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Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
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Subject: Comments on Scoping Document 1 and Study Requests for the Wilder (FERC No. 1892-026), Bellows Falls (FERC No. 1855-045), Vernon (FERC No. 1904-073), and Turners Falls (FERC No. 1889-081) hydroelectric projects, and the Northfield Mountain Pumped Storage Project (FERC No. 2485-063)

Dear Secretary Bose:

The Nature Conservancy is submitting this letter in response to the December 21, 2012 Federal Energy Regulatory Commission (Commission) filing of the Notice of Intent to File License Application, Filing of Pre-Application Document (PAD), Commencement of Pre-Filing Process, and Scoping; Request for Comments on the PAD and Scoping Document, and Identification of Issues and Associated Study Requests for the Wilder, Bellows Falls, Vernon, and Turners Falls hydroelectric projects, and the Northfield Mountain Pumped Storage Project.

The Nature Conservancy (Conservancy) is a private, non-profit 501(c)3 organization with approximately 1 million members worldwide. The Conservancy has been working in the Connecticut River basin for over 50 years, officially establishing the Connecticut River Program in 2003 with a vision to protect and conserve the lands and waters of this important watershed in a way that allows both human and natural communities to thrive.

The Conservancy is a science-based organization that works with partners to identify and implement solutions to complex conservation challenges. Specifically, the staff of the Conservancy's Connecticut River Program has expertise in managing complex issues that correspond to effects of altered hydrological regimes on natural river hydrology, floodplain forest communities, and aquatic species assemblages, as well as expertise in developing management and conservation solutions for complex multiple-use river systems.

The Conservancy is interested in providing information and expertise that will assist the Commission in conducting a thorough and balanced analysis of the issues and effects surrounding the relicensing of the five hydropower projects on the Connecticut River. Because much of the information that we will provide applies to multiple projects, we are submitting this single document to comment and to address issues for all five of the Connecticut River projects. The comments and information herein are based on a review of the three Pre-Application Documents (PADs) submitted by TransCanada and the single PAD submitted by FirstLight on October 31, 2012, as well as the Commission's Scoping Document 1 (SD1) issued December 21, 2012, and the content of the scoping meetings held January 29-31, 2013.

COMMENTS ON SCOPING DOCUMENT 1

Section 3.0: Proposed Action and Alternatives

The SD1 states that "Commission staff will consider and assess all alternative recommendations for operational or facility modifications, as well as PM&E measures identified by the Commission, the agencies, Indian tribes, NGOs, and the public." Operational or facility modifications that the Conservancy recommends will support our overall goal to provide more natural flows in the Connecticut River that support floodplain forests, riparian invertebrates, freshwater mussels, and resident and migratory fish. In recognition of the importance of hydropower as a reliable and clean (i.e., having low carbon emissions) energy source, the Conservancy also seeks license recommendations that balance and optimize the competing values of both hydropower and ecosystem flow requirements.

In partnership with the U.S. Army Corps of Engineers, the University of Massachusetts Amherst (UMass), and the U.S. Geological Survey, the Conservancy is nearing completion of the federally-sponsored Connecticut River Watershed Study. The goal of the Study is to develop a series of models that seek to find optimal solutions for managing flows in the Connecticut River Watershed – solutions that balance both societal needs for water and power as well as natural flows that support ecological needs. As part of the Connecticut River Watershed Study, UMass has developed an hourly-based hydrological optimization model that, in concert with an operational simulation model, will provide the basis for the Conservancy's recommendations for alternative operational modifications to the five Connecticut River relicensed facilities. We propose that the Commission evaluate the alternative(s) that the Conservancy recommends based on model results; we anticipate these results will be further improved by data gathered during the First and Second Study Seasons of the relicensing process.

Furthermore, because of the uncertain and dynamic nature of ecological systems, we suggest that after completion of the two Study Seasons, the Commission recommend a course of adaptive management in those cases where the links between project operations and ecological benefit remain uncertain, or when results demonstrate that climate change effects will alter the nature of these links. An adaptive approach to management is beneficial to meeting ecosystem requirements, but also minimizes the risk of adopting an operational regime that results in loss of power generation or operational flexibility while also failing to meet ecological goals, a possible scenario in an uncertain and dynamic system. An adaptive-type approach to finding operational solutions will ultimately benefit all competing system objectives – both those of power generation and those of ecological needs.

Section 3.6.3: Project Decommissioning

The SD1 states that "[t]here would be significant costs involved with decommissioning the project and/or removing any project facilities. The project provides a viable, safe, and clean renewable source of power to the region. With decommissioning, the project would no longer be authorized to generate power." We concur with these statements; however, whereas there may be significant costs to decommissioning and removing project facilities, it is not clear whether these costs outweigh any potential resulting ecological benefits. Furthermore, project removal does not necessarily require a net loss of energy production. For example, dam removal on the Penobscot River in Maine has been accompanied by an increase in energy production capacity at other facilities (FERC 2004).

The SD1 also states that "No party has suggested project decommissioning would be appropriate in this case, and we have no basis for recommending it." We would like to note that before the scoping meetings and the issuance of the SD1, there was no formal avenue to suggest decommissioning in the FERC relicensing process. Therefore, the alternative of decommissioning should not be removed from consideration because of lack of prior suggestion. The Conservancy does not necessarily support decommissioning, especially without adequate study as to its benefits. However, eliminating this alternative from consideration limits the scope for finding solutions that balance the values and uses of the Connecticut River.

Section 4.1.1: Resources that could be cumulatively affected

As stated in the SD1 "…a cumulative effect is the effect on the environment that results from the incremental effect of the action when added to other past, present and reasonably foreseeable future actions…" The SD1 identified the following as potential cumulatively affected resources: water quality and quantity, fishery resources, and rare, threatened, and endangered species. The Conservancy agrees with this assessment and also suggests adding freshwater mussels and

floodplain communities to this list. Support and justification for the inclusion of water quantity, fishery resources, freshwater mussels, and floodplain communities in the assessment of cumulatively-affected resources follows below.

Water quantity – For the context of the relicensing of the five Connecticut River hydropower projects, we suggest that water quantity be defined as a multi-dimensional resource; that is, it should not be defined simply by volume of water (flow magnitude), but also by how often (flow frequency), how long (flow duration), when (flow timing), and how quickly (rate of change in flow) these volumes of water move through the system (Poff et al. 1997). These water quantity characteristics are important not only as components of a natural flow regime, but also with regard to hydropower operational flows, being essential for both optimizing hydropower production and for meeting requirements of the riverine-dependent ecosystem.

Water quantity may be regarded as a cumulatively-affected resource because of flow modifications by upstream hydropower and flood control projects, impacts of relicensed projects on downstream water quantity, land use activities within the drainage area, and potential climate-induced changes in flow. Furthermore, because water quantity is a cumulatively-affected resource, then it logically follows that any resource directly dependent upon water quantity and its descriptive characteristics (see above) must therefore also be a cumulatively-affected resource. The most simple and direct example of this is that of power production, as energy production is directly related to the volume of water that passes through a hydropower turbine. There are other resources that are dependent upon water quantity that are also important, though the dependencies may be more complex, including fishery resources, freshwater mussels, and floodplain communities.

Fishery resources – The cumulative nature of the effects on migratory fish species is relatively clear: the effects of one project or barrier to upstream or downstream migration will be influenced by the effects of previous barriers along the migration route. Furthermore, multiple additional factors may affect migratory fish, including commercial fishing and conditions in the marine environment. Equally important is the cumulative nature of the effects on non-migratory resident fish species. Resident fish species may be considered cumulatively-affected for at least two reasons. First, because all riverine-dependent species have life-history characteristics that are dependent on the natural patterns of the flow regime (Poff and Ward 1990; Poff et al. 1997; Bunn and Arthington 2002), and because flow regime (water quantity and its descriptive characters) is a cumulatively-affected resource, then as stated above, any flow-dependent ecological resource must also be cumulatively-affected. Second, the definition of the biologically- or ecologically-relevant unit for a resource will determine whether that resource is cumulatively affected, at least on a spatial scale. For example, if we define the biologically-relevant unit of a particular fish species to be the population within a project reservoir, then the

degree to which this resource is cumulatively affected is much less than if we defined the population to include all individuals of the species within the Connecticut River basin. If we choose to use the latter definition, then spatial cumulative effects would include modified flows from dams within the watershed, habitat fragmentation, land use, and invasive species, among other effects. We suggest that in the present context, the biologically-relevant unit for each species of non-migratory fish should include the population of all individuals of each species within the project-affected areas[1] for all five relicensed projects. With this definition, cumulative effects would include effects of the individual relicensed facilities, as well as upstream and tributary modified flows, habitat fragmentation, thermal effects from Vermont Yankee, and land use activities within the project-affected areas, among other potential effects.

There are at least two benefits to considering biologically-relevant units on this suggested larger scale. First, doing so expands the decision context and presents more opportunities for meeting broader ecological objectives, such as minimizing overall extinction risk or maximizing long term population stability. Managing flows at multiple facilities will present more opportunities to meet these broad scale objectives than managing flows at independent facilities for fragments of a larger population. The second benefit to considering populations on a broader scale is that the degree of information obtained and therefore the strength of conclusions will be greater than it would on a smaller scale. The conclusions made about the effects of one project on a resource will be made stronger by examining the effects of similar projects. Furthermore, without understanding the larger context, it becomes more difficult to elicit other non-project-related effects, such as unrelated thermal effects or land use activities. By considering populations on a broader scale and by examining the cumulative impacts on these populations, more information and better decisions can be made regarding whole-system management.

Freshwater mussels – Using the same rationale as described above for resident fish species, we propose that the Commission include freshwater mussels in its assessment of cumulatively-affected resources. In addition, we propose that the biologically-relevant unit for each mussel species be defined as the population that includes all individuals within the project-affected areas for all five relicensed projects.

Floodplain communities – We also propose that the Commission consider floodplain communities in its assessment of cumulatively-affected resources. In a comprehensive regional analysis, alluvial wetlands, such as floodplain forests and river marshes, emerged as the wetland type of greatest concern; 27 percent of their historic extent has been converted, mostly to agriculture. Although 15 percent of the historic area is now secured, only 6 percent is secured

[1] The project-affected area for each project is here considered the full longitudinal (upstream) and lateral (tributary) extent of the project impoundment, as well as the riverine reaches downstream of each project that are affected by the operational flow regime.

primarily for nature, so conversion exceeds securement for nature 5:1 (Anderson and Olivero Sheldon 2011). Flood-dependent tree species like silver maple and black willow occur only in low floodplain forests, while some tree species such as northern hackberry are nearly absent from the Connecticut River basin except on the rich soils of high floodplain terraces (C. Marks, The Nature Conservancy, personal communication). These communities depend on specific inundation regimes that are impacted by management of project reservoirs and potentially downstream flow management as well. If we consider the biologically-relevant unit to be the vegetative communities of the 100-year floodplain (as defined by the Federal Emergency Management Agency, FEMA) adjacent to project-affected areas for all five relicensed projects, cumulative effects on this resource include reservoir and flow management of each relicensed project, upstream and tributary modified flows, invasive species, and land use activities, among other potential effects.

Section 4.1.2: Geographic scope

The Conservancy suggests that in terms of water resources, the downstream geographical extent of a cumulative effects analysis should extend to, and include discharge from, Holyoke Dam in Holyoke, Massachusetts.

In terms of resident fish species and freshwater mussels, we suggest that the geographical extent of cumulative effects should include at minimum the entire project-affected area, from the upstream extent of Wilder reservoir downstream to Sunderland, Massachusetts. However, it is possible that the geographical extent of analysis will need to be lengthened in order to draw any conclusions regarding effect, given the limited riverine habitat within the project-affected areas.

We suggest that the geographical extent of cumulative effects on floodplain communities should include the 100-year floodplain (as defined by FEMA) adjacent to the project-affected area from the upstream extent of the Wilder reservoir downstream to the Route 116 bridge in Sunderland, Massachusetts.

Section 4.1.3: Temporal scope

We suggest that the temporal scope of cumulative effects include potential impacts of future climate change on a 30-50 year time frame. As part of the Connecticut River Watershed Study, researchers at the University of Massachusetts at Amherst have developed models that estimate predicted climate-impacted flows throughout the Connecticut River basin (Polebitski et al. 2012). We suggest that these models be used to evaluate temporal cumulative effects on the resources mentioned above with regard to climate-induced changes in the flow regime.

Section 5.0: Proposed Studies

In each of their PADs, and as noted in SD1, TransCanada has proposed to "[d]evelop a system operations model to assist in the evaluation of project effects." Whereas we recognize the necessity and value for the licensees to develop independent models, we suggest that because water quantity is a cumulatively-affected resource, evaluation of effects should also be considered on a whole-system scale (encompassing all relicensed facilities) and/or in a modeling framework that is consistent across all relicensed facilities (for example, in a framework such as that developed by the Connecticut River Watershed Study).

Literature Cited

Anderson, M.G. and A. Olivero Sheldon. 2011. Conservation Status of Fish, Wildlife, and Natural Habitats in the Northeast Landscape: Implementation of the Northeast Monitoring Framework. The Nature Conservancy, Eastern Conservation Science. 289 pp.

Bunn, S.E., and A.H. Arthington. 2002. Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity. Environmental Management 30:492-507.

Federal Energy Regulatory Commission (FERC). 2004. Submittal of the Lower Penobscot River Basin comprehensive settlement accord with explanatory statement. Project Nos. 2403, 2534, 2666, 2710, 2712, 2721, and 10981. Federal Register, Docket No. DI97-10. FERC, Washington, D.C., USA.

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, and J.C. Stromberg. 1997. The natural flow regime. BioScience 47:769-784.

Poff, N.L., and J.V. Ward. 1990. Physical habitat template of lotic systems: recovery in the context of historical pattern of spatiotemporal heterogeneity. Environmental Management 14:629-645.

Polebitsi, A., K. O'Neil, and R. Palmer. 2012. Connecticut River Basin variable infiltration capacity model. Report prepared for The Nature Conservancy, Connecticut River Program, Northampton, MA.

STUDY REQUESTS

In response to the request for information and studies presented in the SD1, the Conservancy offers the following study requests to provide pertinent information for the preparation of the Environmental Impact Statement and for potential development of new license requirements. In addition, we strongly support the studies requested by the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the Connecticut River Watershed Council, and the State resource management agencies in Vermont, New Hampshire, and Massachusetts, including the various study requests focused on improving fish passage at each of the projects. The following study requests are reflective of those areas of study in which the Conservancy has particular interest and expertise, but we acknowledge the likely need for additional studies in these and other research areas.

Requested Study 1: Evaluation of Project Effects on Impoundment Water Surface Elevations and River Flow Regime

Projects: Wilder (FERC No. 1892-026), Bellows Falls (FERC No. 1855-045), Vernon (FERC No. 1904-073), and Turners Falls (FERC No. 1889-081) hydroelectric projects, and the Northfield Mountain Pumped Storage Project (FERC No. 2485-063)

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained*.

The goal of this study is to evaluate the effects of current and potential future project operations of the Wilder, Bellows Falls, Vernon, Turners Falls, and Northfield Mountain Pumped Storage hydroelectric projects on impoundment water surface elevations and the river flow regime.

Specific objectives of this study include:

1. To develop hourly hydrological simulation models of project operations for the Wilder, Bellows Falls, Vernon, Turners Falls, and Northfield Mountain Pumped Storage hydroelectric projects.
2. To evaluate the effects of existing operations for all five projects, including minimum flow, water level fluctuation restrictions (maximum and minimum pool levels), and other operational requirements on:

a. Hourly reservoir water surface elevations of the Wilder, Bellows Falls, Vernon, and Turners Falls impoundments;
b. Hourly discharge from the Wilder, Bellows Falls, Vernon, Turners Falls, and the Northfield Mountain Pumped Storage projects;
c. Hourly withdrawals of the Northfield Mountain Pumped Storage project from the Turners Falls impoundment;
d. Hourly reservoir water surface elevations of the Holyoke hydroelectric project (FERC No. 2004); and
e. Hourly discharge from the Holyoke hydroelectric project (FERC No. 2004).

3. To evaluate and compare the effects of potential operational and flow modifications on items 2a-2e above; potential modifications will include:
    a. Recommendations for operational and flow modifications that result from studies conducted during the first and second Study Seasons;
    b. Recommendations for operational and flow modifications put forth by the Commission, federal, state, or local resource agencies, Native American tribes, non-governmental organizations, or the public; and
    c. Recommendations for operational and flow modifications based on optimization model results of the Connecticut River Watershed Study, a joint study of the Conservancy, UMass, U.S. Army Corps of Engineers, and the U.S. Geological Survey.
4. To evaluate the potential effects of climate-altered flows on current and potential project operations and corresponding effects on items 2a-2e above.

Relevant Resource Management Goals and Public Interest Considerations

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*

Not applicable.

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a given project is located. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of a project, as well as power and developmental values.

The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. We have over 30,000 members in the Connecticut River Basin and have assisted in the protection of 350,000 acres in the watershed, currently managing approximately 13 preserves. Through the relicensing process, the Conservancy will seek solutions that will restore natural patterns of the Connecticut River's flow regime to support floodplain forests, riparian invertebrates, freshwater mussels, and resident and migratory fish. Natural patterns of river flow are critical to the life history of all riverine-dependent organisms and to the structure and function of riverine-dependent communities. Providing flows that mimic natural hydrological patterns will lead to healthier and more persistent populations and communities. Understanding project effects on the river's natural flow regime is necessary to understand project effects on the river ecosystem. Therefore, ensuring that the effects of project operations on the river flow regime are considered in a reasoned way is relevant to the Commission's public interest determination.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

The information available in the PADs does not indicate how project operations have altered river hydrology, which may affect resident and migratory fish, macroinvertebrates, rare, threatened and endangered species, aquatic plants, and other biota and natural processes in the Connecticut River. It is also unclear how project operations at one facility affect the operations at another.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

The Wilder, Bellows Falls, Vernon, and Turners Falls projects are each currently operated with required minimum flows. The Turners Falls project is also operated with a seasonally-varying minimum bypass flow; there is presently no required minimum flow for the bypassed reach of the Bellows Falls project. Each of these projects operates as a daily peaking facility, such that flows can vary between the minimum required flows and total hydraulic capacity on a daily basis. In addition, Northfield Mountain pumped storage project operates by withdrawing water from the Turners Falls pool and releasing it back into the reservoir during peak generation hours. Furthermore, project operations and potential changes in operations to mitigate impacts at each facility are influenced by inflows and operations of upstream projects.

The operations of these five projects may affect riverine-dependent biota and associated habitat both upstream and downstream of each project by altering the natural patterns of the river's hydrological regime. Study results will provide necessary information regarding the extent of project effects on river hydrology, potential modifications to discharge and reservoir elevation operations, how such changes may be constrained by inflows and upstream project operations, and how these changes may impact natural hydrological patterns. This information may then be used to develop flow-related license requirements and/or other mitigation measures.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Hourly hydrological operations modeling and river hydrology analyses are commonly employed at hydroelectric projects to assess implications of project operations on the river environment. As stated in the PADs, both licensees have developed or are planning to develop hydrological operations models for the relicensed projects. Whereas it is valuable to have separate models for the sake of comparison, given the cumulative nature of project effects on river hydrology, this study would ideally be done within the same modeling framework (for example, in a framework such as that developed by the Connecticut River Watershed Study). Modeled inflows should reflect current operational regimes if applicable (e.g., Fifteen Mile Falls, FERC No. 2007). Climate-altered flows should be based on the output of the Connecticut River Watershed Study variable infiltration capacity (VIC) models (Polebitski et al. 2012).

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

Level of effort and cost of model development are expected to be moderate as much of the baseline modeling has already been completed, but evaluation of various operational scenarios will be needed throughout the relicensing process to assess the implications of changes to the hydrological regime. The modeling exercise will also require coordination and cooperation between both licensees to assure that the modeling framework is consistent and compatible among the relicensed projects.

We would anticipate that the expected level of effort and anticipated costs will be comparable to that experienced on similar FERC relicensing projects.

Literature Cited

Polebitsi, A., K. O'Neil, and R. Palmer. 2012. Connecticut River Basin variable infiltration capacity model. Report prepared for The Nature Conservancy, Connecticut River Program, Northampton, MA.

Requested Study 2: Instream Flow Habitat Assessment

Projects: Wilder (FERC No. 1892-026), Bellows Falls (FERC No. 1855-045), Vernon (FERC No. 1904-073), and Turners Falls (FERC No. 1889-081) hydroelectric projects

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained*.

The goal of this study is to evaluate the effects of project operations on the availability and persistence of habitat for high-priority/target aquatic resources below the Wilder, Bellows Falls, Vernon, and Turners Falls projects, including the bypassed reaches of the Bellows Falls and Turners Falls projects, and to identify appropriate flow regimes that will protect and enhance the habitat for these aquatic resources.

Specifically, the objective of this study is to conduct an instream flow habitat study that will

1. Identify optimal habitat for target species; and
2. Determine the effects of the full range of project operations on the spatial and temporal availability and persistence of this habitat.

Relevant Resource Management Goals and Public Interest Considerations

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*

Not applicable.

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a given project is located. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of a project, as well as power and developmental values.

The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. We have over 30,000 members in the Connecticut River Basin and have assisted in the protection of 350,000 acres in the watershed, currently managing approximately 13 preserves. Through the relicensing process, the Conservancy will seek solutions that will restore natural patterns of the Connecticut River's flow regime to support floodplain forests, riparian invertebrates, freshwater mussels, and resident and migratory fish. Natural patterns of river flow are critical to the life history of all riverine-dependent organisms, in large part because river flow is responsible for the patterns of habitat persistence and availability required for refuge, feeding, reproduction, and juvenile rearing of riverine-dependent organisms. Consequently, providing flows that mimic natural hydrological patterns will lead to healthier and more persistent populations and communities. Understanding project effects on the availability and persistence of critical habitat for target species is necessary to understand project effects on the river ecosystem. Therefore, ensuring that these effects on critical habitat are considered in a reasoned way is relevant to the Commission's public interest determination.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

In the PADs for the Wilder, Bellows Falls, and Vernon projects, TransCanada notes that an evaluation of aquatic macrohabitat was conducted in conjunction with the Yoder et al. (2009) fish assemblage study (p. 3-66, p. 3-77, and p. 3-96 in the Wilder, Bellows Falls, and Vernon PAD, respectively). However, this evaluation was qualitative and was not linked to project operations. Furthermore, there has been no evaluation of aquatic habitat in the Bellows Falls bypassed reach.

According to the PAD for the Turners Falls and Northfield Mountain Projects, FirstLight "conducted a characterization and mapping of aquatic mesohabitat (habitat classes) in the bypass reach from Turners Falls Dam to the Cabot Station discharge and the approximately 30 mile long segment of the Connecticut River from Cabot Station down to the vicinity of Dinosaur Footprints

Reservation." Whereas study results may be useful for some purposes, the resulting information is not sufficient to fully evaluate the effects of project operations on aquatic habitat for target species. The habitat designations in the FirstLight study were qualitative, were evaluated under only a single discharge regime, and were not directly linked to habitat requirements for target species. To adequately assess the effects of project operations on aquatic habitat, an instream habitat study should be quantitative, should be tied directly to specific known or hypothesized habitat requirements for target species, and should be conducted under conditions that characterize the full range of operational flows.

The Wilder, Bellows Falls, and Vernon projects, and Cabot Station at the Turners Falls project are each operated as daily peaking facilities, such that flows can vary between the minimum required flows and total hydraulic capacity on a daily basis. Except for the seasonally-varying minimum flow in the Turners Falls bypassed reach, which is intended to facilitate movement of migratory fish and provide some protection for shortnose sturgeon, the PADs for these projects do not indicate how minimum flow requirements were established or what specific ecological resources they are intended to benefit. None of the established minimum flows, including those provided in the Turners Falls bypassed reach, have been based on quantitative, rigorous scientific studies. However, some information does exist regarding minimum flows necessary for shortnose sturgeon spawning and rearing at the Rock Dam in the bypassed reach (Kynard et al. 2012). Spawning success was observed at the Rock Dam when discharge was between 2,500 and 22,000 cfs during the spawning period of April 27 through May 22 (Kynard et al. 2012, chapter 3). This data would suggest that current minimum flows in the Turners Falls bypassed reach are not sufficient to support the continued success of shortnose sturgeon in this river reach.

Other than the observations regarding sturgeon spawning success, we are not aware of any other studies that have evaluated the adequacy of the minimum flows in the Turners Falls bypassed reach, or of the minimum flows at Cabot Station or any of the upstream projects, in protecting aquatic resources and habitat downstream of these projects. Nor are we aware of any studies that have evaluated project effects of daily hydropeaking on the riverine habitat in these river reaches. Therefore, in order to fill this important information gap, an empirical study is needed to provide information on the relationship between flow and habitat in the Connecticut River downstream of the Wilder, Bellows Falls, Vernon, and Turners Falls projects, including in the bypassed reaches of the Bellows Falls and Turners Falls projects.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

The distance from the upstream end of the Wilder impoundment downstream to the Route 116 bridge in Sunderland, Massachusetts (the headwaters of the Holyoke pool) is 150 miles. A total of 117 miles (78%) of this segment is impounded. The remaining riverine habitat is within the 17 miles downstream of Wilder dam, the 6 miles downstream of Bellows Falls, the 10 miles downstream of Cabot Station (Turners Falls), and potentially a short distance downstream of Vernon Dam (at the scoping meetings, FirstLight indicated that their project assessment may provide evidence that the upstream extent of the Turners Falls impoundment may not reach all the way to Vernon Dam). Because most of the lotic (flowing water) habitat in this section of the Connecticut River has been converted to lentic (still water) habitat, the remaining lotic habitat is critical to sustaining the populations and communities of riverine-dependent species in these river reaches, including American shad and the federally-endangered shortnose sturgeon and dwarf wedgemussel. It follows that understanding the effects of project operations on this habitat is also critical to sustaining these populations and communities.

Additionally, there are two river reaches from which flows have been bypassed into power canals, a 3,500-foot long bypassed reach at the Bellows Falls Project and a 2.7-mile long bypassed reach at the Turners Falls Project. The current license of the Bellows Falls Project does not require any minimum flows in the bypassed reach, such that it only receives flow when inflow exceeds the project's hydraulic capacity, about 30% of the time on an annual basis. These flows do not sufficiently protect the aquatic resources inhabiting or potentially inhabiting this reach of river. Furthermore, the channel morphology and substrate of the Bellows Falls bypass channel is complex and variable, consisting of coarse substrate of various sizes as well as jagged, irregular ledge. Such heterogeneous physical habitat could provide aquatic habitat conditions that are now rare in the Connecticut River due to extensive impoundment of lotic habitat, and are therefore of great conservation value.

Unlike the Bellows Falls bypassed reach, the Turners Falls bypassed channel is currently operated with a seasonally-varying minimum flow (200 cfs starting on May 1, increasing to 400 cfs when fish passage starts through to July 15, then reduced down to 120 cfs until river temperature drops below 7°C). However, these flows were not based on any quantitative, rigorous scientific studies. This section of the Connecticut River contains habitat that supports native riverine species, including spawning and rearing habitat for the federally endangered shortnose sturgeon. It is unlikely that the current minimum flow regime sufficiently protects the aquatic resources, including endangered species, inhabiting the bypassed reach.

The Wilder, Bellows Falls, Vernon, and Turners Falls (Cabot Station) projects are also currently operated with minimum flow releases that were not based on biological criteria or field study.

These continuous minimum flows are only equal to about 40% of the Aquatic Base Flow[2]. Given the variability that is characteristic of the natural flow regime upon which all riverine species depend (Poff et al. 1997, Bunn and Athington 2002), these minimum flows likely do not sufficiently provide the range of habitat requirements for downstream aquatic resources. Furthermore, these projects generate power in a peaking mode resulting in substantial within-day flow fluctuations between minimum flows and project capacity. Large and rapid changes in flow releases from peaking hydropower dams have been shown to cause adverse effects on downstream habitat and biota (Cushman 1985, Blinn et al. 1995, Freeman et al. 2001).

Understanding the effects of the range of operations at each of these facilities and in the bypassed reaches will assist in determining appropriate flow recommendations that will protect and/or enhance the aquatic habitat and the corresponding target species in the river downstream of each project.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Instream flow habitat assessments are commonly employed in developing operational flow regimes that will reduce the impacts to or enhance habitat conditions downstream of hydroelectric projects. We request that an instream flow habitat assessment be conducted in the following areas: in the approximately 17 miles between the Wilder Dam and the headwaters of the Bellows Falls pool, in the 3,500-foot long bypassed reach downstream of Bellows Falls Dam, in the approximately 6 miles between the Bellows Falls Project and the headwaters of the Vernon pool, in the approximately 1.5 miles between the Vernon Dam and the downstream end of Stebbins Island (or the upstream extent of the Turners Pool as determined by FirstLight, whichever river length is greater), in the 2.7-mile long bypassed reach downstream of Turners Falls Dam, and in the approximately 10 miles between Cabot Station and the Route 116 bridge in Sunderland, Massachusetts.

We suggest the use of a methodology similar to that of an Instream Flow Incremental Methodology (IFIM; Bovee et al. 1998) approach. A similar protocol was used during the

[2] The Aquatic Base Flow equates to the August Median Flow as determined using unregulated hydrography or on drainage area at the project site (0.5 cfs per square mile of drainage area) if unregulated hydrography is unavailable.

relicensing of the Housatonic River Project (FERC No. 2576)[3], and has been accepted by the Commission in other licensing proceedings[4].

The study design should involve collecting habitat data specific to the known or hypothesized habitat requirements of target species, including but not limited to depth, velocity, and substrate composition. Target species will include, but are not limited to, shortnose sturgeon, American shad, fallfish, white sucker, yellow perch, smallmouth bass, walleye, dwarf wedgemussel and other freshwater mussels, and benthic macroinvertebrates. Target species and measured habitat components should be determined during the development of the study plan in consultation with fishery agencies and other parties.

Habitat modeling using standard PHABSIM 1-dimensional modeling should be conducted in the deep, homogeneous, straight-channel areas of the specified river reaches mentioned above. Two-dimensional hydraulic modeling should be conducted in the sections of river with more heterogeneous habitat and complex features such as islands, braiding, falls, and shallow-water shoals. For example, 2-dimensional modeling should be conducted for the entire reach of the Bellows Falls bypassed channel, for the Turners Falls bypassed channel from the spillway and mouth of the Falls River to the point where the channel constricts, and for the reach downstream from Cabot Station to the railroad bridge below the mouth of the Deerfield River.

Measurements should be taken over a range of flows sufficient to model the full extent of the operational flow regime. In the Turners Falls bypassed reach this should include a range of flows that will allow for modeling flows up to 6,300 cfs. The upper range of flows for the Bellows Falls bypassed reach should be determined during the development of the study plan in consultation with fishery agencies and other parties. Collected information should then be synthesized to quantify habitat suitability (using mutually agreed-upon habitat suitability index (HSI) curves) over a range of flows for target species. Data should be collected in such a way that allows a dual-flow analysis and habitat time series or similar approaches that will permit assessment of how temporal and spatial availability and persistence of habitat for target species changes over the range of flows that occur as part of the operational flow regime.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

[3] Housatonic River Project License Application, Volume 4, Appendix F. Connecticut Light and Power Company, August 1999.

[4] Glendale Project (FERC No. 2801) Final Bypass Reach Aquatic Habitat and Instream Flow Study in Glendale Hydroelectric Project Application for Subsequent License (FERC No. 2801), Volume 2, Appendix B, pages 7-8, October 2007.

Field work for instream flow studies can be extensive, but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Use of laser measurements, GPS, and/or an Acoustic Doppler Current Profiler (ADCP, if available) can improve efficiency and accuracy of field measurements. Post-fieldwork data analysis would be of moderate cost and effort. We anticipate that the level of effort and cost will be comparable to that of other FERC relicensing projects of similar size to these projects.

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Requested Study 3: Impacts of Water Level Fluctuations on Floodplain, Wetland, Riparian, and Littoral Vegetation Communities and Habitats

Projects: Wilder (FERC No. 1892-026), Bellows Falls (FERC No. 1855-045), Vernon (FERC No. 1904-073), and Turners Falls (FERC No. 1889-081) hydroelectric projects, and the Northfield Mountain Pumped Storage Project (FERC No. 2485-063)

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained.*

The goal of this study is to evaluate the effects of project operations on floodplain, wetland, riparian, and littoral vegetative communities and habitats both upstream and downstream of the Wilder, Bellows Falls, Vernon, and Turners Falls projects (and including the effects of the Northfield Mountain Pumped Storage project), and to identify appropriate project operations that will protect and enhance these communities and habitats.

Specifically, the objectives of this study are to:

1. Delineate, quantitatively describe, and map vegetative communities from the shoreline to the extent of the 100-year floodplain;
2. Delineate, quantitatively describe (e.g., substrate composition, vegetation type and extent of cover), and map littoral habitat types; and
3. Determine the effects of the full range of current and potential future operations of all five projects on the persistence of the communities and habitats described in items 1 and 2.

Relevant Resource Management Goals and Public Interest Considerations

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*

Not applicable.

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a given project is located. In making its license decision, the Commission must equally consider the environmental, recreational, fish and

wildlife, and other non-developmental values of a project, as well as power and developmental values.

The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. We have over 30,000 members in the Connecticut River Basin and have assisted in the protection of 350,000 acres in the watershed, currently managing approximately 13 preserves. Through the relicensing process, the Conservancy will seek solutions that will restore natural patterns of the Connecticut River's flow regime to support floodplain forests, riparian invertebrates, freshwater mussels, and resident and migratory fish. Natural patterns of river flow are critical to the life history of all riverine-dependent organisms and to the structure and function of riverine-dependent communities. Providing flows that mimic natural hydrological patterns will lead to healthier and more persistent populations and communities. Understanding project effects on the vegetative communities and habitats that depend on these patterns of flow is necessary to understand project effects on the river ecosystem. Therefore, ensuring that project effects on floodplain, wetland, riparian, and littoral vegetative communities and habitats are considered in a reasoned way is relevant to the Commission's public interest determination.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

Existing information in the TransCanada PADs regarding floodplain, wetland, riparian, and littoral vegetation and habitat is based on the National Wetlands Inventory, USGS landcover maps, and qualitative surveys and descriptions. As a result, some coarse delineation and mapping has been done and has been presented in the PADs. However, the mapping is too coarse to use to evaluate effects, and does not cover all habitat types in all areas. The PADs acknowledge that "[p]otential effects of the Project[s] on wetland, floodplain, riparian, and littoral resources can occur as a result of hydroelectric operations" (p. 3-104, p. 3-113, and p. 3-142 in the Wilder, Bellows Falls, and Vernon PADs, respectively). However at present, no studies have been done or are proposed to be done that examine the effects of project operations on these resources.

Existing information in the FirstLight PAD regarding floodplain, wetland, riparian, and littoral vegetation and habitat is based primarily on the National Wetlands Inventory and qualitative description of likely occurring community and habitat types. However, the delineations provided by the Wetlands Inventory are too course to use to evaluate project effects, and do not cover all habitat types. In the list of preliminary issues pertaining to the continued operation of the Turners Falls and Northfield Mountain, the FirstLight PAD notes the potential for project effects

on botanical habitat (which includes floodplain communities) and wetland, riparian, and littoral zone habitat (p. 5-1). Additionally, the PAD documents a proposed study to conduct an inventory of botanical resources including a verification of the National Wetlands Inventory data. However at present, no studies have been done or are proposed to be done that examine the specific effects of project operations on these resources.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Because the structure and function of the vegetative communities that comprise floodplain, wetland, riparian, and littoral habitats are defined by the frequency, duration, depth, and timing of inundation, it follows that project operations that cause changes to patterns of inundation (by reservoir levels or downstream flows) could affect these communities and habitats. These effects would consequently impact the fish and wildlife species that depend on these habitats for spawning, juvenile rearing, feeding, and refuge. For example, when the shallow shoreline and bankside habitats of the littoral zone are regularly dewatered, juvenile fish are forced to occupy deeper, more open, and less productive habitat, resulting in slower growth and lower survival (McKinney et al. 2001, Korman and Campana 2009). An additional consequence to altered riparian vegetative communities is a reduction in the stability of underlying soils and sediments, potentially increasing the rate of bank erosion. Furthermore, operations may promote the introduction and expansion of invasive plant species through fluctuating water levels. A study that examines the effects of current and potential future project operations on the extent, duration, and persistence of floodplain, wetland, riparian, and littoral habitats will help inform license requirements to protect and enhance these resources.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Frequency, duration, depth and timing of inundation determine the composition and type of floodplain, wetland, riparian, and littoral vegetation communities. For example, there is a general gradient that follows a trend from high terrace floodplain forest, to low floodplain forest, shrub

swamp, herbaceous emergent marsh, and then to submerged aquatic vegetation. The interaction of topography and impoundment water level or flow regime determines the distribution and relative abundance of these communities.

To evaluate the effects of project operations on these vegetative communities and habitats, the study methods should include the following:

1. Obtain an accurate digital elevation model (e.g. ArcGIS raster) of valley topography in project-affected areas with a minimum 1-foot vertical resolution, which is required to at minimum to distinguish wetland habitat from upland. Topography data should extend between the minimum and maximum of reservoir operations under all possible scenarios, including potential changes to operations. Data should be collected from the upper extent of the Wilder reservoir downstream to the Route 116 bridge in Sunderland, Massachusetts, and should extend laterally from the lowest water level permitted within the operational range to the boundary of the 100-year flood plain as defined by the Federal Emergency Management Agency (FEMA).
2. Quantify critical thresholds in inundation regime (frequency, duration, depth, and timing) limiting the extent of the vegetative communities on the inundation gradient described above (Metzler and Damman 1985, Nislow et al. 2002). See also TNC's Connecticut River watershed-wide study of floodplain forests (C. Marks, The Nature Conservancy, in preparation). Specific defined community types should be determined during the development of the study plan in consultation with resource agencies and qualified subject ecologists.
    a. Identify at least 5 occurrences of each defined community type in each project impoundment (Wilder, Bellows Falls, Vernon, and Turners Falls) and, if possible, at least 5 occurrences in the downstream riverine portion of each project, for a total of 40 occurrences for each community type. Identify at least 5 locations in each of the impoundments and at least 5 locations in the downstream riverine portion of each project that are periodically inundated but lack the target communities. Existing sources mentioned in the PAD should help with identifying appropriate study sites.
    b. At each of these locations survey the elevations where the different communities occur/do not occur, paying particular attention to transitions.
    c. Develop hydraulic models (e.g., HEC-RAS; Nislow et al. 2002) for downstream riverine locations.
    d. Quantify the inundation regime for each of the study sites using impoundment water level and hydraulic model results.
    e. Using the above data calculate quantitative limits for the windows of inundation within which each of these community types occurs. Report all relevant statistics.

3. In GIS, predict distributions of the above riparian communities across the digital elevation model as a function of impoundment water levels and discharge using the statistical relationships developed in step 2. Complete this task using an existing software tool such as HEC-EFM developed by the US Army Corps of Engineers for this purpose (USACE 2013).
4. Verify the accuracy of the model by calculating how well it predicts known community occurrences. Once this is completed, use model outputs to examine how terrace elevation influences the amount of each defined community type that is available in the project areas under realistic alternative scenarios of impoundment water levels and discharge regimes.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

In their PAD, First Light identified impacts of the project operations on wetlands, riparian and littoral zone habitat as a potential issue to be addressed in relicensing, and proposed wetland vegetation mapping. However, additional analysis as described above is needed to understand the impacts of the project on these resources and habitats.

The cost of collecting the data for this study will be largely dependent on how the digital elevation models are developed. Otherwise, field sampling should require 2-3 people for 3-4 months, followed by 3-4 months of analysis by 1 person.

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Requested Study 4: Determine fish assemblage structure in project-affected areas

Projects: Wilder (FERC No. 1892-026), Bellows Falls (FERC No. 1855-045), Vernon (FERC No. 1904-073), and Turners Falls (FERC No. 1889-081) hydroelectric projects

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained.*

The goal of this study is to determine the occurrence, distribution, and relative abundance of fish species present in the project-affected areas from the headwaters of Wilder reservoir to Sunderland, Massachusetts, an area which potentially includes Species of Greatest Conservation Need (SGCN) for New Hampshire, Vermont, and Massachusetts.

Specific objectives include:

1. Document fish species occurrence, distribution, and relative abundance within project-affected along spatial and temporal gradients; and
2. Compare historical records of fish species occurrence in the project-affected areas to the results of this study.

Relevant Resource Management Goals and Public Interest Considerations

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*

Not applicable.

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a given project is located. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of a project, as well as power and developmental values.

The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. We have over 30,000 members in the Connecticut River Basin and have assisted in the protection of 350,000 acres in the watershed, currently managing approximately 13 preserves. Through the relicensing process, the Conservancy will seek solutions that will restore natural patterns of the Connecticut River's flow regime to support floodplain forests, riparian invertebrates, freshwater mussels, and resident and migratory fish. Understanding project effects on the communities of resident fish that inhabit project-affected areas first requires an understanding of the structure of the fish species assemblage within these areas. Therefore, determining the resource status of the resident fish species assemblage in project-affected areas is relevant to the Commission's public interest determination.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

A thorough and comprehensive assessment of the fish assemblage present in the project-affected areas is lacking. Whereas some sampling was conducted in all project-affected areas during a 2008 Connecticut River electrofishing survey (Yoder et al., 2009), this survey did not have the same goals and objectives as those outlined above. Due to the design of this study, limitations in geographic/habitat type coverage both spatially and temporally, and the use of a single gear type, the use of these data are limited and may not represent the full complement of species that occur in the project-affected areas. In addition, some fairly comprehensive fish surveys have been conducted in the Vernon pool, as referenced in the Vernon PAD. However, objectives and methodology for these fish surveys differ from those stated here, and gear types were generally limited to boat electrofishing which may not be suitable for properly assessing all species present in the project-affected areas.

The PAD for the Wilder project states "No targeted studies have been conducted to characterize the fish community in relation to the Project" (p. 3-42, Wilder PAD), and that of the Bellows Falls project similarly states "Little comprehensive information is available regarding characterization of the fish community in relation to the Project" (p. 3-50, Bellows Falls PAD). The PAD for the Turners Falls and Northfield Mountain Pump Storage projects cites resident fish

surveys conducted by the State of Massachusetts in the early to mid-1970s and the 2008 sampling effort by Yoder et al. (2009). This PAD identifies a total of 22 fish species in the project area but omits northern pike, tessellated darter, burbot, and channel catfish, which are known to occur in this area (Ken Sprankle, USFWS, personal communication). It follows that since information is limited or lacking regarding the composition of the fish community and their use of habitats in the project-affected areas, project effects on the fish species assemblage are also unknown.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Project operations have the potential to directly impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, headpond and tailwater water level fluctuations could dewater important spawning areas, thus limiting productivity of fish species by direct impacts to their spawning success or indirectly by limiting the spawning success of forage fish species. Accordingly, a thorough understanding of the current fish assemblage structure and associated metrics are needed in order to examine any potential project-related impacts.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

An accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting fish species likely to be present in the project-affected areas (Bonar et al. 2009) should be used to conduct field surveys. Randomly sampling multiple habitat types using a multi-gear approach will be required to ensure that all fish species present are sampled. The spatial scope of the study will be from the headwaters of Wilder pool downstream to Sunderland, Massachusetts, and will omit the upper reservoir of Northfield Mountain Pump Storage project. Sampling should occur at each selected site across multiple seasons (spring, summer, and fall). Digital photographs should be taken to avoid misidentification of certain species such as Cyprinids.

The sampling design should include replicate samples for estimation of species detection probability. Sample replicates may be gathered temporally, using different methods, by independent observers, or by randomly sampled spatial replicates (MacKenzie et al. 2006). For each replicate sample, data that may be important for describing variation in species occurrence and presence/absence should be collected and recorded, such as gear type, mesohabitat type, depth, velocity, water temperature, substrate, time of day, day of year, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat), and/or other factors as determined by a qualified biologist. Species detection, occurrence, and/or abundance and potential effects of habitat on these parameters should be estimated using methods as described by Kery et al. (2005), MacKenzie et al. (2006), Wenger and Freeman (2008), or Zipkin et al. (2010).

A report should be prepared or supplemental material provided that includes:

- the specific location (coordinates) of each site and date /time of each sample,
- the measures of habitat variables that are collected at each site and for each sample,
- the type of gear used for each sample,
- the identity and length of each individual fish collected,
- photos of representative specimens of each collected species,
- estimates of species detection probability,
- estimates of species occurrence probability,
- estimates of species abundance, and
- tables of model selection results.

Based on first year study results, and on the results of other studies, additional studies examining impacts of project operations on specific fish species may be requested. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

The cost of the study will be moderate to high as seasonal sampling with several types of gear will be required. However, cost will also be partially dependent on the number of sites sampled, the number of sample replicates, and the extent of the covariate data that are measured, all of which should be determined during the development of the study plan in consultation with fishery agencies and other parties. Based on study results of the first year of sampling, a second

year of sampling may be requested, especially if natural environmental conditions are extreme (e.g., a drought or flood occurs). Provided the collected data are of high quality, analysis and synthesis should take approximately 10-20 days. Neither TransCanada nor FirstLight has proposed any studies specifically addressing this issue.

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Requested Study 5: Effects of the Wilder and Bellows Falls Projects on the Dwarf Wedgemussel (*Alasmidonta heterodon*)

Projects: Wilder (FERC No. 1892-026) and Bellows Falls (FERC No. 1855-045) hydroelectric projects

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained*.

The goal of this study is to evaluate the effects of the Wilder and Bellows Falls hydroelectric projects on populations of the federally-endangered dwarf wedgemussel (*Alasmidonta heterodon*) and to develop measures to minimize adverse impacts to the dwarf wedgemussel in the future. The specific objectives of the study are as follows:

1. Conduct an initial survey of the free flowing stretch of the Connecticut River from the Wilder Dam to the upstream end of the Bellows Falls impoundment to determine the distribution of the dwarf wedgemussel in this reach.
2. Determine the best sites for intensive quantitative sampling of mussel communities, with emphasis on the dwarf wedgemussel. Data will be collected to estimate density (mussels per unit area) and age class structure for all species.
3. Lay the groundwork for a long-term monitoring program.
4. Document instream behavior of mussels during varying flow conditions.
5. Determine how availability and persistence of dwarf wedgemussel habitat changes with water level and flow fluctuations.

Relevant Resource Management Goals and Public Interest Considerations

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*

Not applicable.

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a given project is located. In making its

license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of a project, as well as power and developmental values.

The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. We have over 30,000 members in the Connecticut River Basin and have assisted in the protection of 350,000 acres in the watershed, currently managing approximately 13 preserves. Through the relicensing process, the Conservancy will seek solutions that will restore natural patterns of the Connecticut River's flow regime to support floodplain forests, riparian invertebrates, freshwater mussels, and resident and migratory fish. Natural patterns of river flow are critical to the life history of all riverine-dependent organisms and to the structure and function of riverine-dependent communities. As a federally-endangered species, the dwarf wedgemussel is of particular interest to the Conservancy. By understanding project effects on this species, we will begin to understand more about the patterns of flow that are necessary to support the larger river ecosystem. Ensuring that project effects on dwarf wedgemussel are considered in a reasoned way is relevant to the Commission's public interest determination.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

In 2011, Biodrawversity, LLC conducted a freshwater mussel survey throughout the Vernon, Bellows Falls, and Wilder project areas (Biodrawversity and LBG 2012). This survey was semi-quantitative (i.e. timed searches were used) and the main goal was to assess the distribution, abundance, demographics, and habitat of the dwarf wedgemussel in the project areas. Dwarf wedgemussel were found in the Wilder impoundment (all within a 14-mile stretch of the river beginning 27 miles upstream of the Wilder Dam) and Bellows Falls impoundment (located sporadically in the upper 17 miles of the impoundment); none were found in the Vernon project-affected area. These results corroborate the results of other studies performed in the past in these areas (Nedeau 2006a, Nedeau 2006b).

The 2011 survey did not include the 17-mile free flowing stretch of the Connecticut River downstream of Wilder Dam. The dwarf wedgemussel has, in the past, been found within this river reach, although overall there has been limited survey work in the area. A better understanding of the distribution and abundance of the dwarf wedgemussel in this stretch of the river is required before an evaluation of how the dam affects this species can be made. This need is represented in Objective 1.

Since the 2011 survey was semi-quantitative, it cannot be used as a basis for determining population estimates or trends (Wicklow 2005). In fact, few if any of the past surveys performed in the project-affected areas have employed quantitative methodology. In addition, there is little quantitative information regarding the age class structure, and therefore recruitment, of the mussel communities in the area. In order to demonstrate that a dwarf wedgemussel population is viable according to the Dwarf Wedgemussel Recovery Plan (USFWS 1993), it must have a large and dense enough population to maintain genetic variability and annual recruitment must be adequate to maintain a stable population. Thus, knowledge of population size and density as well as a better understanding of age class structure is a necessary step in determining the baseline status of dwarf wedgemussel populations. The 2011 survey and other surveys can be used to determine the best sites for implementing a monitoring program. This need is represented in Objective 2.

Once this baseline is established, it will be important to monitor the sites so that biologists can estimate and track changes to dwarf wedgemussel populations and/or evaluate any project-related population impacts. Therefore, there is a need to develop long-term monitoring plots that will be surveyed at regular intervals using methodology that is repeatable and yields quantitative, statistically valid results. This need is represented in Objective 3.

Flow conditions that result from dam operations may alter the behavior of individual dwarf wedgemussels or individuals of other species. Dam operations affect streamflow, temperature, and dissolved oxygen, and changes to these variables can often be rapid. It is not known how these rapid changes affect various aspects of a mussel's biology, including lure display, shell position (open/closed), siphoning rate, and vertical migration. This need is represented in Objective 4.

Dam operations can also affect the availability of habitat for mussels, and this availability can change quickly as water levels fluctuate under peaking operations. The persistence of habitat is a key element to the long-term success of sedentary lotic organisms such as the dwarf wedgemussel (Maloney et. al. 2012), which is unable to quickly move in response to rapid changes in its environment and can thus become stranded in areas of unsuitable habitat; however, there is currently no information concerning the relation of project operations to habitat persistence within the Wilder and Bellows project-affected areas. This need is represented in Objective 5.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

It has been well documented that the damming of rivers can have detrimental impacts on the mussel communities that inhabit areas both upstream and downstream of dams (Watters 1999, Layzer et. al. 1993, Moog 1993). The dwarf wedgemussel is known to occur within the Wilder and Bellows Falls project areas and operations of these two dams may affect the viability of this species in the Connecticut River. This study plan will allow for a better understanding of how sub-daily flow and water level fluctuations influence dwarf wedgemussel abundance, available habitat, and behavior. This information can be used to inform the development of license requirements that can ensure the continued existence of this species within the project-affected areas.

Additionally, a long-term monitoring program of important dwarf wedgemussel sites within the project areas is necessary to evaluate any project-related population and/or behavioral impacts that may occur. This information can be used to inform decision makers in the future.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

A survey of the 17-mile reach between the Bellows Falls impoundment and the Wilder Dam is the logical first step of the study plan, and this can be done in well less than one field season. This may be treated as an extension of the Biodrawversity and LBG (2012) survey and the same semi-quantitative methodology may be used. Once completed, this survey will help fill in the knowledge gap that exists in the distribution of the dwarf wedgemussel within this reach of the Connecticut River. This proposed methodology corresponds to Objective 1.

Next, quantitative study plots should be established at sites throughout the two project-affected areas that are known to support the dwarf wedgemussel. Plots should be set up and surveyed using methodology that will allow for the estimation of population density and size. Smith et. al. (2001) have developed such a methodology, which is also outlined in Strayer and Smith (2003).

It is based on a double-sampling design (visual inspection of the substrate surface plus excavation of a random subset of quadrats) using 0.25 m2 quadrats that are placed systematically with multiple random starts. This protocol has been used to monitor dwarf wedgemussel populations at two sites on the Ashuelot River in Keene, NH (Nedeau 2004). A number of other recent studies have also made use of this protocol for different species of mussels (Fulton et. al. 2010, Crabtree & Smith 2009, Bradburn 2009).

Data to determine age class structure should also be collected at these selected sites. This would involve measuring the length and estimating the age (through external annuli counts) of each mussel sampled within a quadrat. Based on this information, an analysis of recruitment can be made. This field work and analysis was performed on the mussel community inhabiting the lower Osage River in Missouri as part of the relicensing process of the Osage Hydroelectric Project (FERC no. 459) (ESI 2003). The work done on the Osage can be used as a template for this study. Depending on how many plots are chosen, this phase of the study could take one or two field seasons. This proposed methodology corresponds to Objective 2.

The sites surveyed to meet Objective 2 should be resurveyed using the same methodology at regular intervals in the future so that any changes over time and/or over varied flow regimes can be evaluated. In addition, a mark-recapture pilot study should be initiated to evaluate the potential for using this methodology for long-term monitoring of dwarf wedgemussel abundance and survival. Mark-recapture methods provide statistically robust estimates of population parameters that are superior to simple count estimates in cases where it is not practicable to count all individuals in a population. Methods should be similar to those in Peterson et al. (2011), Meador et al. (2011), and Villella et al. (2004), but should focus on differences among sampled sites. Sites should be selected based on those sampled to meet Objective 2, but should also include sites outside of the project area to fully evaluate project effect and to account for any natural variability that may be independent of project effect.

A long-term mussel monitoring program was devised as part of the study plan for the relicensing of the Lake Blackshear Hydroelectric Project (FERC No. 659) on the Flint River, Georgia. According to the monitoring plan (Lake Blackshear Project 2009), three surveys will be conducted five years apart, beginning five years after issuance of the FERC license. Surveys will be quantitative (there is a qualitative aspect to the Lake Blackshear mussel monitoring plan that can be ignored) and will focus on evaluating changes in recruitment and population size of the purple bankclimber (*Elliptoideus sloatianus*), a federally-listed species. A similar protocol should be used to monitor dwarf wedgemussel populations in the project-affected areas of the Connecticut River post-license, although the number of surveys and the time between surveys may require some research and discussion. This proposed methodology corresponds to Objective 3.

In order to investigate the effects that the hydropower projects have on mussel behavior, individual mussels should be observed as flow fluctuates as a result of dam operations. Researchers should measure changes in shell position (open/closed), siphoning rate, lure display, horizontal migration (movement across the substrate), and vertical migration (burrowing). Past studies have quantified changes in vertical migration due to flow fluctuations (Saha & Layzer 2008, DiMaio & Corkum 1997). This phase of the study will likely take two field seasons in order to maximize the number of behavioral observations so that any trends can be identified and evaluated. This proposed methodology corresponds to Objective 4.

At these same sites, an evaluation of flow fluctuations on dwarf wedgemussel habitat persistence should be conducted following methods similar to those of Maloney et. al. (2012). This will include the development of a two-dimensional hydrodynamic model based on modeled depth, velocity, Froude number, shear velocity, and shear stress. This model will be used to quantify suitable dwarf wedgemussel habitat and its persistence over a range of flows, including flows typically experienced under peaking operations. These methods are being employed to evaluate persistence of dwarf wedgemussel habitat on the Delaware (Maloney et. al. 2012) and Susquehanna (T. Moberg, The Nature Conservancy, personal communication) rivers. Depending on how many plots are chosen, this phase of the study could take one or two field seasons. This proposed methodology corresponds to Objective 5.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

The cost for collecting the data for this study is entirely dependent on the number of study sites selected, as well as how frequently surveys will be conducted as part of the long-term monitoring plan. The expected level of effort and anticipated costs will be comparable to that of similar FERC relicensing projects of this size.

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Requested Study 6: Project Effects on Populations of Tessellated Darter, *Etheostoma olmstedi*

Projects: Wilder (FERC No. 1892-026), Bellows Falls (FERC No. 1855-045) and Vernon (FERC No. 1904-073) hydroelectric projects

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained*.

The goal of this study is to evaluate the effects of project operations on populations of tessellated darter (*Etheostoma olmstedi*), a New Hampshire species of greatest conservation concern and known host species for the federally-endangered dwarf wedgemussel (*Alasmidonta heterodon*). The specific objectives of the study are to:

1. Determine the distribution and abundance of tessellated darter within project-affected areas; and

2. Determine the effects of project operations on the distribution and abundance of tessellated darter.

Relevant Resource Management Goals and Public Interest Considerations

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*

Not applicable.

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a given project is located. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of a project, as well as power and developmental values.

The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. We have over 30,000 members in the Connecticut River Basin and have assisted in the protection of 350,000 acres in the watershed, currently managing approximately 13 preserves. Through the relicensing process, the Conservancy will seek solutions that will restore natural patterns of the Connecticut River's flow regime to support floodplain forests, riparian invertebrates, freshwater mussels, and resident and migratory fish. Because of its importance as a host species for the federally-endangered dwarf wedgemussel, the tessellated is of particular interest to the Conservancy. By understanding project effects on this species, we will begin to understand more about the patterns of flow that are necessary to support dwarf wedgemussel and the river ecosystem as a whole. Therefore, ensuring that project effects on tessellated darter are considered in a reasoned way is relevant to the Commission's public interest determination.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

In the Preliminary Application Documents (PADs) for the Wilder, Bellows Falls, and Vernon projects, the applicant acknowledges that tessellated darter is one of the confirmed hosts of dwarf wedgemussel. It also identifies the occurrence of tessellated darter both upstream and

downstream of each project. However, studies that specifically target small-bodied benthic species are lacking in project-affected areas. It is therefore likely that results of previous investigations are biased and underestimate true population size. An effective evaluation of project effects on a population will require robust, unbiased estimates of population parameters such as abundance or occupancy and similar estimates of population parameters under known conditions of low to no effect.

Existing literature indicates that tessellated darters may be found in a variety of habitats (Scott and Crossman 1979, Van Snik Gray and Stauffer 1999, Hartel 2002, Van Snik Gray et al. 2005, Henry and Grossman 2008), but these habitats are not necessarily equal in their ability to support the population or its function as host to dwarf wedgemussel. We cannot be certain that habitat use infers preference, nor that habitat use will be consistent from basin to basin. Therefore, habitat use within project-affected areas should be evaluated, and should be evaluated in concert with population parameters. By estimating population parameters (e.g., abundance, occupancy, extinction/colonization) as functions of habitat, we may determine whether habitat contributes to any differences in populations and if so, what specific habitat is preferred for stable and persistent populations.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Operations at the Wilder, Bellows Falls, and Vernon projects alter natural river flow and consequently cause changes in the availability of instream habitat on which the tessellated darter and other lotic species depend. Habitat for tessellated darters is directly related to project operations in terms of flow (water depth and velocity, and their timing, duration, frequency, and rate of change) as well as the interactions of flow with other habitat variables such as substrata, vegetation, and cover. Operations both upstream (changes to the reservoir) and downstream (changes to the flow regime) may affect habitat, and may consequently lead to changes in the distribution, abundance, and behavior of tessellated darters that could in turn potentially affect the federally-endangered dwarf wedge mussel, for which the tessellated darter is a host species.

The information collected for this requested study will help determine whether project operations have a substantial effect on populations of tessellated darter, or whether population parameters are consistent with those of other populations in the region. If there is an effect of project operations on darter populations, study results will also permit identification of those habitat components related to operations that are most important for maintenance of stable and persistent

populations of tessellated darter. This will in turn provide information that will assist the development of recommendations aimed to maintain populations of dwarf wedgemussel.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Using an accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting tessellated darters and other similar small-bodied fishes, conduct a field survey for tessellated darters within all project-affected areas from the headwaters of the Wilder pool downstream to the Vernon dam, as well as in selected areas outside of the project-affected areas with known stable populations of tessellated darter and/or dwarf wedgemussel. Such a sampling design should include replicate samples for estimation of species detection probability. For each replicate sample, collect and record data that may be important for describing differences in populations of tessellated darter, such as presence or abundance of other species (e.g., dwarf wedgemussel, slimy sculpin *Cottus cognatus*), depth, velocity, water temperature, substrata, time of day, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat; larger individuals may outcompete smaller individuals for preferred habitat), and other factors as determined by a qualified biologist. Include also as covariates any relevant flow characteristics (Zimmerman 2006) that may differ among sites.

Using methods as described by Kery et al. (2005), MacKenzie et al. (2006), or Wenger and Freeman (2008), determine whether population estimates of tessellated darter are different in project-affected areas and, if so, which measured factors or flow characteristics are most important in describing these differences.

Prepare a report or provide supplemental material that includes:

- the specific location (coordinates) of each site and date /time of each sample;
- the measures of habitat variables that are collected at each site and for each sample;
- the identity and length of each individual fish collected, including fish species that co-occur with tessellated darter;
- documentation of any mussel species that are encountered at each site and in each sample;
- photos of representative specimens of each collected species;
- description of flow characteristics included in the analysis;

- estimates of species detection probability;
- estimates of species occurrence probability;
- estimates of species abundance, and
- tables of model selection results.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

The cost for collecting the data for this study is entirely dependent on the number of sites, number of sample replicates, and the extent of the covariate data that are measured, all of which should be determined during the development of the study plan in consultation with fishery agencies and other parties, and may be adjusted during the course of field sampling. In general, if a species is common and easily captured, few replicates and many sites produce the best estimates, whereas more replicates and fewer sites are preferable for rare species. In general, the more replicates added, the lower the errors in detection probability, and the more sites sampled, the lower the errors in population parameters. The number of people required in the field will be dependent on the sampling method that is selected, but should be at least two individuals. Provided the collected data are of high quality, analysis and synthesis should take at most 5-10 days.

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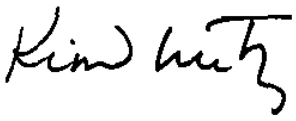
CONCLUSION

Thank you for this opportunity to provide comment on the Commission's Scoping Document 1 and offer study requests for the license renewal of the Wilder, Bellows Falls, Vernon, Turners Falls, and Northfield Mountain Pumped Storage hydroelectric projects.

If you have any questions regarding the comments or study requests herein, please contact Katie Kennedy at the Nature Conservancy's Connecticut River Program office (413-586-2349 or kkennedy@tnc.org).

Respectfully submitted,



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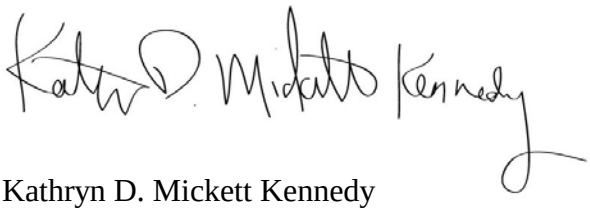

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