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# Field Evaluation of a Hidrostal Pump for Live Transfer of American Eels at a Hydroelectric Facility

P. H. Patrick [a] & R. S. McKinley [a]

[a] Biological Research Section, Chemical Research Department, Ontario Hydro, 800 Kipling Avenue, Toronto, Ontario, M8Z 5S4, Canada

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fishermen because of their small size. However, if large fish become abundant, a new and attractive resource could stimulate major fisheries.

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# Field Evaluation of a Hidrostal Pump for Live Transfer of American Eels at a Hydroelectric Facility

P. H. PATRICK AND R. S. MCKINLEY

*Biological Research Section*
*Chemical Research Department*
*Ontario Hydro*
*800 Kipling Avenue*
*Toronto, Ontario M8Z 5S4, Canada*

*Abstract.*—The effectiveness of using a Hidrostal pump for the live transfer of American eels *Anguilla rostrata* over a hydroelectric dam was evaluated at the Saunders generating station facility on the St. Lawrence River near Cornwall, Ontario, in September 1985. In total, 2,300 American eels were passed live through the pump with no latent mortality. Fish injury was minimal—averaging less than 3% over all test conditions. The Hidrostal pump shows promise for transferring American eels at hydroelectric facilities.

Fish pumps are an integral part of a fish-handling facility where fish are attracted or guided for eventual live removal and transport back into the water body. Recent evaluations of fish pumps have indicated that a Hidrostal pump, which has a screw-type impeller, is effective for live transport of certain species of fish at low-head, steam power plants (Holsapple et al. 1981; Rogers and Patrick 1985). However, the feasibility of using this pump at high-head hydroelectric facilities is largely unknown. At these locations, the pump would have to operate at higher impeller speeds. A study involving both laboratory and field components was conducted to determine the effectiveness of a Hidrostal pump in the live transfer of American eels *Anguilla rostrata* at high impeller speeds. The laboratory results have been published (Patrick and Sim 1985). The objective of this paper is to describe the results of the field verification tests conducted at the Saunders hydroelectric facility on the St. Lawrence River near Cornwall, Ontario.

Approximately 2,300 upstream migrating American eels were collected from the eel ladder at the Saunders station in early September 1985 with the assistance of personnel from the Ontario Ministry of Natural Resources. The fish ranged in size from approximately 27 to 52 cm long.

A submersible, model 16-F Hidrostal pump (Hydrostal, Incorporated, Neunkirch, Switzerland) was used in these tests. This pump was designed for free passage of solid objects up to approximately 15 cm wide. The pump consisted of a screw-type impeller and was powered by a 56-kW motor.

Experiments were conducted at the downstream side of the dam (Figure 1). The pump was operated at a fixed impeller speed of approximately 1,200 revolutions/min (rpm) and was submersed with a crane approximately 2 m below the water. This impeller speed was at the upper range of that used in previous laboratory tests (890–1,204 rpm). The 15-cm-diameter intake pipe was approximately 0.6 m long. The discharge transport pipe was 20 cm in diameter and approximately 7 m long, including three 45° elbows. The calculated head of the transport system was over 10 m—considerably higher than the 3.2 m used in the previous laboratory tests. Estimated water velocities in the transport system exceeded 5.2 m/s, and the discharge rate was approximately 10,599 L/min. These velocities were several times higher than those used in the laboratory tests (Patrick and Sim 1985).

At the beginning of a test, fish were placed in a wire enclosure that fed directly into the pump intake. This pipe was necessary because American eels actively avoided the intake mouth. A screened

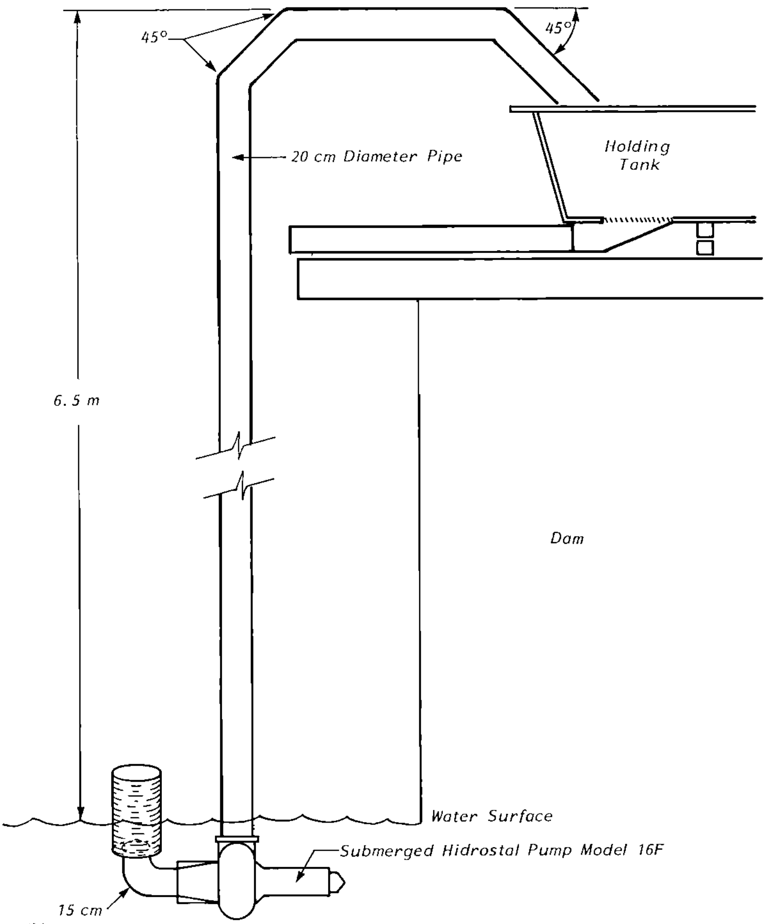


FIGURE 1.—General layout of the Hidrostal pump and transport system tested with American eels at the Saunders hydroelectric facility on the St. Lawrence River.



cage (approximately 2-cm-square mesh) allowed water to be drawn into the intake, yet prevented escape of the fish.

The effectiveness of the Hidrostal pump in the live transfer of American eels was evaluated relative to fish density. Four tests were conducted with 25, 50, 100, or 200 animals and two with 400 animals (Table 1). These numbers corresponded to densities ranging from approximately 34 to 547 animals/100 L of water. Previous laboratory tests involved densities of less than 85 animals/100 L (Patrick and Sim 1985). At the highest density used in the field tests, we far exceeded the capacity of the pump (for optimum efficiency) in the passage of solids in an aqueous environment (which is 40% solid, 60% liquid).

American eel survival was determined immediately following pump passage (time 0 h) and at 24, 48, 72, 96, and 148 h. Immediately following passage, the fish were placed into separate modified hoop nets (6.3-cm ACE mesh, 1.2 × 1.0 × 1.0 m) and held over the specified time periods. The fish were also examined for external injury at each time interval. Controls also were conducted

TABLE 1.—Details for tests on the effectiveness of a Hidrostal pump for the live transfer of American eels at the Saunders hydroelectric facility.

| Number of tests | Number of animals per test | Number of animals per 100 L | Fish : water ratio |
|---|---|---|---|
| 4 | 25 | 34 | 0.043 |
| 4 | 50 | 68 | 0.085 |
| 4 | 100 | 136 | 0.169 |
| 4 | 200 | 273 | 0.402 |
| 2 | 400 | 547 | 0.804 |

to determine mortality due to holding but no deaths were observed.

In total, 2,300 American eels were passed alive through the pump system and there was no latent mortality. These results confirmed the laboratory tests even though fish densities, water head, and discharge velocities were substantially higher than those tested under laboratory conditions (Patrick and Sim 1985). It also was noteworthy that the fish : water ratio was 0.80 in some of the field tests, which far exceeded the capacity of the pump for pumping objects with optimum efficiency. Fish injury also was minimal, averaging less than 3% for each test. The injuries consisted of nonfatal abrasions.

High survival for fish species less robust than American eels may not occur at the impeller speeds tested. Rogers and Patrick (1985) found that survival of several species passed through a Hidrostal pump at even low head varied with impeller speed (450–1,150 rpm). Rainbow trout *Salmo gairdneri* had the highest survival followed by the less hardier species tested, such as yellow perch *Perca flavescens* and alewife *Alosa pseudoharengus*.

Fish avoidance of the intake of a Hidrostal pump would have to be considered if the pump is located in a forebay or other large water body. Under those conditions, an attractant will be required to direct fish toward the pump intake prior to pumping. At present, we are not aware of a successful attractant for American eels.

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# Relationship between the Size of Several Walleye Year Classes and the Percent Harvested over the Life of Each Cohort in Escanaba Lake, Wisconsin

STEVEN L. SERNS[1]

*Wisconsin Department of Natural Resources*
*Box 440*
*Woodruff, Wisconsin 54568, USA*

*Abstract.*—Catch-at-age data for the 1958–1974 year classes of walleyes *Stizostedion vitreum vitreum* were obtained through a complete creel census at Escanaba Lake, Wisconsin. These data, in combination with mark–recapture estimates of fall young of year from the same cohorts, allowed for the determination of the percentage of fall young of year harvested over the life of the cohort. Percent of fall fingerlings harvested averaged 25.9 and ranged from 6.6 to 75.3. Percent of fall fingerlings harvested over the life of the cohort was inversely related to the number of fall fingerlings.

To my knowledge, data describing the percentage of a year class harvested during the life of a cohort over a multiyear time period have never been published for a walleye *Stizostedion vitreum vitreum* population. Kempinger and Carline (1977) stated that the density of age 3 walleyes in Escanaba Lake, a 293-acre lake in northern Wisconsin, was related to their density as fall fingerlings and

[1] Steven Serns passed away while this paper was in press.