STATE OF MAINE
DEPARTMENT OF CONSERVATION
LAND USE REGULATION COMMISSION

IN THE MATTER OF

AMENDED PETITION FOR REZONING AND REVISED CONCEPT PLAN FOR PLUM CREEK'S LANDS IN THE MOOSEHEAD LAKE REGION ZONING PETITION ZP 707	PRE-FILED TESTIMONY OF BRANDON H. KULIK submitted on behalf of MAINE AUDUBON and NATURAL RESOURCES COUNCIL OF MAINE

1. Introduction

The concept plan submitted by Plum Creek for development of the Moosehead Lake Region involves changes to land use that will likely affect the capacity of affected watersheds to continue to support native brook trout populations. This is because significant acreage within several small watersheds will be converted from forest cover to residences, resorts, and roadways that will include impervious surfaces with run-off characteristics that will risk altering the water quality and hydrology of these streams. Brook trout have very narrow water quality tolerances and have been extirpated from other watersheds that have experienced this type of development. The purpose of my testimony is to provide the Commission with related information specific to this concern.

2. Biographical Information and Preparation

My name is Brandon H. Kulik. I graduated from Colby College with a Bachelors Degree in Environmental Studies and American Studies in 1976 and earned a Masters Degree in

Aquatic Zoology from DePauw University in 1978. I have been employed as a professional fishery biologist for 29 years, and have worked extensively with the effects of development on fish and aquatic resources in Maine, New England, the mid-Atlantic states, the southeast, Midwest and California. I am employed by Kleinschmidt Associates in Pittsfield, Maine as Senior Fisheries Scientist. I joined Kleinschmidt Associates in 1986. In this position, I am responsible for conducting studies of fish behavior, populations, ecology, migration and habitat use in rivers, lakes and estuaries for both regulatory, resource management and scientific research purposes. Results of my studies have contributed to a number of protective permitting and licensing terms for water diversions, dam operation, fish passage, fishery management and habitat protection measures implemented in Maine over the past two decades. I also have concurrently taught ichthyology at Unity College, served as a recent past-president of the American Fisheries Society, Atlantic International Chapter, and serve as chairman of the Sheepscot River Watershed Council. In addition, I have attended numerous technical conferences, made scientific presentations on impacts to trout populations and habitat, and have received certified habitat modeling training from the U.S. Fish and Wildlife Service.

My relevant work with impacts to, and assessments of, trout populations and habitat extends back to 1986, and in Maine includes peer-reviewed studies from the Saco, Androscoggin, Kennebec, Penobscot, St. John and St. Croix watersheds. Some recent and current Maine-related clients that I have worked for and made contributions to the science of trout and salmon biology include U.S. EPA, U.S. Fish and Wildlife Service, National Marine Fisheries Service, Maine Atlantic Salmon Commission, Maine Inland

Fisheries and Wildlife Department, Maine Department of Conservation, Maine Department of Transportation, Trout Unlimited, Orvis Corporation, FPL Energy Maine Hydro LLC, and Domtar Industries. Prior to preparing my testimony, I reviewed Plum Creek's site concept plans, conducted a site visit, discussed the fish resources with local experts and reviewed water quality modeling results.

Executive Summary

Plum Creek's proposed large scale developments for Moose Mountain and Lily Bay threaten brook trout in these areas. Brook trout require very high water quality and have been extirpated from other watersheds that have experienced this type of development.

Three stream watersheds that presently support wild brook trout populations will receive run-off from Plum Creek's proposed developments. These are the Burnham Brook, Burgess Brook and North Brook watersheds. Both Burnham and Burgess brooks are identified in the Eastern Brook Trout Joint Venture (EBTJV) database as brook trout resources. I readily observed Brook trout in North Brook during a recent field inspection.

As elsewhere, Maine brook trout have declined in abundance and distribution. In the Maine statewide assessment of status and threats, EBTJV found that the existence of a high percentage of remaining forest cover and rivers remaining unaltered by development have thus far enabled Maine brook trout populations to remain somewhat healthier than in many other states. The report goes on to identify encroachment from increasing residential development as one of the threats to remaining Maine brook trout habitat (EBTJV, 2006).

The large-scale development Plum Creek proposes for Moose Mountain and Lily Bay will result in polluted runoff, loss of forest cover, and changes to the quantity and timing of stream flows, all of which can harm brook trout. It is my conclusion after reviewing the available information that LURC approval of the currently proposed resort developments will likely harm and potentially eliminate native brook trout populations in streams in the development areas.

3. Ecological Value of the Project Area

Three small watersheds that presently support wild brook trout populations will receive run-off from Plum Creek's proposed developments. If this runoff alters water quality sufficiently, the resource represented by these populations will be threatened. This is an important consideration in this instance as brook trout populations have been in regional decline. In fact, brook trout have been extirpated from significant areas of their native range (EBTJV, 2007), and are extremely intolerant of warm water with low oxygen levels (MDIFW, 2001, Scott and Crossman, 1973, Raleigh, 1982).

Brook trout are a recreationally and culturally important species, regional icon and indicator of high water quality in Maine. For example, attainment of instream dissolved oxygen water quality classification standards are institutionally evaluated by Maine DEP based on the growth requirements of indigenous species, using brook trout criteria, because this species was historically widespread across Maine, and requires high water quality conditions (D. Courtemanch, Maine DEP, personal communication). In Maine, brook trout are of great cultural importance as a sport species, recognized for their aesthetic and genetic traits, and once occupied a much vaster distribution than that of today (Maine DIFW, 2001). Maine's wild brook trout populations are concentrated in the interior highlands of the state, much of which is located in privately owned commercial forestlands (MDIFW 2006). As elsewhere, Maine brook trout have declined in abundance and distribution, due to a variety of threats; these include land use practices such as timber harvesting, habitat destruction, industrialization and urbanization (MDIFW, 2001). Goal 2.5 of the Maine Brook Trout Conservation Strategies (MDIFW,

2006) is to "*Prevent continued degradation of brook trout habitat*", and includes the following three strategies:

- protect or restore streambank stability, eliminate erosion and sedimentation concerns, maintain shading and thermal regimes, and reduce rapid precipitation runoff
- develop water use flow and groundwater agreements
- document environmental degradation, recommend venues of responsible development, and enforce violation

These strategies place emphasis on maintaining cool, high-quality streams with enough water in them. This means that any development proposal that threatens to increase water temperature, erosion and sedimentation, or alter hydrology either through runoff or altered stream flow should be flagged as posing a risk to brook trout resources.

The proposed Moose Mountain resort includes the drainage area of Burnham Brook, which includes Burnham Pond and associated sub-tributaries. The proposed Lily Bay Resort area will drain to Burgess Brook and North Brook and a number of unnamed streams. According to the Maine Department of Environmental Protection, (DEP) these streams are rated Class A for water quality (38 MRSA (467)(4)(i). According to Maine Department of Inland Fish and Wildlife (MDIFW), Burnham Brook contains self-sustaining populations of brook trout, and in fact is classified as a heritage water by MDIFW (M. Gallagher, MDIFW, *personal communication*). Both Burnham and Burgess brooks are identified in the Eastern Brook Trout Joint Venture (EBTJV) database as brook trout resources. The Burgess watershed population is classified as

"present/intact/large" which gives it the highest priority for conservation; Burnham Brook is classified as "present/greatly reduced" (M.. Gallagher, MDIFW, personal communication). North Brook is as yet un-classified, but juvenile and adult brook trout were readily observed in August 2007 (Figure 1). Other native fish species that inhabit these stream ecosystems include: common shiner, blacknose dace, fallfish, white sucker and slimy sculpin.

Figure 1. Brook trout and slimy sculpin, North Brook, Maine. August 17, 2007.

These forested watersheds have small drainage areas ranging from 2.5 to 8.8 square miles (Table 1).

Table 1. Drainage areas of three brook trout streams within the Proposed Plum Creek Moosehead Lakes Region development. (*source: USGS, 2005*)

Watershed	Drainage area (square miles)
Burnham Brook	8.8
Burgess Brook	2.5
North Brook	3.5

4.0 Brook Trout Populations And Ecosystems Are Fragile And Unique

Scientists from over 50 state and federal fish and wildlife agencies (including Maine), non-governmental organizations and academic institution formed the EBTJV in order to identify and address the threats causing the decline of brook trout throughout the eastern United States (EBTJV, 2007). The EBTJV found, among other things, that "*land use decisions...have severely impacted the quality of brook trout streams and rivers*" as areas undergo rapid change as the human "*population, road network and water needs continue to grow*" (EBTJV, 2006). In the Maine statewide assessment of status and threats, EBTJV found that the existence of a high percentage of remaining forest cover and rivers remaining unaltered by development, is a refuge that has thus far enabled Maine brook trout populations to remain somewhat healthier than in many other states. The report goes on to identify encroachment from increasing residential development as one of the threats to remaining Maine brook trout habitat (EBTJV, 2006).

a. Brook Trout Populations Require Very Specific Water Quality and Habitat Conditions To Survive

The EBTJV assessment found that in Maine the greatest statewide stream disturbance threats to brook trout populations were elevated water temperatures, urbanization and development, inundation by (beaver) dams, and eutrophication (Hudy, et al. 2005). Other threats included sedimentation from roads and forestry practices. The reason land use practices play such an important role is that they have the ability to directly and indirectly affect water quality, quantity and stream hydrology, and brook trout cannot tolerate much deviation from their habitat requirements without experiencing stress or mortality (Maine

DIFW 2001; Raleigh, 1982). In small trout watersheds such as these brooks, the effect of clearing, armoring or road building on an acre of land is also much greater than in a larger watershed.

b. applicable brook trout habitat and biological requirements

Brook trout require cold, clear well-oxygenated water. Raleigh (1982) gives the optimal temperature range for brook trout as 11-16 °C Brook trout cease feeding and growing at temperatures greater than 20 °C (68 °F); 24°F is lethal (Raleigh 1982). Optimal dissolved oxygen levels should be near-saturation at all temperatures; as water temperature increases, the amount of dissolved oxygen decreases as the fish's metabolism rate goes up, requiring additional oxygen to maintain metabolic equilibrium and avoid stress. Accordingly, Maine's class A water quality standard requires that "*The dissolved oxygen content of Class A waters shall be not less than 7 parts per million or 75% of saturation, whichever is higher.*" (Maine DEP Title 38, §465. Standards for classification of fresh surface waters).

Brook trout have varying habitat requirements depending on the life cycle developmental stage and the time of year. Optimal stream habitat is characterized by silt-free, clear, cold water, with rock/cobble bottoms, and a mix of riffles and pools (Raleigh, 1982). Brook trout spawn in the fall, when females deposit fertilized eggs in pits (*redds*) dug in clean unsedimented gravel bars that are submerged by flow (Figure 2). Eggs incubate during the winter for up to 165 days and hatch during the spring. During this period water flow should be sufficient to submerge the riffle and circulate through small spaces between the gravel (called interstices) to oxygenate embryos. The hatching fry live within

Figure 2. Example of gravel bar and riffle suitable for brook trout spawning and foraging, Burgess Brook, Maine. August 2007.

these gravel interstices until ready to emerge in mid spring. If streams are sedimented, and stream sedimentation is a common result of the type of large-scale development Plum Creek is proposing, gravel interstices will become plugged and eggs will not be bathed in the required well-oxygenated water. These eggs will die.

When juvenile brook trout emerge in the spring, they require low velocity areas (shallow stream pools) with abundant cover such as rubble or cobble, and optimal water temperatures of 12.4-15.4°C; temperatures greater than 18 °C are considered detrimental (Raleigh, 1982). Juvenile brook trout also require clean rubble and cobble substrates; again, sediment caused by development will reduce water flow through rubble and cobble on stream bottoms. This can eliminate habitat for insects (reducing their numbers)

juvenile trout need to feed on and destroy the small shelter areas in the rubble and cobble that juvenile trout need to survive Maine's cold winters.

Adult brook trout in streams require cool, well-oxygenated pools with overhead and instream cover adjacent to riffles capable of supporting plenty of insects trout eat (Raleigh, 1982, Scott and Crossman, 1973) (Figure 3).

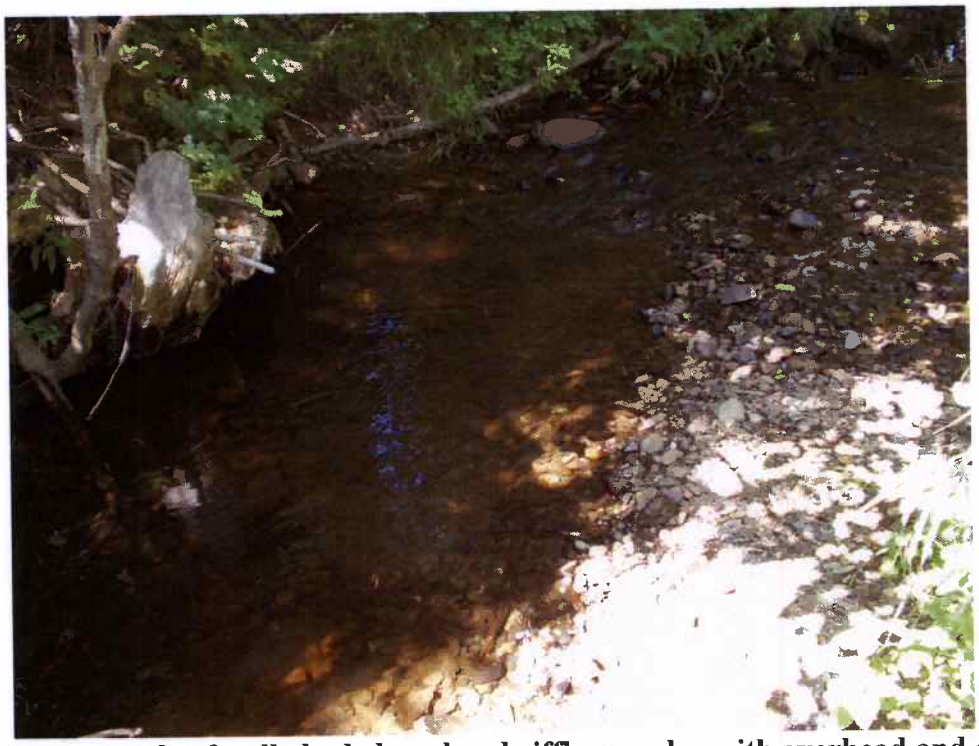

Figure 3. Example of well-shaded pool and riffle complex with overhead and object cover suitable for supporting juvenile and adult brook trout. North Brook, Maine. August 2007.

4. Risk of Degradation to Brook Trout Populations

a. water quality

As I have discussed above, brook trout are extremely intolerant of water quality and dissolved oxygen levels that fall outside a relatively narrow range. Many of the stream insects that brook trout consume such as mayflies have co-evolved with brook trout and thus also require very high water quality. This is a particularly acute concern during summer months when water temperature is naturally high and stream flow is low, due to warm-weather reduced rainfall. Residential, commercial, and recreational development and related infrastructure (such as roadways) can result in increases in stream temperature. This happens if forests are cleared or when rain water washes off parking lots, driveways, and roads that heat up in the summer. Such development can also decrease oxygen in streams because warm water naturally holds less oxygen and because polluted runoff from developed areas often contain substances, such as petroleum byproducts or animal waste, that reduce oxygen in streams as they degrade (bacteria eat these substances and use oxygen in the water to metabolize them, just as we use oxygen from the air to metabolize our food). Runoff from developed areas also often contains high levels of phosphorus from fertilizers, and phosphorus can result in increased algae growth in streams. If algae becomes too abundant, it too can cause lower dissolved oxygen levels as it rots after dying or consumes oxygen out of the water at night. Low dissolved oxygen caused by these factors can harm brook trout.

As noted above, stream-resident brook trout populations require specific substrates, habitat types and cover quality in a stream environment to successfully feed, shelter and

reproduce. Riffles provide stream re-aeration, and are required for spawning and incubation during fall, winter and spring, and pools and runs are required for juvenile and adult fish for shelter and feeding during all seasons. If the combined effects of residential, commercial, recreation development and related infrastructure (such as roadways) result in siltation of gravels, reduction in woody debris, filling of pools, alteration of banks and riparian cover, or habitat fragmentation from poorly maintained or constructed culverts, then the habitat may become too impaired to support brook trout populations.

b. forest cover

Destruction of forest cover can also harm brook trout populations (Theiling, 2006). Reductions in forest cover can increase temperatures in streams through loss of shading, decrease food for insects that trout eat due to loss of woody and leafy material entering streams, and increase non-point-source pollution (forest cover stabilizes soil and also filters out pollution in runoff). Also, loss of forest cover can increase the rate that precipitation enters the streams as surface flow, snow melt, and groundwater flow. This can have negative effects on trout streams. During heavy rainstorms, forest cover lessens the rate at which water enters stream because forested soil absorbs rainwater, allowing the water to enter streams more gradually. Also, forest cover prevents snow from melting as rapidly (due to shade), again allowing for gradual release of water to streams. When forest cover is lost, these moderating effects disappear and water runs into streams much more quickly, altering stream channels and destroying the delicate habitat that trout and their prey need to survive. Also, since forested soils hold more water than non-forested soils in the summer, they provide a better source of groundwater (that is essential to

keeping trout streams cool) than developed areas and allow that groundwater to be released gradually into streams during warm dry summers. This slow, gradual release of cool groundwater is essential to brook trout in many areas.

The high degree of forestation of northern and central Maine highlands has been linked to the health of the remaining statewide brook trout resources. Theiling (2006) determined a strong presence/absence correlation with brook trout populations and forestation. The combined effects of residential, commercial, recreational development and related infrastructure (such as roadways) Plum Creek has proposed will result in as much as 30% of the forest cover being removed from the stream watersheds in the Lily Bay and Moose Mountain areas (Terry Dewan build out scenario). This has potential to impair the ability of these watersheds to maintain brook trout populations (Theiling, 2006).

c. hydrology

Urbanization of small watersheds can alter stream hydrology. Stream hydrology is a function of how land forms store and release run-off from climatic patterns (Dunn and Leopold, 1998). This commonly results in episodes of excessively high flow, followed by protracted periods of low flow (Roberson, *et al.*, 1998). Increased impervious surfaces lack retention and flow buffering characteristics inherent in forested landscape, and this can shunt large volumes of flow into watercourses that the geometry of the stream cannot accept and remain in equilibrium. The cyclical nature of habitat use by brook trout has evolved with natural hydrologic cycles. If these cycles are disrupted, suitable life cycle conditions for brook trout may not be met.

For example, successful spawning relies on seasonal increases in stream flow that sufficiently submerges gravel bars where redds are formed, allows them to remain inundated with circulating water during the incubation season, yet not experience flows high enough to scour eggs from redds or induce bank erosion. Flow pulses at other times of the year are required to maintain channel shape, scour sediments, transport nutrients (Poff, *et al.* 1997). The U.S. Fish and Wildlife Service (USFWS) has determined that a summer base flow equivalent to the naturally occurring August median stream flow is required to maintain suitable coldwater stream habitat in New England (USFWS, 1981).

The proposed concept plan lacks details on where and how consumptive water will be diverted to residences and other facilities, and what effect this will have on stream flow. Maine law requires that Class A streams have habitat that is natural and that is suitable for brook trout and other indigenous fish that need high quality habitat (38 MRSA 465(2)(A). If the combined effects of residential, commercial, recreation development and related infrastructure (such as roadways) result in chronically reduced summer base flows, riffles may go dry, habitats become disconnected (Bain and Meixler, 2000), dissolved oxygen may decline and temperature increase to unsuitable levels, all of which are stressors for brook trout populations. The habitat will also no longer be natural as required by Maine law.

5. The Applicant Proposal Poses Threats to Brook Trout and Lacks Specific Provisions to Protect Brook Trout resources

a. results of modeling

As you have seen in the testimony of Jon Quebbeman, the potential effects by the proposed Moose Mountain and Lily Bay resorts on certain water quality parameters have been modeled, using build-out scenarios developed by Terrence DeWan Associates and available information.

The model output shows that summer water temperature may rise by as much as 4.4°C due to thermal heating of run-off from road surfaces and reduced forest shading and groundwater percolation. Depending on the design of storm water BMP devices, water can be warmed even further. This can easily raise stream water temperature above 20°C, at which point brook trout growth is impaired, and populations are threatened. As I noted above, warm water inherently holds lower amounts of DO; therefore if water is unnaturally warmed, its capacity to hold suitable levels of DO is further compromised.

The model results also show a potential increased Biological Oxygen Demand (BOD) loading leading to an acute decline in dissolved oxygen content in Burnham Brook after storm events. This will likely result in DO concentrations falling below Class A standards and therefore will be detrimental to brook trout populations.

Although I am not aware of a specific phosphorus concentration threshold relative to brook trout survival, increased phosphorus is known to trigger algae eutrophication in

watersheds, which in turn acts to depress DO levels, especially at night when algae consume oxygen, and also whenever increased amounts of decaying plant matter consume oxygen. This would intensify the already stressed DO characteristics of this watershed.

b. other issues

As I have discussed above, expansion of roadway networks in brook trout watersheds has been linked to extirpation of brook trout, primarily due to sedimentation, changes to hydrology, and habitat fragmentation (EBTJV 2006). Theiling (2006) reports that road densities exceeding 2.0 km/km^2 are closely linked to brook trout extirpations. According the existing and proposed road build-outs developed by Deluca Hoffman and Terrance Dewan Associates, respectively, the km/km^2 ratio will be exceeded in the Burgess Brook (3.1 km/km^2), Upper Burnham Brook (4.9 km/km^2), Burnham Pond (19.9 km/km^2), and lower Burnham Brook (6.4) sub catchments (J. Wardwell memo August 27, 2007). This should also be a concern if brook trout resources are to be protected.

The proposed resort developments contain no information on water supply. If water is withdrawn to supply the proposed residences and other facilities, and irrigate golf courses, stream flow could be depleted. This will harm stream habitat. Plum Creek has provided no information on how much water they will use in their developments and where it will come from, so it is unclear whether water used in their proposed developments will harm the fragile brook trout streams in the resort areas.

6. Conclusions

It is my conclusion after reviewing the available information that LURC approval of the currently proposed resort developments will likely harm and potentially eliminate native brook trout populations in streams in the development areas.

VERIFICATION

Brandon H Kulik

Signature of Witness: Brandon H. Kulik

Before me appeared Brandon H. Kulik, who, being duly sworn, did testify that the foregoing testimony was true and correct to the best of his knowledge and belief.

DATED: August 28, 2007

Notary Public

JENNIFER [illegible]
Notary Public
Maine
My Commission Expires March [illegible] 2009

7. Literature Cited

Bain, M.B. and M.S. Meixler, 2000. Defining a target fish community for planning and evaluating enhancement of the Quinebaug River in Massachusetts and Connecticut. NY Coop. Fish and Wildl. unit. Cornell Univ. Ithaca, NY. 18 pp. plus appendices

Dunn, T., and L.B. and Leopold, 1998. Water in environmental planning. W.H. Freeman and Company. New York, NY. 799 pp.

Eastern Brook Trout Joint Venture (EBTJV) 2007. Conserving the Eastern Brook Trout: Strategies for action. Eastern Brook Trout Joint Venture. Conservation Strategy/Habitat Work Group, working draft #7, April 2007.

EBTJV 2006. Eastern Brook Trout: status and threats.. Maine rivers and streams. Eastern Brook Trout Joint Venture. prepared by Trout Unlimited. 4 pp.

Hudy, M,. T.M. Thieling, N. Gillespie and E.P Smith 2005. Distribution status and perturbations to brook trout within the eastern United States. Final Report: Eastern Brook Trout Joint Venture. October 28, 2005. 77 pp.

MDIFW 2001. Brook trout management plan. Maine Dept. of Inland Fisheries and Wildlife. Division of Fisheries and Hatcheries. Augusta, ME. 34 pp.

MDIFW 2006 Maine brook trout conservation strategies. Maine Dept. of Inland Fisheries and Wildlife. Augusta, ME. 5 pp.

Poff, N.L., J.D. Allen, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, and J.C. Stromberg. 1997. The natural flow regime: a paradigm for river conservation and restoration. Bioscience

Raleigh, R.F. 1982. Habitat suitability index models: Brook trout. U.S. Dept. of Int., Fish Wildl. Serv. FWS/OBS-82/10.24. 42 pp.

Roberson, J. A., J. J Cassidy, and M. H Chaudry,. 1998. Hydraulic Engineering. Second Edition. John Wiley & Sons, Inc. New York.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Bulletin 184, Fish. Res. Board. Ottawa, Canada. 966 pp.

Theiling, T.M. 2006. Assessment and predictive model for brook trout *(Salvelinus fontinalis)* population status in the eastern Untied States. M.S.Thesis. James Madison Univ. Dept. of Biology.59 pp.

U.S. Fish and Wildlife Service (USFWS). 1981. Interim regional policy for New England stream flow recommendations. USFWS, Region 5, Newton Corner, MA.

USGS, 2005. National Hydrography Dataset Plus - NHDPlus, Edition. 1.0 [vector digital data]. (2005). U.S. Environmental Protection Agency (USEPA) and the U.S. Geological Survey (USGS).