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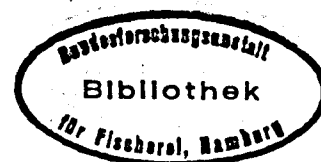
ANADROMOUS AND CATADROMOUS  
FISH COMMITTEE

THE EFFICIENCY OF CERTAIN TYPES OF SMOLT TAGS AND TAGGING  
TECHNIQUES ADOPTED BY THE MINISTRY OF AGRICULTURE, FISHERIES

AND FOOD

by

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One of the earliest large scale salmon smolt tagging experiments was carried out between 1911 and 1915. The investigation, which comprised the affixing of tags on to smolts during the period of migration to the sea, had two principal objects, namely (1) the determination of the question as to the extent to which, if at all, salmon deviated from their habit, as it is generally assumed to be, of returning to spawn in the same river in which they were bred and (2) the possibility of estimating the proportion between the numbers respectively migrating to the sea as smolts and returning as mature fish in subsequent years.

Operations were initiated in 1911 and were continued in 1912 on the Rivers Wye and Lune by the respective Fishery Boards. In 1913 operations, under the general supervision of the Ministry, were extended to the Rivers Severn and Usk. In 1914 they were further extended to the Rivers Exe and Eden. Finally, in 1915 by the inclusion of the Welsh Dee, the number of rivers in which tagging was conducted amounted to seven.

The numbers of smolts tagged are shown in Table 1.

TABLE 1

Salmon smolts tagged in English and Welsh Rivers 1911-1915

River	1911	1912	1913	1914	1915
Severn	-	-	215	3,060	7,048
Wye	523	4,758	445	1,308	7,454
Usk	-	-	249	940	3,230
Exe	-	-	-	467	4,122
Dee	-	-	-	-	7,711
Lune	1,705	1,347	700	5,182	7,946
Eden	-	-	-	5,938	2,424
Totals	2,228	6,105	1,609	16,895	39,935

In all, 66,772 smolts were tagged and liberated. The tag used on the Wye at first consisted of a plain ring of silver or gold wire. On the Lune the tag used during 1911, 1912 and 1913 consisted of a silver tag attached to an open ring of stout silver which was clamped into the tissues at the base of the dorsal fin by means of pliers specially made for the purpose. After a number of trials the tag which was adopted on all rivers consisted of a plain ring of fine silver wire to which was attached a small silver disc bearing a distinguishing letter. The tag was attached to the fish by threading one end of the wire (with the disc attached) through the superficial tissues at the base of the dorsal fin and then twisting the ends together to form a loop which enclosed the first three or four dorsal fin rays. The glitter of the metal was obscured by oxidising the wire and disc. In each river the aim was to select a point where the smolts were to be caught as close as possible to tidal water in order to (i) secure smolts as distinct from parr, (ii) intercept a representative sample of the season's run of smolts from the watershed as a whole, and (iii) enable the smolts after being tagged to reach salt water without mishap.

In most cases, the capture of the smolts involved the use of small-meshed seine nets. On the Lune, Dee and Exe, the existence of conveniently situated weirs made it possible to dispense with seine nets with their attendant cost, inefficiency and damage to the smolts. Hand nets on the Lune and Exe, and a sliding cage on the Dee, were used to scoop out the smolts as they congregated upstream of the obstructions. On the Dee the arrangements for capture appeared to be almost ideal as the fish were liberated directly into tidal water immediately below the obstruction above which they were caught.

None of the smolts were anaesthetised prior to tagging. The period occupied by the marking operations extended in some cases from the last week in March until the end of May, but experience demonstrated that the main run of salmon smolts occurred from about the beginning of the last week in April until the middle of May. In the northern rivers, the run was a little later than in the west and south.

Although the experiments appeared to have been well-advertised at the time the number of recaptures was remarkably low. Of the 66,772 smolts tagged only 34 (0.05%) were recaptured as adults and 4 of these were recaptured as sea trout. Five fish were caught by anglers, the remainder by commercial fisheries operating in tidal waters. The majority of the recaptures were from the 1915 taggings and no recaptures were reported from the 1911 or the 1913 taggings.

The reasons for the poor returns were not evident. It is possible that the smolts were damaged by being caught in the nets and the methods of handling the smolts during tagging may have left much to be desired. Again, with the technique of tagging allowing little room for growth, the tags may have become detached or they may have become buried under the skin so that they were not, later, visible on the adult fish.

A further large-scale smolt tagging experiment was carried out by the Ministry in the 1950s. It was obvious that before any tagging work could be undertaken, the methods of catching the fish and handling them should be considered most carefully. The need to exercise the utmost care could not be emphasised too strongly and without these precautions any type of tagging is worthless. The tagging experiments in the 1950s were carried out on the River Coquet in Northumberland. Here a wooden horizontal grid-type trap was installed into one of the pools of a fish pass situated at the upper limit of the tidal water. This trap was constructed to catch descending smolts and kelts, the fish

being automatically delivered for tagging into wooden boxes through which the river water flowed continuously. For tagging, each smolt was held in a specially-made rubber block through which water flowed and the operation was carried out with the fish always under water. No anaesthetics were used during any of the experiments.

The main object of carrying out the tagging programme on the Coquet was to find out about movements of sea trout off the East Anglian Coast for during the summer months these fish sustain a small fishery there although the rivers in that area do not contain migratory fish. The salmon smolts were tagged in order to obtain information about their migratory pattern. As no trap for ascending adults was available reports of recaptures had to come entirely from the anglers and commercial fishermen. Consequently, an external tag was used throughout the experiments, no internal tagging being undertaken at all.

All the tags used on the Coquet salmon and sea trout smolts were attached to the anterior end of the base of the dorsal fin. Two kinds of materials were used; one was a small diamond-shaped silver plate, the other a small square Ivorine (Xylonite or cellulose nitrate) plate 0.04 inches thick. In both cases, the attachment was by means of silver wire 0.015 inches diameter. The silver tags were virtually identical to the ones used in the 1911-1915 experiments - indeed some of those used in 1951 were actually surplus tags left over from that period. The wire passed through two holes in the tag and was inserted into the fish using a hypodermic needle. The two ends of the wire were twisted together to form a small loop.

Salmon smolts were tagged during the 1952 to 1957 seasons. In 1952, some of the smolts were tagged with a darkened silver tag, others with a light blue Ivorine tag. Table 2 gives the numbers of smolts tagged together with the corresponding recapture figures.

TABLE 2

Recaptures of Tagged Salmon Smolts

River Coquet

Year of Tagging	Type of Tag	Number Tagged	Number Recaptured	Percentage Recaptured
1952	Darkened Silver	669	18	2.7
	Blue Ivorine	1,488	25	1.7
1953	Blue Ivorine	3,497	68	1.98
1954	Blue Ivorine	2,859	48	1.7
1955	Blue Ivorine	4,000	49	1.22
1956	Blue Ivorine	3,587	34	0.95
1957	Blue Ivorine	6,539	203	3.1

The majority of the tagged salmon were caught after they had spent two years in the sea. A number were caught as grilse and a few were taken after three years. For example, from the 1957 tagging 24 (0.36%) were caught as grilse, the remaining 179 being taken as 2 sea-winter fish. The bulk of the recaptures were taken by commercial nets.

Until 1957 the Ivorine tags did not produce such good results as the silver tags used in 1952 but from that final year's tagging 3.1% were recaptured. Even though an ascending adult trap was not in operation at the time, this percentage recapture figure has not yet been equalled in England and Wales.

The percentage recapture values for the blue Ivorine tags on salmon smolts, therefore, varied from 0.95 to 3.1 and it seems that they were capable of producing at least as good a recapture result as the darkened silver tags used earlier. The wide variation in percentage returns with the Ivorine tags must be ascribed, therefore, to other factors than to the characteristics of the tag itself. For instance, the tagging skill of the taggers might have altered (all the taggers did not tag in all years), the natural survival rate of the smolts may have been higher in 1957 or the intensity of commercial fishing in that year higher than in the preceding four years. When both silver and Ivorine tags were used on the same smolt run, in 1952, the latter did produce a smaller return percentage, but the numbers of recaptures (18 and 25) were small.

Sea trout smolts were tagged in the Coquet during the seasons 1951 to 1957. In 1951, the small darkened silver plate tag was used, exactly the same as those used on the salmon smolts in 1952. In succeeding years Ivorine tags of various colours were used, the tags being fixed to the sea trout in exactly the same way as they were to the salmon. Table 3 shows the numbers of sea trout smolts tagged each year and the recapture percentages resulting.

TABLE 3  
Recaptures of Tagged Sea-Trout Smolts

River Coquet

Year of Tagging	Type of Tag	Number Tagged	Number Recaptured	Percentage Recaptured
1951	Darkened Silver	3,930	84	2.14
1952	Darkened Silver	2,503	40	1.6
	Transparent Ivorine	5,000	63	1.26
1953	Red Ivorine	5,671	24	0.43
1954	Green Ivorine	5,022	32	0.64
1955	Yellow Ivorine	6,031	8	0.013
1956	Grey Ivorine	3,890	5	0.013
1957	Darkened Silver	2,995	22	0.73
	Grey Ivorine	1,060	6	0.57
	Green Ivorine	1,978	6	0.30
	Red Ivorine	566	1	0.18
	Mauve Ivorine	399	0	0
	Carlin Tag	317	1	0.32

Although the silver tags were only used during the first two years they produced the best recapture results. It may be significant that the tags producing the lowest recapture percentages proved to be the most easily visible in the water when they were attached to the smolts and it is possible that these fish may have been subjected to heavier predation. However, as a selection of different coloured tags was not used each year, such factors as seasonal fluctuations in fish survival at sea, and fishing intensity are likely to have had some effect.

Salmon smolts are smaller in size than sea-trout smolts and thus more difficult to tag well, and it could be expected, therefore, that immediately after tagging the tag-loss would be greater from the salmon smolts than from the sea-trout.

However, once they enter the sea, the salmon smolts grow more quickly than the sea-trout smolts, and in the open sea could be expected to encounter less weed than the sea-trout smolts which are believed to be more coastal in their habits. It might be expected, therefore, that the chances of salmon smolt tags being pulled out would be less than for sea-trout tags, after the initial post-tagging period.

In table 3, above, it will be seen that there can be a considerable variation in the recapture percentages produced from tagging using the same tag. Thus, the percentage recaptures of grey Ivorine tags used in 1956 and 1957 were, respectively 0.013 and 0.57. This, again, indicates that the variations in recapture percentages are likely to be due to other factors than tag colour. Indeed, from the 3 occasions on which darkened silver tags were used on the sea-trout smolts (1951, 1952 and 1957) the percentage recaptures were 2.14, 1.60 and 0.73.

Unfortunately the light blue Ivorine tags, which provided the highest recapture percentage, 3.1, for the salmon smolts (Table 2) were not, also, used on sea-trout smolts so no species comparison is possible.

A more detailed analysis of the performance of the darkened silver tag is given in a separate paper submitted by Swain and Champion.

In 1966 comparative smolt tagging experiments were carried out with hatchery smolts on the west coast of Sweden. The English team used the darkened silver tag described above and a recapture percentage of 3.37 was obtained. Although this figure is higher than any obtained in home waters it was still much lower than those achieved by the Canadian workers using modified Carlin tags with a double attachment. As a result of this experiment, and in order to standardise the tags appearing on salmon off west Greenland, the Canadian type of tag was adopted by English workers from 1968 onwards. This consists of a rectangular green plastic plate measuring 9/16 inches by 3/16" with rounded ends. A small hole for the monofilament attachment is provided near one end and the tag also carries the address of the Ministry and a serial number. The tag is attached just below the dorsal fin by means of two lengths of polyethylene monofilament, using a double hypodermic needle. The tag is then secured by tying a double reef knot and the surplus monofilament is cut off. The mounting of the tag is so arranged that the green plate is supported about an inch away from the body of the fish by the monofilament, thus allowing ample room for growth. All the smolts were anaesthetised with MS 222 prior to tagging and the adipose fin was removed from each. As the tag was used for the first time

in 1968, so far only the results of two grilse runs and one 2-year old salmon run are known. The results are shown in Table 4.

TABLE 4

Adult Returns of Canadian-Type Smolt Tag

Year of Tagging	Age of Return (Sea-Winters)					
	1		2		3	
	Carrying Tags	Tag Lost	Carrying Tags	Tag Lost	Carrying Tags	Tag Lost
1968	38	12	36	4	-	-
1969	28	5	-	-	-	-

Table 5 compares these results with those of the darkened silver tag results of the previous three years.

TABLE 5

Comparison of Returns from Darkened Silver and Canadian Type Smolt Tags

	Adult Fish			
	Carrying Tags	Tag Lost	Total	% Tag Retention
Canadian Type Smolt Tag 1968 & 1969	102	21	123	83
Darkened Silver Smolt Tag 1965-1967	250	84	334	75

A comparison between the Canadian tag results for 1968 and 1969 and those obtained with the darkened silver tags used in earlier years involves the assumption (which may or may not be justified) that there has been no significant change in smolt survival in the sea, but the figures in Table 5 indicate that the Canadian-Type tag has probably been slightly less susceptible to loss (Chi square 3.34) than the silver tags.

A higher proportion of the Canadian-type smolt tags than of the silver tags used earlier have been recovered from English and Welsh adult salmon caught off Greenland. Unfortunately for comparative purposes, the period during which these Canadian-type tags were used coincided with considerably increased total catches of salmon off Greenland and a substantially higher reward paid for tagged fish.

In spite of being more clearly visible and also carrying an address, the Canadian-type tag has sometimes been overlooked by fishermen and a few tags have been returned from smoking plants, wholesale merchants and even from an hotel chef.

The risk of non-detection, however, was much greater with the darkened silver tags which were not only smaller, and less visible by virtue of their colour, but also tended to become embedded in the fish.

#### SUMMARY

1. Smolt tags with a single silver wire attachment and in particular, the darkened silver tag, have been in use for a considerable number of years.
2. Recaptures from earlier smolt tagging experiments were extremely low. Netting methods of collecting smolts for tagging and insufficient care in handling them during tagging were probably the chief factors. With improved techniques (eg traps and holding blocks) the number of recaptures increased significantly.
3. In experiments carried out with salmon and sea-trout smolts on the River Coquet, the percentage of salmon recaptures was higher than that of sea-trout. The use of conspicuously coloured tags appeared to produce lower returns, than silver or transparent plastic tags when used on sea-trout but the tagging experiments suggested that this was not always so for salmon.
4. The use of MS 222 anaesthetic in later experiments did not appear to produce a marked improvement in the recapture rate.
5. The Canadian-type smolt tag used in recent years has been somewhat less susceptible to tag loss than the darkened silver tags. The main reason is most likely to be the use of the double attachment. Captor-visibility is better with the Canadian-type tag than with the darkened silver tag.