STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

and

STATE OF MAINE
LAND USE PLANNING COMMISSION

IN THE MATTER OF

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| CENTRAL MAINE POWER COMPANY<br>Application for Site Location of Development Act permit and Natural Resources Protection Act permit for the New England Clean Energy Connect ("NECEC")<br><br>L-27625-26- A-N<br>L-27625-TB-B-N<br>L-27625-2C-C-N<br>L-27625-VP-D-N<br>L-27625-IW-E-N<br><br>SITE LAW CERTIFICATION SLC-9 | REBUTTAL TESTIMONY OF GROUP 4<br>WITNESS NAME: Jeffrey Reardon<br><br>DATE: March 18, 2019 |

This testimony is presented in rebuttal to pre-filed testimony presented by CMP witness Mark Goodwin regarding brook trout habitat and riparian buffers. This includes Issue 2 covered in Mr. Goodwin's testimony: Wildlife Habitat and Fisheries. This rebuttal testimony focuses on the discussion of impacts to brook trout habitat in Goodwin's testimony Sections IV, C, ii: Brook Trout Habitat; IV, C, iv: Buffer Strips Around Coldwater Fisheries, and Section IV, C, v: Issue 2: Conclusion. It is related solely to the issues before DEP.

Goodwin concludes that:

- *[I]t is my opinion that there will be no unreasonable disturbance to or unreasonable impact on . . . Brook Trout habitat and the project will not result in unreasonable habitat fragmentation. ... CMP has made adequate provision for buffer strips around cold-water fisheries.* (Goodwin testimony, page 22.)

In reaching this conclusion, Goodwin relies heavily on two studies that assessed impacts of cleared transmission rights of way on cold-water fish habitat and populations: (1) Gleason, N.C. 2008. Impacts of Powerline Rights of Way on Forested Stream Habitat Western Washington, Environmental Symposium in Rights of Way Management, 8th International Symposium, pages 665-678; and (2) Peterson, A.M. 1993 Effects of Electric Transmission Rights-of-Way on Trout in Forested Headwater Streams in New York. North American Journal of Fisheries Management, vol. 13 pp. 581-585.

I was not able to find a complete copy of the Gleason study. A colleague, TU's Senior Scientist Helen Neville, did find a copy of its abstract, which is provided below in the text of my rebuttal comments. The Peterson study is attached.

With respect to the Gleason study, Goodwin states:

- *"A study by N.C. Gleason on the impacts of power line rights of way ("ROW") on forested stream habitat found that despite the open canopy condition, water temperatures were slightly lower than in off-ROW areas and that none of the water quality parameters was significantly different between the on-ROW and off-ROW study areas. Gleeson's study also found no correlation between percent canopy cover and mean percentage of fines and found no significant difference in the Benthic Index of Biotic Integrity scores between on-ROW and upstream areas."* (Goodwin testimony, page 14.)

Gleason's study did not assess the immediate impacts of ROW construction, but instead investigated existing conditions on 30-50-year-old ROWs, noting that "It is likely that the streams intersected by rights-of-way have recovered from the initial disturbances that occurred 30 to 50 years ago." The study addressed impacts on Pacific salmon species, a suite of anadromous fish in the Pacific basin with very different habitat needs and patterns of habitat use than brook trout in inland streams in Maine. Although Goodwin accurately cites some of Gleason's findings that certain parameters were not significantly different between ROW and non-ROW sites, he does not disclose Gleason's finding that canopy cover was significantly lower in ROW sites (29%) compared to non-ROW sites (75%). More importantly, he does not state Gleason's conclusion:

- *Overall, the elements show a decrease from ideal salmonid habitat conditions.* (Gleason, 2008, Abstract.)

Here is the full abstract of Gleason's study (emphasis added):

- *Abstract: Pacific Salmon* Oncorhynchus *spp. have inhabited streams of the Pacific Northwest for thousands of years. In the past century, however, many populations have suffered severe declines and even extinction, largely due to settlement of the West Coast. Hydroelectric dams, an artifact of industrialization, necessitate swaths through forests to extend powerlines from generating facilities to consumers.* ***Rights-of-way are cleared of trees, and roads are built for equipment access. Many rights-of-way that cross streams in forested areas cause disturbances to riparian zones.*** *Salmonids are sensitive to disturbances that lead to altered temperatures, lack of dissolved oxygen, and* *increased sedimentation. This project's objective was to quantify effects of rights-of-way on forested streams by comparing right-of-way and paired upstream habitat. Measurements included benthic macroinvertebrates, canopy cover, fish presence, water quality, and percentage of fine particles (<0.85 mm) in streambed gravel to determine suitability as spawning habitat.* ***The only parameter that was significantly different was canopy cover with a mean of 29% in rights-of-way and 75% upstream. The parameters were expected to show degradation in the right-of-way due to opened canopy and gravel roads. Overall, the elements show a decrease from ideal salmonid habitat conditions.*** *It is likely that the streams intersected by rights-of-way have recovered from the initial disturbances that occurred 30 to 50 years ago and have restabilized to a natural regime. It is also possible that any degradation caused by rights-of-way is masked by wider scale disturbances such as timber harvest and off-road vehicle activities.*

Similarly, Mr. Goodwin selectively reports findings from the Peterson study. Goodwin writes:

- *A.M. Peterson has reported that removal of tree canopy (on new transmission line corridors) increases stream insolation during the short term, but within two years the areas are bordered by dense shrubs and emergent vegetation and water temperatures are not significantly higher than upstream forested reaches. Similarly, Peterson found that stream reaches in electric transmission ROWs were exposed to more light, had denser stream bank vegetation, were deeper and narrower, and had a greater area composed of pools. Peterson's study found that trout were more abundant in stream reaches within ROWs . . ..* (Goodwin testimony, page 15.)

This summary obscures some critical details of Peterson's study. The full study as published is attached below. Among the concerns:

- This study was funded by the New York State Electric and Gas Corporation, for whom Peterson worked. This does not negate the study's findings but does call into question their interpretation and discussion by Peterson.
- Goodwin does not note Peterson's finding of a highly significant difference in physical attributes between the ROW and forest stream reaches—that Mean Shade was 83.3% in forested reaches and only 31.5% in ROW reaches.
- The results regarding stream temperatures are suspect because warm streams were omitted from the study. The Methods section of the study notes that "Intermittent, warm or polluted streams were not selected." This could significantly skew the results, if, for example, sites with groundwater inputs that maintained cool stream temperatures were kept in the study and sites without groundwater influence with warmer stream temperatures were excluded. In my professional judgement, the relatively cool stream temperatures (mean 17.0 for forested streams and 17.4 for ROW streams) recorded

during mid-day, summer conditions would strongly suggest groundwater influence if recorded under similar conditions in Maine. It should also be noted that, although the difference was not statistically significant, forested streams averaged 0.4 degrees cooler than ROW streams.

- The data and conclusions regarding trout numbers and biomass are difficult to interpret. The abstract of the study reports collection of data at 15 headwater stream crossings, but only 10 of these streams were electro fished to collect fish population data. Trout numbers were higher within the ROW reaches than in forested reaches, but trout biomass was not significantly higher. Peterson reports that a very high proportion of the fish collected were young of year (57.7%) or juveniles (39.6%), with very few adult trout (2.7%). A relatively small shift in habitat suitability towards juvenile trout vs. adult trout —for example, due to the documented reduction in mean shade (83.3% in forested reaches vs. 31.5% in ROWs)—could significantly skew trout numbers when these reaches were compared in a population so dominated by young-of-year and juvenile trout. Peterson in fact reports that this shift towards younger age classes was observed in the ROW reaches and may account for the increase in trout numbers there.
- It is of concern that while trout biomass was not significantly higher in ROW reaches than in forested reaches, total fish numbers and total fish biomass were both significantly higher. This indicates that abundance and biomass of non-trout species was significantly higher within ROWs. Peterson did not report the species of fish other than trout collected in New York, but in Maine this would likely reflect a shift to species, many of them non-native, that are significant competitors with brook trout and have been identified as a long-term threat.

Goodwin also fails to acknowledge an extensive literature that documents the importance of intact, forested riparian buffers for brook trout and other fish and wildlife. Much of this literature is specific to Maine. For example, in a review by the Maine Natural Areas Program citing six different "ecological" buffer treatments applies in Maine and New Hampshire, deMaynadier *et al*[1] emphasize the need to maintain greater than 70% canopy closure within the riparian zone, and to include 25-100-foot no-cut zones immediately adjacent to streams. The Maine Department of Inland Fisheries and Wildlife recommends "limiting the harvest of trees and alteration of other vegetation within 100 feet of streams and their associated fringe and floodplain wetlands to maintain an intact and stable mature stand of trees, characterized by heavy crown closure (at least 60 – 70%)" to protect brook trout habitat.[2] Similarly, Haberstock[3] notes

[1] deMaynadier, P., T. Hodgman, and B. Vickery. 2007. Forest Management Recommendations for Maine's Riparian Ecosystems. Technical report submitted to the Maine Department of Inland Fisheries and Wildlife, Bangor, ME.
[2] ME DIFW, undated. Forest Management Recommendations for Brook Trout. https://www.maine.gov/ifw/docs/brook_trout_factsheet_forestry.pdf
[3] Trout Unlimited. 2005. Riparian Buffer and Watershed Management Recommendations for Brook Trout Habitat Conservation. Focus: Mountainous Brook Trout Watersheds of Maine and Northern New Hampshire. Report Prepared for Trout Unlimited, Augusta, Maine, by Kleinschmidt Associates, Pittsfield, Maine. Page 9.

that "a high degree of canopy closure adjacent to streams is necessary for buffers to function at optimal levels" and "is associated with several functions important for salmonid habitat including shading and organic matter inputs." Haberstock also notes that "Intact forested riparian areas also provide organic debris inputs which directly enhance brook trout habitat through the provision of in-stream structure like tree boles, root wads and large branches."[4] Two of these references were attached to my pre-filed testimony. The third is attached here.

Goodwin's testimony on buffers emphasizes CMP's concession to allow 75-100-foot buffers to stream crossings. But this focus on width, rather than on the nature of vegetation allowed to remain within the buffer, ignores the importance of canopy closure, presence of mature tree, forested buffers, and inputs of large woody debris to instream habitat. He emphasizes buffer functions that can be provided by low ground cover or even grasses, like sediment and nutrient removal, but ignores buffer functions like large woody debris and organic matter inputs that are provided by mature trees that will not be allowed within CMPs buffers. He also exaggerates the degree to which the non-capable vegetation allowed to remain within CMPs proposed buffers will provide functions like shade. For example, Goodwin states:

- *Allowing non-capable vegetation to remain as described within the appropriate buffer will provide shading and reduce the warming effect of direct sunlight (insolation). Low ground cover will also remain within these buffers to filter any sediment or other pollutants in surface runoff. These conditions will allow the stream buffers to provide functions and values similar to those prior to transmission line construction.* (Goodwin testimony, p 21.)

This statement is directly contradicted by the only two references Goodwin cites. Gleason noted that:

- *The only parameter that was significantly different was canopy cover with a mean of 29% in rights-of-way and 75% upstream. . .. Overall, the elements show a decrease from ideal salmonid habitat conditions.*

Similarly, Peterson documented that reaches in ROWS had significantly less shade than nearby forested reaches. Exhibit CMP-3-I, "Vegetation Maintenance—High Voltage Direct Current Tangent Structure Detail" clearly shows that no woody vegetation will be allowed within the 54-foot width of the "wire zone", and that even beyond the wire zone, vegetation heights will be no more than about 15 feet. Shading from vegetation at these heights will be minimal, and large

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[4] Trout Unlimited. 2005. Riparian Buffer and Watershed Management Recommendations for Brook Trout Habitat Conservation. Focus: Mountainous Brook Trout Watersheds of Maine and Northern New Hampshire. Report Prepared for Trout Unlimited, Augusta, Maine, by Kleinschmidt Associates, Pittsfield, Maine. P. 10.

wood and other organic inputs will not occur because woody vegetation will not reach maturity, die, and be recruited into the stream channel before it is cut on the proposed 4-year cycle.

The riparian buffers proposed by CMP will be substantially reduced in function from their current status, with shading greatly reduced and large wood inputs to the stream eliminated within CMPs buffer zones. CMP significantly understates the impacts of its riparian clearing on brook trout habitat and has not made adequate provisions for buffer strips around cold-water fisheries. Indeed, in Mr. Goodwin's testimony regarding Issue IV: Compensation and Mitigation, he acknowledges these impacts:

- *The NECEC will have 11.02 linear miles of streams that will be subject to forested conversion impact.* (Goodwin testimony, p. 23.)

In evaluating the degree of impact to those 11 miles, the DEP should consider that:

(1) The studies cited by CMP suggest that these buffers will provide far less shade than forested streams—a reduction of 75% shaded to 29% shaded in Gleason's study and 83.3% shade to 31.5% shade in Peterson;
(2) The proposed initial clearing will remove all woody vegetation taller than 10 feet from the 150-foot width of the ROW;
(3) The routine vegetation maintenance that will occur on a 4-year cycle will periodically cut all woody vegetation taller than 10 feet to ground level and remove this "slash" from the riparian zone. All "capable" trees within the ROW will be similarly hand cut and removed; and
(4) Because of #2 and #3, all buffer functions that rely on large mature trees—canopy closure and related shading and temperature regulation; large woody debris recruitments; organic inputs from leaf litter—will be severely compromised.

**<u>Attachments</u>**

1. Peterson, A.M. 1993 Effects of Electric Transmission Rights-of-Way on Trout in Forested Headwater Streams in New York. North American Journal of Fisheries Management, vol. 13 pp. 581-585.
2. ME DIFW, undated. Forest Management Recommendations for Brook Trout. https://www.maine.gov/ifw/docs/brook_trout_factsheet_forestry.pdf

Notarization

I, Jeffrey Reardon, being first duly sworn, affirm that the above testimony is true and accurate to the best of my knowledge.

Jeff R. Reardon — 3/18/2019

Name — Date

Maine Brook Trout Project Director

Title

Personally appeared the above-named Jeffrey Reardon and made affirmation that the above testimony is true and accurate to the best of his knowledge.

Date: 3/18/19 Notary: Ann Y

**Ann Young**
Notary Public, State of Maine
My Commission Expires July 10, 2025

Group 4
Exhibit
19-JR
Rebuttal

*North American Journal of Fisheries Management* 13:581–585, 1993


# Effects of Electric Transmission Rights-of-Way on Trout in Forested Headwater Streams in New York

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*Abstract.*—Fifteen crossings of headwater streams by electric transmission rights-of-way (ROWs) in forested areas of New York State were studied to determine the effects of ROWs on habitat and populations of brook trout *Salvelinus fontinalis* and rainbow trout *Oncorhynchus mykiss*. Trout habitat and abundance in ROWs were compared with those in adjacent upstream reaches within the forest. The stream reaches in the ROWs were exposed to more light, had more dense streambank vegetation, were deeper and narrower, and had greater area composed of pools; water temperature was not significantly greater. Trout were more abundant in reaches within ROWs. The greater mean depth and more numerous pools within ROWs were believed to have caused higher densities of trout.

Headwater streams with brook trout *Salvelinus fontinalis* and rainbow trout *Oncorhynchus mykiss* are vulnerable to adverse effects from logging and road building (Chapman 1962; Burns 1972; Lynch et al. 1977). The crossing of headwater streams with electric transmission rights-of-way (ROWs) may also degrade trout streams. Such crossings usually involve the permanent removal of trees and construction of an equipment access road across the stream channel. These changes may affect water temperature, the stream channel's cross-sectional geometry, instream cover, fish food availability, and fine sediment deposition.

This study was conducted to determine (1) the effect of electric transmission ROWs upon the physical characteristics of headwater trout streams in forested areas, and (2) the effect of these changes upon trout abundance.

## Study Area

This study was conducted in south-central New York State, in Delaware, Sullivan, and Chenango counties, within the Delaware Hills and Catskill Mountains of the Appalachian Uplands. Bedrock was primarily sandstone. Elevation varied from 300 to 1,000 m above mean sea level. The entire area has been glaciated, and soils are thin glacial tills except along major river valleys, where alluvial deposits occur (Thompson 1966). The area lies within the northern hardwoods section of the Laurentian mixed forest province (Bailey 1976). Forest cover is primarily sugar maple *Acer saccharum*, yellow birch *Betula allegheniensis*, American beech *Fagus grandifolia*, and eastern hemlock *Tsuga canadensis*. The area was heavily logged in the 1800s; however, mature second-growth forest now covers approximately 75% of the land (Brooks 1981). Headwater streams tend to be clear, cold, and relatively unproductive.

*ROW description.*—The physical characteristics of the ROWs studied were variable. Lower-voltage lines (34 and 46 kV) were in cleared ROWs 10–30 m wide; higher-voltage lines (115, 230, and 345 kV) were in cleared ROWs 30–50 m wide. Where parallel sets of lines were constructed, ROW width was as wide as 130 m. Although ROWs usually crossed the streams at a right angle, they sometimes paralleled a stream for up to 450 m. The ROWs were 10–50 years old, and most no longer had active road access.

The vegetation among the ROWs was similar. Trees were absent or limited to scattered saplings, but there was dense growth of forbs and shrubs. Common taxa included hay-scented fern *Dennstaedtia punctilobula*, goldenrod *Solidago* spp., blackberry *Rubus* spp., and grasses. Alders *Alnus* spp. frequently occurred along the streambanks. Hardwood sprouts frequently grew from cut stumps on the streambanks.

## Methods

*Stream survey.*—Stream surveys were conducted during July and August 1988 and 1989. Fifteen ROW crossings of forested headwater streams (first- or second-order) were selected. Care was taken to select stream crossings with no impacts from cattle grazing, logging, or beaver activity. Intermittent, warm, or polluted streams were not selected. The entire cleared ROW stream reach was studied. However, at one reach that flowed parallel to the ROW for 450 m, only the lower 30 m was studied. This was done as a practicality—to keep the reaches of generally equal lengths, and to detect a worst-case increase in stream temperature and other potential ROW effects. The ROW reaches averaged 29 m long but varied from 15 to 45 m long. An upstream reach of the same length and morphology (i.e., gradient, discharge, and channel pattern) was located in the forest immediately (<10 m) adjacent to the ROW edge for comparison. However, one ROW reach was 44% longer than the upstream reach due to the presence of a long, deep pool in the ROW.

The intent of the design was to enable an extensive posttreatment sample from which the effects of the ROWs on trout habitat and abundance could be assessed. One goal of this posttreatment sample was to detect not only mean habitat changes but also also the "worst cases" to help identify potential adverse effects of future ROW clearing, construction, and maintenance. This is why polluted, logged, or otherwise already disturbed stream reaches were not selected. It is also why stream temperature, riffle fines, and shade were sampled in such a manner as to detect maximum differences, not mean differences.

The habitat variables selected for study were chosen from the brook trout habitat suitability index (HSI) model (Raleigh 1982). The model contains suggested methods for measurement of the variables along with more detailed descriptions of sampling procedures.

Sampling transects were established systematically across each stream reach, usually at 3-m intervals, 7–16 transects were sampled per reach depending on the length of the reach. On three shorter reaches (15, 15, and 20 m), the distance between transects was reduced to 2 m. Water velocity was measured with a Montedoro-Whitney PVM-2A velocity monitor at the middepth and midchannel of each transect. The measurements for all transects were summarized as mean velocity (m/s) for each stream reach. Wetted width was measured to the nearest 0.25 m. Water depth was measured at 0.25, 0.50, and 0.75 the width on each transect. The deepest measurement was considered to be the thalweg depth. Mean wetted width and mean water depth were computed for each stream reach. At each point where stream depth was measured (three locations per transect) the presence or absence of shade at the water's surface was recorded. A reach with 10 transects would then have 30 shade readings. The percent of points that were shaded for each reach was then calculated. All shade readings were collected between 1000 and 1600 hours, when the sun was high in the sky. Within paired reaches, shade readings were taken within one hour of each other to minimize variation due to change in the sun's angle.

The surface area of pools and riffles was measured and mapped to scale on planform maps. The percentage of the stream reach that was pool or riffle was calculated for each reach.

Dominant substrate size was visually categorized at each transect following Raleigh (1982): 1.0 = rubble or small boulders dominant, with limited fines, large boulders, or bedrock; 0.6 = boulders, rubble, gravel, and fines equally present, or gravel is dominant; or 0.3 = large boulders, bedrock, or fines dominant, little rubble or gravel. The mean numeric values for all transects were then calculated.

Fines in riffles were sampled in the first riffle upstream and downstream from each ROW; the upstream sample represented forest conditions; the downstream sample, though in forest, represented the effects of ROWs. At each riffle, 10 samples of the top 5 cm of substrate were collected in 250-mL wide-mouthed jars. Each jar was filled in a single upstream sweep. The generally low water velocities and depths prevented significant loss of fines. These samples were returned to the laboratory, where they were passed through a 3-mm sieve. The percent of fines (<3 mm) was then determined for each sample by volume displacement, and the mean was computed.

The length of streambank and stump and tree undercuts that were greater than 5 cm and had an underlying water depth of at least 5 cm were measured within each reach and mapped to scale on planform maps. The undercuts' lengths were summed to determine the percentage of overhead bank cover within each reach.

The presence and location of streambank vegetation (grasses, shrubs, and trees) were mapped to scale on planform maps. The percentage of the stream reach dominated by grasses and shrubs, as opposed to trees, was calculated for each reach.

Water temperature was measured with a Corning PS-15 probe. One reading was taken midstream at the farthest downstream sampling transect of each ROW and upstream reach between 1000 and 1600 hours and during sunny weather. Preliminary sampling indicated that worst-case increases in water temperature occurred midchannel at the downstream end of the ROW reach.

The trout were sampled by electrofishing during August 1989. Only 10 of the 15 study streams were sampled because access restrictions prohibited sampling the remaining five streams. At each reach,

TABLE 1.—Average electrofishing trout catches as percentages of total population estimates of age-0 and older trout in seven streams in New York, 1989. Reach was designated as either on or off an electric transmission right-of-way (ROW).

| Stream | Reach | Catch (% of total) | |
|---|---|---|---|
| | | Grams | Numbers |
| Denman Brook | On ROW | 99 | 97 |
| | Off ROW | 60 | 80 |
| Lybolt Brook | On ROW | 96 | 79 |
| Neversink Tributary | On ROW | 98 | 93 |
| | Off ROW | 97 | 96 |
| Ward Road Brook | On ROW | 91 | 73 |
| | Off ROW | 99 | 80 |
| Average | | 91 | 85 |

block nets were placed at the upstream and downstream ends. Three upstream passes were made with a Smith-Root pulsed-DC backpack shocker. All stunned fish were netted, counted, identified to species, measured to the nearest millimeter (total length), and weighed to the nearest 0.1 g.

All electrofishing data were corrected to standard 30-m reaches. Three-pass depletion estimates of trout standing stock (g/reach) and population (number/reach) were calculated (DeLury 1951) based upon results from 7 of the 20 sites. Sampling efficiency often exceeded 90% (Table 1).

A paired $t$-test was used to detect significant ($P \leq 0.05$) changes between habitat variables in ROWs and off and significant changes in the fish population characteristics in ROWs and off. Because the substrate value data were discontinuous, they were analyzed with the Wilcoxon signed-rank test (Snedecor and Cochran 1967). Paired $t$-tests were performed with the Statistical Analysis System (SAS Institute 1985a, 1985b).

## Results

### *Stream Survey*

Five of the 10 stream habitat variables differed significantly between the ROWs and the upstream forested reach (Table 2). The reaches in the ROWs received more direct sunlight, had more low streambank vegetation, were narrower and deeper, and had more pool area. The greater mean depth in ROWs resulted from a higher average minimum depth recorded at each transect (8.4 cm for ROW transects versus 6.4 cm for forest transects), whereas thalweg (maximum) depth was not different (13.6 cm versus 13.5 cm). Although the amount of bank cover did not differ between forested and ROW reaches, its composition did. There were significantly more undercut earthen banks in the ROW than in the forested reaches, yet no significant difference in undercut stumps, trees, and logs (Table 2).

TABLE 2.—Mean physical attributes of 15 headwater trout streams in New York, 1989. Thirty-meter reaches in cleared electric transmission ROWs were compared with adjacent upstream 30-m reaches in the forest by paired $t$-tests. The $P$-values represent the probability that the mean difference between the forested and ROW reaches was equal to zero.

| Variable | Stream reach | | $P$ |
|---|---|---|---|
| | Forest | ROW | |
| Mean velocity (m/s) | 0.19 | 0.21 | 0.40 |
| Mean width (m) | 3.6 | 2.8 | 0.04 |
| Mean depth (cm) | 9.5 | 12.1 | 0.02 |
| Area of pools (%) | 25.7 | 38.3 | 0.02 |
| Substrate size | 0.80 | 0.82 | 0.80[a] |
| Mean riffle fines (%) | 23.4 | 20.5[b] | 0.09 |
| Mean shade (%) | 83.3 | 31.5 | 0.01 |
| Bank cover (%) | 14.7 | 23.3 | 0.26 |
| Earthen portion | 10.1 | 19.5 | 0.05 |
| Woody portion | 4.6 | 3.8 | 0.75 |
| Bank shrubs and grass (%) | 4.6 | 91.8 | 0.01 |
| Temperature (°C) | 17.0 | 17.4 | 0.24 |

[a] Wilcoxon signed-rank test.
[b] Collected from first riffle in forest downstream of ROW edge.

Trout abundance estimates were significantly higher in ROWs than in forested reaches (Table 3). Nine of 10 streams had more trout in the ROW than in upstream reaches. Although the difference in trout standing stock estimates between forested and ROW reaches was not significant, the difference in the standing stock of all fish (trout and nonsalmonids combined) per reach was significant (Table 3). The trout population structure was weighted heavily towards small fish in both ROW and forested reaches. Young-of-year trout (≤9.9

TABLE 3.—Mean population and standing stock estimates of 10 headwater stream fish communities in New York, 1989. Fishes in 30-m reaches in cleared electric transmission ROWs were compared with those in adjacent upstream 30-m reaches in the forest by paired $t$-tests.

| Variable | Stream reach | | $P$ |
|---|---|---|---|
| | ROW | Forest | |
| Number of trout/reach[a] | 30.8 | 18.9 | 0.01 |
| Grams of trout/reach | 342 | 228 | 0.12 |
| Number of all fish/reach[b] | 118.5 | 62.8 | 0.03 |
| Grams of all fish/reach | 585 | 368 | 0.04 |

[a] All were brook trout except for nine rainbow trout in one ROW reach and five in the paired forested reach.
[b] Includes all brook and rainbow trout.

cm) constituted 57.7% of the sample; 39.6% of the trout were juveniles (10–17.3 cm) and only 2.7% were adults (≥17.4 cm).

## Discussion

Removal of the forest canopy in ROWs caused a significant increase in incident sunshine, which in turn encouraged a dense growth of low streambank vegetation. The ROWs were always bordered by a robust forb and shrub layer, and vegetation often overhung the stream channel. The grasses approached 1 m in height and usually obscured the ground completely. The darkened forest streambanks, in contrast, usually held only scattered herbs and an occasional sapling or mature tree.

The added root mass of the forb and shrub layer appears to have stabilized the streambanks and increased their resistance to erosion. In addition, the channel point bars, which were normally unvegetated even when exposed at low flows, became covered with a dense growth of tall grasses and forbs. This combination of bank and bar stabilization restricted increases in stream width during peak flows and probably resulted in increased bed erosion instead. The increased bed erosion is the probable cause of the observed increases in depth and areas of pools. This interpretation is consistent with the hydraulic geometry demonstrated by Leopold and Maddock (1953) whereby, at a constant discharge and velocity (which were present between paired reaches), any decrease in channel width must be compensated for by a corresponding increase in depth.

These changes in streambank vegetation and hydraulic geometry appear to have caused the significant difference in the nature of the bank cover. The dense root mass of the ROWs' forb and shrub layer apparently prevented the undercut upper soil horizons from sloughing off into the current as they tended to do in the forested reaches. However, the initial ROW clearing removed large streambank trees. Time and floods removed the stumps, and ROW vegetation management insured that large trees did not reappear. As a result, the relatively few undercut trees in the ROW reaches tended to be replaced with a greater amount of undercut banks.

The differences observed in trout abundance between forested and ROW reaches were likely caused by the greater water depth and pool area in the ROWs. Many of the riffle areas in the forested reaches were too shallow for fish. However, the riffles in the ROWs were deeper and yielded large numbers of fish during the electrofishing effort. Smith (1980) noted a similar relationship in populations of brown trout *Salmo trutta* between forest and meadow reaches of a small tributary of the River Tweed, Scotland. Scarnecchia and Bergersen (1987) also found that narrower and deeper small streams yielded increased salmonid production. The ROW reach trout populations consisted of greater numbers of small trout compared with the forested reaches. This suggests that ROW stream reaches may be better habitat for young fish, perhaps increasing their survival.

Electric transmission ROWs need not constitute an adverse effect on headwater trout population densities in forested basins. They can generate positive effects as long as they do not cause stream warming to greater than 20°C and as long as long-term damage by construction equipment is avoided. The data herein suggest that the selective removal of riparian trees may increase the amount of habitable area for trout by increasing mean water depth. The greatest advantages of selective tree removal may be seen if riffles are opened to sunlight but pools are left shaded. Most of the trout in the streams studied were young of year and juveniles, and the major fishery benefit to such streams may be increased downstream recruitment to the fishery. Trees that are undercut and provide bank cover for adult trout should not be cut. Stream temperatures in managed reaches should be monitored to ensure that opening of the riparian canopy does not cause significant stream warming.

## Acknowledgments

Funding for this project was provided by New York State Electric and Gas Corp. Doug Cerretani, Dale Madison, John Titus, and Dick Andrus provided many helpful comments; field assistance was provided by Tim Sienkiewicz and Mark Lindberg. I also thank Wayne Hubert, Steve Miranda, and anonymous reviewers for their encouragement and assistance with manuscript preparation.

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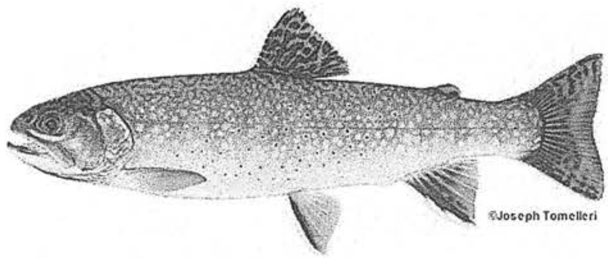
Group 4 Exhibit 20-JR Rebuttal

**MAINE DEPARTMENT OF**
**INLAND FISHERIES AND WILDLIFE**




**Forest Management Recommendations for Brook Trout**

***Background***

Brook trout (*Salvelinus fontinalis*), commonly referred to as squaretail, brookie, and speckled trout, are native to Maine and are the most preferred sport fish sought by Maine anglers. Size may vary, depending on water temperature, productivity, and food sources, but 3 year-old brook trout in Maine lakes may range from 7.5 to 17.5 inches long. Stream populations are typically slower growing, and lengths of 6 to 10 inches are more common place, although some populations mature and reproduce at lengths smaller than 6 inches.

Maine is the last stronghold for wild brook trout in the eastern United States. There are more than twice as many watersheds supporting wild populations in Maine than all of the other 16 states within the historical eastern brook trout range combined. Maine is also the only remaining state with extensive intact lake and pond dwelling populations of wild brook trout.

Brook trout require clean, cool, well oxygenated water and are very sensitive to changes in habitat and water quality. Rivers and streams typically provide spawning and nursery habitat. Adults are commonly resident in streams, but migrate throughout and between drainages to meet seasonal life history requirements.

Stream habitat suitability is maintained by the presence of intact, mature wooded riparian corridors that conserve forest soils, provide shade to reduce stream warming, protect stream water quality, provide cover for fish, and provide a source of woody debris and leaf litter from mature trees that maintain in-stream habitat for fish and the aquatic insects they feed upon. Floodplain and fringe wetlands associated with streams can be a significant source of springs and groundwater discharge that maintain stream flows and cool temperatures during warm low flow summer periods. Protection of these important riparian and wetland functions ensures that the overall health of the stream habitat and watershed is maintained.

Maine brook trout fisheries are unique and highly valuable, but they are vulnerable to habitat alteration that may be caused by poorly planned and implemented land management activities. Well planned forestry operations can protect habitat and help ensure that forests remain as forest; a compatible land use for brook trout and many other fish and wildlife.

***Forest Management Recommendations***

Brook trout are not afforded any special state or federal regulatory protection for forestry operations, and as such management recommendations are advisory.

The MDIFW recommends following Best Management Practices (BMPs) during all road and trail building activities, as well as timber harvesting. BMPs are detailed in the booklet titled *Best Management Practices for Forestry*, which offers guidance on managing and protecting water quality, installing road-stream crossings, and providing fish passage. This booklet is available at: http://www.maine.gov/doc/mfs/pubs/bmp_manual.htm or contact the Maine Forest Service at 1-800-367-0223.

Potential harmful impacts to fish and wildlife may be further minimized by designating low impact "riparian management zones" adjacent to streams and stream-associated fringe and floodplain wetlands in forest management and harvest plans. Smaller streams may be greatly influenced by land management practices; these systems benefit the most from well-managed and intact riparian corridors.

The MDIFW also recommends limiting the harvest of trees and alteration of other vegetation within 100 feet of streams and their associated fringe and floodplain wetlands to maintain an intact and stable mature stand of trees, characterized by heavy crown closure (at least 60 – 70%) and resistance to wind-throw. In some situations wider buffers should be considered where severe site conditions (e.g., steep slope, vulnerable soils, poor drainage, etc) increase risk to soil and stand stability. Any harvest within the riparian management zone should be selective with a goal of maintaining relatively uniform crown closure.

Roast beef

Horseradish

Dijon mustard

Fresh rosemary

Fresh Thyme

Parsnips

Cauliflower

Celery root

Cooking greens