Chapter 22
Successful survival of wrasse through winter in submersible netcages in a fjord in western Norway

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Most wrasse stocked with salmon die during the winter. A trial was undertaken to try to improve winter survival using four closed net cages ($3\,m^3$) each filled with approximately 200 wrasse. Two cages were deployed in late October 1993 at a depth of 17 m and two at 25 m at Åkre in Hardangerfjord in western Norway. At each depth, one cage was filled with goldsinny [*Ctenolabrus rupestris* (L.); total length 8–14 cm], and the other with corkwing [*Crenilabrus melops* (L.); total length 9–18 cm]. The cages were inspected monthly. In late April 1994, the cages were raised to the surface. An average of 94% goldsinny survived, compared with only 13% corkwing. The average condition factor (CF) decreased for all groups during the experiment, and was most pronounced for corkwing. Deployment at different depths did not influence the decrease in CF.

22.1 Introduction

In commercial Atlantic salmon (*Salmo salar* L.) farming in Norwegian waters, smolts are attacked by sea lice (*Lepeophtheirus salmonis* Krøyer and *Caligus elongatus* Nordmann) immediately after release to seawater from April to May (Viga, *pers. comm.*). Where wrasse are used to control sea lice infestations, few are available at the time of first stocking because of low catches to the fishery. In addition, most wrasse kept with salmon in net pens die during winter (Kvenseth, 1993). Successful maintenance of wrasse through winter would make them available before the first sea lice infestations. Improved survival of wrasse over winter would also be important in avoiding possible local over-fishing by reducing annual demand. Preliminary experiments on overwintering wrasse in shallow water (2–13 m) gave promising results with 34–68% survival (Skog *et al.*, 1994). In nature, some wrasse may migrate to deeper waters in winter (Hilldén, 1984). The aim of the present study was to increase winter survival of wrasse by deploying cages at greater depths than those used by Skog *et al.* (1994).

20.2 Materials and methods

The experiment was performed at a MOWI salmon farm at Åkre in the Hardangerfjord in Western Norway, from 28 October 1993 until 20 April 1994.

Wrasse were caught by fyke nets within a range of 1 km from the salmon farm and stored for about one to two weeks in an empty pen prior to the experiment. Only wrasse without wounds or signs of disease were used in the experiment. Wrasse were sorted by species into two groups: 358 goldsinny [*Ctenolabrus rupestris* (L.)] and 369 corkwing [*Crenilabrus melops* (L.)].

Wrasse were maintained in submersible cages at two different depths, 17 and 25 m. The species groups were divided between two cages at each depth. The species were kept in separate cages to avoid any interspecific competition. The cages measured 1 × 1 × 3 m and were made with a solid wooden floor and a wooden frame covered with 12 × 12 mm^2 net (Fig. 22.1).

Shelters for the wrasse were provided in each cage, made of sectioned (40 cm long) plastic pipes (50 mm dia.), tied together and attached to the floor. There were 80 pipes in each cage. In addition, two black plastic bags were shredded to look and function as artificial seaweed. Each cage was anchored to 100 kg concrete blocks resting on the fjord bottom (Fig. 22.1). For stabilization small

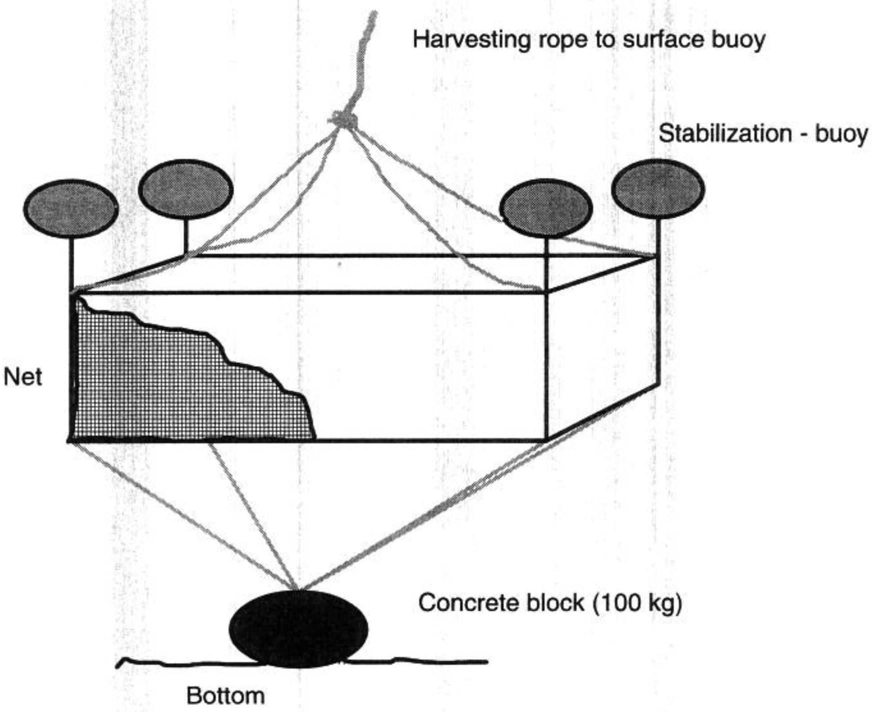

Fig. 22.1 Submersible net cage used to keep goldsinny and corkwing wrasse through the winter.

subsurface buoys were located at each corner of the cages. A harvesting rope was attatched to the top of each cage. The cages were not influenced by wind or surface wave action.

Before the cages were submerged, about 45% of the fish were measured at random for total length (TL) to an accuracy of 1 mm, and wet weight (W) to the nearest g. A condition factor (CF) was calculated using Fulton's formula:

$$(W \times 100)/TL^3,$$

where W was in g, TL in cm. The fish were not anaesthetized before measuring. A sample of 30 goldsinny and 30 corkwing were killed and examined immediately for live ectoparasites.

The cages filled with wrasse were quickly lowered to the nominal depths. To avoid stressing the fish while submerged, they were not fed and no samples were taken during the experimental period. The cages were inspected monthly, except in January, by SCUBA divers, and the activities of the wrasse recorded for about 30 min. by video camera.

Temperature and salinity recordings were made daily at depths of 1 and 10 m. Measurements were only sporadically performed at 20 m from November to April. Temperature was measured with an accuracy of 0.1°C using a mercury thermometer. Salinity was estimated by means of a densimeter to the nearest ‰.

At the end of the experiment, the cages were raised to the surface over time periods of 5–30 min. All surviving fish were transferred to tanks with fresh seawater, and length and weight measured for all living corkwing, and 60% of living goldsinny. A random selection of about 20 surviving fish from each cage were examined for ectoparasites.

22.3 Results and discussion

22.3.1 *Water quality and wrasse activity*

The lowest temperature during the experimental period at 10 m depth was 2.8°C (27 February 1994), the highest 12.1°C (1, 3 and 11 October 1993) (Fig. 22.2). The lowest temperature at 20 m was 3.9°C (21 March 1994), the highest 10.2°C (8 November 1993).

The video recordings showed decreasing activity of wrasse through winter, although this was neither defined or quantified. It was assumed that goldsinny were in a torpid state in periods from January to the end of the experiment. This state of torpor has previously been reported for goldsinny (Hilldén, 1984; Kvenseth, 1993; Chapter 10, this volume); corkwing have not been observed in this condition (Hilldén, 1984). During January to April the average temperature at depths of 10 and 20 m was below 5°C, in the range 2.8–5.5°C at 10 m, and 3.9–5.3°C at 20 m.

Throughout the experimental period, salinity was highest at 20 m depth (Fig.

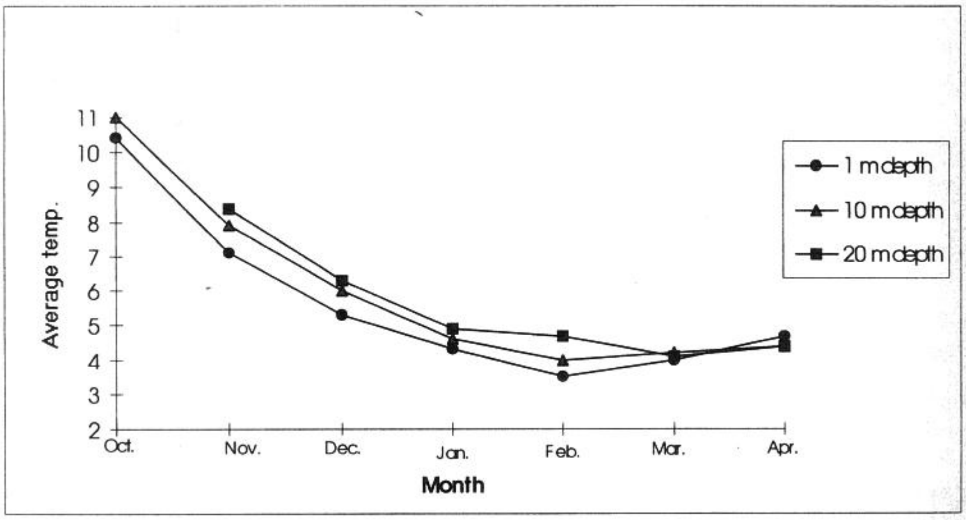

Fig. 22.2 Average monthly temperature (°C) at depths of 1, 10 and 20 m for the months in the experimental period.

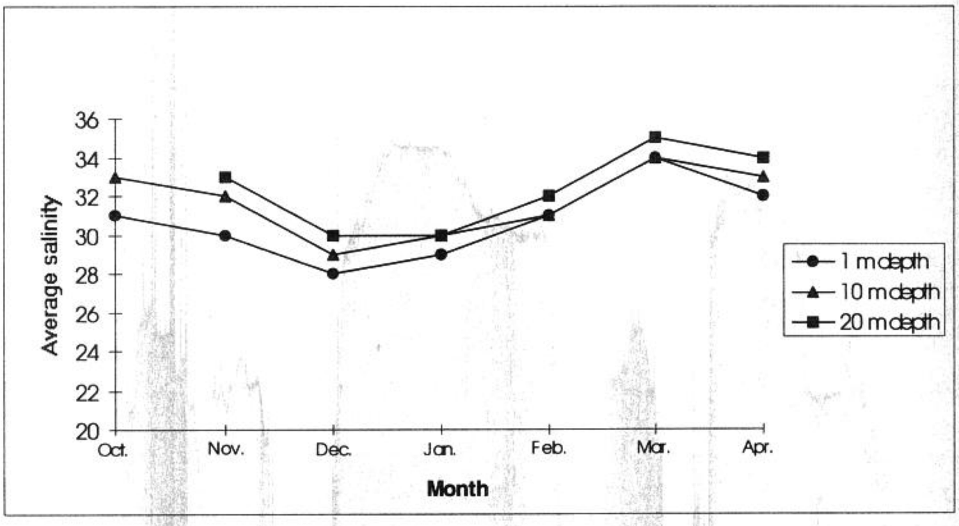

Fig. 22.3 Average monthly salinity (‰) at depths of 1, 10 and 20 m for the months in the experimental period.

22.3). The lowest salinity measured at 10 m depth was 24‰ (December and January), and the highest 35‰ (October, November, January, March and April). The lowest salinity at 20 m was 25‰ (December and January), and the highest 35‰ (November, December, February, March and April).

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vulnerability to low salinity for either corkwing or goldsinny. As the lowest salinity measurement during the experiment was 25‰, it is assumed that salinity had no influence on mortality.

22.3.2 *Wrasse survival*

There were marked differences in survival between the species during the six months of submergence (Table 22.1). A total of 91.8% of goldsinny survived at 17 m depths, and 95.5% at 25 m. For corkwing, 12.4% survived at 17 m, 14.0% at 25 m. For both species, there were no significant differences between the two depths (Fishers exact test, $\alpha = 0.05$).

If goldsinny were in a torpid state for most of the experimental period, this might explain the higher level of survival. According to Hilldén (1984), goldsinny do not eat at temperatures below 5°C. Lack of food would therefore be unlikely to affect survival. The relatively high densities at which they were maintained did not appear to affect goldsinny survival. Goldsinny have been observed crowded in crevices during winter (Harberg, *pers. comm.*), but the natural behaviour of corkwing is not well known. High corkwing mortality in this experiment indicates that they may have other winter survival strategies in the field compared with goldsinny.

22.3.3 *Wrasse condition*

The average weight of corkwing decreased during the experimental period (Table 22.2). The largest reduction was observed for corkwing at 25 m, with an average loss of 23% whole body weight. The average whole body weight reduction of corkwing at 17 m depth was 11%. Average length decreased for both groups of corkwing (Table 22.2). Corkwing CF decreased from 1.6 to 1.3 at both depths. Because of high corkwing mortality, it is difficult to draw any firm conclusions from these results, but the decrease in CF may reflect poor living conditions.

Goldsinny gained weight during the over-wintering by an average of 5.6% body weight at both depths. The average length of goldsinny increased at both depths.

Table 22.1 Survival of corkwing and goldsinny at 17 and 25 m depths.

Species	Depth (m)	Number at start	Number of survivors	Dead counted	Survival (%)
Corkwing	17	169	21	14	12.4
	25	200	28	7	14.0
Goldsinny	17	158	145	2	91.8
	25	200	191	0	95.5

Table 22.2 Weight (W), total length (L) and condition factor (CF) of corkwing and goldsinny before and after submergence.

	Species	Depth (m)	Number measured	Mean W (g) (range)	Mean L (cm) (range)	Mean CF (range)
Before submergence	Corkwing		169	35 (11–96)	12.8 (8.7–18.4)	1.6 (1.0–2.9)
	Goldsinny		158	18 (9–47)	10.6 (8.3–14.1)	1.4 (0.8–2.8)
After submergence	Corkwing	17	21	31 (14–56)	13.0 (11.1–15.8)	1.3 (1.0–1.8)
	Goldsinny	17	86	19 (10–47)	11.3 (9.4–14.5)	1.3 (0.9–1.6)
	Corkwing	25	28	27 (10–64)	12.5 (9.2–16.5)	1.3 (1.0–1.5)
	Goldsinny	25	120	19 (10–38)	11.1 (9.0–13.9)	1.3 (0.7–1.7)

However, both these results may be explained by a disproportionate level of mortality among smaller fish. Goldsinny CF decreased from 1.4 to 1.3 (Table 22.2).

22.3.4 *Ectoparasitic infection*

Surviving corkwing were considerably more infected with ectoparasites, mainly *Trichodina* spp. Ehrenberg, than goldsinny.

22.4 Conclusions

The experiment demonstrated the possibility of storing goldsinny successfully through winter in submersible netcages with high levels of survival. Corkwing were not as tolerant to maintenance under similar conditions. The behaviour of goldsinny at low temperatures, where they are observed to enter a state of torpor, may be an adaption which enhances survival over winter. These results accord with the work of Sayer *et al.* (Chapter 10, this volume) on the physiology of wrasse.

Acknowledgements

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