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# TROUT TAGGING EXPERIMENTS IN DUTCH COASTAL WATERS DURING THE SUMMER OF 1990

by

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## ABSTRACT

A tagging experiment has been carried out in the coastal waters off the Haringvliet sluices, during the months of June and July 1990. A total number of 1068 trout were caught of which the majority, in the length range of 17 up to 40 cm, is probably in their first marine or post-migration year. There proved to be a positive simple correlation between the average catch per hour trawling and the discharge per day. A total of 963 trout were tagged, using Carlin tags. Up till the end of June 1991, 118 recaptures have been recorded (12%), of which 74 were made during the experiment by the three vessels involved. A number of 44 recaptures were made by others: 21 by fishermen and 23 by anglers. A total of 105 recaptures (89%) were made in the area of the experiment and 13 fish showed movement away from the tagging location. Of these, 7 were recaptured at sea, at distances varying from 24 up to 280 km away from the point of release, migrating in a northern direction with the prevailing sea current. The remaining 6 fish - significantly larger than other recaptures - entered the river system, probably on their way to possible spawning grounds in the higher river stretches. The recapture in the Rhine at Iffezheim in Germany proves that it is possible to ascend the river for a distance of at least 730 km. In view of the distribution of the recaptures in fresh water it seems not likely that trout can enter the river system by way of the Haringvliet sluices. Entrance via the Nieuwe Waterweg is more likely although no trout were caught at that location. The findings of this study seem to support the conclusion that next to the completely fresh water-living type of trout, there still is an anadromous type of trout in the catchment areas of the Rhine and the Maas.

After finishing the text of this paper another recapture was recorded from the area of the experiment itself. The fish was caught by an angler on the 5th of July 1991 after it had been free for a period of 346 days. It was released on the 23th of July 1990 at a lenght of 31 cm. This indicates that after reaching maturity the fish do indeed return to the Haringvliet estuary, possibly trying to enter the fresh water system.

# 1. INTRODUCTION

Dutch riverine fisheries have a long history; first written evidence of salmon being caught in considerable quantities dates back to 1100 (de Groot, 1989a). From way back riverine fisheries concentrated mainly on anadromous species like sturgeon (*Acipenser sturio*), salmon (*Salmo salar*), sea trout (*Salmo trutta* ), houting (*Coregonus oxyrinchus*), allis shad (*Alosa alosa*), twaite shad (*Alosa fallax*) and river lamprey (*Lampetra fluviatilis*) (Havinga, 1938; Lobregt et al, 1977).

Recently the issue of salmonids in the river system of the Rhine (Fig. 1) regained international attention. The 7th Ministerial Conference on the Pollution of the river Rhine, held in Rotterdam in December 1986, agreed upon a programme for the ecological rehabilitation of the river. For the first time, biological objectives were explicitly formulated: by the year 2000 the Rhine aquatic ecosystem should have recovered from man-made perturbations so that populations of higher species, such as that of the salmon, might develop (Anon., 1988).

The 8th Ministerial Conference, held in Strasbourg in October 1987, agreed upon a "Rhine Action Plan" (RAP) with the following objectives (Anon., 1988):
1. to create the conditions for the return of higher species (e.g. the salmon);
2. to saveguard the use of Rhine water for the supply of drinking water;
3. to eliminate the pollution of sediment with hazardous compounds .

Although the emphasis in the RAP is on salmon (environmental conditions should be created in the river system that facilitate the restoration of a viable salmon population) research on this species, in the Dutch situation, is not possible on account of its extinct state. Research on trout (*Salmo trutta*), a close relative with by and large the same demands regarding the quality of its environment, is possible, but is complicated by its occurrence in rather small numbers.

Registered landings of trout seldom exceed 5000 kg per annum (Liewes & Fonds, 1983), the greater part originating from the offshore fisheries. Trout landings from coastal, riverine and lake fisheries amount to 1000 kg per annum, the majority coming from the IJsselmeer as by-catch. This could easily lead to the conclusion that trout is most abundant in the IJsselmeer, but the scale of riverine fisheries is only a fraction of fisheries in the IJsselmeer and in recent years there are indications of considerable trout catches by salmon stake net fishers in the lower Rhine branches. Unfortunately trustworthy statistics are not available.

Through the years the accessibility of the catchment area of the Rhine from the North Sea has been greatly reduced. Where there used to be seven open connections (Keuning, 1970), there is now only one, the Nieuwe Waterweg (Fig. 2) near Rotterdam. The remainder are either completely closed off or are connected with the North Sea by means of sluices (Cazemier, 1988). Passage from the North Sea to the higher river stretches without complications is only possible via the Nieuwe Waterweg. The sluices in the other possible entrances will more or less act as a barrier. Probably as a consequence of this barrier-effect trout is present in catchable concentrations in the sea area close to the Haringvliet dam (Fig. 3), during certain periods of the year.

The origin of trout present in the coastal and inland waters of the Netherlands is unclear; probably they are strayers and/or individuals originating from stocking operations, but the

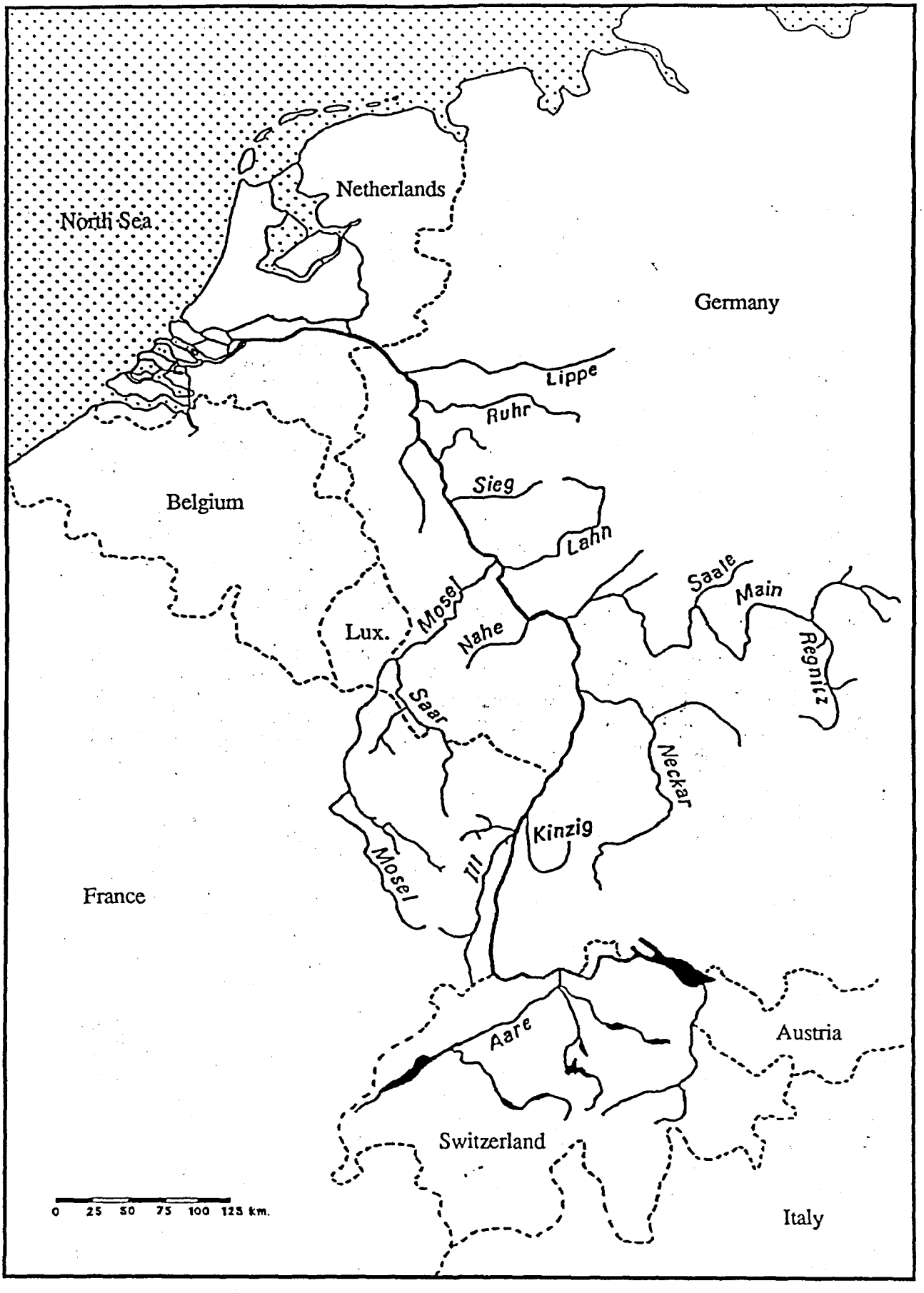


Fig. 1. The catchment area of the river Rhine.

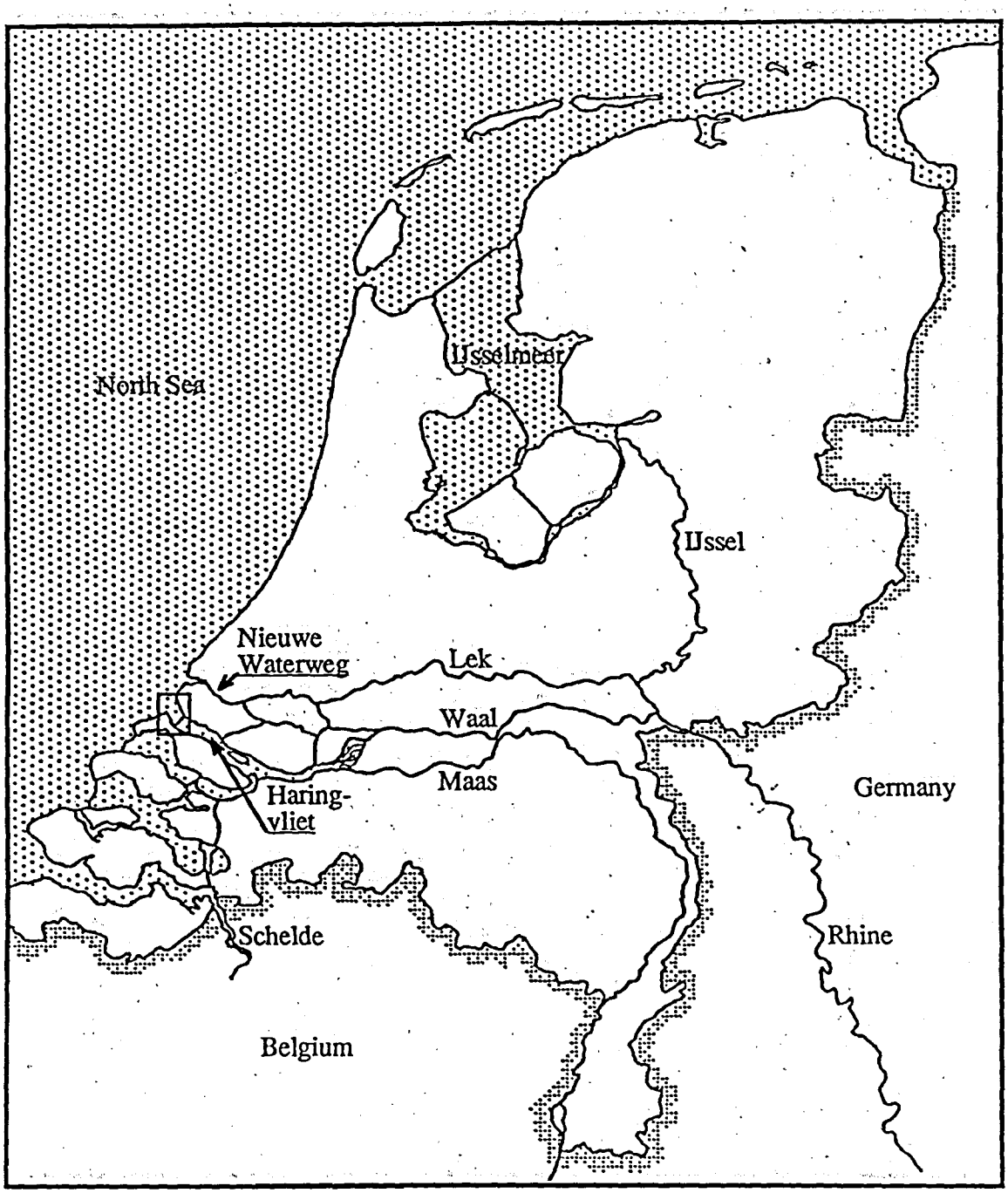


Fig. 2. The Netherlands, within the small box: the coastal waters off the Haringvliet sluices.

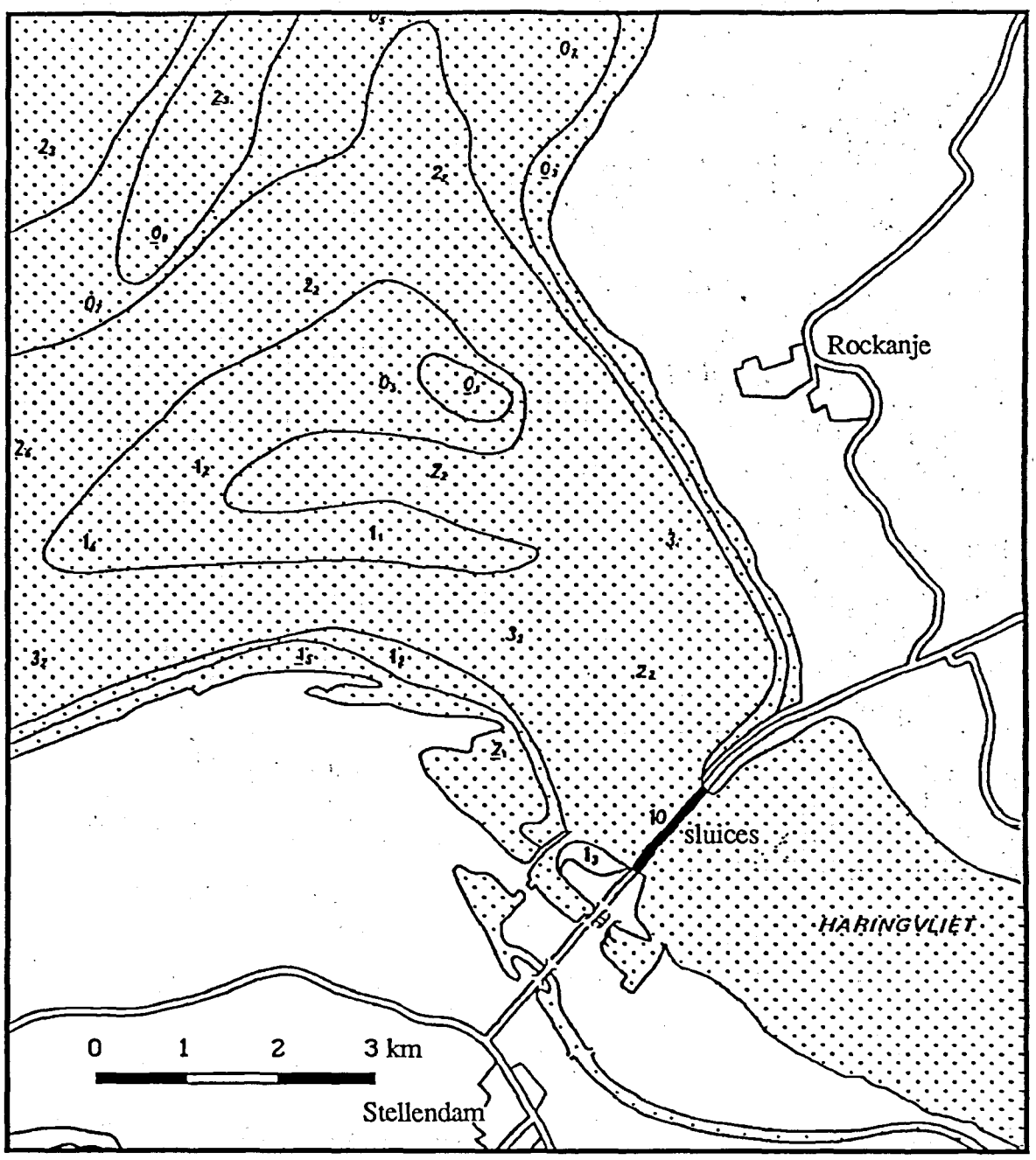


Fig. 3. The coastal waters off the Haringvliet sluices.

possibility of a viable population of anadromous trout in the catchment area of the Rhine can not be excluded. To gather information about the trout present in the coastal area off the Haringvliet dam and to study the migration of tagged trout originating from this area and to reveal whether it is possible for trout to migrate upstream by way of the Haringvliet sluices, a tagging experiment has been carried out in the months June and July 1990.

## 2. AREA, MATERIAL AND METHODS

The Haringvliet (Fig. 3) estuary was once the mayor passageway of surface water from the rivers Rhine and Maas to the North Sea. Through this large outlet the tidal movement could progress inland for a considerable stretch and thus combined with spring tide and spate conditions in the river, cause flooding of the populated areas. This situation came definitely to an end in November 1970 when the estuary was closed off by the Haringvliet dam.

The discharge of surface water through the seventeen sluices in the Haringvliet dam amounts to 30 billion cubic meters on a yearly basis. The amount of water drained is only surpassed by the discharge through the open connection with the sea (the Nieuwe Waterweg) .By way of this heavily used shipping-route almost 50 billion cubic meters of water reaches the North Sea. The discharge programme of the Haringvliet sluices is controlled by one variable only; the amount of Rhine water entering the Netherlands near Lobith .

The sluices, of the undershot type, are opened when the amount of Rhine water entering the Netherlands is equal or exceeds 1100 cubic meters per second. When this condition is met opening the sluices at low tide results in two daily drainage periods of approximately 8 hours, during which large fluctuations of salinity can occur in the immediate vicinity (seaward side) of the Haringvliet sluices.

Fish passage is possible only during a small time span (approx. 20 min) at the beginning and at the end of a drainage period when water flow velocity under the sluice gate is less than 3 meters per second (Beach, 1984). To what extent the sluices constitute an obstruction to migratory fish is unknown.

Through communications of professional fishermen it is known that trout can be caught in a period of several weeks in the months June, July and August in the coastal waters off the Haringvliet dam. In most years there is a small scale fishery on sprat (*Sprattus sprattus*) in the area, that yields some trout as by-catch.

Three vessels were involved in the tagging programme; the Netherlands research vessel "Stern" and two local chartered fishing vessels.

The experiment started on the 5th of June; the research vessel was brought into action to explore the coastal waters and to signalize the presence of trout. Local fishermen were also involved in monitoring the area. In case of increasing trout catches the commercial vessels were to start their operations in order to maximize catches. Both ships were successively active for 10 days in the period 27 June - 27 July.

Several pelagic trawls (meshsize 20 - 40 mm) were used, dimensions varying from vessel to vessel. Haul duration was set at 20 minutes to reduce the risk of injuring the catch. As the amount of damage done appeared to be very small, haul duration became variable; the majority of hauls lasting for 30 - 40 minutes. Average towing speed was approximately 4 km/hr, dependent on weather conditions, tidal movement and towing direction.

Trout were stored in tanks with a continuous supply of fresh seawater. Carlin tags were fastened with double stainless steel wire just below the dorsal fin (Carlin, 1955; Bartel et al, 1987), after anaesthesia with 3/10,000 ethylene glycol mono-phenyl ether in water. Total lengths were determined and scales were taken from the left-hand side of the fish, 3-6 rows above the lateral line and on a line extending from the anterior edge ot the anal fin to the posterior edge of the dorsal fin (Anon. 1982). After recovery in the tanks, fish were released at the location of the original catch.

Secchi-depth, weather conditions, temperature of air and water, wind direction and force were registered according to RIVO-DLO standard procedures.

To stimulate the report of captured tagged trout large scale publicity was given to the tagging programme. Also fishermen, fishing with salmon stake nets in the rivers Lek, Waal and Maas were asked to keep records of their trout catches.

## 3. RESULTS

### CATCHES IN SALT WATER

*(a) General*

During the period 5th June - 27th July 375 hauls were carried out in the coastal area off the Haringvliet dam (Fig. 3), varying in duration from 20 to 60 minutes. A total number of 1068 trout were caught and during the course of the experiment 74 recaptures were made by the three vessels involved in the experiment. Of the 1068 trout captured 963 were tag-ged and released, the remaining 105 (9.8 %) were withdrawn from the experiment, their condition being to poor to be succesfully tagged.

In the period 27th June - 10th July two ships were active in the area, the invested effort was high but catches were not yet at their peak (Fig. 4). Daily catches were highest in the last two weeks of the experiment, with a maximum of 25 trout caught in one haul.

The tagging programme was divided into two periods: 5th June - 10th July and 17th July -27th July, on acount of a 6 days cessation of the experiment, due to dropping catches at the end of the first period.

In the beginning of the first period, when catches were rather low, there seemed to be an effect of tide on the catches, as hauls at low tide were often more productive than those at high tide. During the remainder of the experiment this effect was no longer discernible. Although no 24-h surveys were completed, fishing activities lasted from early in the morning (sometimes as early as 4 a.m.) to well into the evening (sometimes even night) and the overall impression was that there was no explicit peak in catches during specific hours, i.e. during sunrise or sunset.

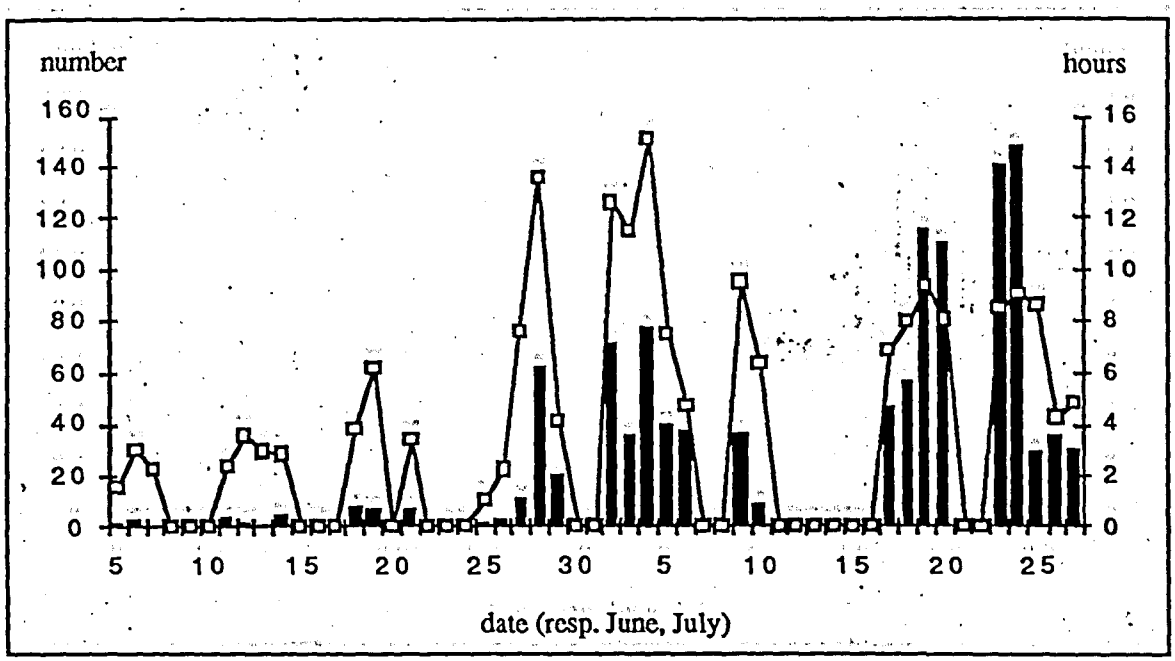


Fig. 4. Daily catches ( ■ ) of trout including recaptures and invested effort ( -□- ) in hours trawling in the period 5th June - 27 July 1990.

In both periods the greater part of all fish were infested with sea-lice (*Lepeotheirus salmonis* (Krøyer)), a parasitic marine copepod, though they were clearly more prevalent on the larger individuals.

During the whole period of the experiment sprat (in considerable quantities) and juvenile herring (*Clupea harengus*) were present in the catch. The amount of sprat reached its peak in the period of 17th - 20th of July, when catches of several thousands of kilograms per haul were quite common. Using echo-sounding equipment while towing, trout could be seen foraging in large shoals of sprat.

The catch of 4 rainbow trout (*Salmo gairdneri* ), of lengths 27, 35, 37 and 38 cm and 1 coho salmon (*Oncorhynchus kisutch* ) of 45 cm length is quite remarkable. As these species are not indigenous, these individuals must have originated from stocking operations or have escaped from hatcheries.

*(b) Length composition*

The length compositions shown in Fig. 5, are divided into two periods; 5th June - 10th July and 17th July -27th July, on acount of a 6 days termination of fishing activities.

*5th June - 10th July.* Up to 28th June catches were rather low and the number of positive hauls (hauls with at least one trout present) was only 32 out of 103 (31%). Later catches increased and the number of positive hauls over the remainder of the period was 126 out of 170 (74%). The average length of the most abundant group (up to 40 cm) was 25 cm. From 28th June onwards, larger fish in the range of 45 - 73 cm, started to appear in the catches, though their number was relatively small.

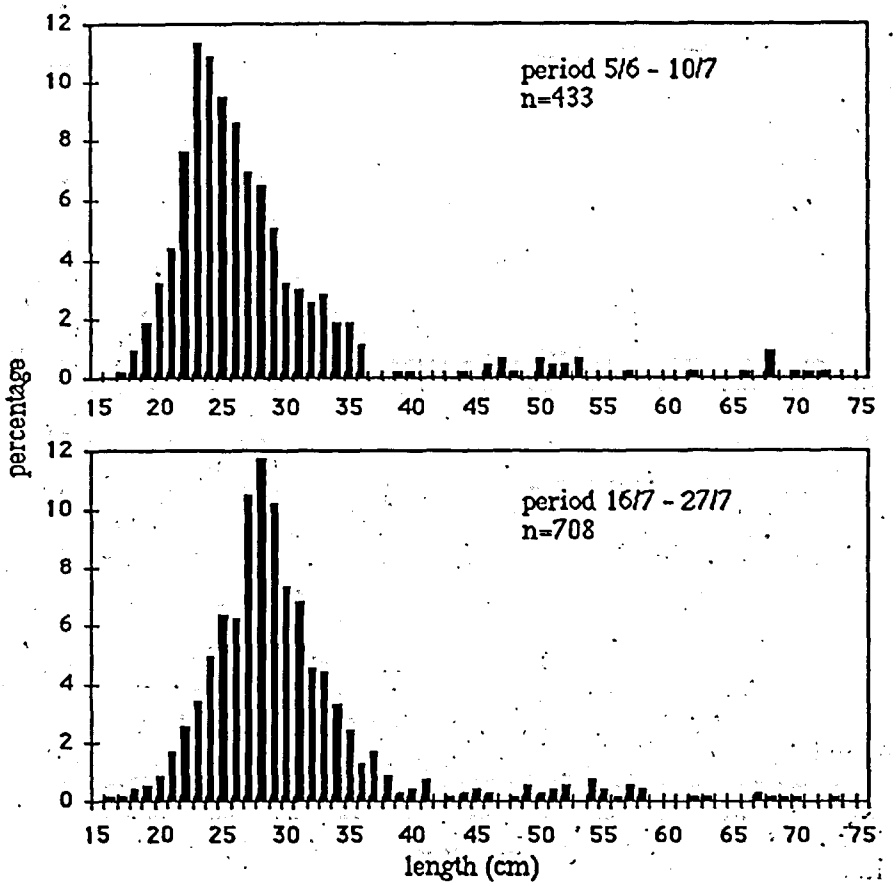


Fig. 5. Length composition of trout, expressed as a percentage for each period (5/6 -10/7; n=433, 16/7 - 27/7; n=708).

*17th July - 27 July.* All hauls (102) during this period was positive. The histogram shows a marked shift to the right in the most abundant group, resulting in average length of 28 cm, probably due to the arrival of large numbers of larger fish (>25 cm). The influx of larger fish in the range of 45 - 73 cm continued.

*(c) Littoral distribution*

As shown in Fig. 3, the coastal waters off the Haringvliet dam are quite shallow, water depths beyond 3 meters are only found in the channels (3 - 5 m) leading through the area and in the immediate vicinity of the sluices( 3 - 10 m).

In the first few weeks of the experiment, catches were rather low and of an incidental nature, no conclusion on distribution during that period could be drawn. The impression however, was that there were no great differences in distribution over the area.

In later weeks it became apparent that trout were invariably taken within the channels or in the vicinity of the Haringvliet dam, within 500 m of the shore. Drainage of fresh water had started to increase and this was probably causing trout to concentrate alongside the

dam. At low tide the bulk of the released fresh water flows off through the channels, probably attracting trout from other areas.

Pemberton (1976) reporting on sea trout in North Argyll sea lochs mentions that in numerous bottom and midwater trawls in deeper and more open water, within and outside the lochs, no sea trout were recorded. In the course of the experiment 3 journeys were made to the nearby mouth of the Nieuwe Waterweg, where several hauls were carried out. At this location, some distance from the shore and with water depths exceeding 10 m, no trout could be caught.

*(d) Discharge of water*

The discharge of fresh water is a considerable influence in the area, causing fluctuations in salinity and probably attracting large amounts of sprat and trout. Theoretically fish passage through the sluices is possible at the beginning and at the end of each drainage period, but up till now it has always been assumed that passage at the beginning of the drainage period was not likely on account of trout not being present in the immediate neighbourhood of the sluices, due to the absence of an attracting flow of fresh water. Catches were analysed with regard to the status of the sluices, i.e. being open or closed and it was concluded that the amount of trout in the catch did not differ accordingly ($F_{1,\infty} = 0.44$, $P>0.5$).

Fig. 6 shows the amount of fresh water discharged daily from the end of May to the end of July. There proved to be a positive simple correlation between the average catch per hour trawling and the discharge per day. A delay between the actual attraction of trout by the water drained and the arrival in the area of the experiment is quite probable. However, available data excluded calculation of cross correlations, since data series were interrupted by periods of cessation of fishery. Simple correlations were found to peak at a delay of 10 days ($r=0.82$).

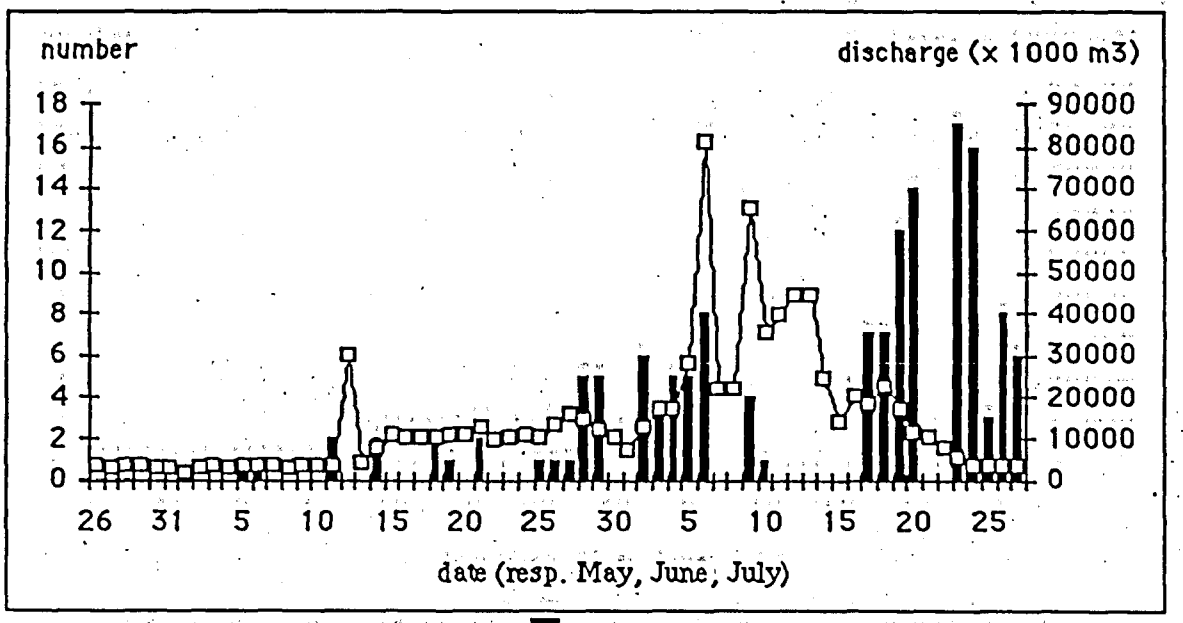


Fig. 6. Average catch per hour trawling ( ■ ) and discharge of fresh water ( -□- ).

## CATCHES IN THE RIVERS

Several professional fishermen, fishing with salmon stake nets in the rivers Lek, Waal and Maas from the middle of June to the middle of August, were asked to keep record of their trout catches. The fishery in the Lek was conducted specifically for this tagging experiment, as no such fishery was present in the lower part of this river.

In the Lek 74 trout were caught. Fig. 7 shows the length frequency distribution of the catch. With the exception of three individuals all fish are well over 40 cm length.

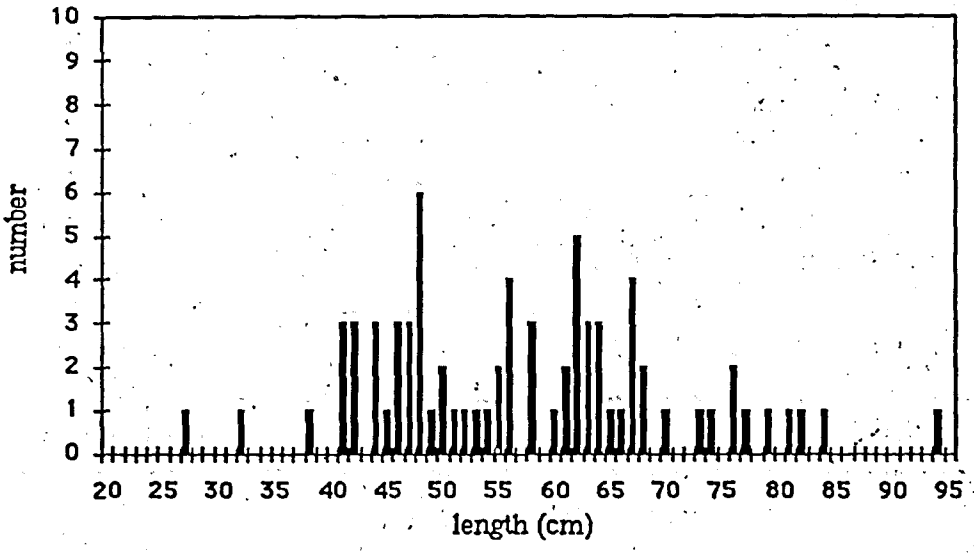


Fig. 7. Length composition of trout catches (n=74) in the river Lek.

The length frequency distribution of the catches in the rivers Waal and Maas were said to be very similar, but the exact data regarding the catches were not supplied by the fishermen. Several hundreds of trout were supposedly caught in the Waal and around 70 were caught in the Maas.

## TAGGING

### *(a) General*

The tagging experiment was carried out to study the migration of tagged trout originating from the coastal area off the Haringvliet dam and to find out whether it is possible for trout to migrate upstream by way of the Haringvliet sluices. Up till the end of June 1991 6 recaptures were made in the inland waterways, of which two actually in the Haringvliet. As the interval between release and recapture was several months it is by no means certain that these fish succeeded in passing the sluices; they could have entered the river system via the Nieuwe Waterweg.

*(b) Returns*

Of the 1068 trout captured between 5th of June and the 27th of July, 963 were tagged and released, of which 885 (92%) were in the length range of 17 to 40 cm. Up till the end of June 1991, a total of 118 recaptures have been recorded (12%), of wich 74 were made during the tagging programme by the three research vessels involved in the experiment. 44 recaptures were made by others, 21 by professional fishermen and 23 by anglers. The 118 recaptures involved 111 fish, 106 being recaptured once, 4 being recaptured twice and 1 even 4 times (3 times by research vessels and finally by a local angler, all in a period of 45 days). As the research vessels operated mainly in the area of the experiment and as angling is concentrated in the immediate vicinity of the Haringvliet sluices, there is a bias towards recaptures of resident fish. Of all recaptures at sea (111), 95% was reported within a distance of 6 km from the Haringvliet sluices.

*(c) Recaptures in the area of the experiment*

A total of 105 recaptures were made in the tagging area, 74 by research vessels, 11 by local fishermen and 20 by anglers. Most of the recaptures (87) were made within 1 month (Fig. 8). The interval between release and recapture exceeded 3 months for 8 fish and 6 months for 2 fish.

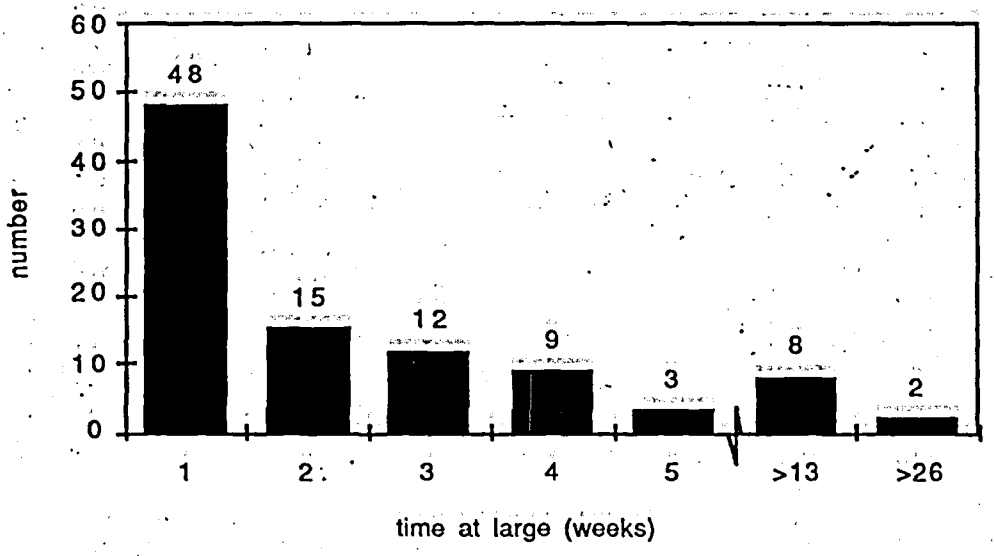


Fig. 8. Tag returns from the area of the experiment (n=87).

The last recapture in the area was made after the fish had been free for a period of 203 days. When it was first caught its length was 28.5 cm and at the time of recapture it had reached a length of 46.5 cm, an average growth of 0.9 mm/day. As this fish was delivered to our institute measurements are correct. Calculating growth from recapture data supplied by others can be rather hazardous. Length can be measured in many different ways e.g., total length, fork length or even length without head and tail, resulting in unreliable estimates for growth rates. For example, of the 44 recaptures made by others 15 fish had actually shrunk for several centimeters, which is highly unlikely. So, no further calculations regarding growth were carried out.

Though the recaptures in the area of the experiment were qualified as resident fish, re-immigration might occur, specially when time intervals between realease and recapture are large.

*(d) Recaptures in other areas*

13 fish (11%) showed movement away from the point of release and were recaptured in different areas (Fig. 9).

*Recaptures in fresh water* 6 fish were recaptured in the inland waterways: 4 by professional fishermen and 2 by anglers. Table I shows details with regard to the time interval between release and recapture, recapture sites and distance travelled.

Table I. Tagged trout recaptured in fresh water

| RELEASE | | RECAPTURE | | | | |
|---|---|---|---|---|---|---|
| date | length (cm) | place | date | length (cm) | days free | distance (km) |
| 28/06/90 | 70 | 1 Woudrichem | 23/07/90 | 63 | 25 | 80 |
| 23/07/90 | 41 | 2 Hartelcanal | 18/09/90 | 40 | 57 | 44 |
| 23/07/90 | 29 | 3 Haringvliet | 15/10/90 | 36 | 83 | 1 |
| 24/07/90 | 58 | 3 Haringvliet | 15/10/90 | 57 | 82 | 1 |
| 04/07/90 | 72 | 4 Iffezheim | 25/11/90 | -- | 144 | 730 |
| 25/07/90 | 52 | 5 Oss | 17/02/91 | -- | 238 | 120 |

The length distribution of trout caught in fresh water is significantly different ($P<0.001$, Wilcoxon test) from the length distribution of the other recaptures using length at tagging, the fresh water recaptures being larger than the recaptures in the coastal waters.

Entering the river system is more or less restricted to larger individuals, probably on their way to the spawning grounds in the higher river stretches. To what extend trout succeed in reaching the spawning grounds, is not clear, as the actual spawning grounds are not known. The recapture in the Rhine at Iffezheim in Germany proves that it is possible to ascend the river for a distance of at least 730 km. This case also represents the highest value for mean distance of daily travel: 5 km/day, for a period of 144 days after being caught for the first time.

*Recaptures at sea* 7 fish were recaptured at sea; 1 by an angler close to the Nieuwe Waterweg and the remainder by professional fishermen using active gear. Details are presented in table II. The one caught by an angler after being free for 9 days, was probably trying to migrate upstream into fresh water, as it was taken near to the cooling-water outlet of a power station at the seashore.

There were no significant differences in size between fish recaptured at sea and those recaptured in the tagging area. The distance covered before recapture varied considerable, from 24 up to 280 km. Only one recapture was made several kilometers to the south of the tagging location. The overall picture of the recaptures shows that trout tend to migrate in a northern direction, with the prevailing current.

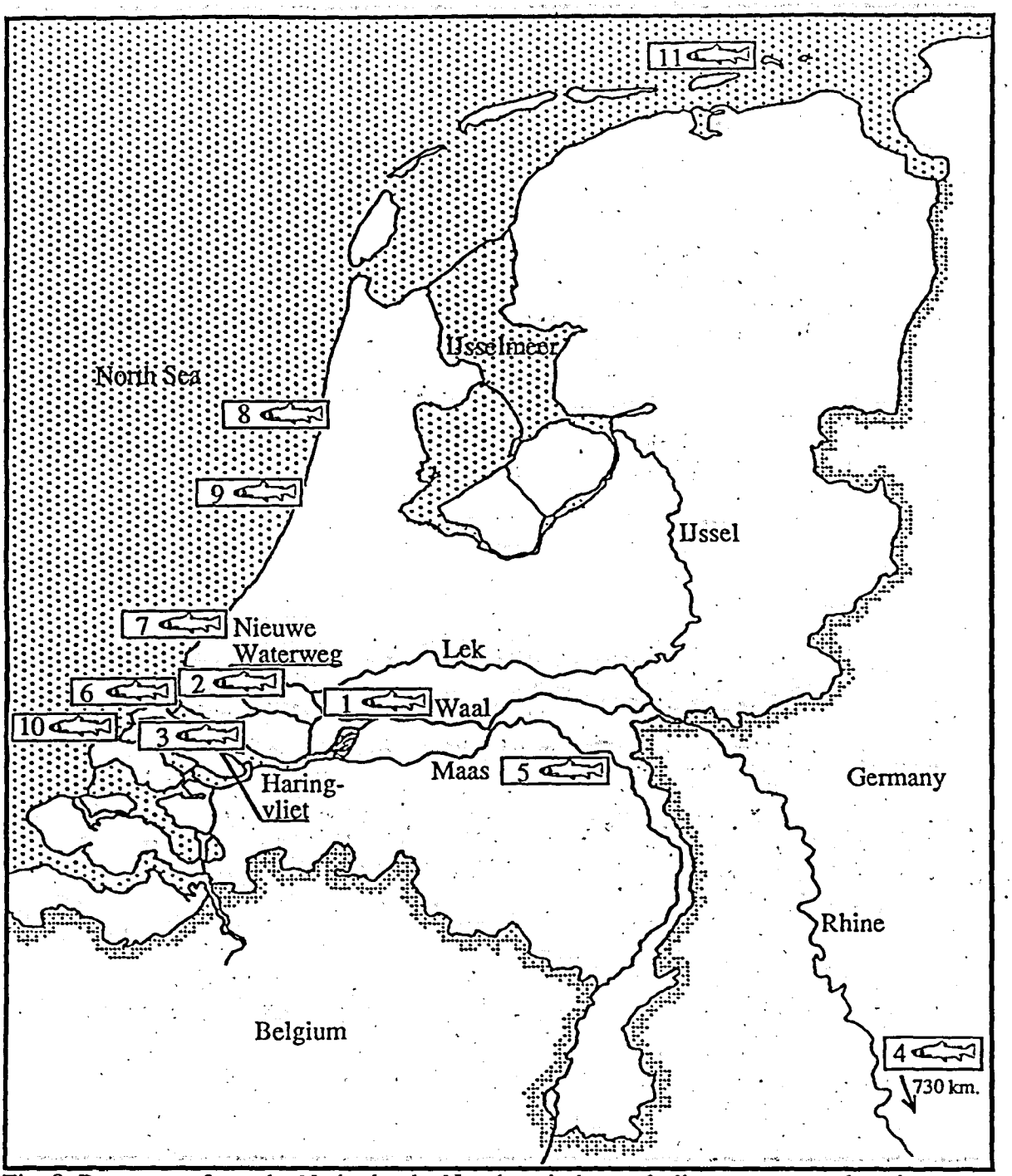


Fig. 9. Recaptures from the Netherlands. Numbers in boxes indicate recapture locations as mentioned in tables I and II.

Table II. Tagged trout recaptured at sea

| RELEASE | | RECAPTURE | | | | |
|---|---|---|---|---|---|---|
| date | length (cm) | place | date | length (cm) | days free | distance (km) |
| 05/07/90 | 49 | 6 Maasvlakte | 14/07/90 | 49 | 9 | 24 |
| 23/07/90 | 30 | 7 Loosduinen | 03/08/90 | 29 | 11 | 30 |
| 27/07/90 | 35 | 8 Bergen | 16/10/90 | 34 | 81 | 104 |
| 20/07/90 | 28 | 9 IJmuiden | 24/11/90 | 40 | 127 | 84 |
| 18/07/90 | 27 | 10 Schouwen-bank | 23/11/90 | 30 | 128 | 40 |
| 19/07/90 | 38 | 8 Bergen | 25/11/90 | 44 | 129 | 104 |
| 20/07/90 | 33 | 11 Schiermon-nikoog | 17/12/90 | 36 | 150 | 280 |

## 4. DISCUSSION

The tags used in this study are Carlin tags, attached with double stainless steel wire, as there is evidence that this type of tag yields the best results in terms of return rates and longevity in contrast to other external tags as Floy tags, streamers and tags attached with single bonds (Saunders, 1968; Bartel et al, 1987). Laboratory experiments on *Salmo gairdneri* with several types of tags (unpublished data RIVO) showed that Carlin tags in some specimens moved to the base of the dorsal fin in a growth period of 9 months, sometimes resulting in tag loss. As this is also likely to occur with tagged fish at large (specially with smaller individuals), it might be an important cause of tag loss. Saunders (1968) also observed this phenomenon and reported that in returning adults there seemed to be no correlation between the deepness of tag attachement (deeply embedded versus shallow attachement to the base of the dorsal fin) and the type of attachment (double steel wire versus double polyethylene monofilament). Hence the choice of steel wire but lower returns from smaller length groups might be expected.

The primary result of the presented tagging experiment is that trout concentrates during the summer months in the coastal area off the Haringvliet sluices. The majority of the trout present, in the length range of 17 to 40 cm, is probably in their first marine or post-migration year, growing to maturity before entering the river system on their way to the spawning grounds.

De Groot (1989b) reported that smolts in our waters migrate to sea at the age of 1-3 years and at a length of 17-20 cm. The exact timing of the smolt descend is not known, but it is likely to occur in the early spring months. Pemberton (1976) reporting on sea trout in North Argyll sea lochs states that smolt runs in the Lusragan Burn in the years 1972, 1973 and 1974 were found to extend from the end of March to mid-May. Jonsson (1985) reports something similar regarding migrant brown trout in Norway. On reaching the sea a search for food occurs, requiring a migration away from the area off the sluices, into more marine conditions. This would explain the rather low catches in the area of the experiment in the month of June. Lateron, increasing fresh water discharges seem to attract large amounts of sprat, which in turn seems to attract trout towards the area off the sluices. Early seasonal migrants might have gone farther away offshore and therefore

come back later. Their prolonged stay at sea might have caused further growth, thus explaining the shift that occurred in the length frequency distribution during the season. Attracted by the discharge of fresh water larger fish (> 40 cm) started to appear from the end of June onwards, probably trying to enter the river system for their journey to the spawning grounds. At present the location of the spawning grounds in the river system of the Rhine and the Maas are unknown.

In view of the distribution of the recaptures it seems not very likely that trout, motivated for a migration into fresh water, can enter the river system via the Haringvliet sluices easily. In the last two weeks of the experiment, when the amount of tagged trout at large in the immediate vicinity of the sluices reached its peak, recaptures from the Haringvliet would be expected when easy passage through the sluices was possible. Only two recaptures were made in the Haringvliet and as the time interval between release and recapture was several months, they could have entered the river system by way of a different route. The catch of these two tagged trout proves that recaptures can be made in the Haringvliet although fishing intensity in that area is not quite as high as in the coastal waters off the Haringvliet sluices. The conclusion can be drawn that the Haringvliet sluices present a considerable barrier to migratory fish, virtually blocking upstream movement.

The patterns of recapture observed in this study show that there are two groups of trout; one staying in the coastal waters close to the Haringvliet estuary during the autumn and winter months that can be classified as short-distance migrating versus a group of long-distance migrants tending to migrate in a northern direction, with the prevailing current. Several authors have found similar results with regard to the migration direction of long-distance migrants. Toivonen & Tuhkunen (1975) and Ikonen & Auvinen (1982) reported that the migration of sea trout in the coastal waters of Finland is predominantly northwards, following the sea current. Jensen & Berg (1977) found a marked similarity existing between results obtained for sea trout and arctic char from the Vardnes river in Norway. The long-distance migrants of both species tend to migrate northwards, with the sea current in the area.

The high returns from the coastal waters off the Haringvliet sluices can be explained by the very high fishing intensity in that area during the course of the experiment. Bartell et al (1987) state that tag returns may be affected by the fishing intensity and migration of tagged fish. The low returns from the long-distance migrating group are to be expected as it is quite difficult to catch trout during feeding migration. For instance, tagging experiments with widly migrating Polish sea trout often yielded low returns.

The question arises as to whether these trout originate from the river system of the Rhine. De Groot (1989b) explaines the presence of trout in coastal and inland waters of the Netherlands by means of Thorpe's hypothesis regarding the "archetypal" trout (Thorpe, 1987). De Groot (1989b): "Thorpe's hypothesis places the occurrence of sea trout in the Rhine and Maas in a different light. Sightings of silver-coloured trout in Nordrhein-Westfalen or in the Maas can no longer be taken as proof that trout have swum upstream from the sea. These fish could equally well originate from brown trout populations and have been forced to leave their environment because of insufficient food supplies or inadequate conditions. Similarly, the presence of sea trout in the lower reaches of the rivers Maas, Lek, Merwede or in the Rhine-Maas-Schelde estuary cannot be viewed as conclusive evidence that these fish are intending to ascend the river. In contrast to the behaviour of salmon, young sea trout often undertake what are known as "dummy runs". Sexually imma-

ture trout that inhabit coastal waters often accompany their sexually mature counterparts some way up the river before returning to sea"

The results of the tagging experiment shed a different light on this matter. A total number of 78 trout with lengths in excess of 40 cm were tagged of which 14 were successively recaptured. Of these recaptures, 8 were caught in the coastal waters off the Haringvliet sluices and 1 was caught near a cooling-water outlet of a power station at the seashore several kilometers to the north of the tagging location presumably attracted by the fresh water discharge, all within 1 month after being released. The other 5 recaptures (36%) were realized within the catchment areas of the Rhine and the Maas, after having been free for a period of 25 up to 238 days and covering distances from 1 to 730 kilometers upstream. No recaptures of individuals with lengths in excess of 40 cm at tagging were made at sea. This indicates that after having stayed for some time in the coastal waters off the Haringvliet sluices where feeding conditions are favourable, mature individuals tend to migrate into fresh water. In view of the distances covered, this upstream movement goes beyond the short excursions that are to be expected when trout is present in estuarine surroundings and is probably directed towards possible spawning grounds in the higher stretches of the rivers. It is also in accordance with the catches of large trout by professional fishermen in the rivers Lek, Waal and Maas in the months June, July and August. That these well silvered trout with lengths up to 94 cm (see fig. 7) might arise from "landlocked" or resident populations is not ruled out but in that case it should be possible to show that resident and migrant trout in the river system of the Rhine are parts of the same demes, like Jonsson (1985) did for fresh water resident and sea-run migrant trout in Norway. As long as that type of direct evidence is lacking, the results of this study give priority to the hypothesis that - next to the completely fresh water type of trout - there is indeed an anadromous population of trout in the catchment area of the Rhine and Maas.

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