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Comparisons of different types of tags from the recaptures of marked trout (Salmo trutta L.) in Denmark

by

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ABSTRACT

A Danish tagging experiment was undertaken in the years 1958-1966, among other things to determine the efficiency of external versus internal tags on trout (Salmo trutta L.) from ten different places of liberation. Such factors as types of tags, colour of tags and tag loss are considered. External tags mounted on a single stainless steel wire enclosed in a drain of polyethylene showed a 50% higher total number of recaptures bearing the tag compared to the same tag without a drain. About 70 % of the external tags with a drain are lost after the first year. No differences between recaptures of different colours of external tags could be demonstrated.

The total tag loss of external tags with a drain is about 7 times higher than the most efficient internal tag.

Depending on the thickness of the tag, the position in the dorsal musculature of the fish, differences of tag loss between different types of internal tags could be demonstrated.

1. Introduction.

The different types of tags used in Denmark for salmonids up to 1955 have previously been reviewed by Dahl (1959). During the years 1958-1966 a series of liberations of tagged pond-reared trout were undertaken in different coastal areas of Denmark in order to examine the profitableness of such liberations (Christensen 1967). Fig. 1 shows the geographic position of the 10 liberation localities used in the experiment. During this study a number of different types of tags were applied, many of them having not been used previously, thus making it possible to test and compare their suitability. A total of ab. 82,000 trout were tagged during these years. The result of the taggings are described below, comparing the different types of tags, the technique of tagging and the colour of the tags.

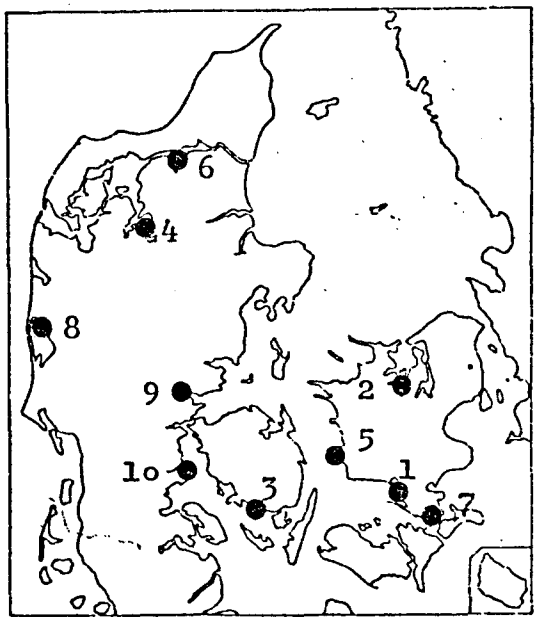
2. Material.

The stocking material used in the tagging experiments was pond-reared trout, all the years originating from the same trout farm, the hereditary origin of the stock however being lost in the past. At the time of liberation the fish were considered to be typical brown trout, whereas the recaptured fish all showed the typical sea trout colours. Both one- and two-year old trout were used in the experiments, the mean lengths being ab. 17-18 cm and 23-24 cm respectively.

The different types of tags and tagging technique used during the experiment are described below. Types 1, 2, 3 and 4 are external tags, types 5, 9, 10, 11 and 18 are internal tags.

Fig. 1.

1: Dybsø
2: Ejby
3: Fjellebro
4: Virksund
5: Korsør
6: Sebbersund
7: Petersværft
8: Ringkøbing
9: Vejle
10: Årøsund



Type 1: Red celluloid tag (14 x 4 x c.5 mm) mounted on a single stainless steel wire (s.s.s.w.) (o.35 x 85 mm). Total weight (tag + wire) ab. o.125 g. The wire is attached to the fish through the back below the posterior third of the dorsal fin by means of a hollow needle.

Type 2: Same as type 1, but wire covered by a drain of polyethylene. Total weight ab. o.175 g.

Type 3: Red celluloid tag (14 x 4 x o.5 mm) on s.s.s.w. (o.35 x 7o mm) in a drain of polyethylene. Total weight ab. o.155 g. The wire is attached to the fish through the back of the fish below the anterior dorsal fin ray by means of a hollow needle.

Type 4: Same as type 3, but green.

Type 5: Red celluloid tag (14 x 4 x o.5 mm). Through an incision made with a fine scalpel the tag is inserted into the dorsal musculature by means of a flat-pointed pair of pincers. The tag is pushed down into the incision in a ventro-caudal direction and is placed in the dorsal muscle about ½ - 1 cm lateral to the dorsal fin. In 1959 the distance from the edge of the incision to the middle part of the tag was ab. 2 cm, in 196o ab. 3 cm.

Type 9: Green celluloid tag (14 x 4 x o.4 mm). Total weight ab. o.o28 g. Placed in the fish like type 5. The distance from the edge of the incision to the mid of the tag was ab. 2 cm for the one-year old trout and ab. 3 cm for the two-year old trout.

Type 1o: Green celluloid tag (14 x 4 x o.5 mm). Total weight ab. o.o35 g. Placed in the fish like type 9.

Type 11: Red celluloid tag (14 x 4 x o.5 mm). Total weight ab. o.o35 g. Placed in the fish like type 9.

Type 18: Green celluloid tag (14 x 4 x o.3 mm). Total weight ab. o.o23 g. Placed in the fish like type 9.

All the fish were both tagged and fin-clipped (adipose and/or pelvic fins). Fin-clipping was made according to a special code, allowing the recaptured fish to become identified with respect to year of liberation and type of tag, even if the tag had been lost. Only in 1958 the same fin-clip code was used at those localities where tag 1 and 2 were used at the same time (table 1).

The fish were fin-clipped at the trout farm, whereas the tagging took place at the different liberation stations, and each fish was liberated immediately after tagging. The whole procedure was performed without any use

of anaesthetics. All liberations were undertaken in April - May.

Ten different ccastal areas were chosen for the liberations during the whole experiment (fig. 1, table 1). The localities were distributed all over the country, thus differing from each other with respect to salinity, current and depth. The hydrological differences between the localities were reflected by great variations in the number of recaptures. However, this paper deals only with the proportion between fish without a tag but fin-clipped (-m) and fish with a tag (+m) in relation to the total number of recaptures T (=(-m) + (+m)), presuming that these proportions only depend on the type of tag, the tagging technique and experience in the individual year of liberations.

By far the greater part of the recaptured fish (i. e. with or without tag, but fin-clipped) were sent to the institute and examined for length, weight, sex, stomach contents and condition of tag. In a few cases only the later information was supplied without the investigator having been able to examine the fish in person.

It should be mentioned that in 1958 no size limit was claimed for recapture of the tagged/marked trout, but in 1959 a size limit of 3o cm was claimed. From 196o and onwards the size limit was 4o cm, like the official Danish size limit for sea trout. From the growth data the percentual part of those trout which exceeded 4o cm as a function of time after liberation could be calculated and has been used in this context in order to make the material from the liberations in 1958 and 1959 comparable to the other years.

The efficiency of the different tags can be compared by calculating the raising factor. This is the figure with which the actually observed number of recaptured fish above 4o cm still with the tag intact (+m) must be multiplied in order to give the true number of recaptures (T). In order to obtain a reliable comparison between the rate of loss of the different tag types the proportion -m/T has been calculated in table 2. 1 - (-m/T) gives the fraction of the total recaptures in which the tag was still intact (+m/T), which again gives the raising factor T/+m. A tag which is not lost at all has a raising factor of 1, whereas a tag with a high rate of loss has a raising factor greater than 1.

3. Results and discussion.

All the basic results covering most of the total material are recorded in table 2. The results of the remaining material are described below.

3.1. External tags.

The 4 types of external tags were only used in 1958 and 1959 (table 1). It appears from table 2 that the tags are very quickly expelled from the bo-

dy of the fish, so that the proportion -m/T increases. As the fin-clip code in 1958 gave no possibility for separating tag 1 and tag 2 at the three localities where they were used simultaneously, we can only compare the total number of recaptures with a tag (i.e. (+m)) from the localities 1, 2, 6 and 10:

	tag 1	tag 2	both tags
number liberated	6,000	2,000	8,000
number caught (+m)	600	301	901
number caught (-m)	?	?	1,298
% of recapture	10.0	15.1	27.5

The number caught with a tag mostly comprised undersized fish. If we exclude these the raising factor for type 1 can be calculated to 9.41. Though the raising factor of tag type 2 cannot be estimated directly from the results above it can be deduced that it must be about 2/3 of 9.41, i.e. ab. 6.3. Thus a wire covered by a drain results in a slower rate of tag loss.

The tag types 3 and 4 only differed in colour. At the localities 2, 6, 7 and 8 both tags were used simultaneously.

	type 3	type 4
number liberated	4,000	4,000
number caught (+m)	316	274

A Chi-square test showed no difference between these two tags (x^2 = 2.99, $0.05 < p < 0.1$, D. of f. = 1). Therefore the results from the two tags are pooled together in table 2. The efficiency of tag 3 and 4 is much higher than that of tag 1 and 2, but a percentage of recaptures based only on recaptured fish with the tag still intact seriously underestimate the real figure. It is not known whether the shorter length of the wire or the different position of the wire in the fish is the cause of the difference between tag 1 and 2 as compared with tag 3 and 4.

3.2. Internal tags.

The 5 types of internal tags differed by size, colour, and position in the dorsal musculature of the fish. It is clearly seen from table 2 that the total loss of internal tags is much lower, irrespective of the type, compared with the external tags. From table 2 it appears that the figure (-m/T) does not increase as a function of time as it does for the external tags, so it must be assumed that a certain fraction of the internal tags are lost at once, probably immediately after tagging.

Tag 5 was used both in 1959 and 1960. In 1960 the tag was inserted

deeper into the musculature than in 1959 and the raising factor decreased from 1.42 to 1.19. This difference, however, may also be explained by a better tagging experience of the tagging team. But tag 9 was also used in 1960 and compared with tag 5 the raising factor of this tag was 1.28. The thickness of tag 9 (0.4 mm) may explain this difference as it seems rather unreasonable to believe that green versus red colour of internal tags would have anything to do with this difference. Tag 9 was also used for one-year old trout and in this case the raising factor was a little lower than for the same tag used for two-year old fish. The number of liberated one-year old fish is however too small for any safe conclusions.

Type 10 and 11 differed only in colour and throughout the years 1961-1966 no differences in tag efficiency and raising factor could be observed (table 2).

Type 18 was only used in 1966. With a thickness of only 0.3 mm its efficiency was relatively low. (table 2).

In order to illustrate the importance of using a tag with a high efficiency the described tags may be compared in a fictive tagging experiment where the total percentage of recaptures is 10, that is calculated from (+m) + (-m)/ number liberated. Normally only (+m) is known, but from the results described above (-m) is also known because of the simultaneous fin-clippping.

	true % of recapture	raising factor	observed % of recapture
tag 1	10	9.41	1.1
- 2	10	(6.27)	1.6
- 3, 4	10	3.70	2.7
- 5 (1959)	10	1.42	7.0
- 5 (1960)	10	1.19	8.4
- 9	10	1.28	7.8
- 10	10	1.10	9.1
- 18	10	1.48	6.8

This very clearly illustrates the importance of using a tag with a very low or no rate of loss, or at least to know the rate of tag loss. The external tags without an alternative marking such as that used in these experiments are of no value at all. Internal tags require either some kind of automatic sorting device or the investigator must be able to examine all the recaptured fish. Both of these methods will normally be very expensive.

4. References.

Christensen, O., 1967: Resultaterne af udsætningsforsøg med ørreder. (The results of experiments with liberations of trout.) - Ferskvandsfiskeribladet 65 (9):134-140.

Dahl, J., 1959: A review of the efficiency of the types of tags used in Denmark for salmon and sea trout, as shown by the recaptures. - Rapp. Proc. Verb. Réun. Cons. int. Explor. Mer 148:19-22.

Place of liberation and code	1958	1959	1960	1961	1962	1964	1965	1966
Dybsø, 1	1 - 1500 - 2 2 - 500 - 2					10 - 1000 - 2 11 - 1000 - 1		18 - 978 - 2 11 - 974 - 1
Ejby, 2	1 - 1490 - 2 2 - 500 - 2	3 - 1000 - 2 4 - 1000 - 2	9 - 500 - 2 9 - 1000 - 1	10 - 1435 - 2	10 - 1500 - 2	10 - 1000 - 2 11 - 1001 - 1	10 - 1000 - 2 11 - 1000 - 1	18 - 1003 - 2 11 - 964 - 1
Fjellebro, 3	1 - 1973 - 2	3 - 2000 - 2	9 - 1500 - 2	10 - 1500 - 2	10 - 1500 - 2			
Virksund, 4	1 - 1978 - 2	3 - 1000 - 2 4 - 1000 - 2	9 - 1500 - 2	10 - 1500 - 2	10 - 1500 - 2		10 - 500 - 2 11 - 500 - 1	
Korsør, 5	1 - 2000 - 2	3 - 1000 - 2 5 - 1000 - 2	5 - 1500 - 2	10 - 1500 - 2	10 - 1500 - 2			
Sebbersund, 6	1 - 1500 - 2 2 - 500 - 2	3 - 2000 - 2	9 - 1500 - 2	10 - 1500 - 2	10 - 1500 - 2			
Petersværft, 7		3 - 1000 - 2 4 - 1000 - 2	5 - 1428 - 2	10 - 1482 - 2	10 - 1500 - 2			
Ringkøbing, 8		3 - 1000 - 2 4 - 1000 - 2	9 - 500 - 2 9 - 1000 - 1	10 - 1500 - 2	10 - 1500 - 2	10 - 1000 - 2 11 - 1000 - 1	10 - 1000 - 2 11 - 1000 - 1	18 - 1000 - 2 11 - 1009 - 1
Vejle, 9		3 - 1000 - 2 5 - 1000 - 2	5 - 1494 - 2	10 - 1500 - 2	10 - 1500 - 2			
Årøsund, 10	1 - 1500 - 2 1 - 500 - 2							

Table 1: Types of tags, number and age of tagged fish in the years of study. The table reads as follows:

Dybsø, 1958: tag type 1, 1500 specimen, age 2 years.

tag type 2, 500 specimen, age 2 years.

etc.

tag type	1			3, 4			5			5			9		
age of fish	2 years			2 years			2 years			2 years			2 years		
place of liberation	3,4,5			2,3,4,5,6,7,8,9			5,9			5,7,9			2,3,4,6,8		
year of liberation	1958			1959			1959			1960			1960		
total no. liberated	5951			14000			2000			4422			5500		
total no. recaptured	2631			3503			436			389			510		
% recaptured	44.2			25.0			21.8			8.8			9.3		
total no. recapt. ≥ 40 cm	731			1215			153			360			474		
% recapt. ≥ 40 cm	12.3			8.7			7.7			8.1			8.6		
	-m	T	-m/T	-m	T	-m/T	-m	T	-m/T	-m	T	-m/T	-m	T	-m/T
1. quarter	23	1166	0.0198	45	401	0.1123	5	41	0.1220	0	3	0	2	6	0.3334
2. quarter	349	587	0.5946	912	1350	0.6756	56	200	0.2800	5	28	0.1786	21	106	0.1982
3. quarter	230	288	0.7987	1089	1309	0.8320	45	132	0.3409	10	73	0.1370	19	81	0.2346
4. quarter	43	58	0.7414	65	93	0.6990	6	18	0.3334	5	34	0.1471	5	36	0.1389
1. year	645	2099	0.3073	2111	3153	0.6695	112	391	0.2864	20	138	0.1449	47	229	0.2052
2. year	449	460	0.9761	285	320	0.8906	11	39	0.2821	37	221	0.1674	49	228	0.2149
3. year	57	57	1.0000	21	22	0.9545	3	6	0.5000	6	30	0.2000	10	33	0.3030
4. year	5	5	1.0000	1	2	0.5000									
total all years			0.4394			0.6917			0.2890						
total ≥ 40 cm			0.8937			0.7300			0.2939			0.1620			0.2163
raising factor = $(1-(-m/T))^{-1}$	9.41			3.70			1.42			1.19			1.28		

Table 2:

tag type	9			1o			1o			11			18		
age of fish	1 year			2 years			2 years			1 year			2 years		
place of liberation	2,8			2,3,4,5,6,7,8,9			1,2,4,8			1,2,4,8			1,2,8		
year of liberation	196o			1961, 1962			1964, 1965			1964, 1965, 1966			1966		
total no. liberated	2ooo			23917			55oo			8448			2981		
total no. recaptured	236			3872			154o			98o			5oo		
% recaptured	11.8			16.2			28.o			11.6			16.8		
total no. recapt. ≥ 4o cm	221			3693			1416			5o6			463		
% recapt. ≥ 4o cm	11.1			15.4			25.7			1o.7			15.5		
	-m	T	-m/T	-m	T	-m/T	-m	T	-m/T	-m	T	-m/T	-m	T	-m/T
1. quarter				o	18	o	1	15	o.o667	o	4	o	1	1	1.oooo
2. quarter				43	843	o.o51o	31	333	o.o931	3	18	o.1667	51	136	o.375o
3. quarter				56	949	o.o59o	41	249	o.1647	13	82	o.1585	43	115	o.3739
4. quarter				28	318	o.o881	13	2o5	o.o635	15	127	o.1181	18	61	o.2951
1. year	5	46	o.1o87	127	2128	o.o597	86	8o2	o.1o72	31	231	o.1342	113	313	o.361o
2. year	18	16o	o.1125	16o	1553	o.1o3o	51	549	o.o929	7o	624	o.1122	32	139	o.23o2
3. year	5	1o	o.5ooo	18	173	o.1o4o	6	61	o.o984	5	47	o.1o64	5	11	o.4545
4. year				2	18	o.111o	o	4		1	4	o.25oo			
total all years															
total ≥ 4o cm			o.1296			o.o793			o.1o1o			o.1181			o.324o
raising factor = $(1-(-m/T))^{-1}$	1.15			1.o9			1.11			1.13			1.48		

Table 2:(contd.)