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Migration of sea trout along the coastal waters of Finland on the basis of tagging experiments.

by
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Sea trout (Salmo trutta L.) have earlier been found in about 50 Finnish rivers discharging into the Baltic (HURME 1966). As a result of pollution and the construction of power plants, the amount of sea trout smolts descending to the sea has radically diminished, and reared trout smolts are being released into the sea in increasing numbers to compensate for these losses. In 1974 ca. 465 000 smolts were released, this quantity being estimated almost to correspond to the natural smolt production. Some of the released fry are tagged in order that such questions as the value of the releases and the extent of migration may be studied.

This investigation concerns the migration behaviour of the sea trout and the factors influencing it. The material comprises recaptures of fish tagged in the years 1962 - 1972. Altogether 25 394 tagged sea trout with an average length of 19 cm were released in 56 lots. The number of tag returns was 4729 (17.6%) , and the site of recapture was located in 4212 cases.

The smolts were released in different parts of the archipelago and in some rivers (Fig. 1). and the different areas have been considered separately, the results being divided between the Bothnian Bay, the Bothnian Sea, the Gulf of Finland and the rivers.

Among the factors possibly affecting the direction of migration are the salinity gradients in the Baltic brackish water area, the currents and the presence and width of the archipelago.

Fig. 2 shows that both in the Gulf of Bothnia (=Bothnian Sea + Bothnian Bay) and in the Gulf of Finland the salinity decreases from 6 °/oo at the mouth to 3 °/oo in the headward region. Separate fresh water areas form at the mouths of the rivers and in winter extend far out to sea in thin layers under the ice cover.

The directions of the prevailing currents are shown in Fig. 3. In the Gulf of Bothnia the current flows northwards along the Finnish coast and then southwards down the coast of Sweden. In the Gulf of Finland the conditions are somewhat more complex, but a weak main current moves westwards along the southern Finnish coast.

The occurrence and extent of the archipelago varies widely. In most parts of the Bothnian Sea the archipelago is almost totally missing. In some parts it is 2-14 km wide, but generally under 6 km. Parts of the Bothnian Bay also lack an archipelago, but in the north there is an archipelago of varying width (0-32 km). In the Gulf of Finland a definite archipelago extends along the Finnish coast, its width varying from 4 to 30 km and mostly being over 10 km.

The extent of the migration area.

Table 1 shows the extent of the migration in different parts of the sea. The distance is measured as a straight between the points of release and recapture. In the case of the river releases, the distance is measured from the mouth of the river.

Table 1. Percentage return of tags at different distances from the releasing place.

	0-10	0-20	0-50	0-100	0-200	0-over 200 km	tag returns number	tag returns %
Gulf of Finland	22.4	42.0	65.5	83.1	93.0	100.0	608	13.8
Gulf of Bothnia								
Bothnian Sea	16.6	32.3	57.6	73.8	89.1	100.0	229	11.4
Bothnian Bay	33.5	54.3	75.4	88.6	98.7	100.0	3163	19.5
-River releases	38.5	55.8	67.3	78.8	92.3	100.0	52	14.0
-Stayed in rivers							160	
All together	30,9	51,2	72,7	86,7	97,1	100,0	4212	

The trout had moved farthest in the Bothnian Sea and migrated much less in the Bothnian Bay. This is partly due to the fact that in the Bothnian Bay many trout were caught off Oulu in the first summer after release. The extent of the migration in the Gulf of Finland lies between that of the Bothnian Sea and the Bothnian Bay. No information about recaptures is available from the territorial waters of the USSR, in the eastern part of the Gulf of Finland so that the migration area may be larger than is shown here.

The direction of migration.

The main purpose of this investigation was to discover whether there are any clear patterns in the migration of the sea trout, as is the case with the salmon. CARLIN (1965) has demonstrated that the sea trout released in Sweden mostly remain in the archipelago area, and the same is indicated by the Finnish results. Some typical recapture charts are shown in Figs. 4-9. Migration to the open sea was observed only in individuals caught in the Baltic Proper. Only one trout released in the Gulf of Finland was recaptured on the southern side of the Gulf, off the Estonian coast. The fish were observed to concentrate in the areas around the river mouths, particularly in the Gulf of Bothnia.

In the Gulf of Bothnia, the fish crossing to the Swedish coast evidently keep close to the land, moving through the upper part of the Bothnian Bay or across the narrow parts of the Gulf at the Quark and Åland.

According to CARLIN (1965), the migration of the trout off the Swedish coast is rather passive and lacks a definite direction. In contrast, off the Finnish coast in the Gulf of Bothnia, definite northward migration was observed in this investigation. In Table 2, this is particularly evident in the Bothnian Sea, where 77.6% of the recaptures were made north of the releasing place (Fig. 4). The corresponding value for the Bothnian Bay is 66.1 % (Figs. 5,6 and 7). The trout that cross to Sweden continue southwards along the Swedish coast. No trout released in the Gulf of Bothnia have been recaptured in the Gulf of Finland.

Table 2. Percentage distribution of recaptured sea trout by direction of migration in the sea.

	direction	%	direction	%	number
Gulf of Finland	west	51.3	east	48.7	608
Gulf of Bothnia:					
Bothnian Sea	north	77.6	south	22.4	229
Bothnian Bay	"	66.1	"	33.9	3163
-River releases	"	56.9	"	43.1	52
-Stayed in rivers					160
					4212

In the Gulf of Finland, the trout seem to move eastwards from the releasing place as frequently as westwards (Figs.8 and 9). Since there is no information from the eastern part of the Gulf, eastward migration may be more extensive than indicated here. From the Gulf of Finland migration continued partly to the Baltic Proper, partly to the Bothnian Sea.

The recaptures of sea trout released off different parts of the Finnish coast are divided as follows between the countries fishing these waters: Finland 3914, Sweden 294, Denmark 2, USSR 1 and GDR 1.

Homing behaviour.

The homing behaviour of the trout was studied more closely with six lots reared in the Oulu River and released at its mouth. Of these fish 8% were recaptured in the Oulu River, 9.6 % in a "foreign" river and 82.4 % in the sea. The large number of fish visiting the wrong river at spawning time, when most of the river recaptures were made, is partly due to a power plant dam situated near the mouth of the Oulu River. These results otherwise support CARLIN's (1965) observation that the homing behaviour of the sea trout is poorly developed.

Two further lots were studied, which were released in the Gulf of Finland by the open sea, far from any rivers. In one of the two, the fish were found to gather at the releasing place at spawning time in the second or third year (Fig. 8). Of the 19 trout found within 10 km of the releasing place, 12 were captured in the third year. In the other lot (Fig. 9), only 6 of 16 recaptures near the releasing place at spawning time were made in the second and third year. No trout were caught near any river mouths in either of the lots.

In these eight lots, the fish were observed to migrate farthest in the first and second year: from the third year on - wards, they returned to the vicinity of the releasing place. In the Oulu lots, for instance, only a few individuals were recaptured outside a 50 km radius in the third and fourth year.

Discussion.

There appear to be relatively great differences in the size of the migration area of sea trout in different parts of the

Baltic. The most limited area was reported from Danish waters by CHRISTENSEN (1967); with the exception of a few lots, all the trout were recaptured within 30 km of the releasing place. In contrast, far migrating stocks were found in the southern parts of the Baltic Proper by SVÄRDSON & ANHEDEN (1963) and BACKIEL & BARTEL (1967). The sea trout of the Finnish coast also migrate relatively far, their migration area being of the same order of magnitude as that of the Swedish trout examined by CARLIN (1965). The differences between the areas are apparently partly due to the genetic properties of the different stocks, but the nature of the coast is also an important factor. Migration is extensive off open coasts, as in the Baltic Proper and the Gulf of Bothnia , but is relatively limited in the archipelago of Denmark and the Bothnian Bay.

On the Finnish coast of the Gulf of Bothnia, the feeding migrations were observed to be directed northwards. Migrating with the main current, the fish at first move through water of decreasing salinity, but are then carried into increasingly saline water off the Swedish coast. The migration behaviour of the trout thus differs from that of the salmon, as, for instance, the salmon leaving the Oulu River migrate south along the Finnish coast to the Baltic, swimming against the current.

The migration was not found to have any particular direction in the Gulf of Finland, where the weak main current goes west along the Finnish coast from less to more saline water. Nor could CARLIN (1965) observe any direction in the migration on the Swedish side of the Gulf of Bothnia.

These observations indicate that the sea trout partly follows the currents but also favours the less saline parts of the sea, in the vicinity of river mouths and in the archipelago, thus contrasting with the salmon, which moves to more saline water on feeding migration and keeps to the open sea.

Summary.

The migrating behaviour of sea trout in the coastal waters of Finland was studied by analysing the total of 4729 tag returns obtained when 25 394 sea trout smolts were tagged and released in 56 lots in the years 1962 - 1972.

The size of the migration area is shown by the percentages of the recaptured fish obtained at different distances from the releasing place: 0-10 km:30.9%, 0-20 km:51.2% 0-50 km:72.7%, 0-100 km:86.7%, 0-200 km:97.2% and 0-over 200 km:100%.

As a rule the trout remained in the archipelago, but some migration was observed across narrow stretches of open sea.

In the Gulf of Bothnia, migration clearly showed a northward direction;on their feeding migration the fish travel with the prevailing current through decreasingly saline water. In the Gulf of Finland migration was not observed to have any particular direction;there the weak main current along the Finnish coast moves westward to more saline water, which the trout seem to avoid to some degree.

The homing behaviour of the present stocks of trout appeared to be relatively weakly developed, because at spawning time they were found in other rivers as often as in the one where they had been released.

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SVÄRDSON, G.& ANHEDEN,H. 1963: Långvandrande skånsk havsöring. -Svensk fiskeritidskrift 72(8/9):109-113.

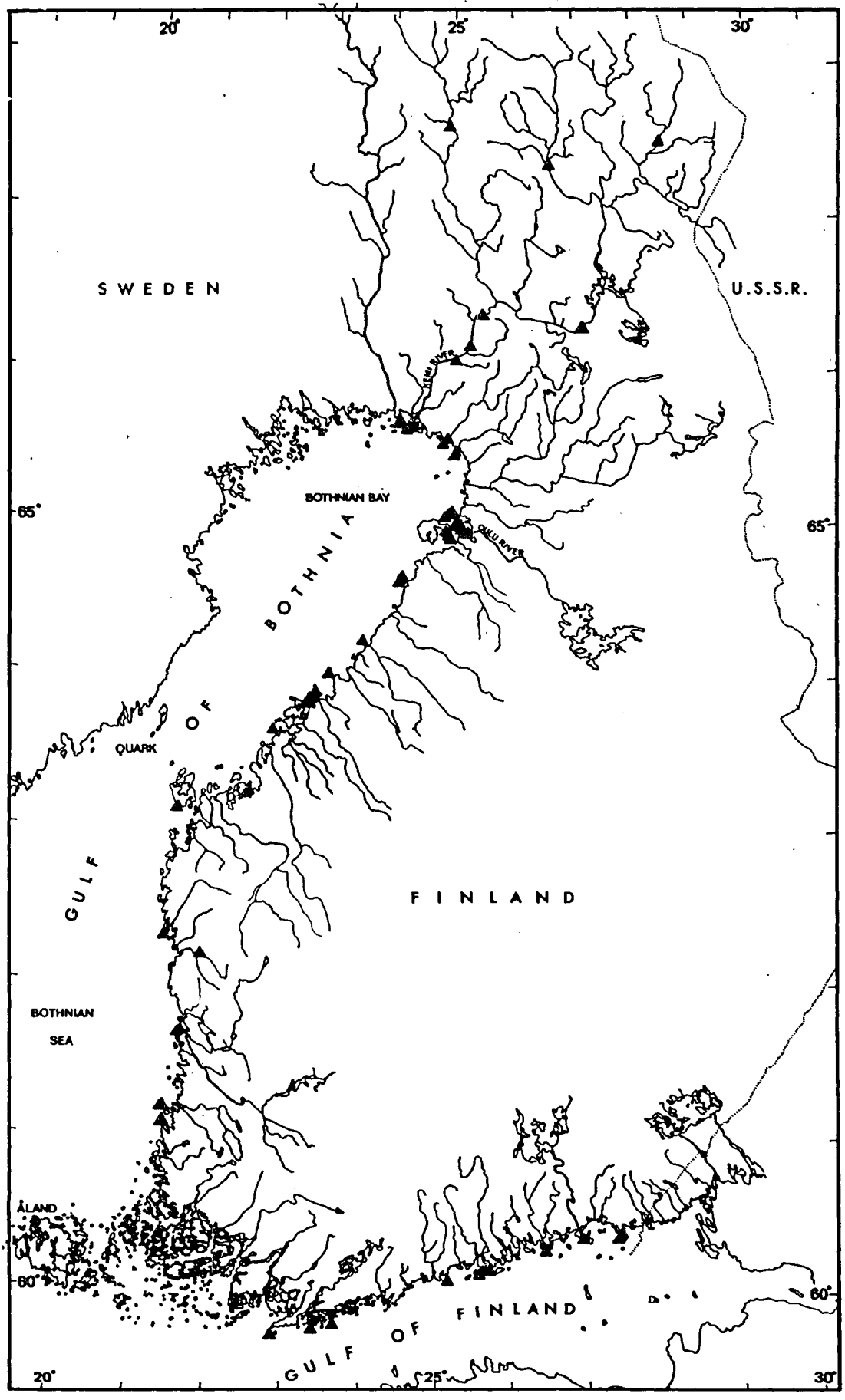


Figure 1. The releasing places of sea trout in the years 1962 - 1972.

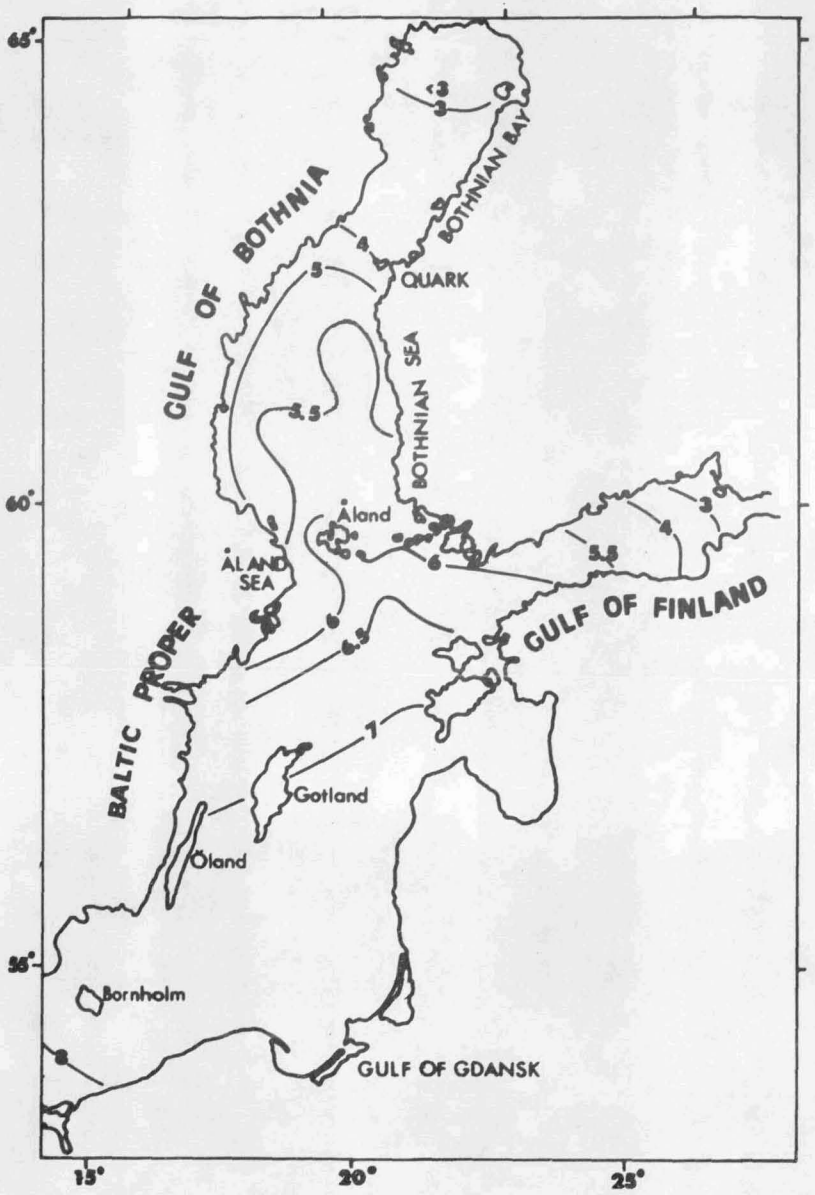


Figure 2. The surface isohalines (°/oo) in the Baltic Sea.

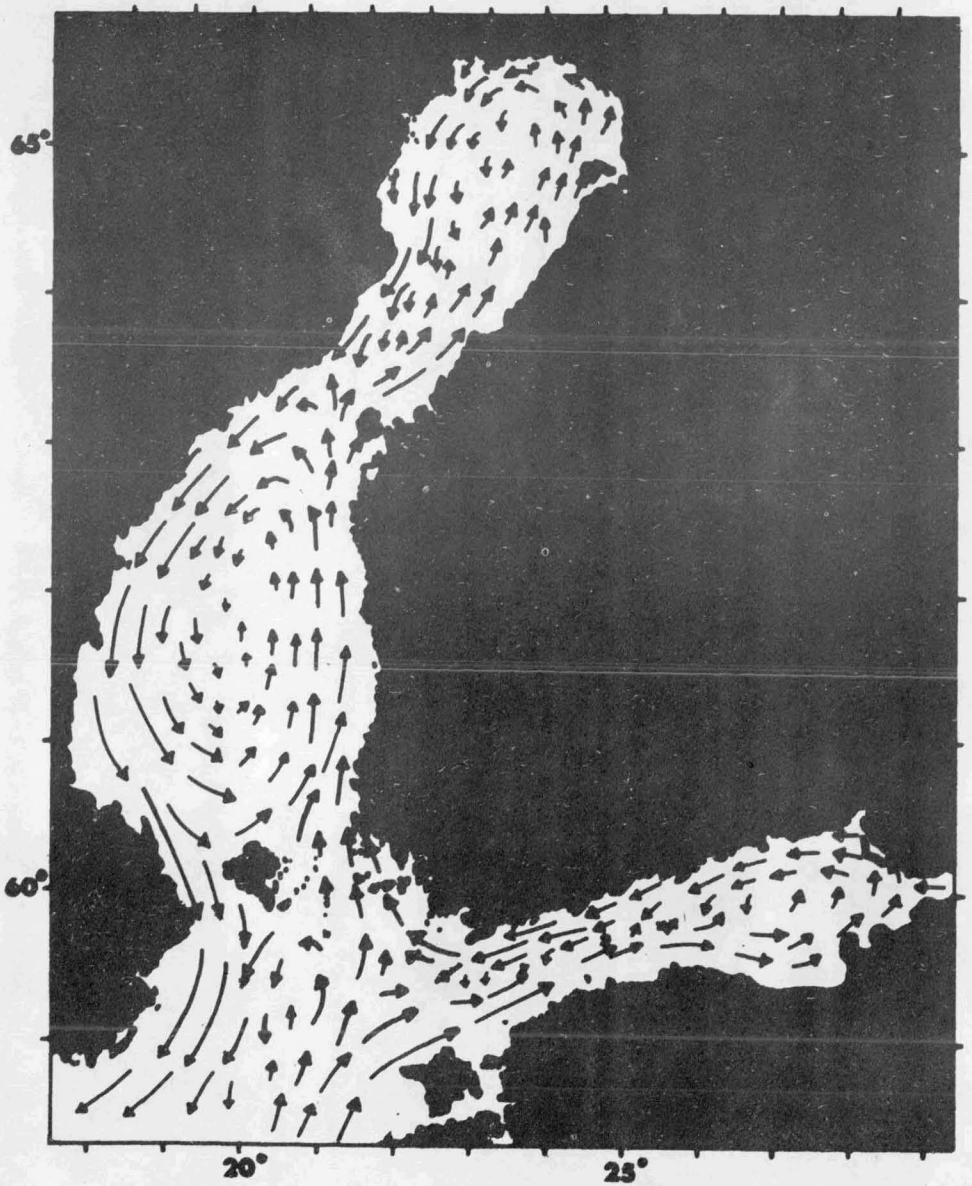


Figure 3. Surface currents; mean vectors in the Gulf of Finland and in the Gulf of Bothnia.

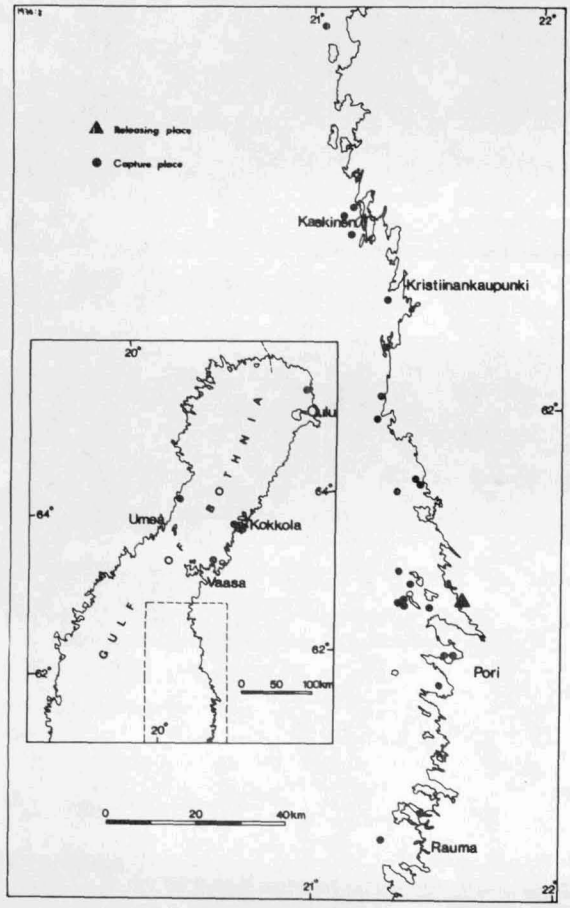
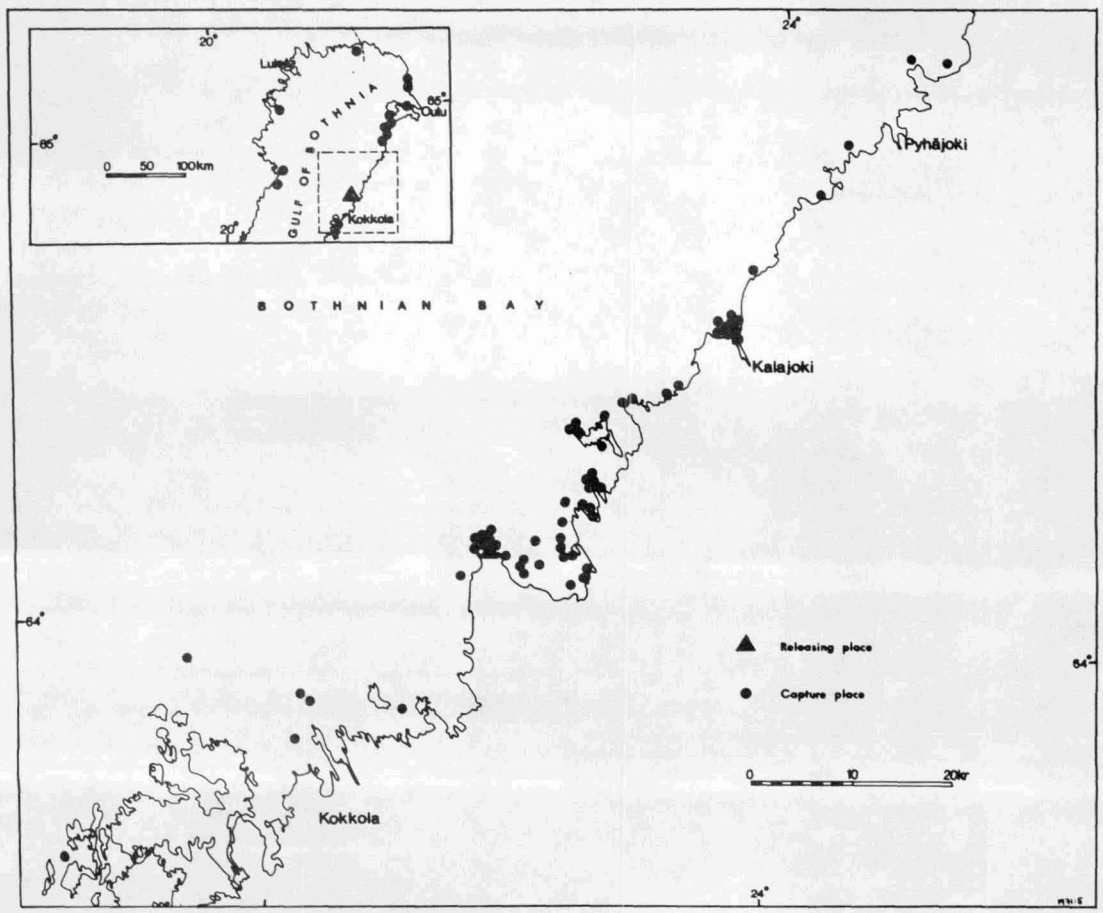
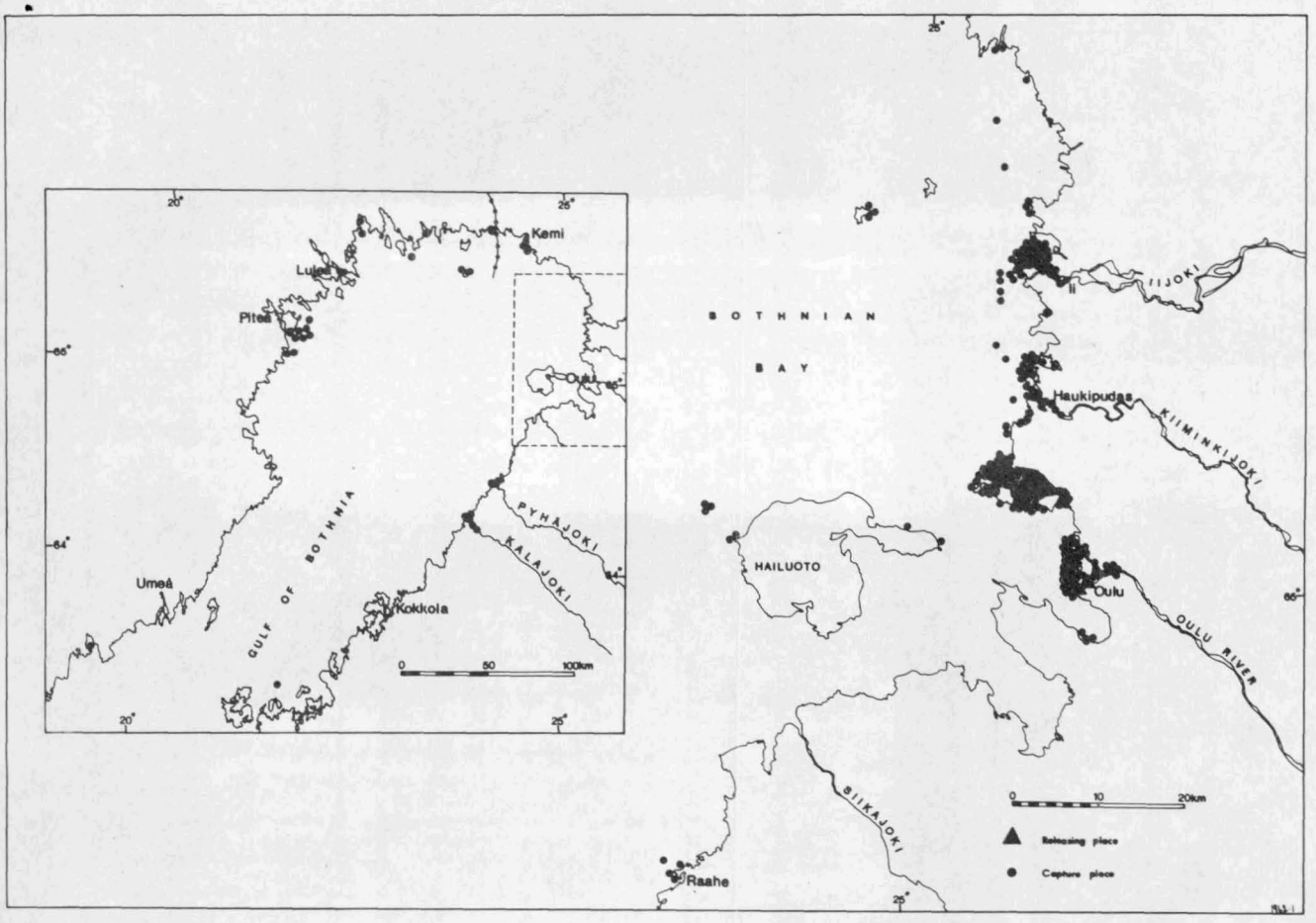
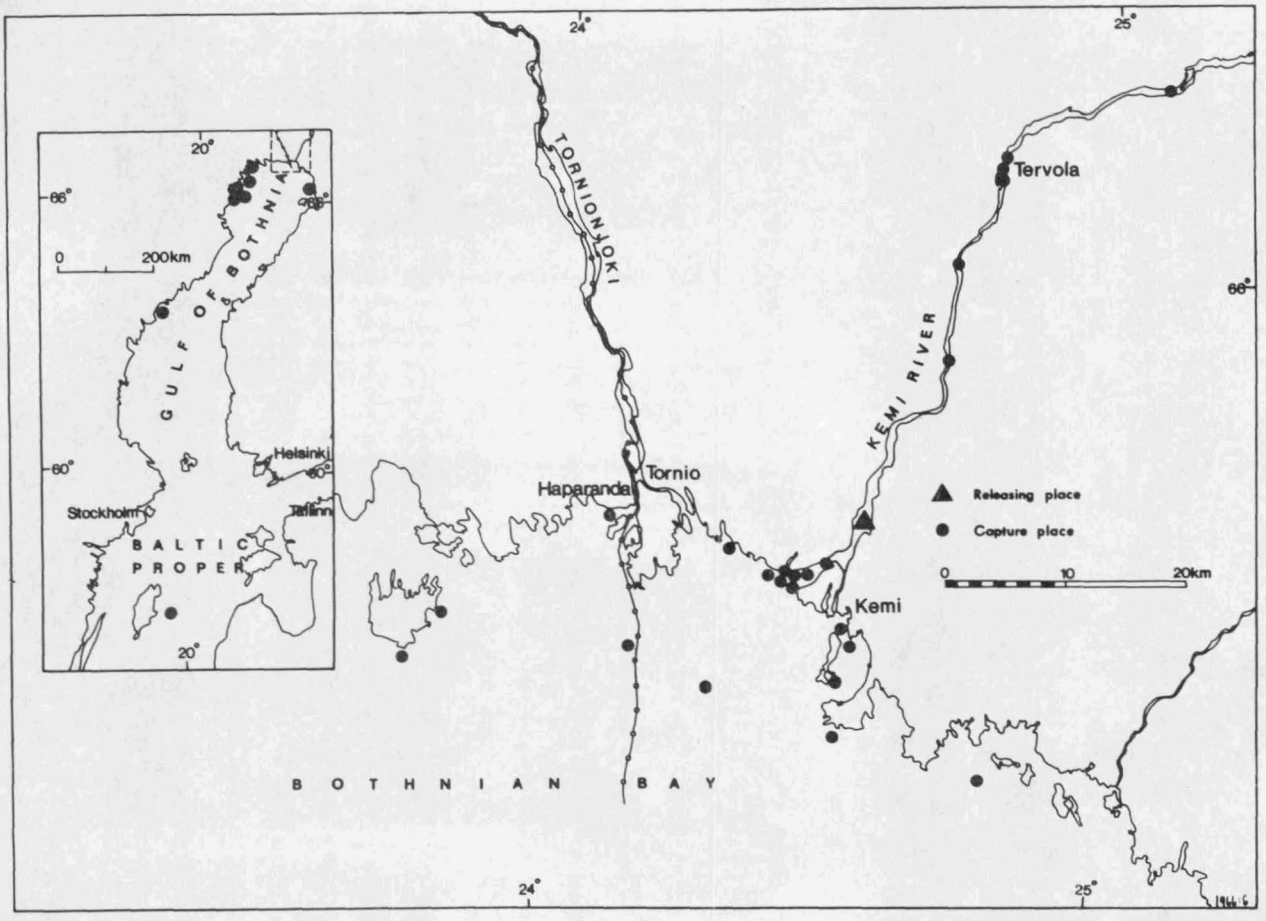


Figure 4. Recaptures of sea trout released in the Bothnian Sea.

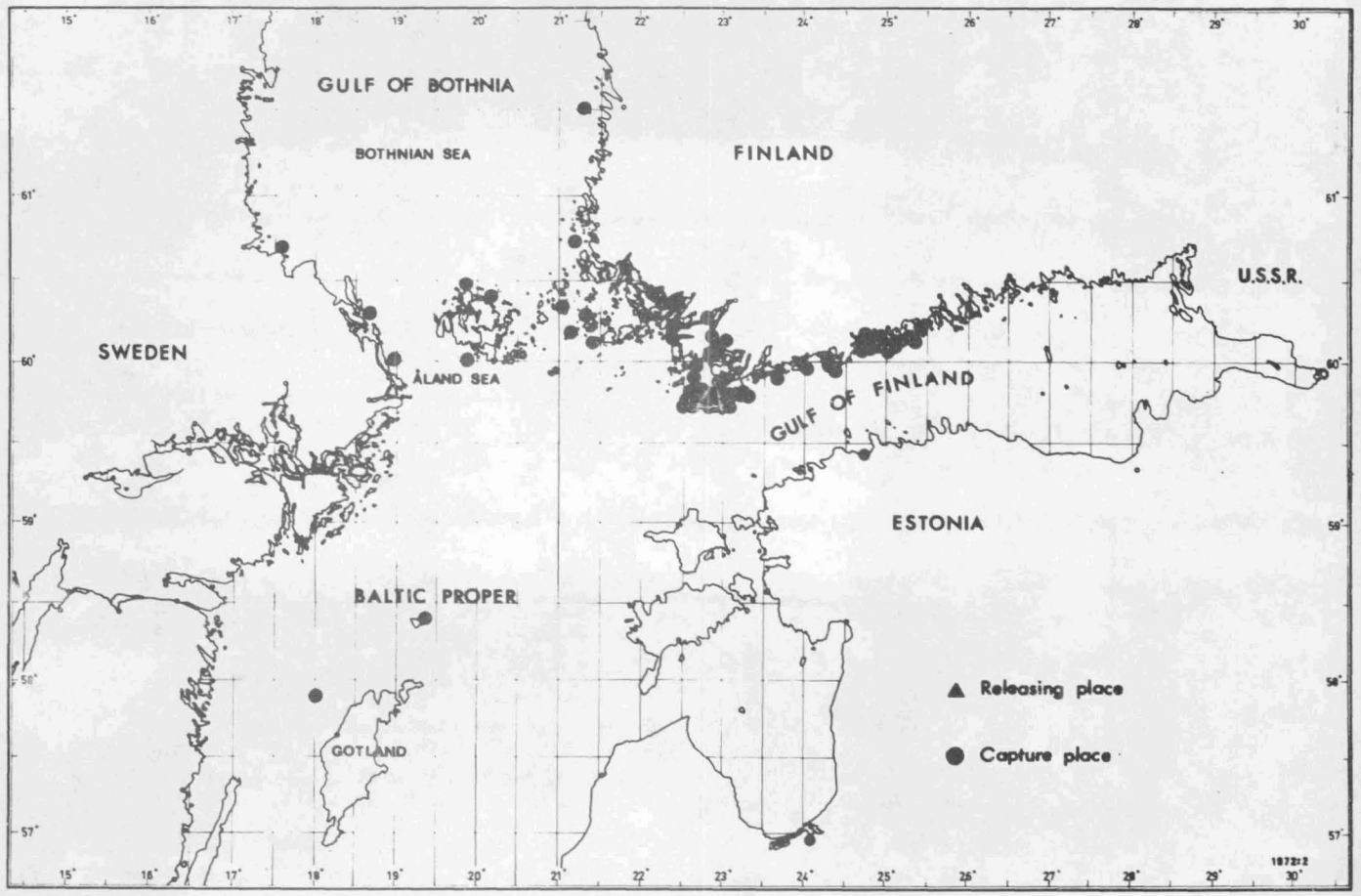
Figure 5. Recaptures of sea trout released in the Bothnian Bay.

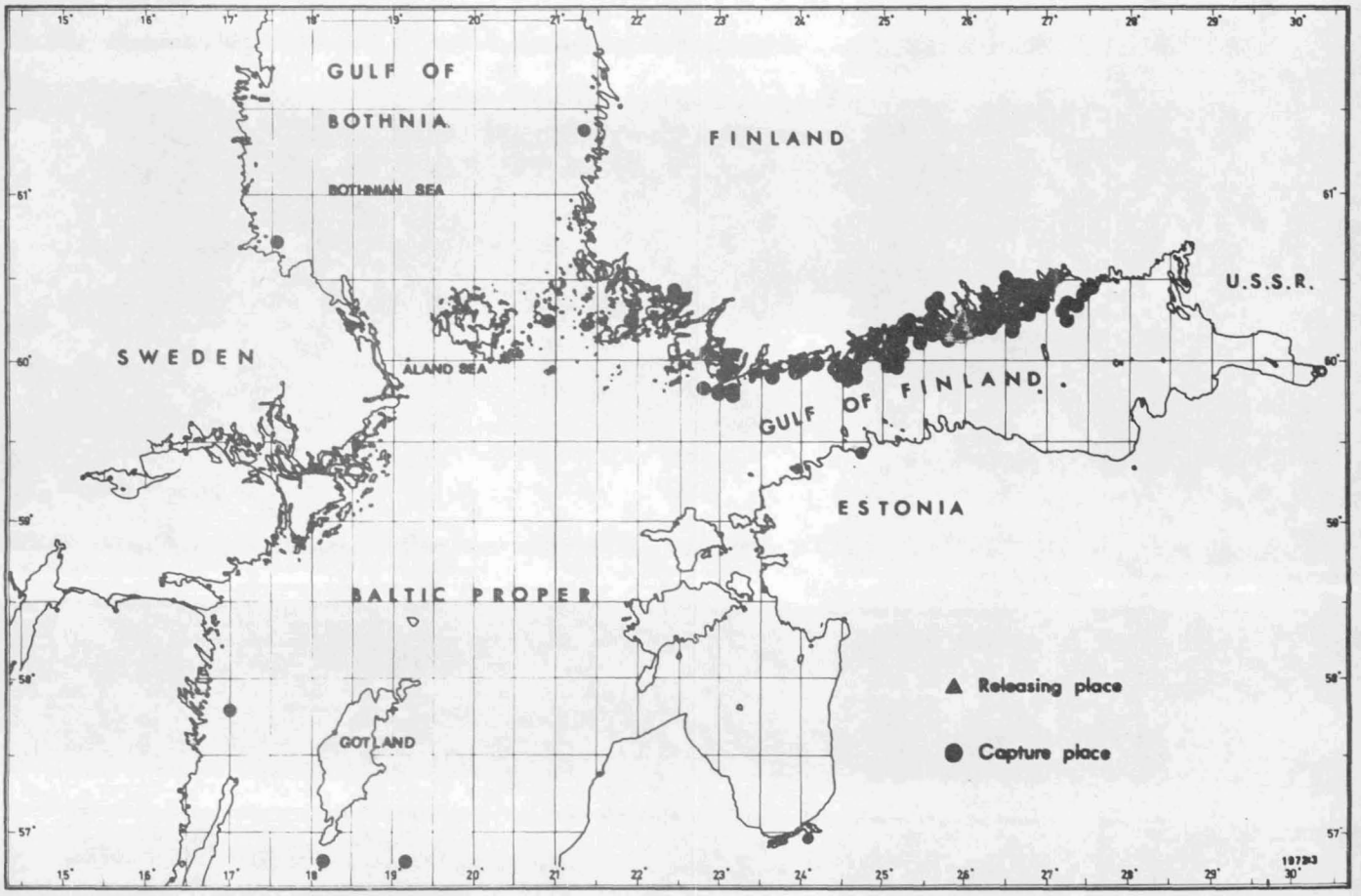






Figures 6-7. Recaptures of sea trout released in the Bothnian Bay.





Figures 8-9. Recaptures of sea trout released in the Gulf of Finland.