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A TAGGING AND RELEASE EXPERIMENT OF 2-GROUP ARTIFICIALLY REARED COASTAL COD (*GADUS MORHUA*)

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ABSTRACT

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Cod were raised in an outdoor enclosure for the first 3 months after hatching and then transferred to the laboratory. After 2 years and at a length range from 33 to 52 cm (0.3 kg to 1.3 kg), 68 cod were tagged and released in the Flødevigen Bay area. Of these cod, 29% were reported recaptured and most of these (65%) were fished not more than 5 km from the place of release. The results indicated that the fish disperse quickly within the area after release, with one moving about 5 km within one day. The fish dispersed in both directions along the coast, moving a maximum of 30 km in each direction. Of the fish recaptured, 50% were reported within 30 days and 75% within 100 days. No recapture was reported later than 16 months after the release. Released cod tend to migrate little, although these cod (33-52 cm) dispersed over a wider area than did smaller cod (7-17 cm) in previous release experiments in the same area. The recapture rate indicates that releasing artificially reared cod for later harvesting of market size cod (minimum 1.5 kg), will not be economically profitable.

INTRODUCTION

Since the first tagging and release experiments with reared juvenile cod (Moksness and Øiestad 1984) in 1976 and 1977, several similar experiments have started and still proceed. The three main release areas in Norway today are in Western Norway (Noreide and Salvanes 1988, Svåsand 1985, Svåsand and Godø 1987, Svåsand et al. 1987a, Svåsand et al. 1987b), Southern Norway, and Northern Norway. In all but one, these experiments (Svåsand, in prep), juvenile cod (10-20 cm; ~ 50 g) were released. The preliminary results from these experiments confirm the observation of Moksness and Øiestad (1984) that the small released cod tend to stay in the area where they are released, that the growth rate of the released cod is about the same as for wild fish in the same area, and

that most of the returns occur within 2 years. In addition, results from recent investigations (Svåsand, in prep, Godø et al. 1986) show that the recapture rate increases with the size of the cod at release.

The present paper describes an experiment where 33-52 cm cod were released in the same area where Moksness and Øiestad (1984) released small cod (7-17 cm). The paper also discusses the effect of size at release on recapture rates, migration, and production cost of the recaptured cod.

MATERIALS AND METHODS

A fertilized egg batch from the local cod stock was incubated in the laboratory. The larvae hatched on 13 April 1985 and were transferred to a 4400 m^3 outdoor basin at an age of 4 days. The basin was drained on 17 July 1985 and 111 of the surviving cod juveniles were transferred to the laboratory. In the laboratory, the cod were kept in 4.5 m^3 basins and fed moist pellets three times a week until the time of release, 22 months later. During the laboratory period, 39% of the fish died from infection of the parasite *Trichodina* sp. The cod were exposed to variations in temperature from 3.0°C to 14.0°C and a stable salinity of 34.0 ± 0.4‰. At the time of release the temperature and salinity in the laboratory were 5.0°C and 34.0‰ respectively. Simultaneously in the release area, temperatures and salinities were respectively 11.5°C and 21.3‰ at the surface, 10.8°C and 24.8‰ at a depth of 1 m, 8.0°C and 30.0‰ at a depth of 19 m, and 5.3°C and 34.3‰ at a depth of 75 m. The average wet weight and average total length of the fish were 754.5 ± 197.3 g and 42.5 ± 4.0 cm respectively. The size distribution of the released cod are given in Fig. 1. A total of 68 cod were tagged with Floy anchor tags and released on 18 May 1987 in the Flødevigen bay next to the Flødevigen laboratory (see Fig. 2).

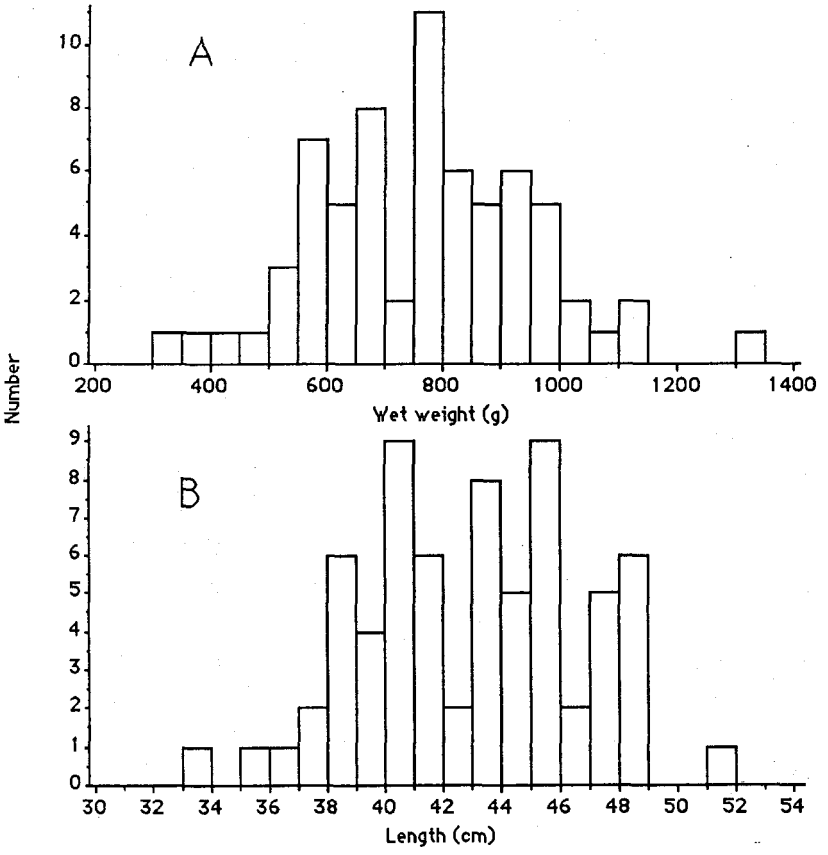

Fig. 1. The total wet weight frequency (A) and total length frequency (B) distribution of the tagged cod at release (18 May 1987).

RESULTS

The first tagged cod were caught in a net about 5 km from the release point within 1 day of release (Fig. 2). The total number of tags returned by 1 October 1989 was 20, or 29.4% of all the tagged fish. Of these, 1 and 4 were reported taken by net and hook respectively, while no such information was available for the other 15 captured cod. Of the reported recaptured fishes, 65% were caught within 5 km of the release area, as indicated in Fig. 2. The most distant recaptures were about 30 km from the release area, in both directions along the coast line. Unfortunately, limited information are available on the weight and length of the

recaptured cod. The recapture data indicate that the cod caught were distributed randomly in relation to size distributions at release.

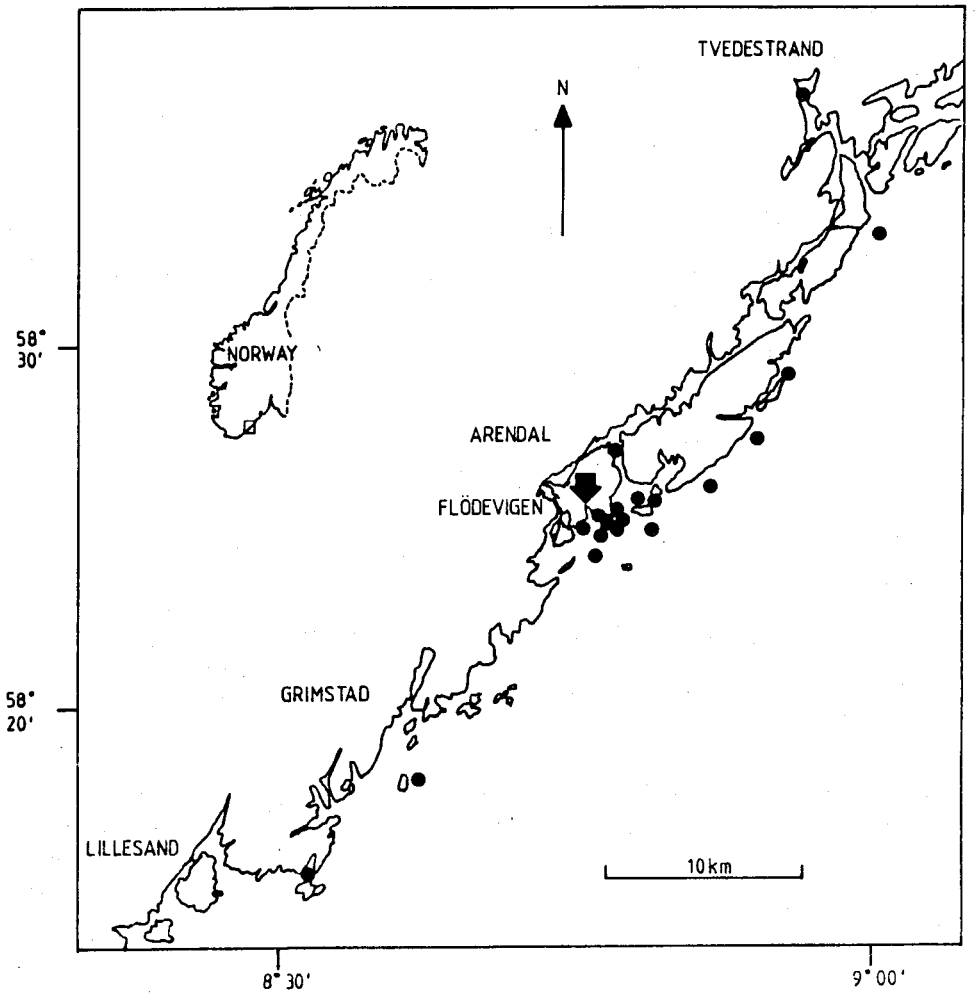

Fig. 2. Location of release (arrow at Flødevigen) and location of recapture (•) of the tagged cod.

Most of the released fish were recaptured within four months (to August 1987) of release (Fig. 3). Of the recaptures, 50% were captured within 30 days and 75% within 100 days of release. Only 4.4% were reported recaptured during the following year. The last recapture was reported 13 September 1988, approximately 16 months after release.

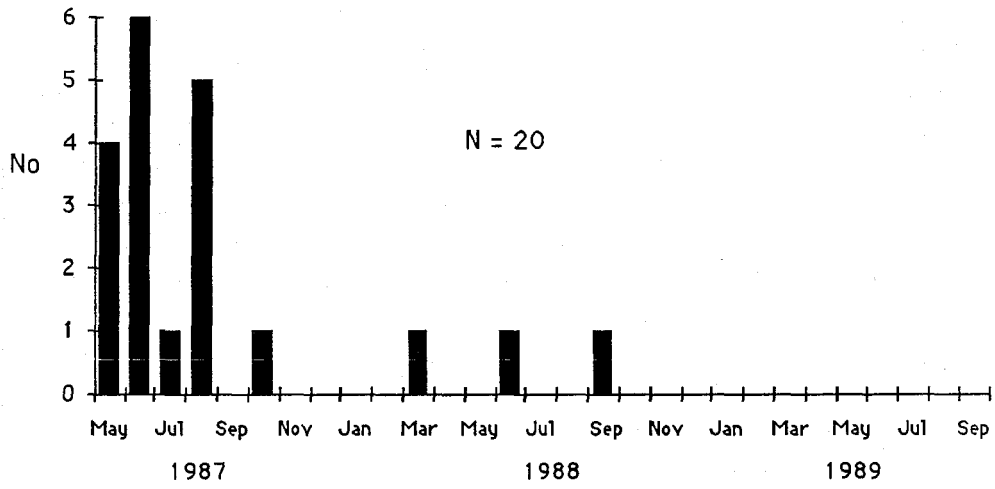

Fig. 3. Number of recaptured cod in each month from the release in May 1987 to September 1989.

DISCUSSION

The cod in this study had been reared for two years before they were tagged and released in the same area as 0-group cod in the earlier release experiment (Moksness and Øiestad 1984). At release, the temperature at the surface in the sea was more than 5.8°C higher than in the laboratory. However, mortality caused by both tagging and the differences in temperature is expected to be very low. The recapture of the tagged cod indicate that the cod disperse quickly after release, with one cod moving 5 km within 24 hrs after the release. Recaptures were reported until 16 months after the release, and the cod had spread over a much larger area than in the the previous study (Moksness and Øiestad 1984). This indicates that as the size at release increases, the cod disperse over a greater area. The recapture rate (29.4%) in the present study is more than three times that in the earlier release experiment with 0-group cod in the same area (Moksness and Øiestad 1984). This is in accordance with other studies, where the recapture rate increased with increasing size of the fish at release (Godø 1986, Svåsand, in prep). Svåsand and Kristiansen (in press) also concluded that natural mortality decreases and fishing mortality increases as the size of the cod at release increases.

In the present study, most of the recaptures occurred within the first 100 days after release; only 4.4% were recaptured more than one year after release or greater than 1.5 kg in total wet weight. Few cod were used in this investigation (68 released; 20 recaptured). However, the results are in accordance with studies by Godø et al. (1986) and Svåsand (in prep), who released cod in the size range 25 to 70 cm. In both studies the recapture rate was initially high: between 32 and 48% were reported recaptured, with only about 5% recaptured later than one year after the release. Danielssen (1969) found an almost linear relationship between size at release and recapture rate of wild cod, starting out with a recapture rate of 5% at 20 cm and increasing to 55% at 100 cm. In 21 transplantation and control experiments with same sized wild cod (mostly 31-45 cm total length) in the Baltic and the neighbouring Kattegat area from 1962 to 1968, the recapture rate varied from 14.7 to 34.0% (Otterlind 1985). Most of the returns were reported within the first year after the release and cod transplanted to a new area behaved and migrated similarly to the local stock in the area. An overview of some tagging experiments with different sized cod is given in Table 1. For cod released as 0-group, less than 5% have been recaptured later than 2.5 years after release (above an estimated size of 1.5 kg) (Table 1).

Table 1

Overview of some tagging experiments, both with reared (r) and wild (w) cod, showing recapture rate later than 1 and 2.5 years after release of cod released as respectivily 0-group (7-22 cm) and older than 0-group (larger than 25 cm).

Size at release	r/w	Total recapture (%)	Recapture later then 1 year (%)	Recapture later then 2.5 year (%)	References
0-group	r	15.0		3.3	Svåsand and Godø (1987)
7 - 17 cm	r	3.8 - 10.2		0.0	Moksness and Øiestad (1984)
10 - 22 cm	r	7.6 - 11.7		< 1.0	Svåsand et al. (1987b)
15 - 20 cm	r	0.8 - 17.5		-	Svåsand (1985)
25 - 45 cm	r/w	40 - 47.9	4.9		Svåsand (in prep)
25 - 49 cm	r	32.0	5.0		Godø et al. (1986)
30 - 80 cm	r	40.0	5.0		Godø et al. (1986)
33 - 52 cm	r	29.4	4.4		Present study
15 - 84 cm	w	10.9 - 34.0	-		Otterlind (1985)
< 40 cm	w	3.0			Otterlind ock Norberg (1988)
> 40 cm	w	12.6			-
22 - 110 cm	w	24.9 - 35.6	11.1		Danielssen (1969)

From the above discussion it is concluded that (1) the 2-group cod in the present study tend to stay in the area where they are released, but they do disperse more than cod released as 0-group, (2) the recapture rate is initially higher and in total more than twice that of the 0-group cod and (3) for both size groups, 0- and 2-group, less than 5% of the recaptures are taken later than 2,5 and 1 year (at a total wet weight larger than 1.5 kg) after the release, respectively.

The tagging experiments with cod have given valuable information on the natural population of cod in terms of feeding ecology, migration, and estimation of natural and fishing mortality. In addition, there is today a growing interest in releasing cod to increase production in local areas. However, as pointed out by Godø et al. (1986), most of the released cod are taken by gamefishing as small-sized fish, as indicated in Table 1, fewer than 5% of the released cod (either 0- or 2-group) being recaptured at a size greater than 1.5 kg (minimum market size). The following sescribes two simple approaches to estimate minimum acceptable recapture rate (approach 1) and minimum initial cost of recaptured, released cod (approach 2). The two approaches are summarized in Table 2. For both approaches the production costs of 0- and 2-group cod are set to 5 and 10 NOK respectively. The market price

paid to the fishermen for cod above 1.5 kg in size is set to 15 NOK per kg. Approach 1 is as follows: releasing 100 of each of 0- and 2-group will have a production cost of 500 and 1000 NOK respectively. With an average market price for cod to the fisherman equal to 15 NOK/kg, 33 and 66 kg of the two released size groups respectively must be caught to break even. With an average wet weight of 2 kg for recaptured cod, the recapture rates needed are calculated at respectively 17% and 33% of 0- and 2-group cod, fished later than 2.5 and 1 year from release, which is more than three times the estimated recapture rate of cod larger then 1.5 kg (see Table 1).

Approach 2 is as follows: when releasing either 0- and 2-group cod, fewer than 5% of these cod (Table 1) will be fished as market size cod (minimum 1.5 kg). This means that for every recaptured cod above 1.5 kg, a minimum of 20 must be released with a total production cost of at least 100 and 200 NOK respectively. This is above what will be paid to the fishermen for each fish on average.

From the above discussion it is concluded that releasing cod for later harvesting of market sized cod (minimum 1.5 kg), will not be economically profitable with the described methods. As indicated by the two approaches (Table 2), there have to be rather large changes in both the production cost of the juveniles and the market price to the fishermen before such a release can be profitable.

Table 2

Two approaches to estimate minimum acceptable recapture rate (approach 1) and minimum initial cost of recaptured, released cod (approach 2).

	0-group (15-20 cm)	2-group (35-45 cm)
(A) Production cost/cod	5 NOK	10 NOK
(B) Market price to fisherman/kg (cod > 1.5 kg)	15 NOK	15 NOK
Approach 1:		
(C) Production cost/100 cod (C=A*100)	500 NOK	1000 NOK
(D) Break even in kg (D=C/B)	33 kg	66kg
(E) Minimum percentage recapture; cod > 1.5 kg (E=(100*(D/2))/100)	17 %	33 %
Approach 2:		
Recapture as > 1.5 kg (from Table 1)	5 %	5 %
(F) Number cod released/cod recaptured	20	20
(G) Production cost/cod recaptured (G=F*A)	100 NOK	200 NOK

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