

A Low Cost Bar Grader for the Harvest of Hybrid Striped Bass (*Morone chrysops* x *M. saxatilis*)

C.C. Easter¹, L.A. Helfrich*¹, A. Tate¹, G.S. Libey¹

¹ Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061 USA

*Corresponding Author, present address:
Department of Fisheries and Wildlife Sciences
152 Cheatham Hall
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061 USA
Email: lhelfric@vt.edu

ABSTRACT

Four bar graders were designed and built to separate a mixed-size population of market-size reciprocal cross hybrid striped bass *Morone chrysops* x *M. saxatilis* in rectangular culture tanks in an indoor, recirculating aquaculture system. Grader frames were constructed of 5.1 cm (2 inch) PVC pipe and fittings. PVC electrical conduit (1.27 cm, 0.5 inch) was used to form a series of parallel, equally spaced vertical bars within the frame. Bar slot spaces were 1.90, 2.54, 3.20, or 3.80 cm (0.75, 1.0, 1.25, 1.5 inches). A strip of flexible vinyl siding was attached to the outer edges of the bar grader to permit a tight fit between the grader and tank walls, and prevent fish from swimming around the grader. The graders were placed sequentially into one end of the tank, largest slot size first, and maneuvered to the opposite end. Each grader

remained in the tank for 60 min. Fish too large to pass through a grader were netted and measured for weight, length and width. Regression analysis was performed for average weight retained at each bar spacing ($Y = 7.13619 + 0.070716 X$; $r^2 = .9987$). By rearrangement, an equation was derived which allows a culturist to select a bar spacing that retains fish of a predetermined weight :

$$\text{Grader bar slot size (mm)} = \text{Fish weight (g)} - 177.9 / 31.7$$

Construction of each grader required approximately 2 h, and materials cost \$20.

INTRODUCTION

Striped bass *Morone chrysops* and their hybrids are cultured under extensive or semi-intensive conditions in ponds, or at high densities in raceways, recirculating water systems, or cages (Van Olst and Carlberg 1990; Trosclair 1992). Fish grown at high densities, including hybrid striped bass, exhibit non-uniform growth (Nunley 1992; Bromage and Shepherd 1990). Variable growth within a year-class often leads to low feed conversion efficiency and survival (Huner et al. 1984, Kirby et al. 1987). Therefore, grading of small fish during growout is necessary to increase size uniformity and reduce cannibalism (Smith et al. 1985). However, grading can be labor intensive and injurious to fish, making it economically unattractive to culturists. As a result, a mixed-size population often exists at harvest. Commercial hybrid striped bass markets often demand fish of uniform size because of intended product use and customer desires. Therefore, fish culturists must selectively harvest from a mixed population only those individuals meeting size requirements of the buyer.

Panel graders, grader boxes, grading baskets, sorting or grading tables, mechanical pumps with graders, and live cars or socks are common tools designed to separate fish into size categories (Jensen 1990). The preferred sorting method is dictated by the size and species of fish and farm conditions (Huner et al. 1984). Fish may be graded from a variety of culture vessels, including ponds, raceways, tanks, or holding vats. Panel graders are the most common technique separating fish of various sizes in raceways and rectangular tanks. They are constructed as a

vertical or angled assembly of equally-spaced, parallel bars. Aluminum is the most common construction material (Jensen 1990). Fish are separated by girth according to their ability to pass through the spaces between bars (Huner et al. 1984). Bar space-fish size relationships for small, fingerling (83 to 163 mm; 3.3 to 6.4 inch) striped bass have been developed (Ludwig and Tackett 1991), but have not been determined for market-size (>260 mm; >10.2 inch) striped bass. This paper describes an inexpensive, easily constructed, bar grader used to separate live, market-size hybrid striped bass into specified size gradations using two laborers.

METHODS

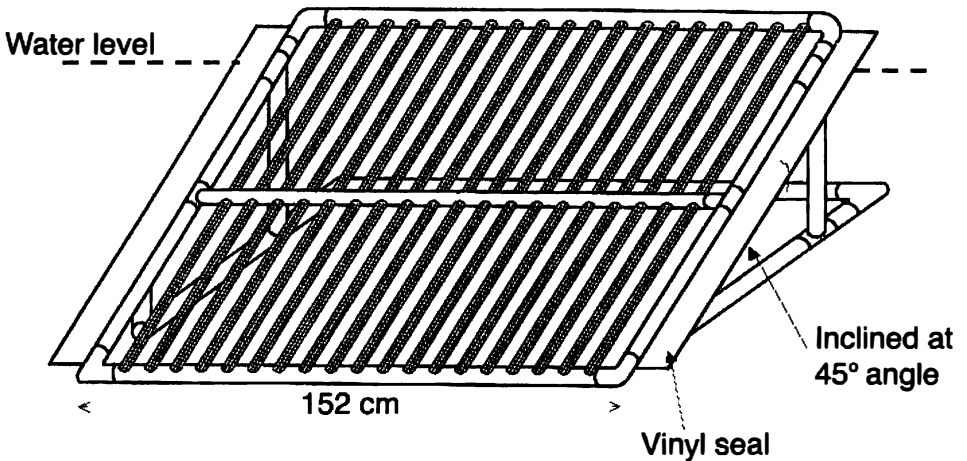
Four bar grader panel frames of 152 x 152 cm (60 x 60 inches) were constructed of 5.1 cm (2 inch) PVC pipe and fittings. Parallel, vertical bars were built of 1.27 cm, PVC conduit and spaced (internal slot distance) at 1.90, 2.54, 3.20, or 3.80 cm (0.75, 1.0, 1.25, 1.5 inch) intervals. Bars were attached to the grader frame by drilling 1.27 cm (0.5 inch) sockets into the top and bottom of the frame and inserting the partially flexible PVC, allowing 360 degree rotation of the bars. The grader frame and bars were inclined at a 45° angle and supported on a PVC base (Figure 1). Inclined bars facilitated fish passage and reduced entrapment by redirecting fish movement downward and through the bars. Holes were drilled in the bar grader base to allow water entry, sinking of the grader, and to prevent fish from swimming under the frame. Flexible 0.64 cm (0.25 inch), vinyl house siding was attached to the sides of the grader frame to provide a close fit against the tank walls. The production tank (1.53 m x 6.11m x 1.22 m; 4.9 x 19.7 x 3.9 feet) was part of a 12,390 L (3,261 gal) recirculating fish culture system at the Virginia Tech Aquaculture Center.

Hybrid striped bass (n=300), length (TL) 271.3 ± 27.7 mm (mean \pm SE), weight 288.9 ± 98.7 g, and width 39.3 ± 6.3 mm, were size-sorted by sequentially placing the graders (largest to smallest slot size) into one end of the culture tank and slowly sliding each, one at a time, completely to the opposite end. Each of the 3 grading trials took a total of 240 min, or 60 min for each of the 4 slot sizes tested. Fish not passing through each sequential grade were removed by net, weighed (nearest 0.1 g), and measured for total length and maximum width (nearest mm) (Table 1).

Table 1. Total mean weight (g), +/- SE, length (mm), and width (mm) of hybrid striped bass retained in sequential grading of a mixed-size population (n=300)

Bar Space (cm)	Weight (g)	Width (mm)	Length (mm)
3.80 - 3.20	387.4 +/- 51.9	45.3 +/- 2.4	298.6 +/- 13.8
3.20 - 2.54	301.5 +/- 58.7	39.8 +/- 2.8	277.6 +/- 15.5
2.54 - 1.90	237.2 +/- 62.4	35.5 +/- 3.7	258.9 +/- 20.5

Figure 1. Low-cost bar grader



RESULTS and CONCLUSIONS

Regression analysis was performed (SAS Institute 1985) with mean fish weights against bar width. An equation describing this line ($Y = 177.9 + 31.7 X$; $r^2 = 0.9968$) was developed and can be used to predict the appropriate slot-size for selection of fish of a certain size:

$$\text{Slot size (mm)} = \text{Fish Weight (g)} - 177.9 / 31.7$$

By substituting the desired fish weight into the equation, the fish culturist can determine the appropriate bar spacing to retain harvest-size reciprocal hybrid striped bass from a population of mixed size. The bar-grader harvesting system was inexpensive (\$20 per grader) and constructed in approximately 2 h. The graders were highly mobile and maintenance is expected to be low. Two individuals were needed to push the grader through the rectangular tanks. Harvest-sized fish can be graded in an hour, and handling minimized to netting and removing big fish. This relatively low-cost grader system can be used to harvest and selectively sort (by weight or length) striped bass and other commonly cultured fish species once the initial relationships between grader bar spacing and fish sizes (weight or length) retained are validated.

REFERENCES

- Bromage, N., Shepherd, J. **1992**. Intensive Fish Farming. Blackwell Scientific Publications, Cambridge, MA, USA
- Huner, J.V., Dupree, H.K., Greenland, D.C. 1984. Harvesting, Grading, and Holding Fish. In Third Report to the Fish Farmers: The Status of Warmwater Fish Farming and Progress in Fish Farming Research. Dupree, H.K. and Huner, J.V., Eds., **1984**. U.S. Fish and Wildlife Service, Washington, D.C., USA.
- Kirby, J.H., Hinshaw, J.M., Huish, M. T. Increased Growth and Production of Striped Bass x White Bass Hybrids in Earthen Ponds. *Journal of the World Aquaculture Society* **1987**. 18, 35-43.
- Jensen, G.L. **1990**. Sorting and Grading Warmwater Fish. Southern Regional Aquaculture Center, Publication No. 391. Mississippi State University, Stoneville, MS, USA.
- Ludwig, G.M., Tackett, D.L. Relation Between Bar Grader Size and Size of Striped Bass. *The Progressive Fish Culturist* **1991**. 53,128-129.
- Nunley, C.E. **1992**. Production of Hybrid Striped Bass (*Morone chrysops* x *M. saxatilis*) in a Recirculating Aquaculture System. Master's thesis, Virginia Polytechnic Institute and State University, Blacksburg, VA, USA
- SAS Institute. **1985**. SAS/STAT Guide for Personal Computers, 6th edition. SAS Institute Inc., Cary, NC, USA.
- Smith, T.I.J., Jenkins, W.E., Snelvel, J.F. Production Characteristics of Striped Bass (*Morone saxatilis*) and F1, F2 Hybrids (*M. Saxatilis* x *M. chrysops*) Reared in Intensive Tank Systems. *Journal of the World Mariculture Society* **1985**. 16, 57-60.
- Trosclair, C. U.S. Aquaculture Production Nearing \$1 Million. *Water Farming Journal* **1992**. 7(10), 5.
- Van Olst, J.C., Carlberg, J.M. Culture of Hybrid Striped Bass. *Aquaculture Magazine* 1990. 16(1), 49-59.