# USE OF WATER-TO-WATER TRANSFERS TO MAXIMIZE SURVIVAL OF SALMONIDS DIRECTLY ENTERED TO SEAWATER

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Abstract

Juvenile Atlantic salmon dewatered by dip net at transfer to seawater and held in net-pens had 52.3% mortality within 49 d post-entry. Fish transferred to seawater using near continuous water-to-water transfer methods had 15.2% mortality over the same time period.

In marine farming of salmonids, fish are commonly transferred directly from the transport container to the seawater net-pen (Novotny 1975; Mighell 1981; Harrell et al. 1984). Even for apparently smolted fish, this direct transfer from a freshwater to a seawater environment can cause immediate ionic, hormonal, and enzymatic imbalances that require time to equilibrate (Folmar and Dickhoff 1979; Redding and Schreck 1983; Blackburn and Clarke 1987). It has been shown that direct seawater transfer may reduce the fish's ability to survive the severe physical stress of swimming to fatigue (Flagg et al. 1983). However, little is known regarding the effects of less severe stress (e.g., handling) during adjustment to seawater.

Stress in fish results in biochemical changes including measurable increases in plasma glucose, blood lactate, and circulating levels of catecholamines and corticosteroids, all of which may affect homeostasis (Wedemeyer 1976; Mazeaud et al. 1977; Strange and Schreck 1978). Even moderate stress may disrupt osmotic balance through increased gill permeability (as a result of higher adrenaline levels), whereas severe stress may lead directly to death (Mazeaud et al. 1977). Handling and netting in fresh water have been shown to induce stress responses in salmonids that, while at times severe, are normally nonlethal (Barton et al. 1980). However, additional stress during transfer to seawater has the potential to further compromise the fish's physiological condition.

In 1986, we conducted an experiment to compare the effects of dip-net (with its inherent dewatering) vs. water-to-water transfer of fish directly to seawater (28 ppt). Juvenile Atlantic salmon (*Salmo salar*) were used in this experiment. On 18 April, the fish were crowded into 5-gal buckets submerged in the freshwater rearing pond and then water-to-water transferred into a hauling tank. A total of 2,000 yearling smolting fish (10/lb) were transported in the

fish hauling tank for 2 h at a density of 0.3 lb/gal from the freshwater hatchery to the National Marine Fisheries Service's (NMFS) Marine Experimental Station near Manchester, Washington. During transport, aeration was supplied by bottled oxygen and the water temperature remained between 50° and 54°F.

At transfer to seawater (50°F), the fish were randomly divided into two groups. Because all fish were part of a brood-stock program, and previous experience had indicated that dip-netting may be harmful, the sample size for the dip-netted group was set at approximately 10% of the population. The dip-netted group (n = 176) was dewatered for 10-15 s (in a 12- X 16- X 10-in, 3/8-in stretch mesh dip net) with about 40 fish per net, then transferred to seawater. The second group (n = 1,824) was crowded into buckets submerged in the hauling tank (with 20 to 25 fish/5-gal bucket) and then transferred to seawater--a near continuous "water-to-water" transfer.

Survival of the fish was monitored for the first 49 d of seawater residence, after which the populations were combined. The dip-netted group had 52.3% mortality, whereas the water-to-water transferred fish had 15.1% mortality (Fig. 1). It appears that dip-net dewatering caused an almost 2.5-fold (246%) increase in mortality.

Most mortalities occurred during the first 3 weeks of seawater residence (Fig. 1). Moribund and dead fish from these populations were examined at our pathology laboratory, and in most cases, no pathogens were observed. This large initial mortality is consistent with osmotic problems (Prentice et al. 1981). Therefore, we assume handling stress precipitated osmoregulatory dysfunction to a greater degree for the dip-net dewatered fish than for the water-to-water transferred fish.

Many studies have documented the adverse effects of both chronic and acute stress in fish culture (including long-term dewatering or high-density

crowding), and it is well understood that highly stressful situations should be avoided. However, it appears from our study that even the added stress of dip-netting salmonids at transfer to seawater may have a pronounced negative effect on ultimate survival.

Matthews et al. (1986) implicates dip-net dewatering as a major source of stress associated with marking and transportation programs in the Columbia River Basin and suggests the use of watertight sanctuary nets for these programs. Our work supports these views and indicates that when transferring fish directly to seawater, a water-to-water transfer method should be employed.

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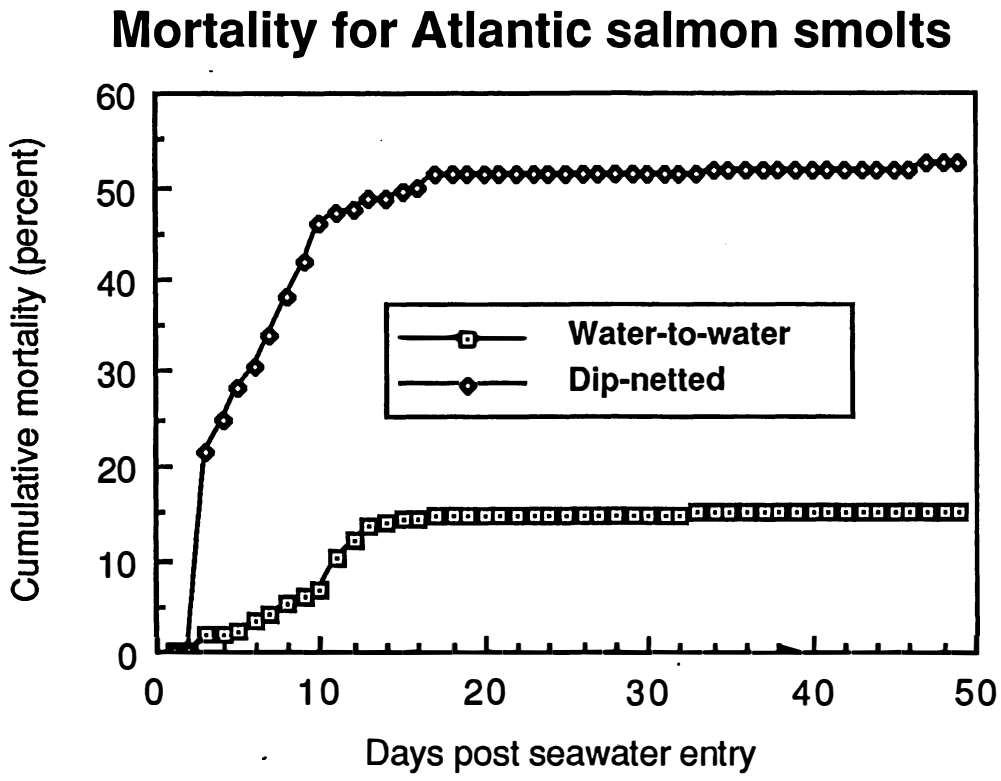
Figure 1. Comparison of overall 49-d mortality for Atlantic salmon smolts dip-net and water-to-water transferred to seawater net-pens.


Mortality for Atlantic salmon smolts
Cumulative mortality (percent)
60
50
40
30
20
10
0
0
10
20
30
40
50
Days post seawater entry
Water-to-water
Dip-netted