3	9.0	52	11.3
45	7.2	8.7	48	7.7
46	7.2	8.3	46	9.2
47	7.3	7.5	45	11.3
48	7.3	6.4	42	11.0
49	7.3	5.4	40	8.4
50	7.3	5.0	41	7.1
51	7.4	4.1	42	5.6
[illegible]	[illegible]	4.7	37	7.2

APPENDIX 4c.

1985.

YEAR IN WEEKS.	pH.	TEMP. (°C)	COLOUR.	TURBIDITY.
1	7.0	5.8	52	5.1
2	7.0	5.1	49	4.7
3	7.1	4.0	48	4.6
4	7.1	2.9	48	6.7
5	7.1	3.4	51	9.1
6	7.1	4.3	53	11.9
7	7.0	2.5	53	11.3
8	7.1	2.5	49	10.5
9	7.1	3.8	50	9.5
10	7.1	4.4	50	9.3
11	7.1	4.7	45	9.4
12	7.2	3.9	40	11.6
13	7.1	4.9	40	7.3
14	7.1	6.4	40	7.9
15	7.1	6.4	40	9.3
16	7.2	6.2	44	8.7
17	7.2	8.5	39	7.7
18	7.2	9.0	38	5.4
19	7.1	9.3	38	4.7
20	7.2	9.9	40	11.9
21	7.1	10.8	35	6.8
22	7.1	11.6	31	4.1
23	7.0	11.6	30	4.0
24	7.0	11.2	33	4.0
25	7.0	11.3	36	4.1
26	6.9	11.3	36	4.7
27	6.8	12.5	36	4.5
28	6.9	12.6	40	5.5
29	6.9	12.5	38	5.7
30	6.8	13.6	56	8.2
31	6.9	14.3	71	70.6
32	6.9	13.1	77	63.0
33	7.1	13.3	77	28.8
34	7.0	13.2	74	14.7
35	7.0	13.0	85	9.2
36	7.0	12.8	85	9.6
37	7.0	12.8	85	8.6
38	7.0	12.9	74	5.0
39	7.0	13.1	80	8.8
40	6.9	12.9	81	6.6
41	7.0	12.3	86	9.0
42	7.1	11.9	78	6.0
43	7.0	11.8	76	4.8
44	7.0	10.4	75	4.6
45	7.1	9.5	71	6.9
46	7.1	8.1	71	7.3
47	7.2	6.6	67	5.7
48	7.2	5.0	65	4.9
49	7.2	5.3	65	5.5
50	7.1	6.1	66	5.3
51	7.2	6.6	63	7.6
		5.9	61	17.4

1986.

YEAR IN WEEKS	pH.	TEMP. (°C)	COLOUR.	TURBIDITY.
1	7.2	4.7	61	12.5
2	7.1	3.9	62	10.4
3	7.1	3.6	59	26.6
4	7.0	4.1	54	29.5
5	7.0	3.4	52	27.6
6	7.0	2.7	52	25.8
7	6.9	2.0	49	16.4
8	6.9	2.0	49	13.2
9	6.9	2.2	48	11.0
10	6.8	2.9	47	11.1
11	6.8	2.8	45	25.3
12	6.9	3.5	46	20.1
13	7.0	4.2	39	21.3
14	7.0	5.3	38	15.2
15	6.9	4.9	37	20.8
16	7.0	4.8	37	17.2
17	7.1	5.3	35	12.0
18	7.1	6.0	34	6.7
19	7.1	7.2	30	5.5
20	7.1	8.0	26	4.3
21	7.1	9.0	24	5.0
22	7.2	10.3	28	5.9
23	7.0	10.6	31	5.9
24	7.0	11.0	29	3.9
25	7.0	11.5	34	4.9
26	6.9	12.1	33	4.3
27	6.9	12.0	33	3.7
28	6.8	11.9	31	2.3
29	6.9	12.5	34	4.0
30	6.7	12.5	35	4.7
31	6.6	11.6	37	4.7
32	6.6	11.8	37	6.1
33	6.6	12.7	43	10.6
34	6.8	13.1	38	9.1
35	6.9	12.9	39	18.1
36	6.8	12.4	40	11.8
37	7.0	12.2	37	6.2
38	7.0	11.6	32	5.7
39	6.9	11.6	32	4.6
40	7.0	11.9	31	4.8
41	7.0	11.4	28	7.9
42	7.1	11.7	32	25.3
43	7.0	9.0	36	45.8
44	7.0	7.8	38	26.1
45	6.8	7.8	37	13.8
46	6.9	7.5	38	10.9
47	6.9	7.2	35	17.3
48	7.0	6.9	36	16.4
49	7.0	7.1	34	11.6
50	6.9	6.9	40	11.5
51	6.7	5.7	42	11.6
52	7.0	4.2	40	8.6

1987.

YEAR IN WEEKS.	pH.	TEMP. (°C)	COLOUR.	TURBIDITY.
1	7.1	4.6	38	7.5
2	7.1	4.3	33	9.9
3	7.1	1.8	36	13.2
4	7.0	1.9	36	9.4
5	7.0	2.1	32	6.9
6	7.1	3.0	34	7.7
7	7.1	3.1	33	19.3
8	7.0	3.2	39	16.7
9	7.1	3.4	38	11.3
10	7.1	3.7	36	10.4
11	7.1	3.0	36	11.3
12	7.3	3.3	32	11.2
13	7.1	3.9	32	10.5
14	7.1	4.9	36	26.4
15	7.2	5.1	35	17.8
16	7.2	5.5	35	8.1
17	7.2	6.5	31	5.7
18	7.1	7.6	33	4.0
19	7.1	8.1	29	5.4
20	7.2	8.9	25	4.3
21	7.2	9.4	25	5.3
22	7.3	10.6	25	6.8
23	7.2	11.0	27	5.2
24	7.2	11.0	35	6.5
25	7.2	11.4	37	5.6
26	6.9	11.8	36	5.3
27	6.9	11.8	35	5.1
28	7.0	12.1	30	6.0
29	7.0	12.1	31	6.7
30	7.0	12.4	33	7.4
31	6.9	12.9	37	6.9
32	7.0	13.7	47	8.6
33	7.1	14.6	47	7.0
34	7.1	14.8	45	5.2
35	7.1	14.6	67	24.6
36	7.2	14.9	64	15.1
37	7.3	14.9	51	9.2
38	7.1	14.3	59	16.5
39	7.2	13.5	60	9.9
40	7.3	12.1	56	7.2
41	7.2	11.6	54	9.4
42	7.2	10.0	56	12.4
43	7.2	9.7	52	14.7
44	7.2	9.1	51	10.3
45	7.1	8.7	49	8.5
46	7.2	8.2	46	8.7
47	7.3	7.3	45	11.3
48	7.3	6.3	43	10.9
49	7.3	5.4	40	8.5
50	7.3	5.1	41	6.3
51	7.4	4.1	42	5.4
52	7.2	4.9	38	7.1

APPENDIX 4d.

1985.

YEAR IN WEEKS.	ATMOS. PRESSURE. (mmHg)	MAX. TEMP. (°C)	MIN. TEMP. (°C)
1	752	3.5	-1.0
2	753	2.3	-6.6
3	751	0.4	-5.8
4	732	3.2	-3.8
5	743	8.2	2.6
6	747	2.3	0.4
7	749	0.8	-4.4
8	758	5.4	-1.0
9	751	5.8	0.1
10	751	9.0	1.2
11	753	5.9	-1.7
12	737	4.6	-1.7
13	739	8.9	1.7
14	738	11.4	6.1
15	735	7.6	4.2
16	753	11.3	4.8
17	753	8.6	0.5
18	744	10.4	3.0
19	748	14.4	4.9
20	749	14.8	7.5
21	743	14.7	8.0
22	756	17.2	5.7
23	748	13.4	6.8
24	744	13.7	6.3
25	744	15.9	8.0
26	747	15.2	8.6
27	751	20.4	11.0
28	751	17.2	12.0
29	745	15.5	8.4
30	747	18.5	11.8
31	740	15.0	11.1
32	739	16.0	8.8
33	744	16.3	10.5
34	746	14.7	10.8
35	750	16.2	9.8
36	748	14.2	7.6
37	752	16.4	10.1
38	747	15.4	9.9
39	753	18.0	10.8
40	743	17.0	11.5
41	750	14.0	6.7
42	764	12.1	6.6
43	759	11.3	5.1
44	750	7.5	1.0
45	730	8.3	2.2
46	751	5.1	-1.6
47	758	4.8	1.1
48	744	5.1	-2.4
49	740	8.1	5.5
50	751	8.0	3.0
51	747	9.1	6.1
52	740	2.5	-1.8

1986.

YEAR IN WEEKS.	ATMOS. PRESSURE. (mmHg)	MAX. TEMP. (°C)	MIN. TEMP. (°C)
1	736	2.7	-3.2
2	744	4.5	-0.7
3	745	7.0	1.1
4	737	4.5	-0.3
5	741	2.6	0.3
6	751	0.9	-1.5
7	754	-0.1	-3.7
8	746	0.9	-4.9
9	756	1.6	-3.7
10	744	7.8	-1.1
11	750	7.6	2.0
12	747	8.4	1.8
13	727	7.0	1.2
14	746	7.4	-0.7
15	754	5.6	0.9
16	740	6.7	1.9
17	741	11.0	1.4
18	747	14.2	4.6
19	741	12.7	6.6
20	743	12.2	5.4
21	746	13.9	7.8
22	750	13.1	7.4
23	747	13.5	6.4
24	749	17.2	8.9
25	751	17.7	9.2
26	752	20.9	12.0
27	750	18.6	10.8
28	751	16.4	9.0
29	754	18.7	12.5
30	746	15.3	9.2
31	743	14.9	10.6
32	747	16.8	10.1
33	747	15.5	10.6
34	747	14.8	5.4
35	742	13.4	7.1
36	751	14.1	9.0
37	752	14.0	2.4
38	756	14.2	2.6
39	755	14.4	7.7
40	756	15.6	9.0
41	752	14.4	8.0
42	752	12.0	3.8
43	732	9.1	4.2
44	744	10.2	5.4
45	752	10.1	4.3
46	739	10.6	5.0
47	740	8.0	1.2
48	749	10.0	4.9
49	746	10.6	4.0
50	744	7.0	0.9
51	743	5.9	0.8
52	749	6.4	0.9

1987.

YEAR IN WEEKS.	ATMOS. PRESSURE. (mmHg)	MAX. TEMP. (°C)	MIN. TEMP. (°C)
1	742	7.5	2.4
2	750	1.0	-3.1
3	755	-1.6	-5.1
4	761	5.9	-0.4
5	748	3.3	-4.0
6	747	7.6	0.8
7	741	4.9	-0.7
8	752	4.3	-2.5
9	748	6.5	0.6
10	752	3.4	-0.5
11	758	4.3	-1.9
12	739	6.0	-0.8
13	732	7.1	1.9
14	741	7.0	3.1
15	737	8.7	2.9
16	754	14.2	6.7
17	752	16.4	5.4
18	751	15.5	5.8
19	758	15.4	4.0
20	741	10.5	3.9
21	753	13.1	3.8
22	750	15.7	6.4
23	742	13.2	8.3
24	745	12.4	6.3
25	746	15.5	7.0
26	748	15.4	9.4
27	753	19.2	10.2
28	750	18.7	10.9
29	740	19.2	12.2
30	752	17.7	10.3
31	747	16.7	11.6
32	748	15.6	7.9
33	748	17.6	11.0
34	747	19.9	14.0
35	749	17.3	10.4
36	746	16.9	10.1
37	744	15.5	9.7
38	750	16.0	9.3
39	744	14.4	7.4
40	754	13.7	6.1
41	731	11.1	5.6
42	732	11.0	5.0
43	748	10.8	5.0
44	749	10.2	4.2
45	759	7.5	4.3
46	736	8.6	3.6
47	749	9.2	6.1
48	748	5.5	-0.4
49	756	5.5	2.9
50	753	3.5	-2.6
51	743	8.0	3.5
52	752	8.7	4.4

APPENDIX 4e.

1985.

YEAR IN WEEKS.	SUNSHINE. (HOURS)	CLOUD COVER. (1/8ths)	RAIN-FALL. (mm)	WIND SPEED. (m/s)
1	2.7	4	0.2	0.62
2	1.3	6	0.6	0.34
3	0.5	7	0.7	1.29
4	1.4	6	7.5	3.17
5	0.4	8	6.9	3.77
6	1.0	8	0.4	4.88
7	5.5	4	0.0	2.48
8	1.8	8	1.4	0.77
9	0.2	8	3.7	4.88
10	2.9	5	1.3	0.43
11	5.2	4	0.8	1.20
12	2.6	6	1.7	1.37
13	4.9	6	5.7	2.31
14	1.2	7	7.8	2.66
15	2.2	7	8.4	3.80
16	3.2	7	0.2	1.97
17	6.9	6	1.2	2.74
18	5.2	6	1.1	2.23
19	6.3	5	0.0	1.95
20	2.6	7	5.6	1.44
21	1.6	7	4.4	1.64
22	12.1	1	1.1	2.36
23	4.3	6	2.2	1.63
24	8.0	7	3.8	2.57
25	3.7	6	3.2	1.37
26	6.4	7	0.5	2.23
27	6.5	5	0.3	0.77
28	3.7	7	4.5	1.37
29	6.2	7	5.2	2.91
30	5.2	7	12.8	2.57
31	2.5	7	10.5	2.16
32	6.0	6	6.7	1.71
33	3.7	7	8.5	2.40
34	2.4	7	9.6	3.16
35	4.1	7	4.4	2.26
36	3.8	6	7.3	1.63
37	4.4	6	2.9	1.97
38	1.9	7	9.3	2.66
39	3.4	6	0.4	0.86
40	3.4	7	6.3	2.40
41	4.5	6	6.5	2.57
42	0.6	8	0.0	0.34
43	4.2	3	0.0	0.86
44	2.1	6	0.8	0.77
45	2.4	6	10.7	2.06
46	3.0	4	1.3	1.03
47	0.9	8	0.0	1.97
48	2.3	6	2.2	0.43
49	0.4	7	6.4	2.14
50	0.3	8	6.3	0.34
51	0.2	7	16.8	4.63
52	2.4	5	0.6	0.90

1986.

YEAR IN WEEKS.	SUNSHINE. (HOURS)	CLOUD COVER. (1/8ths)	RAIN-FALL. (mm)	WIND SPEED. (m/s)
1	0.9	7	6.9	1.80
2	1.0	7	10.1	2.66
3	0.8	7	10.4	4.71
4	2.8	5	8.0	4.71
5	0.4	7	2.6	3.86
6	0.8	7	0.3	3.60
7	2.6	6	0.0	2.91
8	3.7	6	0.1	1.37
9	6.1	4	0.0	4.97
10	2.1	7	7.6	3.08
11	1.2	7	1.2	1.80
12	4.3	6	9.0	2.66
13	4.9	6	6.0	5.04
14	6.6	4	2.2	0.60
15	3.2	6	0.9	3.86
16	1.3	8	8.0	2.48
17	5.3	5	1.4	1.29
18	5.7	5	2.2	2.66
19	2.7	7	6.7	2.26
20	7.4	6	2.8	3.80
21	6.8	7	10.1	3.50
22	5.4	6	0.9	3.80
23	5.6	7	0.7	2.06
24	5.5	7	6.7	2.66
25	6.3	6	0.7	2.40
26	5.9	6	1.4	1.54
27	7.1	5	1.3	2.14
28	5.7	6	0.5	1.37
29	3.8	7	0.6	2.40
30	3.8	6	1.9	2.91
31	2.1	7	5.9	2.40
32	5.8	7	4.1	1.71
33	2.9	8	1.6	1.89
34	4.8	5	0.7	0.94
35	2.1	8	7.5	1.54
36	6.0	7	3.9	3.25
37	9.5	3	0.0	0.77
38	8.8	4	0.1	0.43
39	4.0	7	0.3	1.29
40	4.2	7	0.2	0.68
41	2.4	6	3.2	1.03
42	3.1	5	6.7	0.17
43	1.8	6	13.2	4.63
44	3.3	5	12.1	3.34
45	2.3	5	5.3	2.83
46	2.0	5	3.6	2.14
47	2.7	4	14.2	2.66
48	0.5	6	7.3	3.60
49	1.0	7	11.6	4.20
50	1.4	7	9.9	1.89
51	1.6	7	10.2	3.94
52	1.5	6	8.2	2.31

1987.

YEAR IN WEEKS.	SUNSHINE. (HOURS)	CLOUD COVER. (1/8ths)	RAIN-FALL. (mm)	WIND SPEED. (m/s)
1	0.8	7	11.9	3.08
2	2.7	4	0.7	2.14
3	0.9	7	0.1	3.08
4	1.3	7	1.1	0.00
5	2.6	5	0.9	0.17
6	0.6	7	6.1	2.40
7	2.4	6	4.6	1.97
8	3.6	4	0.1	0.17
9	1.6	8	5.2	1.25
10	1.8	7	2.6	3.34
11	4.0	7	0.1	1.80
12	5.7	4	2.8	1.80
13	2.9	8	13.4	4.80
14	0.8	8	3.2	2.40
15	3.3	7	4.7	1.97
16	5.1	7	2.5	0.88
17	7.5	5	0.0	0.51
18	7.6	5	1.7	1.45
19	9.4	3	0.7	1.45
20	5.3	6	4.0	2.74
21	7.4	5	0.1	1.71
22	7.1	5	1.5	0.77
23	0.7	8	12.5	1.63
24	2.6	7	2.0	0.17
25	9.0	5	0.6	1.71
26	2.7	7	4.5	1.97
27	8.1	6	0.9	2.74
28	7.8	4	4.1	1.20
29	1.2	8	6.8	1.03
30	6.3	6	2.9	1.89
31	4.2	7	2.3	2.74
32	5.9	6	1.3	1.63
33	3.5	8	4.2	1.03
34	2.3	7	11.8	0.34
35	5.5	6	0.8	2.06
36	4.9	7	3.5	1.80
37	5.6	7	7.7	2.74
38	3.9	6	4.8	2.74
39	6.1	6	2.4	1.45
40	4.4	6	0.6	2.06
41	1.8	8	9.5	2.91
42	2.1	7	10.9	1.71
43	2.6	7	3.8	1.80
44	2.4	7	2.5	1.20
45	0.2	8	0.1	0.81
46	1.7	7	9.3	2.91
47	0.9	8	6.6	3.94
48	2.5	4	0.6	1.54
49	1.1	7	0.1	2.91
50	2.0	5	0.1	0.43
51	0.4	8	7.2	2.14
52	0.2	8	7.3	1.23

Appendix 5.

Weekly length category species impingement, 1985 to 1987.

5a. Rainbow trout.

5b. Brook trout.

5c. Brown trout.

APPENDIX 5a.

Rainbow trout.

1985.

YEAR IN WEEKS.	SMALL. (<150mm)	MEDIUM. (151mm-300mm)	LARGE. (>301mm)	TOTAL. RAINBOWS IMPINGED.
10	0	0	0	0
11	0	0	1	1
12	0	2	1	3
13	0	0	0	0
14	0	0	0	0
15	0	5	0	5
16	0	1	1	2
17	0	1	0	1
18	0	2	0	2
19	0	3	0	3
20	0	10	3	13
21	0	6	1	7
22	0	9	3	12
23	0	4	0	4
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	1	1	2
28	0	0	0	0
29	0	0	1	1
30	0	2	0	2
31	0	0	0	0
32	0	0	0	0
33	0	1	0	1
34	0	0	1	1
35	0	0	0	0
36	0	0	0	0
37	0	0	0	0
38	0	0	0	0
39	0	0	2	2
40	0	0	3	3
41	0	0	1	1
42	0	0	0	0
43	0	1	1	2
44	0	0	0	0
45	0	0	0	0
46	0	0	2	2
47	0	2	1	3
48	0	2	1	3
49	0	1	0	1
50	0	1	0	1
51	0	1	1	2
52	0	2	0	2

1986.

YEAR IN WEEKS.	SMALL. (<150mm)	MEDIUM. (151mm-300mm)	LARGE. (>301mm)	TOTAL. RAINBOWS IMPINGED.
1	0	0	0	0
2	0	1	1	2
3	0	4	1	5
4	0	0	0	0
5	0	2	0	2
6	0	6	2	8
7	0	6	7	13
8	0	2	1	3
9	0	0	0	0
10	0	3	0	3
11	0	4	0	4
12	0	2	0	2
13	0	2	2	4
14	0	4	2	6
15	0	6	0	6
16	0	6	0	6
17	0	0	1	1
18	0	1	0	1
19	0	0	0	0
20	0	1	1	2
21	0	0	0	0
22	0	0	1	1
23	0	0	0	0
24	0	0	0	0
25	0	0	1	1
26	0	0	0	0
27	0	0	1	1
28	0	0	0	0
29	0	0	1	1
30	0	0	1	1
31	0	0	4	4
32	0	1	0	1
33	0	0	2	2
34	0	0	0	0
35	0	0	0	0
36	0	0	2	2
37	0	0	0	0
38	0	1	0	1
39	0	1	2	3
40	0	1	2	3
41	0	3	1	4
42	0	1	4	5
43	0	3	8	11
44	0	0	3	3
45	0	0	0	0
46	0	1	1	2
47	0	1	0	1
48	0	0	1	1
49	0	0	0	0
50	0	0	0	0
51	0	0	0	0
52	0	1	0	1

1987.

YEAR IN WEEKS.	SMALL. (<150mm)	MEDIUM. (151mm-300mm)	LARGE. (>301mm)	TOTAL RAINBOWS IMPINGED.
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	1	1
5	0	0	0	0
6	0	0	0	0
7	0	0	1	1
8	0	0	0	0
9	0	2	0	2
10	0	0	0	0
11	0	0	1	1
12	0	1	2	3
13	0	0	1	1
14	0	0	1	1
15	0	1	2	3
16	0	1	0	1
17	0	0	0	0
18	0	1	1	2
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	1	1	2
25	0	0	1	1
26	0	0	1	1
27	0	0	0	0
28	0	2	0	2
29	0	1	6	7
30	0	0	1	1
31	0	0	0	0
32	0	0	0	0
33	0	0	0	0
34	0	0	0	0
35	0	0	3	3
36	0	0	2	2
37	0	1	1	2
38	0	0	0	0
39	0	0	1	1
40	0	0	3	3
41	0	0	0	0
42	0	0	0	0
43	0	1	0	1
44	0	0	0	0
45	0	0	0	0
46	0	0	0	0
47	0	1	0	1
48	0	1	3	4
49	0	0	1	1
50	0	1	0	1
51	0	0	1	1
52	0	0	0	0

APPENDIX 5b.

Brook trout.

1985.

YEAR IN WEEKS.	SMALL. (<150mm)	MEDIUM. (151mm-300mm)	LARGE. (>301mm)	TOTAL. BROOKS IMPINGED.
10	0	0	0	0
11	0	0	0	0
12	0	1	3	4
13	0	0	3	3
14	0	0	0	0
15	0	0	1	1
16	0	1	0	1
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	1	0	1
21	0	0	0	0
22	0	2	0	2
23	0	1	1	2
24	0	1	0	1
25	0	0	0	0
26	0	1	1	2
27	0	2	4	6
28	0	9	5	14
29	0	3	3	6
30	0	0	4	4
31	0	0	1	1
32	0	1	2	3
33	0	1	1	2
34	0	1	1	2
35	0	1	2	3
36	0	0	2	2
37	0	0	0	0
38	0	0	3	3
39	0	0	0	0
40	0	0	0	0
41	0	0	0	0
42	0	0	4	4
43	0	1	1	2
44	0	0	0	0
45	0	0	0	0
46	0	0	0	0
47	0	0	0	0
48	0	0	0	0
49	0	0	0	0
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0

1986.

YEAR IN WEEKS	SMALL. (<150mm)	MEDIUM. (151mm-300mm)	LARGE. (>301mm)	TOTAL BROOKS IMPINGED.
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	1	0	1
21	0	4	0	4
22	0	0	0	0
23	0	4	0	4
24	0	4	1	5
25	0	12	2	14
26	0	7	0	7
27	0	4	0	4
28	0	2	1	3
29	0	1	0	1
30	0	4	2	6
31	0	7	1	8
32	0	9	0	9
33	0	15	5	20
34	0	5	0	5
35	0	6	1	7
36	0	8	1	9
37	0	0	0	0
38	0	2	0	2
39	0	6	2	8
40	0	2	2	4
41	0	25	10	35
42	0	27	17	44
43	0	13	4	17
44	0	2	1	3
45	0	0	0	0
46	0	0	0	0
47	0	0	0	0
48	0	0	0	0
49	0	0	0	0
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0

APPENDIX 5c.

Brown trout.

1985.

YEAR IN WEEKS.	SMALL. (<150mm)	MEDIUM. (151mm-300mm)	LARGE. (>301mm)	TOTAL. BROWNS IMPINGED.
10	1	1	0	2
11	0	1	1	2
12	8	17	2	27
13	1	4	0	5
14	1	2	0	3
15	1	13	0	14
16	6	13	0	19
17	1	3	3	7
18	0	6	5	11
19	0	1	0	1
20	0	0	1	1
21	0	1	2	3
22	0	10	7	17
23	0	6	15	21
24	3	11	14	28
25	0	3	7	10
26	0	7	5	12
27	0	11	20	31
28	1	12	15	28
29	0	14	13	27
30	0	9	13	22
31	0	5	5	10
32	0	2	0	2
33	0	1	1	2
34	1	2	0	3
35	0	2	0	2
36	0	1	1	2
37	0	0	2	2
38	2	2	1	5
39	0	4	2	6
40	0	3	3	6
41	0	1	1	2
42	0	2	2	4
43	0	3	1	4
44	0	0	0	0
45	0	0	0	0
46	1	5	2	8
47	0	9	0	9
48	2	2	0	4
49	0	0	1	1
50	2	2	0	4
51	1	4	0	5
52	0	5	0	5

1986.

YEAR IN WEEKS.	SMALL. (<150mm)	MEDIUM. (151mm-300mm)	LARGE. (>301mm)	TOTAL. BROWNS IMPINGED.
1	0	0	0	0
2	0	1	0	1
3	2	8	1	11
4	0	0	0	0
5	0	0	0	0
6	0	3	0	3
7	2	15	1	18
8	0	1	0	1
9	1	1	0	2
10	0	4	0	4
11	1	3	1	5
12	0	1	0	1
13	0	0	0	0
14	2	9	0	11
15	3	15	0	18
16	3	19	0	22
17	0	3	0	3
18	1	8	0	9
19	1	8	0	9
20	0	8	0	8
21	0	1	0	1
22	0	2	0	2
23	0	1	0	1
24	4	7	0	11
25	9	10	2	21
26	5	8	3	16
27	4	2	0	6
28	0	2	1	3
29	1	2	0	3
30	1	2	2	5
31	1	9	7	17
32	1	5	6	12
33	1	2	2	5
34	7	8	2	17
35	13	14	3	30
36	0	6	2	8
37	0	2	1	3
38	5	10	1	16
39	3	20	5	28
40	1	11	3	15
41	3	28	16	47
42	0	40	13	53
43	5	43	18	66
44	6	17	9	32
45	3	16	2	21
46	4	1	0	5
47	3	7	1	11
48	3	2	3	8
49	1	2	0	3
50	1	4	0	5
51	1	3	0	4
52	2	0	0	2

1987.

YEAR IN WEEKS.	SMALL. (<150mm)	MEDIUM. (151mm-300mm)	LARGE. (>301mm)	TOTAL BROWNS IMPINGED.
1	0	2	0	2
2	1	3	0	4
3	0	0	0	0
4	1	5	1	7
5	0	2	0	2
6	0	0	0	0
7	0	2	0	2
8	0	2	0	2
9	0	2	2	4
10	0	1	1	2
11	6	6	2	14
12	1	12	3	16
13	1	14	2	17
14	1	5	1	7
15	8	15	3	26
16	15	27	0	42
17	6	13	2	21
18	4	20	1	25
19	1	21	0	22
20	0	6	0	6
21	2	4	0	6
22	2	7	0	9
23	0	7	2	9
24	1	21	4	26
25	0	5	0	5
26	0	0	2	2
27	0	3	3	6
28	0	3	2	5
29	0	7	1	8
30	0	5	3	8
31	0	2	0	2
32	0	1	0	1
33	0	2	2	4
34	1	3	0	4
35	0	2	7	9
36	1	3	1	5
37	0	6	1	7
38	0	4	3	7
39	0	5	5	10
40	0	5	1	6
41	0	1	0	1
42	0	3	0	3
43	0	5	1	6
44	0	6	1	7
45	0	3	0	3
46	0	1	0	1
47	0	2	0	2
48	0	7	0	7
49	0	7	0	7
50	1	7	0	8
51	0	3	0	3
52	0	2	0	2