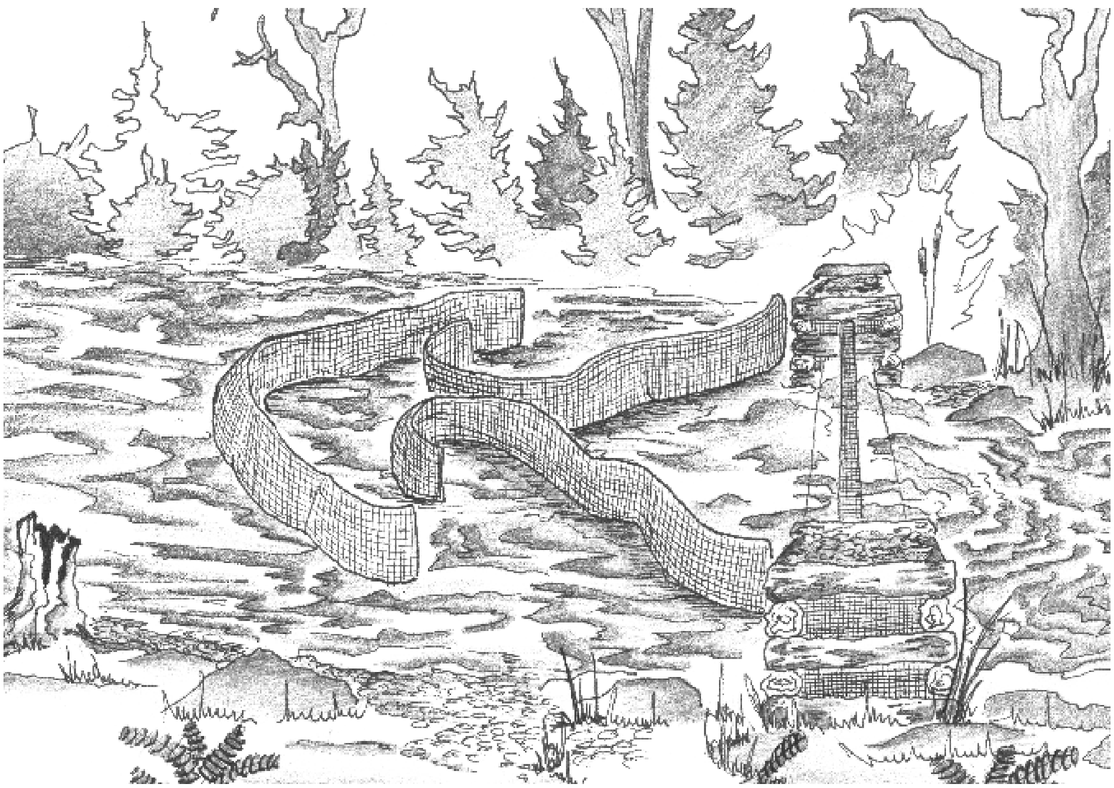
Lake Outlet Blocks as a Management Tool for Stocked Trout and Salmon: **A Guide for Lake Managers**



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http://fish.dnr.cornell.edu/trout/Lake_Outlet_Blocks.pdf

Introduction

Fall emigration -- or the movement of mature brook trout and landlocked salmon out of coldwater lakes at spawning time -- can significantly reduce populations of these large stocked fish in New York waters. Managers of private lakes and ponds can benefit from research demonstrating that the operation of lake outlet blocks during the fall spawning season will prevent the escape of mature trout and salmon that are in search of spawning habitat not accessible in stocked lakes. While outlet blocking can improve fishing in lakes with stocked fish populations, these measures may not be suited for lakes in which native trout populations are maintained by natural reproduction. In the following pages, we describe results from research evaluating the effectiveness of lake outlet blocks. We also offer criteria for determining whether lake outlet blocking is suited to a particular lake, and provide guidelines for constructing outlet block structures.

Previous Experiences with Outlet Blocking

Researchers working with the Coldwater Fishery Research Program at Cornell University have established that fall emigration (mid September – late November) of mature brook trout and landlocked salmon from drainage lakes (i.e. lakes with outlets) can lead to significant losses of older fish (Josephson and Youngs 1996, Nemeth 2000) (Tables 1 and 2). Many coldwater lakes without suitable spawning habitat in the Adirondacks and other areas of New York are stocked with trout and salmon to support recreational fisheries. When fish stocked in lakes without suitable spawning habitat reach maturity, a large proportion of the population emigrates via lake outlets, presumably in search of spawning habitat (see Tables 1 and 2). In these lakes, emigration by mature fish significantly increases the remaining proportion of younger, smaller brook trout and landlocked salmon. Table 3 shows a comparison of the age structure of stocked brook trout populations in drainage lakes with unblocked outlets and seepage lakes without outlets. In lakes without outlets, 41% of brook trout were age 3 and older, while only 2.5% of brook trout in lakes with outlets were age 3 and older. Springtime emigration of brook trout is much less important by comparison with fall losses (Table 1).

Brook Trout

Additional research comparing pre and post-outlet blocked fish populations provides evidence that blocking a lake can significantly increase the angling catch per unit effort (CPUE) of "notable" brook trout (exceeding 1.5 pounds and at least 3 years old), as well as increase the proportion of older fish caught in assessment nets. In a study of four Adirondack drainage lakes, angling catch of notable brook trout was greater following construction of an outlet block, by comparison with catch prior to installation (Josephson et al. 2001). The average angling catch of notable brook trout in one lake increased from 0.1 fish/year in the pre-block period to 4.5 fish/year in the post-block period. A similar increase was recorded in the other lake from 0.0 fish/year in the pre-block period to 5.5 fish/year in the post-block period. Within the same study period, the differences in the angling catch of notable brook trout in the unblocked, reference lakes were negligible (Table 4).

After outlet blocking, catches of age 2 and older brook trout increased in assessment nets used by researchers to evaluate the entire lake fish population (instead of only angled fish). The proportion of age 2 and older brook trout increased in one lake from 15% to 30% between the pre-block and post-block periods. A similar increase (13% to 23%) was observed in the other lake.

These studies indicate that outlet blocking can significantly increase the angling catch of notable brook trout and the percentage of age 2 and older fish within stocked coldwater lakes. It is important to note that outlet blocking has been found to be most successful when brook trout were sufficiently abundant prior to blocking.

Blocking Considerations

While outlet blocking is an attractive tool for managing brook trout and landlocked salmon populations in lakes, it is not appropriate for all situations. Many factors must be considered in determining whether blocking a lake outlet can be an effective management tool. In addition, it is necessary to be familiar with New York State and Federal regulations and required permits.

What to consider before blocking a lake outlet?

Blocking is only an option for drainage lakes with outlets. If a lake's fishery is sustained with stocked trout, yet large (>14"), older trout are not showing up in the angling catch, then outlet blocking may be a suitable management option for improving the abundance of larger fish. Due to the extensive amount of materials required to construct an outlet block, this approach is only feasible if these materials can be transported to the construction site. Outlet blocking has proven most effective at retaining fish that spawn during fall, such as brook trout and landlocked salmon. Blocking during the springtime is not recommended due to the difficulty of managing high flows from spring run-off. Similarly, if a lake drains a large watershed area, you must consider the possibility that high flows during rain events will jeopardize the structural integrity of an outlet block.

While outlet blocking can be an effective tool for managing stocked trout populations, it can also be detrimental to self-sustaining populations of native brook trout. To avoid potential negative impacts, it is essential to determine if natural reproduction is occurring in the lake outlet proposed for blocking. This can be accomplished by looking for brook trout spawning areas known as redds. These are usually associated with areas of groundwater upwelling in shallow areas along the shores of lakes and within streams. Redds can be distinguished as small patches of disturbed substrate similar to a small pillow in shape and often a lighter color than the surrounding substrate. If a lake sustains a productive wild trout population, it is not appropriate to block the outlet, thereby disrupting natural reproduction. If trout populations are maintained by stocking, yet some natural reproduction is known to occur within the lake outlet, the outlet block can be established downstream from the spawning area to allow native fish access to suitable spawning habitat.

Brook trout on spawning redds

State regulations and permit information

All outlet block construction efforts will require at least one permit from the New York State Department of Environmental Conservation (NYSDEC) prior to construction. Since these structures will be constructed and maintained in “classified waters” and/or navigable waters, an Article 15 “Stream Protection permit” will be required prior to construction. In addition, a dam safety permit could also be required under certain circumstances. If the work site is located within the Adirondack Park, a jurisdictional consultation and likely a wetlands permit will be required from the Adirondack Park Agency (APA). Prior to starting any work, the APA will need to be contacted regarding a site inspection. Contact information for regional NYSDEC offices and the APA is provided in Appendix 1.

Outlet Block Design Options

Screen-weir outlet barrier system with log cribs and keyways

There are two types of blocks that can be used on lake outlets: blocks with fish traps and those without traps. Blocks with fish traps can only be installed if the landowner/manager holds a scientific collector's permit (administered under the jurisdiction of the NYSDEC), and is engaged in certified scientific research . Private landowners cannot obtain a scientific collector's permit without participating in a planned research project. Furthermore, while outlet blocks with traps allow managers and scientists to monitor fish emigrating from lakes, they require more maintenance than simple block screens without a trap. In either case, it is essential that debris deflector and collector screens be constructed to prevent excessive buildup of leaves, needles and other debris that could impede water flow through the block. In order for an outlet block to be effective and last more than a few years, it is important to carefully design the structure, then invest the time and material resources into its construction.

Blocks without Traps (Screened-weir and Culvert-box)

The two recommended types of blocks without traps are: (1) screened-weir and (2) culvert-box. The foundation is the most important component of any screened-weir outlet block. This type of block is most easily established on outlets that have existing structures, such as base logs and/or cribs (Figure 1). Building a block system on an existing base log and/or crib structure is the ideal

Culvert-box style outlet barrier

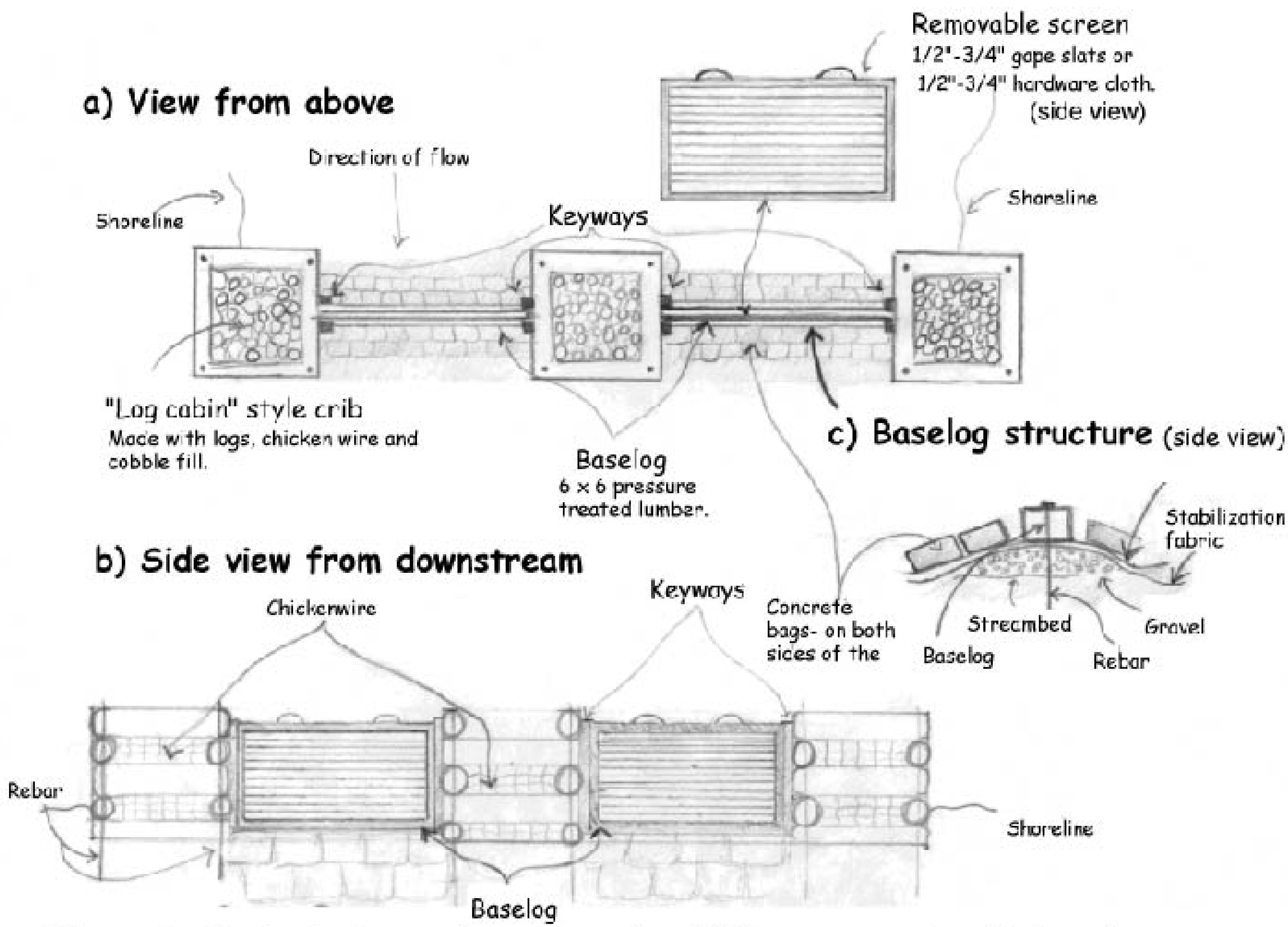

Figure 1. Basic design and components of the screened-weir barrier

situation, as construction expenses can be reduced and the permit application process simplified.

A screened weir block consists of three basic components: (1) "log cabin" style cribs, (2) the base log structure, and (3) screens (Figure 1). In constructing the foundation for an outlet block, it is essential that cribs are soundly constructed to withstand large water run-off events – most common in spring and fall. As shown in Figure 1, cribs are constructed in a "log cabin" shape by placing parallel log segments on top of and perpendicular to each other in the form of a square box. The inside of this log box is lined with chicken wire and stabilization fabric. The interior is filled with pebble and cobble-sized fill material.

The next component of this system is the base log structure. This is installed by first placing a layer of gravel on the streambed, upon which is placed a layer of "gardener's" style stabilization fabric, followed by a layer of ½"- ¾" mesh steel hardware cloth. A 6" x 6" pressure-treated base log is placed on top of these layers, perpendicular to stream flow. This log base is secured to the streambed using rebar lengths driven into the streambed as shown in Figure 1. It is important to install the base log as level as possible.

Next, two to three rows of unopened bags of concrete are placed on top of the gravel and cloth layers, both upstream and downstream from the base log. Once in place, stream water will set the concrete and solidify the base log structure. Rectangular screens with ½"- ¾" wide horizontal slats constructed of welded steel or wooden frames with hardware cloth are placed vertically within "key ways" on top of the base logs between the cribs. Screens with ½" gaps will successfully exclude fish greater than 8" in length, while screens with ¾" gaps will exclude fish greater than 10½" in length. In order to prevent fish from escaping through the outlet block, it is essential to secure the bottom of these screens to the top of the base log.

A culvert block is used to block lakes and ponds drained by a culvert pipe. Important design considerations for a culvert block are the pipe diameter and the size of the fish exclusion box. Larger diameter culverts (> 1½ ' diameter) are more effective than smaller ones, since they can accommodate larger stream flows. Fish exclusion boxes, made of pressure treated wood and hardware cloth, should be large enough

Small diameter culvert drain pipe

to ensure that they are not quickly clogged by debris. They should have open tops at a sufficient elevation to allow the box to overflow before rising water will overflow the dam or road. The open area of the exclusion box should exceed the cross-sectional area of the culvert pipe. Due to their lower maintenance requirements, culvert blocks are a good choice for remote lakes.

While blocks without traps don't require as much maintenance as those with traps, it is still important to clean the screens regularly to prevent debris build-up. Clogged screens can increase lake levels and reduce the effectiveness of the block. A screened culvert that becomes plugged can result in increased water levels that wash out the road or dam through which the culvert passes. All blocks should have removable screens to assist with cleaning and maintenance. Screening a culvert on a public road is not acceptable.

Blocks with Traps (inclined screen trap)

Construction of an outlet block that includes a fish trap can provide an opportunity to monitor fish emigration from a lake. Because of permit requirements, these blocks are primarily of interest to scientists and managers. Within New York State, permit authorization requires an approved research plan implemented in conjunction with either NYSDEC staff or university researchers.

The inclined screen trap (Wolf 1951) is most easily established on lakes with an existing spillway or dam structure that provides at least a 1 meter vertical drop (Figure 2). In instances where such a structure does not exist, a crib and baselog structure can be established to provide the necessary change in elevation. Four main parts of the inclined screen trap include: the crib or dam structure, the inclined screen, the trough, and the trap. Fish leaving the lake flow over the inclined screen to the trough, where they are directed into the trap.

Inclined screen trap

The inclined screen should be constructed with pressure-treated 2 x 4 lumber and ½" mesh steel hardware cloth aligned at approximately a 5% incline from the lip of the baselog down to the lip of the trough. To prevent fish from sliding off the screen, the inclined screen is bordered with 12" tall sides constructed from ½" mesh steel hardware cloth. The 12" deep trough is made of 1" x 12" treated pine with similar raised sides. A piece of PVC pipe 8" in diameter is inserted

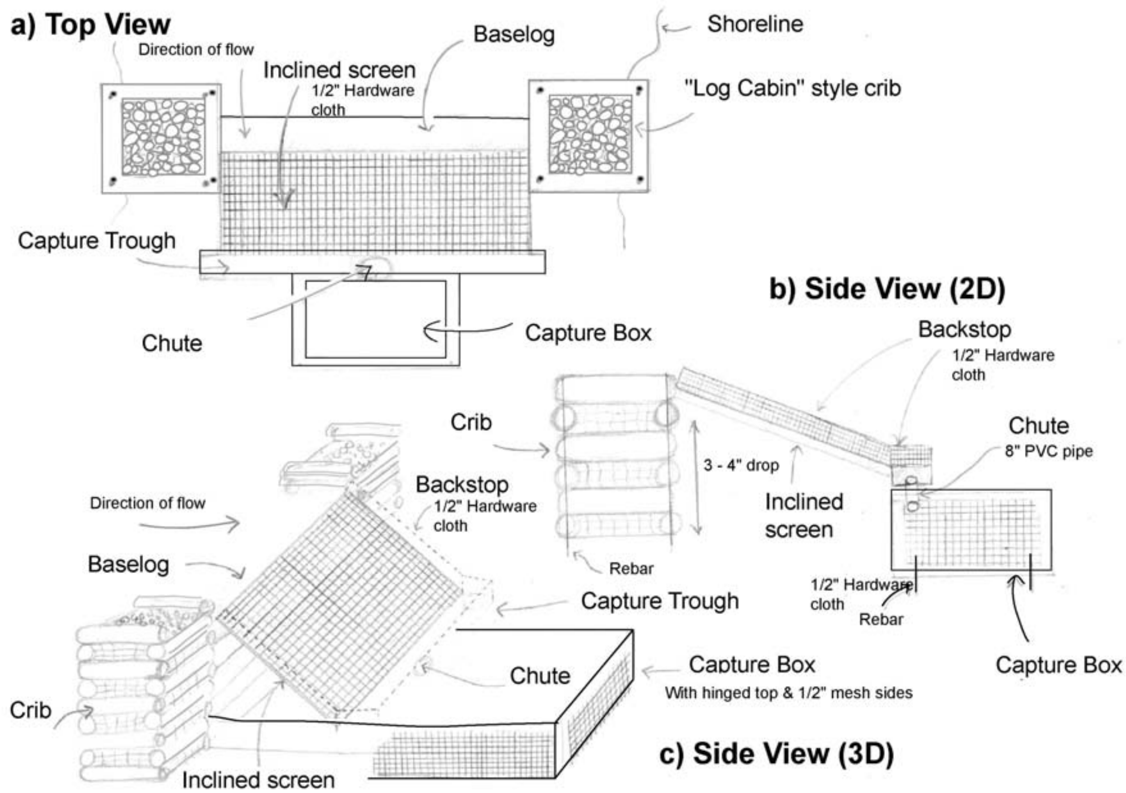

Figure 2: Inclined screen trap (Wolf trap design)

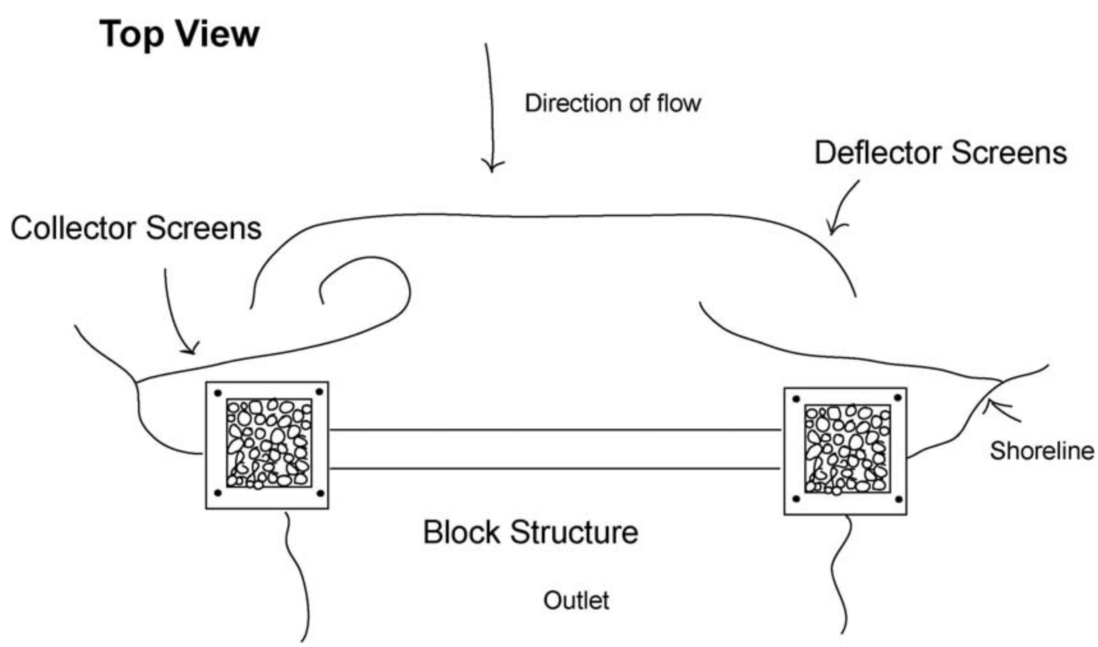

Figure 3. Design and components of deflector and collector screens.

into a hole in the center of the trough to direct fish into the trap. The trap is made of a pressure treated 2 x 4 wooden frame that is covered with ½" mesh steel hardware cloth. In order to protect fish from exposure to the sun, yet allow water to circulate, black plastic sheets (heavy duty garbage bags will work) can be fastened over the hardware cloth on the sides of the trap. A hinged top constructed from heavy-duty plywood or OSB facilitates access to the trap. The trap should be placed solidly in the stream, then secured with sections of rebar driven into the streambed.

Tending inclined screen trap

One advantage of the inclined screen trap is that it will allow high flows to pass over the barrier without affecting the lake level. Daily maintenance of outlet traps is extremely important to reduce stress by trapped fish. Outlet barriers and traps should be left in place only during periods of peak brook trout and/or landlocked salmon emigration (mid-September to late November). These structures should be removed when emigration has ended, in order to prevent lakeshore damage to docks and boathouses from high water and ice.

Debris Deflector and Collector Screens

Deflector and collector screens in front of an inclined screen trap

Debris deflectors and collector screens are essential to any successful outlet block. Even the best maintained outlet block could become clogged with debris and result in increased lake levels if deflectors and collectors are not installed. Debris deflector and collector screens are constructed of ½" hardware cloth faced with ⅛" plastic mesh, positioned with rebar sections driven into the substrate and secured with tie-wrap fasteners (Figure 3). These screens trap debris by creating eddies in the outflow current. Deflector and collector screens do not require cleaning because debris will settle to the bottom behind the screens.

Summary

Outlet blocking prevents losses of mature brook trout and landlocked salmon due to emigration from drainage lakes during the fall spawning period, and has produced significant increases in angling catch of notable brook trout and the proportion of age 2 and older fish within some Adirondack lakes. Outlet blocking has been most successful as a management tool in thermally-stratified coldwater lakes that were intensively stocked. It is also important to recognize that without careful consideration, outlet blocks could be detrimental to self-sustaining populations of native brook trout. An outlet block constructed with a fish trap can provide a useful research tool for managers and scientists, if implemented as part of a scientific research program evaluating fish emigration. All screen structures require frequent maintenance to remove leaves and other debris, but fish traps require additional attention and maintenance to avoid undue stress to fish. Outlet blocks and blocks with traps should be operated only during the period of peak brook trout and/or landlocked salmon emigration (mid September – late November). When the outlet block is not in operation, all blocking screens should be removed. Special catch and release regulations, in combination with an outlet block, can help produce trophy brook trout and landlocked salmon.

Further Technical Information

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Nemeth, Matthew. 2000. Innate migratory behavior and spawning habitat use by landlocked Atlantic salmon: Implications for population restoration in New York. Master's thesis, Department of Natural Resources, Cornell University. 86 pp.

Wolf, Philip. 1951. A trap for the capture of fish and other organisms moving downstream. Transactions of the American Fisheries Society 80: 41-45.

Table 1. Summary of observed spring (March-June) and fall (September-December) emigration by brook trout from five Adirondack study waters.

	Season	Year	Marks released from trap nets (M)	Marks recaptured in outlet trap (R)	Percent emigration (R*M-1*100)	Total emigrants (N)	Mature emigrants in outlet trap	Immature Emigrants in outlet trap
Lake 1	Fall	1979	267	105	39.3	190	185	5
	Spring	1980	283	0	0	11	*	*
Lake 2	Fall	1989	137	51	37.2	454	59**	0**
	Spring	1990	*	*	*	186	*	*
Lake 3	Fall	1991	219	1	0.5	4	4	0
	Spring	1992	89	0	0	0	*	*
Lake 4	Fall	1992	168	55	32.7	258	232	26
	Spring	1993	*	*	*	19	*	*
Lake 5	Fall	1992	64	44	68.8	68	68	0
	Spring	1993	*	*	*	14	*	*
Combined sample							548 (94.6%)	31 (5.3%)

* No data available; ** Incomplete sample since maturity wasn't recorded on all sampling dates.
From (Josephson and Youngs 1996)

Table 2. Proportion of adult landlocked salmon emigrating from 2 Adirondack study lakes.

	Year	Mature, Marked Fish in Lake	Mature, Marked Fish Leaving Lake	% Emigration	Total Emigrants
Lake 1	1997	48	12	25%	30
	1998	35	18	51%	19
	1999	32	8	25%	9
Lake 2	1998	21	10	48%	18
	1999	39	22	56%	25

From (Nemeth 2000)

Table 3. Age structure (% catch) of brook trout populations in fall trap-net samples from 1978 to 1992.

		Percent Catch						
	Sample (years)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7
Drainage lakes with outlets, stocked with mixed strained fish								
Lake 1	9	86.9	13.4	0.8				
Lake 2	8	76.8	20.7	2.4				
Lake 3	9	72.8	24.2	2.2	0.5	0.1		
Lake 4	5	78.9	19.6	1.2	0.2			
Lake 5	7	86.3	12.6	1.2				
Lake 6	12	74.4	21.2	3.5	2.3	0	0.1	
Lake 7	6	71	25.1	2.8	0.6			
Lake 8	8	86	12.5	1.9	0.4			
Mean		79.1	18.7	2	0.5	0.01	0.01	
Seepage lakes without outlets, stocked with similar mixed strained fish								
Lake 9	5	25.3	21.4	14.7	15.3	12.9	7.9	2.5
Lake 10	3	33.1	37.7	21.7	5.3	1.4	0.7	
Mean		29.2	29.6	18.2	10.3	7.2	4.3	1.3

Table 4. Average number of notable brook trout (>400 mm in length and >680 g in weight, 3+ yrs. old) caught annually by anglers in the study lakes.

	Notable Fish (number/year)	
Water	Pre-Block Period	Post-Block Period
Treatment Lakes (Blocks constructed)		
Lake 1	0	5.5
Lake 2	0.1	4.5
Reference Lakes (No Blocks constructed)		
Lake 1	0	0.7
Lake 2	0	0.3

Appendix 1. Agency Permit Contacts

Adirondack Park Agency
P.O. Box 99
Ray Brook, NY 12977
(518) 891-4050

Regional Fisheries Offices of the NYS Department of Environmental Conservation

Central Office- Albany
Bureau of Fisheries
(518) 457-5420

Region 1- Stony Brook: Suffolk and Nassau counties
(516) 444-0354

Region 2- Manhattan, Bronx, Queens, Brooklyn and Staten Island
(718) 482-4900

Region 3- New Paltz: Sullivan, Ulster, Orange, Dutchess, Putnam, Rockland and Westchester counties
(914) 256-3161

Region 4- Stamford: Montgomery, Otsego, Delaware, Schoharie, Schenectady, Albany, Greene, Rensselaer and Columbia counties
(607) 652-7366

Region 5- Ray Brook: Franklin, Clinton, Essex, Hamilton, Warren, Fulton, Saratoga and Washington counties
(518) 897-1333

Region 6- Watertown: Jefferson, St. Lawrence, Lewis, Oneida and Herkimer counties
(315) 785-2261

Region 7- Cortland: Oswego, Cayuga, Onondaga, Madison, Tompkins, Cortland, Chenango, Tioga and Broome counties
(315) 753-3095, Ext. 213

Region 8- Avon: Orleans, Monroe, Wayne, Genesee, Livingston, Ontario, Yates, Seneca, Steuben, Schuyler and Chemung counties
(716) 226-2466

Region 9- Olean: Niagara, Erie, Wyoming, Chautauqua, Cattaraugus and Allegany counties
(716) 372-8676