# Influence of Water Hardness, Salts, and MS-222 on Survival of Phase I Striped Bass During and After Transport

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*Abstract:* Phase I striped bass hauled in varying levels of sodium chloride (NaCl) had significantly higher survival than fish hauled in varying levels of calcium chloride ($CaCl_2$), regardless if the fish came from a hard water or soft water hatchery. The addition of MS-222 to the transport water did not have a beneficial effect on phase I striped bass survival.

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Environmental calcium levels are an important consideration in fish culture and management. Mazik et al. (1991) reported striped bass *Morone saxatilis* hauled in soft water (hardness 28 mg/liter as $CaCO_3$) to a hard water facility (110 mg/liter as $CaCO_3$) had 100% mortality after 1 month recovery when fish were hauled and recovered in freshwater or 0.1% $CaCl_2$. Adding $CaCl_2$ to soft water to raise the hardness to at least 50 mg/liter has been recommended for fish handled or transported in soft water (Grizzle et al. 1985, Wedemeyer 1972). Studies have indicated that environmental calcium can also effect the action of anesthetics such as MS-222 (Marking 1967, Schoettger and Julin 1967). Marking (1967) reported that higher concentrations of anesthetics were needed to anesthetized fish in low calcium waters (hardness 10 mg/liter) and Schoettger and Julin (1967) found that fish in soft water (hardness 10 mg/liter) needed twice the exposure time to be anesthetized as fish in hard water (hardness 180 mg/liter).

Striped bass are often transported to stocking sites where water quality characteristics are notably different from those in the hatchery where the fish were cultured. Studies have shown that transporting fish in salt increases survival and decreases the stress response associated with the transportation process (Carmichael et al. 1984,

Mazik et al. 1991, Tomasso et al. 1980). Recommendations for transporting striped bass include hauling the fish in 1.0% NaCl (Mazik et al. 1991) and using an anesthetic such as MS-222.

The objective of this study was to determine the influence of salts and anesthetic on survival of phase I striped bass during and after transport from a soft and hard water hatchery.

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## Methods

Phase I striped bass (mean, 0.5 g) for this study were transported from the Warm Springs National Fish Hatchery (WSNFH), a soft water hatchery, to the Southeastern Fish Cultural Laboratory (SFCL) and from the Carbon Hill National Fish Hatchery (CHNFH), a hard water hatchery, to the SFCL. Water quality characteristics for WSNFH, CHNFH, and SFCL, respectively, were as follows: pH 7.9, 7.4, 8.2; hardness (mg/liter as $CaCO_3$) 16, 100, 108; alkalinity (mg/liter as $CaCO_3$) 11, 103, 118; temperature (°C) 25, 17.5, 22.5. Dissolved oxygen levels were $\geq$ 7.0 mg/liter and ammonia and nitrite levels were $\leq$ 0.01 mg/liter at all facilities.

Striped bass were harvested and handled at WSNFH and CHNFH according to standard procedures for each facility. At both facilities, fish were harvested from ponds 24 hours prior to transport and held in concrete raceways. Fish were handled in a solution of 0.5% NaCl + 0.02% $CaCl_2$ at WSNFH and in a solution of 1.0% NaCl at CHNFH. Prior to transport at each facility, 50 fish were stocked into plastic bags inside transport boxes containing 6 liters of water (fresh soft water at WSNFH and fresh hard water at CHNFH) and 1 of the following chemical additives without anesthetic: 1.0%, 0.5%, 0.25%, 0.1% NaCl or $CaCl_2$, 0.5% NaCl + 0.5% $CaCl_2$, and 0.5% NaCl + 0.02% $CaCl_2$. The above series was then repeated with the addition of 25 mg/liter of MS-222. Treatments were in duplicate and freshwater controls with and without anesthetic were included. Transport bags were inflated with oxygen before boxes were sealed for transport. Dissolved oxygen, pH, and temperature were taken in each transport box immediately prior to and after transport. Dissolved oxygen, temperature, pH, ammonia, and nitrite were taken in each recovery tank every 24 hours throughout the study. Upon completion of transport from each facility, the lids of each box were slightly opened for 20 minutes to allow fish to acclimate to the light. The sealed bags were then placed in the individual recovery tanks for 30 minutes to allow for temperature acclimation. Fish were recovered for 1 week at the SFCL in hard water containing the same additives, except anesthetic, as in the water in which they were transported. Each recovery tank contained 70 liters of water circulated through a separate biological filter.

The data are presented as percent mortality. Analysis of variance and Duncan's

multiple-range tests (procedure GLM, SAS 1985) were used to test for significant differences at the $P \leq 0.05$ level.

## Results and Discussion

CHNFH striped bass hauled and recovered in 1.0% $CaCl_2$ (Table 1) had significantly higher mortality than fish hauled and recovered in fresh water, regardless of the presence or absence of MS-222. After 1-week recovery, striped bass hauled and recovered in the NaCl treatments (0.1 to 1.0% NaCl) and the combination (0.5% NaCl + 0.02% $CaCl_2$) treatment had significantly lower mortality than fish hauled and recovered in freshwater.

WSNFH striped bass transported and recovered in 1.0%, 0.5%, and 0.25% $CaCl_2$ soft water with anesthetic and recovered in hard water (Table 2) had significantly higher mortality immediately after transport compared to fish hauled in freshwater. After 1 week recovery, fish in 1.0%, 0.5%, 0.25% $CaCl_2$, and 0.5% NaCl + 0.5% $CaCl_2$ had significantly higher mortality compared to controls. Striped bass hauled in soft water without anesthetic and recovered in hard water had significantly higher mortality immediately after transport and after 1 week recovery in 1.0% $CaCl_2$ compared to fish hauled and recovered in freshwater.

**Table 1.** Percent mortality of phase I striped bass transported in hard water (110 m/liter hardness), with and without anesthetic, and recovered in hard water for 1 week. Immediate mortalities were noted upon arrival at the SFCL and delayed mortalities are after 1-week recovery at the SFCL. An asterisk indicates significant differences (0.05) from freshwater controls.

| | Transport with MS-222 | | Transport without MS-222 | |
|---|---|---|---|---|
| Salt | Immediate mortality | Delayed mortality | Immediate mortality | Delayed mortality |
| 1.0% NaCl | 0 | 0* | 0 | 0 |
| 0.5% NaCl | 0 | 0* | 0 | 0 |
| 0.25% NaCl | 0 | 1* | 0 | 0 |
| 0.1% NaCl | 0 | 0* | 0 | 0 |
| 1.0% $CaCl_2$ | 28* | 77* | 44* | 62* |
| 0.5% $CaCl_2$ | 7 | 30 | 19* | 20* |
| 0.25% $CaCl_2$ | 6 | 13 | 1 | 2 |
| 0.1% $CaCl_2$ | 0 | 3 | 7 | 9 |
| 0.5% NaCl + 0.5 % $CaCl_2$ | 0 | 17 | 1* | 1 |
| 0.5 % NaCl + 0.02 % $CaCl_2$ | 0 | 0* | 0 | 0 |
| Freshwater | 3 | 32 | 1 | 2 |

**Table 2.** Percent mortality of phase I striped bass transported in soft water (28 mg/liter hardness) with and without anesthetic and recovered in hard water for 1 week. Immediate mortalities were noted upon arrival at the SFCL and delayed mortalities are after 1 week recovery at the SFCL. An asterisk indicates significant differences (0.05) from freshwater controls.

| | Transport with MS-222 | | Transport without MS-222 | |
|---|---|---|---|---|
| Salt | Immediate mortality | Delayed mortality | Immediate mortality | Delayed mortality |
| 1.0% NaCl | 0 | 0 | 0 | 0 |
| 0.5% NaCl | 0 | 0 | 0 | 0 |
| 0.25% NaCl | 0 | 0 | 0 | 0 |
| 0.1% NaCl | 1 | 0 | 0 | 0 |
| 1.0% $CaCl_2$ | 8* | 24* | 31* | 67* |
| 0.5% $CaCl_2$ | 6* | 9* | 8 | 14 |
| 0.25% $CaCl_2$ | 4* | 5* | 4 | 6 |
| 0.1% $CaCl_2$ | 0 | 1 | 3 | 5 |
| 0.5 % NaCl + 0.5 % $CaCl_2$ | 0 | 5* | 1 | 2 |
| 0.5 % NaCl + 0.02 % $CaCl_2$ | 0 | 0 | 0 | 2 |
| Freshwater | 0 | 0 | 1 | 5 |

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