United States Department of the Interior

FISH AND WILDLIFE SERVICE

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In Reply Refer To: TransCanada Hydro Northeast Inc. March 1, 2013
Vernon Hydroelectric Project, FERC No. 1904
Bellows Falls Hydroelectric Project, FERC No. 1855
Wilder Hydroelectric Project, FERC No. 1892
Connecticut River
COMMENTS ON PRE-APPLICATION DOCUMENT
STUDY REQUESTS
SCOPING DOCUMENT 1

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, DC 20426

Dear Secretary Bose:

This responds to the Pre-Application Documents (PADs) for the Vernon, Bellows Falls and Wilder projects, located on the Connecticut River in Vermont and New Hampshire. The PADs are being provided in preparation of applications for new federal licenses for the projects. We offer the following comments based on the PADs (submitted to us by TransCanada Hydro Northeast Inc. [TransCanada] on October 30, 2012) and information we obtained at the site visits and joint agency meetings held on October 1-3, 2012 and the Federal Energy Regulatory Commission (Commission) scoping meetings held on January 29 and 31, 2013.

PRE-APPLICATION DOCUMENTS

PROPOSAL

Vernon Project

The Vernon Project is located in Cheshire County, New Hampshire and Windham County, Vermont. Project works include a 956-foot-long, 58-foot-high dam with the spillway portion made up of a trash sluice, tainter gates, hydraulic flashboard bays, and stanchion bays. The dam impounds 26 miles of river and the Vernon headpond encompasses 2,550 acres. The powerhouse is integral with the dam and contains six vertical Francis and four vertical Kaplan turbine-generator units. The turbines range in size from 2.5 MW to 4.2 MW. Units 1-4 have a maximum

hydraulic capacity of 1,465 each (minimum hydraulic capacity was not specified), units 5-8 have a maximum hydraulic capacity of 1,800 cfs each (minimum capacity of 900 cfs), and units 9 and 10 have a maximum hydraulic capacity of 2,035 cfs each (minimum capacity of 900 cfs). The total installed capacity of the project is 32.4 MW and the total hydraulic capacity is 17,130 cfs.

The intake to the powerhouse is covered with two sets of trashracks; racks over units 9 and 10 are spaced 4 inches on center, and racks over units 1-8 are spaced 2 inches on center.

The project operates as a peaking facility when flows are within the hydraulic capacity of the station, with allowable headpond fluctuations of up to eight feet (from elevation 212.0 feet msl to 220.0 feet msl). The project is required to release a minimum below-project flow of 1,250 cfs, or inflow (whichever is less). In 1998, the station was automated, with operations controlled from TransCanada's Connecticut River Control Center in Wilder, Vermont.

The project operates both upstream and downstream fish passage facilities. The facilities include an upstream anadromous fish ladder located on the bank side of the powerhouse and two downstream fish bypasses (a partial depth louver array and fishway pipe located between units 4 and 5, and a smaller fish bypass located on the far west side of the powerhouse).

Average annual generation for the Vernon Project was 131,516 MWh for the period 1982 to 2011.

Bellows Falls Project

The Bellows Falls Project is located in Cheshire and Sullivan counties, New Hampshire and Windham and Windsor counties, Vermont. Project works include a 643-foot-long, 30-foot-high dam with the spillway portion made up of roller-type flood gates and stanchion bays. The dam impounds 26 miles of river, and the Bellows Falls headpond encompasses 2,804 acres. The powerhouse is located at the end of a 1,700-foot-long canal and contains three vertical Francis turbines. Each turbine has a rated capacity of 16 MW and a maximum hydraulic capacity of 3,670 cfs (minimum hydraulic capacity of 1,300 cfs). The total installed capacity of the project is 40.8 MW.

The intake to the powerhouse is covered with trashracks that have clear spacing of 4 inches. The project operates as a peaking facility when flows are within the hydraulic capacity of the station, with allowable headpond fluctuations of up to 3 feet (from elevation 288.6 feet msl to 291.6 feet msl). The project is required to release a minimum below-project flow of 1,083 cfs, or inflow (whichever is less). In 1998, the station was automated, with operations controlled from the Connecticut River Control Center in Wilder, Vermont.

The project bypasses 3,700 feet of the Connecticut River. There is no required flow in the bypass reach. The project operates both upstream and downstream fish passage facilities, including an upstream anadromous fish ladder located on the bank side of the powerhouse and a downstream fish bypass (a partial depth diversion boom across the canal and sluiceway/skimmer gate located on the island side of the canal, upstream from the powerhouse).

Average annual generation for the Bellows Falls Project was 242,829 MWh for the period 1982 to 2011.

Wilder Project

The Wilder Project is located in Grafton County, New Hampshire and Windsor and Orange counties, Vermont. Project works include a 59 foot-high dam with a 526-foot-long spillway portion made up of tainter gates and stanchion bays. The dam impounds 45 miles of river and the Wilder headpond encompasses 3,100 acres. The powerhouse is integral with the dam and contains two adjustable Kaplan turbine-generator units and one vertical Francis turbine-generator unit. The two Kaplan turbine-generators are rated at 16.2 MW each and the Francis turbine generator has a nameplate rating of 3.2 MW. The operating range of the Kaplan units is from 1,000 cfs up to 6,000 cfs (each), while the Francis unit is fixed at 700 cfs.

The intake to the powerhouse is covered with trashracks that have clear spacing of 5½ inches. The project operates as a peaking facility when flows are within the hydraulic capacity of the station, with allowable headpond fluctuations of up to 5 feet (from elevation 380.0 feet msl to 385.0 feet msl). The project is required to release a minimum below-project flow of 675 cfs, or inflow (whichever is less). In 1998, the station was automated, with operations controlled from TransCanada's Connecticut River Control Center in Wilder, Vermont.

The project operates both upstream and downstream fish passage facilities. There is an upstream anadromous fish ladder with both a spillway and turbine entrance. Downstream fish passage is provided by the existing log sluiceway located between unit no. 3 and the fish ladder entrance gallery and spillway.

Average annual generation for the Wilder Project was 153,738 MWh for the period 1982 to 2011.

All Projects

TransCanada is not proposing any new facilities as part of this relicensing and also is not proposing any additional protection, mitigation and enhancement (PME) measures.

COMMENTS

2.3.2 Powerhouse Features

Vernon Project

TransCanada states that the Turners Falls impoundment backwaters to the base of Vernon Dam. According to FirstLight (owner of the Turners Falls Project), the Turners pool does not extend to the base of Vernon Dam.

All Projects

While TransCanada provides the spacing of the trashracks, it does not specify the dimensions of the racks (wetted area). This information is needed so that the agencies can calculate the average approach velocities to the racks.

2.5.2 Normal Operations

All Projects

In the PADs, TransCanada states that the projects are operated on a daily run-of-river basis. While technically the projects may pass the daily inflow over the course of a day, a more accurate description of the mode of operation is peaking, whereby the projects generate at maximum capacity for a period of hours and only pass the required minimum flows for the remainder of the day.

3.1 Introduction

Vernon Project

TransCanada states that in the PAD, the term "Vernon Project affected area" refers to Vernon dam to the upstream extent of the Vernon impoundment. As we noted earlier, FirstLight has indicated that according to a recent water surface elevation survey, the Turners Falls pool does not extend to the base of Vernon Dam; therefore, Vernon operations do impact the Connecticut River some distance downstream of the dam.

3.4.5 Reservoir Shoreline and Streambanks

Vernon Project

TransCanada indicates that typically headpond levels are kept between 218.6 feet msl and 219.8 feet msl, although the licensed range is between 212.13 feet msl and 220.13 feet msl. In addition, the stanchion and hydraulic flashboard sill elevations are given as 220.13 feet msl. This information conflicts with data provided earlier in the PAD; in Table 2.1-1, the operating range is given as 212.0 to 220.0 feet msl and Table 2.3-1 lists the flashboard and stanchion elevations as 212.13 feet msl.

In this section of the PAD, TransCanada also refers to a number of surveys conducted on the eastern riverbank downstream of Vernon Dam. According to TransCanada, the results of those surveys identified two major causes of the changes to the riverbank, one being the higher interface between the bank and the river due to the raising of the Turners Falls impoundment elevation in the mid-1970s.

As stated previously, FirstLight now contends that the Turners pool does not extend up to Vernon Dam. This conflicting information needs to be clarified and resolved, as it has bearing on both projects.

3.5.2 Hydrology

Drainage Area

All Projects

In this section and in others, TransCanada specifies that it has a self-imposed drawdown rate of 0.3 feet per hour. While this may be the case during normal operations, it is unclear if this same drawdown rate can be maintained when TransCanada needs to lower the headpond down to the concrete crest in order to replace the stanchion beams. Drawdown rates during these events need to be clarified.

Project Inflow and Outflow

All Projects

Figure 3.5-6 shows hourly outflow from the three stations from 2001 through 2011, although as presented, the data are compressed. By compressing these data, it is difficult to see the actual daily fluctuations in flow below the project. Likewise, the box and whisker graphs in Figure 3.5-1 are helpful in understanding the highest and lowest headpond levels at the projects from 2001 through 2011, but they do not provide a representation of the magnitude and frequency of daily headpond variations.

Because the information in the PADS does not provide the level of detail necessary to fully understand how the projects operate individually and together with TransCanada's other projects, we are requesting that TransCanada provide hourly data (water surface elevations, gate discharges, generation) from all projects (three stations) for the past five years.

3.5.3 Water Use

Vernon Project

In its description of Vermont Yankee Nuclear Power Station's (VY) use of Vernon impoundment water, TransCanada states that the cooling water is returned to the reservoir at a slightly warmer temperature. In fact, it has been reported that discharge temperatures from VY are as high as 100°F (Normandeau 2003), which could be substantially warmer than ambient river water, depending on the season.

3.5.5 Water Quality Standards

All Projects

All three TransCanada projects lie within two state boundaries: Vermont and New Hampshire. Both states classify the Connecticut River in the vicinity of the projects as Class B, but Vermont designates it as coldwater fish habitat, while New Hampshire does not, and the criteria to meet Class B standards differs between the states.

3.5.6 Existing Water Quality Data

All Projects

The PADs provide a summary of existing water quality data. While a number of monitoring efforts have taken place and include sample sites within the project boundary, none of those studies were designed to comprehensively investigate whether all relevant project areas currently meet Class B standards. The monitoring effort conducted by the New Hampshire Department of Environmental Services (NH DES) for the Connecticut River Joint Commission (CRJC) occurred in 2004, and it is unclear how often measurements were taken; the University of Massachusetts Water Resources Research Center's bacterial monitoring that took place in 2008 and 2009 only gathered data from the Wilder Project area; and the U.S. Geological Survey's long-term water quality monitoring station located immediately upstream of the Vernon Project area stopped taking samples in 2007, only collected information roughly once per month, and sampled dissolved oxygen even less frequently.

The PADs contain information on water quality monitoring within the project areas that was completed by TransCanada between June 20, 2012 and September 11, 2012.

Vernon Project

Continuous water quality data were collected in the tailrace and immediately upstream of the dam. Additionally, weekly water column profiles were collected at three locations within the impoundment. Results indicated that water temperature reached critical threshold levels for salmonids. Summary results presented in the PAD indicate that, in general, temperature and pH increased from upstream to downstream, while dissolved oxygen decreased, reflecting the impacts of the impoundment on increased travel time in the river.

Bellows Falls Project

Continuous water quality data were collected in the tailrace, bypass reach, and immediately upstream of the dam. Additionally, weekly water column profiles were collected at three locations within the impoundment. The data indicated that Vermont and New Hampshire water quality standards for dissolved oxygen were not met in the bypass reach and in the impoundment. Furthermore, pH readings collected in water profile measurements indicated that in two different locations during two separate events, the impoundment did not meet Vermont

and New Hampshire water quality standards. Summary results presented in the PAD indicate that, in general, temperature and specific conductivity increase from upstream to downstream within the impoundment.

Wilder Project

Continuous water quality data were collected in the tailrace and immediately upstream of the dam. Additionally, weekly water column profiles were collected at three locations within the impoundment. The data indicated that Vermont water quality standards for dissolved oxygen were not met during a seven-day period in August. Summary results presented in the PAD indicate that, in general, temperature and specific conductivity increased from upstream to downstream, while dissolved oxygen decreased, reflecting the impacts of the impoundment.

All Projects

The manner in which the results are presented in the PADs does not allow for an adequate understanding of how water quality is affected by project operations.[1] Further, the results that were presented indicate that water quality standards are not being met during certain periods at some of the projects. TransCanada does not propose to continue the water quality monitoring effort it began last summer. Additional monitoring is needed so that resource agencies can properly evaluate the potential impact of project operations on water quality; therefore, the U.S. Fish and Wildlife Service (Service) herein submits a request for such a study.

Climate Change

The PADs contain no information relative to climate change and how climate change predictions may impact future operation of the hydroelectric plants, nor of how the projects either mitigate for or exacerbate predicted climate change impacts to freshwater ecosystems.

The three mainstem projects have very long impoundments capable of storing large volumes of water. These impoundments effectively have converted large portions of the Connecticut River into a series of in-river "lakes." Because water velocities slow in these impounded sections of river, it allows for increased thermal loading and resultant higher water surface temperatures than in free-flowing sections of river. TransCanada's PADs provide a summary of water quality data collected in 2012. These data indicate that from the upstream end of the Wilder headpond to the Vernon tailrace, water temperature increased approximately 6°C. In addition, the VY discharges heated effluent into the Vernon impoundment, further increasing water temperatures. The most recent climate change prediction models specific to the Northeast forecast warmer air temperatures, more frequent high precipitation events, more heat waves, and an increase in the incidence of short-term droughts (Karl *et al.* 2009). The increase in air temperature will increase thermal loading into the impoundments which will then be discharged downstream of the dams.

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[1] With the exception of trends in water temperature. Monitoring results show that both the mean and median temperature increased by 10°F (6°C) from the uppermost monitoring station in the Wilder impoundment down to the Vernon tailrace station. The cumulative impact of the three long impoundments on water temperature is of concern to the Service, particularly in the context of climate change.

Relative to existing flood management protocols at each station, TransCanada's PADs identify that all three dams utilize stanchion bays (two at Vernon, three at Bellows Falls, and four at Wilder) to release flood flows. When inflows to each dam reach certain levels, the stanchion bays are removed, and cannot be replaced until inflows subside. The depth of these bays and the flows at which they are removed are outlined in Table 1 below.

Table 1. Summary of Pertinent Stanchion Bay Information for the Vernon, Bellows Falls, and Wilder Projects.

Project	Stanchion Height (feet)	Flow Triggering Complete Stanchion Removal
Wilder	17	145,000 cfs
Bellows Falls	13	50,000 cfs
Vernon	10	105,000 cfs

The PADs provide no information on the history of stanchion removal at any of the projects (frequency, duration, timing), nor a discussion of how predicted climate change might alter management of the stanchion bays in the future (with respect to the frequency and seasonality of occurrence). There also is no discussion of potential impacts to headpond resources that occur as a result of stanchion bay removal.

These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations with respect to the Service's management goals and objectives, including those identified in its draft Climate Adaptation Strategy document (Anonymous 2012).

3.6.2 Summary of Existing Fishery Studies

Fish Assemblage

All Projects

In the PADs, TransCanada summarizes stocking data, fish passage data, and fish survey reports. The most relevant fish study related to the Bellows Falls and Wilder project-affected areas is a Connecticut River electrofishing survey conducted in 2008 (Yoder *et al.* 2009). While some sampling was conducted in both project-affected areas during the 2008 survey, this survey was not designed to assess whether project operations are affecting fish assemblages upstream and downstream of the dams. Additionally, both the Bellows Falls and Wilder PADs acknowledged that fish species assemblage data are limited and that the synthesized data may not be a full representation of species occurrence in the project-affected areas.

Although fish data have been collected by VY for many years in the Vernon Dam project-affected area, gear types were generally limited to boat electrofishing, which is not adequate for properly assessing all species present in the project-affected areas.

It is unknown if other species may inhabit or utilize aquatic habitats in the project areas that have not been documented by previous surveys. It follows that without more information on the fish community in the project-affected areas, project impacts on fish species cannot be determined.

A thorough and comprehensive assessment of the fish assemblages present in the project-affected areas of the Vernon, Bellows Falls, and Wilder projects is needed in order to determine whether project operations are impacting the health of the fish community within the project areas. TransCanada has not proposed any studies to address this deficiency; therefore, the Service is submitting a request for such a study.

Headpond Fluctuations

All Projects

All three of TransCanada's projects operate in a peaking mode. In the PADs, TransCanada states that while it is allowed to fluctuate each impoundment anywhere from 3 feet (at Bellows Falls) up to 8 feet (at Vernon), it voluntarily operates the projects over much narrower ranges (1.2 feet at Vernon; 1.8 feet at Bellows Falls; and 2.5 feet at Wilder). However, given that TransCanada is not proposing to formalize those narrower operating ranges in its new license, it still could utilize the full drawdown levels. Regardless, even at the narrower operating bands, there is the potential for the project to dewater littoral areas important to shallow water nesting species.

The PADs contain no site-specific information on littoral spawners residing within the impoundments, or potential impacts of project operations on those species. This information gap needs to be filled so that the agencies can determine appropriate recommendations relative to headpond fluctuation restrictions. The Service herein provides such a request.

In addition to potentially impacting littoral spawners, daily drawdowns also may impact species that move from mainstem habitat into tributaries to spawn or fulfill other life history requirements. The PADs provide no information regarding how far upstream the influence of the impoundments extends into tributaries entering the mainstem. It is possible that when the headponds are at the lower ends of their operating ranges, the mouths of tributaries could become perched, creating a barrier to upstream movement. This issue needs to be investigated so that agencies can use the results to develop recommendations regarding future project operations. The Service herein submits a request to address this issue.

Peaking Releases

Vernon Project

American shad (*Alosa sapidissima*) are known to spawn upstream of the Vernon Dam; however, we are not aware of any studies that have determined actual spawning site locations within the Vernon pool or free-flowing stretch of river below Bellows Falls.

Peaking releases from Bellows Falls produce rapid flow changes, and operations at Vernon Station result in fluctuations of the Vernon pool. Both peaking releases and pond fluctuations affect physical parameters (i.e., water depth and velocity) that may be important for shad spawning success. The Service is not aware of any studies being conducted specifically designed to determine if project operations at Bellows Falls and Vernon affect American shad spawning behavior, habitat use, and egg deposition, therefore we herein submit a study request to address this issue.

All Projects

TransCanada operates all three projects as peaking facilities. During periods of off-peak generation, the projects release required minimum flows equivalent to 0.2 cfm (0.2 multiplied by the drainage area at each respective dam). Below the Wilder Dam, there are 18 miles of free-flowing river, and below the Bellows Falls Dam, there are 6 miles of free-flowing river. The free-flowing reach below Vernon Dam is of undetermined length as noted above. The large and rapid changes in flow releases from hydropower dams are known to cause adverse effects on habitat and biota downstream of the project (Cushman 1985; Blinn *et al.* 1995; Freeman *et al.* 2001). This section of the Connecticut River contains habitat that supports native riverine species, including important spawning and rearing habitat for migratory fish such as American shad and the federally endangered dwarf wedgemussel (*Alasmidonta heterodon*) (DWM).

The Service is not aware of any previously conducted studies that evaluated the adequacy of these minimum flows in protecting aquatic resources in the riverine habitat below each station. 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 station tailraces. Results will be used by the Service to determine appropriate flow recommendations. The Service herein submits a study request intended to address this information gap.

Bypass Reach

Bellows Falls Project

The Bellows Falls Project bypasses a 3,500-foot-long section of the Connecticut River. Presently, this bypass reach only receives flow when inflow exceeds the hydraulic capacity of the Bellow Falls station. According to exceedance curves provided in the PAD, the bypass reach receives flow in the following amount of time, each month:

Month	% Time Flow > 11,000 cfs	Month	% Time Flow >11,000 cfs
Jan.	15	July	10
Feb.	15	August	8
March	50	Sept.	4
April	90	Oct.	20
May	60	Nov.	35
June	20	Dec.	26

No information exists on the adequacy of the existing bypass flow regime to protect water quality and aquatic life. The bypass reach receives flow less than 30 percent of the time on an annual basis. While TransCanada did conduct a preliminary water quality study in the summer of 2012, only a summary of the data is provided in the PAD. It does not indicate where the sonde was located, or the bypass reach conditions during the study period (e.g., what was the flow into the bypass reach during the study? was the sonde located in the only wetted area of the bypass reach?). Further, the PAD provides no detailed description of the physical or biological characteristics of the bypass reach.

The Connecticut River in the project vicinity is dominated by sections that are impounded, backwatered from downstream impoundments, or otherwise deep and slow-flowing. In contrast, the Bellows Falls bypass channel is very irregular and diverse, consisting of both coarse substrate of various sizes and in the more downstream segment, jagged, irregular ledge. Given an adequate flow regime, the bypass could provide habitat types that are now rare and therefore of great importance.

An empirical study is needed to provide the Service information on the relationship between flow and habitat in the bypass reach, and in determining appropriate flows in the bypass reach. The Service herein submits a request to address this issue.

The bypass reach at Bellows Falls contains a small dam that was constructed to prevent upstream migrant Atlantic salmon (*Salmo salar*) from becoming trapped and isolated in the bypass reach after being attracted to periodic spill flows. In the PAD, TransCanada does not propose any changes with respect to the barrier dam. However, now that the Atlantic salmon restoration program is in the process of modifying management activities, the need for the barrier dam should be re-evaluated.

Anadromous Fish Studies

Vernon Project

TransCanada provides a summary of a number of studies that have been conducted over the years to evaluate the effectiveness of the downstream bypass facilities at the project. Passage efficiency and turbine survival have been studied for Atlantic salmon smolts before and after turbines 5-8 were replaced. Both turbine survival and passage efficiency were conducted for

juvenile shad prior to turbine replacement; the passage efficiency testing was deemed ineffective, but the turbine survival was estimated at 95 percent. No bypass effectiveness or turbine survival studies have been conducted for adult shad, and no such studies have been done for adults or juveniles since the turbines were replaced. These data gaps need to be filled so that agencies can determine the overall through-project survival of post-spawned adult and juvenile shad. The Service herein submits a request to address these issues.

No directed studies have been conducted to evaluate the effectiveness of the upstream fish ladder at the Vernon Project. However, Table 3.6-1 provides passage data at Vernon from 1981 up to 2012, including the ratio of shad passed at Vernon Dam relative to the number passed at the Turners Falls gatehouse. Based on those data, the ratio has ranged from 0 percent to over 100 percent (likely due to undercounting at the Turners Falls Project gatehouse fishway counting facility), with a mean of 41 percent over all years. While this overall passage ratio falls within the goal of 40 percent to 60 percent identified in the Connecticut River Atlantic Salmon Commission Strategic Plan, there have been a number of years when passage fell far short of the stated goal (e.g., 2004 through 2011). In addition, while the internal efficiency of the ladder may be sufficient (when the ladder is being maintained and operated properly), no information exists on potential delays experienced at the ladder entrance. Any delays due to Vernon project operations and/or exposure to VY's thermal discharge could impact spawning success.

Additional information on pre-spawned adult shad movement up to and through the Vernon Project area is needed in order to determine if project operations are impacting shad passage and spawning success. The Service herein submits a request to address this issue.

Resident Fish Passage

All Projects

The three projects currently have upstream fishways primarily designed for passage of Atlantic salmon, and at Vernon, also designed for passage of American shad and blueback herring (*Alosa aestivalis*). The operation of the fishways has been limited to a limited spring period during the anadromous fish passage. Riverine fish and American eel (*Anguilla rostrata*) have used the existing fishways, but there are limited data on counts and not all existing data have been reviewed. In addition, the seasonal operation of the fishways has been limited, whereas riverine species are expected to move both prior to and after the spring anadromous fish upstream passage period. The Service hereby submits a study request to review existing passage data for fish other than anadromous species, and to evaluate the passage of fish throughout the spring, summer and fall periods to assess the appropriate operation period for fishways for riverine species.

3.6.4 Diadromous Species Descriptions

American Eel

All Projects

TransCanada provides a description of the life history of the American eel, as well as the status of its presence within the project areas; according to the PAD, eel have been documented upstream and downstream of the Vernon Project and upstream of the Bellows Falls Project.

The Service is aware that both the New Hampshire Fish and Game Department (NHFGD) and the Vermont Fish and Wildlife Department (VFWD) have observed eels upstream of Wilder Dam (Lael Will, VFWD, personal communication; Gabe Gries, NHFGD, personal communication). While this information indicates that some eels are passing all three dams (Vernon, Bellows Falls, and Wilder), it remains unknown how many eels may be rearing in the mainstem habitat upstream of the dams or in tributaries and lakes and ponds that feed into the mainstem river.

No targeted eel surveys have been conducted to determine the abundance and distribution of American eels in riverine and lacustrine habitat upstream of the three projects. This information gap needs to be filled so resource agencies can properly evaluate the need for, and timing of, downstream passage and protection measures for outmigrating silver phase eels. The Service herein submits a request to address this issue.

Eel Passage

All Projects-Upstream

The PADs contain no information relative to areas where eels seeking to move upstream concentrate downstream of the three dams, or annual numbers of eels attempting to ascend past the dams. While eels have been known to ascend the Vernon and Bellows Falls fish ladders, the efficiency for these structures to pass eels is unknown. In addition, the ladders are only operated during the American shad and salmon passage season at Vernon (April 15 through July 15) and during the salmon passage season at Bellows Falls and Wilder (from May 15 through July 15). While there also is a fall passage season for salmon, typically the ladders are operated during the fall only if there is evidence that there is a salmon immediately below the dam.

Eels are currently able to pass Vernon, Bellows Falls, and Wilder dams (as evidenced by documented presence of eels upstream), but the total number of eels attempting to pass all three dams and the proportion successfully passing each project is unknown (but suspected to be low). The downstream Holyoke Project has operated upstream eel passage facilities since 2004. Last year, these facilities passed over 40,000 juvenile eels. While the next dam upstream (Turners Falls Project, FERC No. 1889) has no dedicated upstream eel passage facilities, eels have been known to ascend the Cabot Station fish ladder (A. Haro, U.S. Geological Survey, personal communication). Although there is rearing habitat in between the Turners Falls and Vernon

dams, some eels will attempt to continue upstream, and passage needs to be provided so these fish can access historical habitat.

The Service needs to understand the numbers and locations of juvenile eels downstream of each dam in order to determine the best locations to site upstream eel passage facilities and assess whether operating the existing anadromous ladders would be an effective mechanism to move juvenile eels upstream past the projects. The Service herein submits a study request to address this issue.

All Projects-Downstream

TransCanada operates downstream fish passage facilities at all three projects. The downstream bypasses were designed to guide and pass Atlantic salmon smolts, and studies to determine the effectiveness of the facilities for Atlantic salmon have been conducted. In addition, as mentioned above, the Vernon Project has assessed its downstream passage facilities for American shad (although those studies were inconclusive). Turbine survival studies also have been undertaken at all three projects, both for Atlantic salmon and American shad (although the turbine survival study for shad at Vernon is outdated due to unit replacement). To date, no studies have been undertaken to evaluate the effectiveness of the existing downstream bypasses or turbine survival for silver phase eels.

The Service believes that studies need to be conducted to fully understand how silver phase eels move through the project areas. In addition, turbine and gate discharge mortality studies are needed for eels and should be used in conjunction with the results of the passage routing studies to calculate total through-project survival rates. The Service herein provides a study request in order to address this information need.

Federal Listing Status

All Projects

It should be noted that within the past seven years, the Service has received two petitions to list the American eel under the Endangered Species Act (ESA). The first petition was received on November 18, 2004. On July 6, 2005, the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011, the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. It is likely that the Service's 12-month finding on the latest petition will be made prior to any new licenses being issued for the projects. If listed, consultation with the Service will need to be initiated by the Commission as required under section 7 of the ESA.

Sea Lamprey

In its overview of the life history of the sea lamprey (*Petromyzon marinus*), TransCanada fails to mention that during their spawning migrations, adult lamprey are not parasitic because they are not feeding. Given the lamprey's status in the Lake Champlain basin as an invasive pest, it is very important to note the differences between landlocked populations of sea lamprey and those where there is access between the marine and freshwater environment. In the Connecticut River the lamprey is not considered a nuisance, but in fact is a beneficial component of the ecosystem.

As noted in the PADs, sea lamprey have been documented upstream and downstream of the Vernon and Bellows Falls projects and in 2008, a lamprey was counted passing the Wilder fish ladder. Lamprey are known to spawn in the Connecticut River main stem at least as far upstream as Wilder Dam, as well as in tributary waters including the West, Williams, Black and White rivers (Kart *et al.* 2005).

To date, no studies have been conducted that aim to identify spawning habitat and spawning activity of sea lamprey within the Wilder, Bellows Falls, and Vernon project areas or to determine whether project operations are affecting these activities. The Service herein provides a study request in order to address this information need.

3.6.5 Resident Species Descriptions

Tessellated Darter

All Projects

In the PADs for the Wilder, Bellows Falls, and Vernon projects, the Applicant acknowledges that the tessellated darter (*Etheostoma olmstedi*) is one of the confirmed hosts of the DWM. It also identifies the occurrence of the tessellated darter both upstream and downstream of each project. However, information on the impact project operations may have on tessellated darter populations is lacking. Of the known host species for the DWM (Atlantic salmon and slimy sculpin [*Cottus cognatus*] being the other two), the tessellated darter is the only species likely to inhabit the mainstem Connecticut River in the vicinity of the projects; therefore, maintaining healthy, sustainable darter populations is extremely important to the long-term viability of the DWM.

Detailed information on the population dynamics of darter populations within the project-affected areas is needed in order for the agencies to determine if project operations are affecting the tessellated darter. A cumulative effects analysis should be conducted, where appropriate. For example, the Vernon PAD summarizes electrofishing, impingement and entrainment data collected by VY for the period 1991 to 2011. Those data suggest that the tessellated darter is not a large component of the fish assemblage in the Vernon pool. However, TransCanada did not mention that VY undertook a more rigorous entrainment study in 2005 than the annual monitoring effort, sampling from April through September (Normandeau 2011). Results revealed

that while only six tessellated darter were seined from Vernon pool during 2005, over three million larvae were entrained at the VY intake.

The Service herein provides a study request in order to address this information need.

3.6.7 Mussels and Macroinvertebrates

Dwarf Wedgemussel

All Projects

In the PADs, TransCanada states that it commissioned BioDrawversity and the Louis Berger Group to conduct a mussel survey in 2011. Areas surveyed included a number of sites extending the length of each impoundment and each tailwater (within one mile below each dam). At Vernon, six mussel species were found in the headpond and four species were found in the tailwater (no DWM were found). At Bellows Falls, seven mussel species (including DWM) were found in the headpond and five species were surveyed in the tailwater. At Wilder, five mussel species (including DWM) were found in the headpond and three species were surveyed in the tailwater.

The 2011 survey did not include free-flowing stretches of river between the projects (beyond the 1-mile tailwater reach). At Wilder, there are 17 miles of free-flowing river that are affected by peaking releases at Wilder. Similarly, below the Bellows Falls Dam, there are 6 miles of free-flowing river affected by peaking operations at Bellows Falls. A better understanding of the distribution and abundance of the DWM in these stretches of the river is required.

In addition, quantitative information regarding population size, density, and age class structure of the mussel communities known to occur within project-affected areas is needed. Further, effects of project operations (headpond fluctuations and peaking releases) on various aspects of DWM biology, including lure display, shell position (open/closed), siphoning rate, and vertical migration, as well as habitat persistence, need to be assessed. The Service herein provides a study request in order to address these information needs. If the results of that study indicate that river flows and water levels associated with the relicensing may affect the DWM or its habitat, further consultation with this office under the Endangered Species Act is recommended.

3.7.3 Plant and Animal Species

Invasive Species

All Projects

In the PADs, TransCanada notes that the Invasive Plant Atlas of New England (IPANE) lists a number of invasive species as occurring in the general vicinity of the projects. Under the Project Effects section of the PADs (section 3.7.4), TransCanada acknowledges that the disturbance resulting from daily project operations creates opportunities for invasive plant species to colonize

and dominate the shorelines of the projects. This is an impact that needs to be quantified and addressed as part of the relicensing process. Below we discuss invasive species in more detail.

TransCanada should be aware that in the Connecticut River watershed, six Cooperative Invasive Species Management Area (CISMA) partnerships are working on invasive species projects, including public outreach, inventory and on-the-ground invasive plant control. In addition, a full Connecticut River watershed-wide initiative networks these CISMAs, including state and regional partners, to prioritize invasive plant control actions that plan and implement early detection and rapid response to new invaders to the watershed.

3.8.2 Habitats

Wetlands

All Projects

TransCanada utilized National Wetland Inventory (NWI) maps to determine that wetland habitats cover 109 acres in the vicinity of the Wilder Project, 490 acres of the Bellows Falls Project area, and 123 acres within the Vernon Project area. In addition to NWI maps, TransCanada conducted a shoreline survey in 2011 that identified sites where erosion was occurring, as well as verifying wetlands within the project areas. While the PADs contain general descriptions of different wetland types and provide species typically associated with each type of wetland, it does not appear that TransCanada collected site-specific species information as part of its shoreline survey.

TransCanada acknowledges that the project-induced daily water level fluctuations have resulted in a zone of sparse vegetation along most shorelines of the impoundments and that wetland and littoral resources in the fluctuation zones are limited by the frequent wetting and drying.

Site-specific baseline information on wildlife and botanical resources within each project area is needed in order for the agencies to determine if project operations may be impacting wetland, riparian or littoral species and their habitats (including invasive species). The Service herein provides a study request in order to address this information need.

3.9.2 RTE [Rare Threatened and Endangered] Species in the RTE Project Area

Bellows Falls Project

Table 3.9-1 is missing the federally endangered northeastern bulrush plant (*Scirpus ancistrochaetus*).

3.9.4 Biological Opinions, Status Reports, and Recovery Plans

Bald Eagle

All Projects

The bald eagle (*Haliaeetus leucocephalus*) breeds and overwinters in all three project areas. Known roosting and nesting sites represent important habitat and, to the extent possible, should be protected. More detailed information regarding the locations of active and/or historical roosting and nesting sites is needed, including identification of land use and ownership on those parcels containing roosting and/or nesting sites. These data should be taken into consideration in the development of any shoreline management plan for the projects, including acquisition of those lands outright or establishing conservation easements for their long-term protection and conservation to benefit bald eagles. The Service has included eagle habitat assessment in the study request addressing wetlands and riparian vegetation.

3.10.6 Specially Designated Lands

Silvio O. Conte National Wildlife Refuge

All Projects

We offer the following corrections to acreages given in the PADs: the Conte Refuge now comprises 35,658 acres, and the Nulhegan Basin Division in Vermont's Northeast Kingdom accounts for 26,526 acres.

In addition, TransCanada should be aware that a Cooperative Conservation Plan (CCP) for the Conte Refuge is scheduled to be completed this calendar year. One of the outputs of the CCP will be identification of additional land protection priorities.

4.0 Preliminary Issues and Studies List

All Projects-Proposed Studies

TransCanada is not proposing to conduct any additional studies beyond those already conducted or under development (i.e., shoreline survey, mussel survey, water quality monitoring, federally endangered Jesup's milk vetch [*Astragalus robbinsii* var. jesupi] habitat stage-flow rating curve development, Phase 1A historic and archaeological reconnaissance surveys, river operations optimization/simulation model, and RTE survey).

Regarding the river operations optimization/simulation model, TransCanada proposes to develop a model that would simulate existing operations of the three projects as well as assess alternative operations. While TransCanada would use the model to understand how any changes would impact generation at the stations, the Service supports this study because it will allow the agencies to understand what, if any, limitations there may be to changing project operations to

benefit natural resources within and beyond the project areas. The Service herein submits a request for such a study request.

All Projects-PME Measures

TransCanada proposes no PME measures other than to continue the current operational constraints (reservoir operations, high water procedures, and minimum flow releases) and operate the fish passage facilities. TransCanada states that any PME measures for RTE species will be based on the results of the RTE survey.

5.3 Comprehensive Waterway and Resource Management Plans

All Projects

In the Wilder PAD, TransCanada identifies 19 federal plans for New Hampshire and 15 for Vermont recognized by the Commission as Comprehensive Waterway Development Plans. For Bellows Falls, 20 plans are identified for New Hampshire and 12 for Vermont. For Vernon, 19 plans are identified for New Hampshire and 12 for Vermont. In addition to those plans, the Service hereby submits the following plan to the Commission for consideration in determining whether it qualifies as a comprehensive plan pursuant to Section 10(a)(2)(A) of the Federal Power Act (Attachment A):

Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

If the Commission determines that the plan identified above does not qualify as a comprehensive plan, we request that it be considered as a relevant resource management plan.

ADDITIONAL INFORMATION

The following information is needed:

1. the dimensions of the trashracks (wetted area) at each project. This information is needed so that the agencies can calculate the approach velocities;
2. a more thorough description of how project operations are monitored and recorded;
3. hourly data (water surface elevations, dam discharge, generation, from all three projects in spreadsheet format for the past five years; and
4. verification of the extent of the backwatering from the Turners Falls Project and the length of lotic habitat between Vernon Dam and the upper extent of the Turners Falls headpond.

RECOMMENDED STUDIES

The Applicant already has undertaken a shoreline survey, a mussel survey, a water quality monitoring effort, development of a Jesup's milk vetch habitat stage-flow rating curve, Phase 1A historic and archaeological reconnaissance surveys, development of a river operations

optimization/simulation model, and RTE surveys. TransCanada proposes no additional studies. Enclosed please find our formal study requests (Attachment B), in the format required pursuant to 18 CFR §4.38(b)(5).

SCOPING DOCUMENT 1

3.6.3 Project Decommissioning

The Commission proposes to eliminate this alternative from detailed study in the environmental analysis, because no party has suggested project decommissioning would be appropriate in this case. The Commission asserts that there would be significant costs involved with decommissioning the projects, including lost energy production.

We recommend that the Commission include project decommissioning in the environmental analysis. No party has suggested this alternative because, up to this point in the Integrated Licensing Process, there has been no formal opportunity to provide such a recommendation. Further, the Commission has supplied no supporting information to justify the contention of significant decommissioning costs; and given the substantial increase in proposed renewable energy projects, it is possible that there may be no net loss of energy production when viewed on a regional basis.

4.1.2 Geographic Scope

The Service recommends that the geographic scope of the Commission's environmental analysis of the impacts to cumulatively effected fishery, water quantity and water quality resources extend from the upstream extent of the Wilder Project impoundment, downstream to Long Island Sound. For terrestrial resource issues, the geographic scope should be from the upstream extent of the Wilder impoundment to the upstream extent of the Holyoke headpond. For threatened and endangered species, the geographic scope should be from the upper extent of the Wilder impoundment to the Holyoke Dam.

4.3.3 Aquatic Resources

Effects of project facilities and operations on fish migration should be analyzed cumulatively as well as for individual projects.

Effects of entrainment should not be limited to fish populations, but should include impacts to food web interactions and overall ecosystem productivity.

Thank you for this opportunity to comment. If you have any questions regarding these comments, please contact John Warner of this office at (603) 223-2541.

Sincerely yours,

Thomas R. Chapman
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Attachments

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ATTACHMENT A

Comprehensive Waterway Development Plans

Atlantic States Marine Fisheries Commission

ADDENDUM II TO THE FISHERY MANAGEMENT PLAN FOR AMERICAN EEL

ASMFC Vision Statement:
Healthy, self-sustaining populations for all Atlantic coast fish species or successful restoration well in progress by the year 2015.

Approved October 23, 2008

INTRODUCTION

The Atlantic States Marine Fisheries Commission's American Eel Management Board initiated the development of Addendum II in January 2007 to propose measures that would facilitate escapement of silver eels during or just prior to their spawning migration as a means to improve American eel recruitment and abundance. Although the available data for American eel in the U.S. have not been sufficient to perform a reliable quantitative assessment of the population size or fishing mortality rates (ASMFC 2001, 2006), there has been evidence that the stock has declined and is at or near low levels (ASMFC 2000, 2001, 2006; USFWS 2007). The Management Board asked the Technical Committee (TC) and Advisory Panel (AP) to consider closed seasons, gear restrictions, size limits or a combination of these measures to reduce the harvest of emigrating eels. The public comment draft of Addendum II proposed these management measures, as well as recommendations for increased protection of American eels during their upstream and downstream migration.

This Addendum recommends stronger regulatory language to improve upstream and downstream passage of American eel to state and federal regulatory agencies. As such, there is no implementation schedule and there are no new compliance requirements. Member states are still required to submit annual compliance reports by September 1. This Addendum does not alter any other provisions from the Interstate Fishery Management Plan (FMP) and makes no changes to Addendum I to the FMP.

Background

The American eel occupies fresh, brackish, and coastal waters along the Atlantic from the southern tip of Greenland to northeastern South America. The species is catadromous, spending the majority of life in freshwater, but migrating to the Sargasso Sea to spawn. Newly hatched eels drift on oceans currents, eventually entering nearshore areas where they migrate up-river. Therefore, a comprehensive eel management plan and comprehensive set of regulations must consider the various unique life stages and the diverse habitats used, in addition to society's interest and use of this resource.

American eel (*Anguilla rostrata*) occupy a significant and unique niche in the Atlantic coastal reaches and its tributaries. Historically, American eel were very abundant in East Coast streams, comprising more than 25 percent of the total fish biomass. Eel abundance declined from historic levels but remained relatively stable until the 1970s. More recently, fishermen, resource managers, and scientists postulated a further decline in abundance based on harvest information and limited assessment data. This resulted in the development of the Atlantic States Marine Fisheries Commission FMP for American Eel. The goals of the FMP are:

1. Protect and enhance the abundance of American eel in inland and territorial waters of the Atlantic States and jurisdictions and contribute to the viability of the American eel spawning population; and
2. Provide for sustainable commercial, subsistence, and recreational fisheries by preventing overharvest of any eel life stage.

In support of these goals, the following objectives were included in the FMP:

- Improve knowledge of eel utilization at all life stages through mandatory reporting of harvest and effort by commercial fishers and dealers, and enhanced recreational fisheries monitoring.
- Increase understanding of factors affecting eel population dynamics and life history through increased research and monitoring.
- Protect and enhance American eel abundance in all watersheds where eel now occur.
- Where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.
- Investigate the abundance level of eel at the various life stages, necessary to provide adequate forage for natural predators and support ecosystem health and food chain structure.

Status of the Stock

Current stock status (i.e., overfished or not overfished) for American eel is poorly understood due to limited and non-uniform stock assessment efforts and protocols across the species' range. No range-wide estimate of abundance exists and reliable indices of abundance of this species are scarce. Information on demographic structure is lacking and difficult to determine because the American eel is a single population (termed *panmixia*) with individuals randomly spread over an extremely large and diverse geographic range, with growth rates and sex ratios environmentally dependent. At present, limited data (fishery-dependent and independent) from indirect measurements (harvest by various gear types and locations) and localized direct stock assessment information are collected.

In 2003, declarations from the International Eel Symposium (AFS 2003, Quebec City, Quebec, Canada) and the Great Lakes Fishery Commission (GLFC) highlighted concerns regarding the health of American eel stock. Canada has recently applied the "Special Concern" designation to American eel. Available data attributes the population drop to decreasing recruitment combined with localized declines in abundance. This information is cause for concern and represents an opportunity for cooperation with other entities such as the GLFC to preserve the American eel stock.

The most recent peer reviewed stock assessment was presented to the Commission's American Eel Management Board in February 2006. The stock assessment did not meet some of the terms of reference according to the Terms of Reference and Advisory Report to the American Eel Stock Assessment Peer Review (ASMFC 2006). In May 2006, the Board tasked the American Eel Stock Assessment Subcommittee (SASC) with following up on specific recommendations in the peer review report to improve the 2005 stock assessment. The SASC follow-up to the Terms of Reference and Advisory Report to the American Eel Stock Assessment Peer Review was presented to the Board in October 2006. This report was inconclusive regarding the status of the stock. In their follow-up report, the SASC created a coastwide index for American eel using yellow eel indices that are monitored along the Atlantic Coast, both in the United States and Canada, and combing them with General Linear

Modeling (GLM). The SASC's report included a suggestion that the coastwide yellow eel GLM index could be used as a management trigger and would be a means to monitor coastwide, yet act locally.

In reaction to the extreme declines in eel abundance the Saint Lawrence River-Lake Ontario portion of the species' range, the Commission requested in 2004 that the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) conduct a status review of American eel. In February 2007, the USFWS announced the completion of a Status Review for American eel. The report concluded that protecting eel as an endangered or threatened species is not warranted. The USFWS did note that while the species' overall population is not in danger of extinction or likely to become so in the foreseeable future, the eel population has "been extirpated from some portions of its historical freshwater habitat over the last 100 years…[and the species abundance has declined] likely as a result of harvest or turbine mortality, or a combination of factors" (50 CFR Part 17).

Following the 2005 stock assessment, Terms of Reference and Advisory Report to the American Eel Stock Assessment Peer Review, and Stock Assessment Subcommittee's 2006 report, the Board initiated this Addendum to consider management options to halt the current decline in yellow eel abundance.

Status of the Fishery

American eel currently support important commercial fisheries throughout their range. Fisheries are executed in rivers, estuaries, and ocean. Commercial glass eel harvest is legal in Maine and South Carolina, although reported landings are minimal in South Carolina. Yellow and silver eel fisheries exist in all states and jurisdictions with the exception of Pennsylvania and the District of Columbia. South Carolina and Georgia recorded no commercial yellow or silver eel landings in 2007.

Commercial

Commercial landings decreased from a high of 1.8 million pounds in 1985 to a low of 641,000 pounds in 2002. Landings of yellow and silver eel in 2007 totaled 834,500 pounds.[1] New Jersey and Delaware each reported landings over 100,000 pounds of eel and Maryland reported landings over 300,000 pounds in 2007. Combined, these three states accounted for 73% of the coastwide commercial landings. Massachusetts, Pennsylvania, Georgia, Florida, and the District of Columbia were granted *de minimis* status for the 2007 commercial fishing year. De *minimis* is approved if a member states' commercial landings of yellow and silver eel for the previous year is less than 1% of the coastwide landings for the same year. Additionally, member states must request *de minimis* status.

Recreational

Few recreational anglers directly target eel and most landings are incidental when anglers are fishing for other species. Eel are often purchased by recreational fishermen for use as bait for larger sport fish such as striped bass, and some recreational fishermen may catch their own eel to utilize as bait. The NMFS Marine Recreational Fisheries Statistics Survey (MRFSS)

[1] Harvest data for 2007 comes from the 2008 State Compliance Reports. The landings are preliminary and some are incomplete.

shows a declining trend in the catch of eel during the latter part of the 1990s. According to MRFSS[2], 2007 recreational total catch was 140,372 fish, which represents a 63% increase in number of fish from 2006 (86,024 fish). About 59% of the eel caught were released alive by the anglers. MRFSS 2007 total recreational harvest was 57,986 fish.

For current commercial and recreational regulations for American eel by state, please see Appendix I.

STATEMENT OF THE PROBLEM

While the status of the American eel stock is uncertain, the latest stock assessment information indicates that the abundance of yellow eel (a juvenile life stage) has declined in the last two decades and the stock is at or near low levels. Further, relative abundance is likely to continue to decline unless mortality decreases and recruitment increases. The American Eel Management Board directed the American Eel Plan Development Team (PDT) to develop potential management measures for American eel that would facilitate an increase in the number of adult American eel (also known as silver eel) that are able to move from fresh and estuarine water to the ocean—also known as out-migrate—and spawn. The recommended management measures included gear and size restrictions, seasonal closures, and a recommendation to protect the upstream and downstream migration of American eel.

The Board initiated this Addendum based on a concern for the American eel population and sought public comment on measures that would facilitate escapement of silver eel on their spawning migration with the intent of halting any further declines in juvenile recruitment and eel abundance. The Board chose not to implement any additional restrictions on the fishery at this time and requested that a new stock assessment be initiated to better understand the stock status. The primary objective of this document is to recommend stronger regulatory language to improve upstream and downstream passage of American eel to state and federal regulatory agencies.

PROPOSED MANAGEMENT OPTIONS from the PUBLIC COMMENT DRAFT of ADDENDUM II

Gear restrictions, size limits, and seasonal closures employed individually or in combination can protect out-migrating silver eels by allowing more silver eel to reach the Sargasso Sea and spawn. American eel larvae and glass eel recruit to estuaries and freshwater at random; it is predicted that increased escapement from any part of the species' range has the potential to benefit the species throughout the entire range. While operating under the theory that allowing more silver eel to escape will result in increased juvenile recruitment, the PDT recognizes that several factors can influence the amount of silver eels that are allowed to out-migrate, including:

1. The time duration in which silver eel out-migrate;

[2] MRFSS Data for American Eel are unreliable. 2007 Proportional Standard Error (PSE) values for recreational harvest in Massachusetts, Rhode Island, New Jersey, Delaware, Virginia, and South Carolina are 100, 84.3, 70.2, 100.4, 100 and 100 respectively.

2. The portion of the out-migration period that is covered by the closed season;
3. The maximum size eel that gear can catch;
4. The maximum size eel that harvesters are allowed to possess.

The Board chose to delay action on commercial fishery management measures in order to incorporate the results of the upcoming stock assessment, which will present new and updated information on American eel stock status, including the long-term young-of-the-year index being conducted by the states. In addition, the Board received substantial public comment and advice from its Advisory Panel that further restrictions on American eel harvest would significantly impact fishermen. The states will revisit management measures upon completion of the American eel stock assessment.

RECOMMENDATIONS FOR IMPROVING UPSTREAM AND DOWN STREAM PASSAGE OF AMERICAN EEL

There are multiple factors that influence the American eel population across its range, as well as factors that influence their local abundance. Such factors include barriers to upstream and downstream migration, loss of habitat, and natural oceanographic conditions. On the Atlantic and Gulf coasts, 33,663 dams potentially hinder American eel movement. Of these dams, 1,511 (4.5 percent) are for hydropower (50 CFR Part 17).

Recommendations for Federal Energy Regulatory Commission Relicensing
The Commission recognizes that many factors influence the American eel population, including harvest, barriers to migration, habitat loss, and natural climatic variation. The Commission's authority, through its member states, is limited to controlling commercial and recreational fishing activity; however, to further promote the rebuilding of the American eel population, the Commission strongly encourages member states and jurisdictions, as well as the U.S. Fish and Wildlife Service, to consider and mitigate, if possible, other factors that limit eel survival. Specifically, the Commission requests that member states and jurisdictions request special consideration for American eel in the Federal Energy Regulatory Commission relicensing process. This consideration should include, but not be limited to, improving upstream passage and downstream passage, and collecting data on both means of passage.

Recommendations for Improving American Eel Passage at Non-Federally Licensed Dams
Of the 33,663 dams located on the Atlantic and Gulf Coasts that potentially hinder American eel movement, 95% are not licensed by the federal government. Therefore, the states should strive to remove these obstructions where feasible. If removal is not feasible, then upstream and downstream passage should be improved to provide access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel consistent with the goal of the FMP.

APPENDIX I

Table A1. Commercial Regulations by State*

State	Size Limit	License/Permit	Other
ME		· Harvester and dealer license · Dealer reporting	· Seasonal closures · Gear restrictions
NH	6"	· Commercial saltwater license · Coastal harvest permit · Monthly trip level catch & effort reporting of harvest	· 50/day for bait · Gear restrictions in freshwater
MA	6"	· Commercial permit with annual catch report requirement · Registration and reporting for all eel buyers	· Nets, pots, spears, and angling only · Mesh restrictions · Coastal towns may have additional requirements
RI	6"	· Commercial fishing license required for the sale of American eel · Quarterly reporting	
CT	6"	· Commercial license with dealer reporting	· Gear restrictions
NY	6"	· Commercial harvester and dealer license and harvester reporting	· Gear restrictions
NJ	6"	· License required · Monthly reporting for eel pot license	· Gear restrictions
PA		· No commercial fishery	
DE	6"	· License required · Monthly reporting with catch and effort	· Commercial fishing in tidal waters only
MD	6"	· Licensed required with monthly reporting.	· Prohibited in non-tidal waters · Gear restrictions · Commercial crabbers 50 eel pots/day max no harvest limit
DC		· No commercial fishery	
PRFC	6"	· Eel license · Harvester weekly reporting w/daily effort	· Gear restrictions
VA	6"	· License with two-year delayed entry system · Mandatory monthly reporting (at trip level)	· Mesh size restrictions on eel pots
NC	6"	· Standard Commercial Fishing License for all commercial fishing	· Mesh size restrictions on eel pots · Bait limit of 50 eels/day
SC		· Permits by gear and area fished · Mandatory monthly reporting · License for all commercial fishing and sale	· Various gear restrictions
GA	6"	· Personal commercial fishing license and commercial fishing boat license · Harvester/dealer reporting required	· Gear restrictions on traps and pots
FL		· Commercial fishing license · Mandatory permit for all commercial eel harvesters · Mandatory trip and monthly sales summary reporting for permittees	· Gear restrictions

* For specifics on licenses, gear restrictions, and area restrictions, please contact the individual state.

Table A2. Recreational Regulations by State*

State	Size Limit	Possession Limit	Other
ME	6"	50 eels/person/day	· Gear restrictions · License requirement and seasonal closures (inland waters only)
NH	6"	50 eels/person/day	· Coastal harvest permit needed if taking eels other than by angling · Gear restrictions in freshwater.
MA	6"	50 eels/person/day	· Nets, pots, spears, and angling only · Mesh restrictions · Coastal towns may have additional requirements
RI	6"	50 eels/person/day	
CT	6"	50 eels/person/day	
NY	6"	50 eels/person/day	· Additional length restrictions in specific inland waters
NJ	6"	50 eels/person/day	
PA	6"	50 eels/person/day	· Gear restrictions
DE	6"	50 eels/person/day	· Two pot limit/person
MD	6"	No possession limit in tidal areas (hook & line); 25/person/day w/10 eel pot max for rec. crabber in tidal; 25/person/day in non-tidal	· Gear restrictions
DC	6"	10 eels/person/day	· Five trap limit
PRFC	6"	50 eels/person/day	· Recreational license
VA	6"	50 eels/person/day	· Recreational license, no reporting · Recreational commercial gear license, annual report required · Two eel pot limit (both licenses) · Mandatory annual catch report for eel pot license · Mesh size restrictions on eel pots
NC	6"	50 eels/person/day	· Gear restrictions · Noncommercial special device license, allowed two eel pots under Recreational Commercial Gear license
SC	None	None	· Gear restrictions
GA	None	None	
FL	None	None	· Mesh size and funnel opening restrictions on eel pots

* For specifics on licenses, gear restrictions, and area restrictions, please contact the individual state.

ATTACHMENT B

Study Requests

TransCanada Study Request #1

Model River Flows and Water Levels Upstream and Downstream from the Wilder, Bellows Falls, and Vernon Stations and Integrate Project Modeling with Downstream Project Operations

(Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

The goal of this study is to develop river flow models that permit the evaluation of the hydrologic changes to the Connecticut River caused by the physical presence and operation of the Wilder, Bellows Falls, and Vernon hydroelectric projects and the interrelationships between the operation of all five hydroelectric projects up for relicensing and river inflows. Specific objectives of this study include:

1. Conduct quantitative hydrologic modeling of the hydrologic influences and interactions that exist between the water surface elevations of the Wilder, Bellows Falls, and Vernon project impoundments and discharges from the Wilder, Bellows Falls, and Vernon projects and the downstream hydroelectric projects, including:
   a. inflows into the Wilder, Bellows Falls, and Vernon impoundments from the Fifteen Mile Falls Project, FERC No. 2007, and other sources;
   b. existing and potential discharges from the Wilder, Bellows Falls, and Vernon project generating facilities and spill flows, including existing and potential minimum flow and other operational requirements;
   c. existing and potential water level fluctuation restrictions (maximum and minimum pond levels) of the Wilder, Bellows Falls, and Vernon impoundments, and consequent changes in downstream project discharges; and
   d. incorporation of the potential effects of climate-altered flows on project operations over the course of the license.

2. Assess how existing and potential operations of the Wilder, Bellows Falls, and Vernon projects affect the operations of the Northfield Mountain Pumped Storage and Turners Falls projects, including:
   a. how Wilder, Bellows Falls, and Vernon flow fluctuations affect pool levels of the Turners Falls impoundment; and
   b. how operations of the Wilder, Bellows Falls, and Vernon projects affect Turners Falls discharges.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to aquatic resources, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide an instream flow regime that meets the life history requirements of diadromous fish and resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the areas impacted by project operations.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.
4. Minimize the current negative effect of project operations on shortnose sturgeon spawning and rearing within the Montague spawning area (i.e., Rock Dam and Cabot Station spawning sites and associated early life stage rearing areas) at the Turners Falls Project.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a resource agency.

Existing Information

Available information in the PADs does not indicate how project operations have altered the hydrology downstream from each of these facilities, 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 operations at one facility affect the operations at another.

Nexus to Project Operations and Effects

The Wilder, Bellows Falls, and Vernon projects are each currently operated with required minimum flows of 675 cfs, 1,083 cfs, and 1,250 cfs (or inflows if less) for each facility, respectively, though in practice minimum flows are operated as 700 cfs, 1,300 cfs, and 1,600 cfs, respectively. There is presently no required minimum flow for the bypassed reach of the Bellows Falls Project. Each of the projects operates as a daily peaking facility, such that "generation can vary during the course of any day between the required minimum flow and full

capacity if higher flows are available" (p. 2-28, p. 2-29, and p. 2-30 in the Wilder, Bellows Falls and Vernon PADs, respectively). Total hydraulic capacity of each facility is 12,700 cfs, 11,010 cfs, and 12,634 cfs, respectively. Regular daily fluctuations on the order of 9,000 cfs or greater are commonly recorded at USGS gages 01144500 (Connecticut River at West Lebanon, New Hampshire, below Wilder Dam) and 01154500 (Connecticut River at North Walpole, New Hampshire, below Bellows Falls Dam). Daily fluctuations in headpond elevation are approximately 2.5' (382' to 384.5' MSL), 1.2' (289.9' to 291.1' MSL), and 1.2' (218.6' to 219.8' MSL) at the Wilder, Bellows Falls, and Vernon impoundments, respectively.

These described changes affect biotic habitat and biota upstream and downstream of each project. Project operations and potential changes to operations to mitigate impacts at each facility are influenced by inflows and operations of upstream projects. Results of river flow analyses will provide necessary information regarding changes that can be made to the Wilder, Bellows Falls, and Vernon project flow releases and/or water level restrictions, how such changes may be constrained by inflows and upstream project operations, and how these changes potentially affect downstream resources. This information will then be used to develop flow-related license requirements and/or other mitigation measures.

Methodology Consistent with Accepted Practice

River hydrology statistics and hourly flow modeling are commonly employed at hydroelectric projects to assess implications of project operations on the river environment.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

Level of effort and cost of model development are expected to be moderate, as much of the baseline modeling has already been completed, but running of various scenarios through the model(s) will be needed throughout the relicensing process to assess the implications of changes to the operations of each project on other projects and other resources. The modeling exercise will also require coordination and cooperation between TransCanada and the downstream licensee to assure that the model inputs and outputs can be accurately related.

We would anticipate that the expected level of effort and anticipated costs will be comparable to those experienced on similar Federal Energy Regulatory relicensing projects of this size (e.g., Conowingo, FERC No. 405).

TransCanada Study Request #2

Instream Flow Habitat Assessment
Downstream of Wilder, Bellows Falls, and Vernon Dams
(Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

The goal of this study is to determine an appropriate flow regime that will protect and enhance the aquatic resources below the Wilder, Bellows Falls, and Vernon projects. Specifically, the objective of this study is to conduct an instream flow habitat study to assess the impacts of the range of proposed project discharges on the wetted area and optimal habitat for key species.

The study should include non-steady flow approaches to assess effects of within-day flow fluctuations due to peaking power operations on target fish species and benthic invertebrate communities. Target species will include, but are not limited to American shad, fallfish, white sucker, yellow perch, smallmouth bass, walleye, and dwarf wedgemussel.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to aquatic resources, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide an instream flow regime that meets the life history requirements of resident and migratory fish and wildlife (including invertebrates such as freshwater mussels) throughout the areas impacted by project operations.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a fish and wildlife resource agency.

Existing Information

The distance from the upstream end of the Wilder impoundment downstream to the Vernon Dam is 120 miles. A total of 97 miles (81 percent) of this segment is impounded. The remaining riverine habitat is within the 17 miles downstream of Wilder Dam and the 6 miles downstream of Bellows Falls. At the scoping meetings, FirstLight also 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. This would suggest that there may be additional riverine habitat for a presently unknown distance below the Vernon Project.

The Wilder, Bellows Falls, and Vernon projects are each operated as daily peaking facilities. Total hydraulic capacity of each facility is 12,700, 11,010, and 12,634 cfs, respectively. Each of the PADs for these projects indicate that "Generation can vary during the course of any day between the required minimum flow and full capacity if higher flows are available" (p. 2-28, p. 2-29, and p. 2-30 in the Wilder, Bellows Falls and Vernon PADs, respectively). Regular daily fluctuations on the order of 9,000 cfs or greater are commonly recorded at USGS gages 01144500 (Connecticut River at West Lebanon, New Hampshire, below Wilder Dam) and 01154500 (Connecticut River at North Walpole, New Hampshire, below Bellows Falls Dam). Required minimum flows are 675, 1,083, and 1,250 cfs (or inflows if less) for each facility, respectively, though in practice minimum flows are operated as 700, 1,300, and 1,600 cfs, respectively. The PADs for these projects do not indicate how these minimum flow requirements were established or what specific ecological resources they are intended to benefit. The Service is not aware of any previously conducted studies that have evaluated the adequacy of this minimum flow in protecting aquatic resources in the 23+ miles of riverine habitat below these projects, nor project effects of daily hydropeaking on riverine habitat. 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, and Vernon projects. Results will be used by the Service to determine an appropriate flow recommendation.

Nexus to Project Operations and Effects

The Wilder, Bellows Falls, and Vernon projects are currently operated with a minimum flow release that was not based on biological criteria or field study. Further, the projects generate power in a peaking mode resulting in substantial within-day flow fluctuations between the minimum and project capacity. The large and rapid changes in flow releases from peaking hydropower dams are known to cause adverse effects on downstream habitat and biota (Cushman 1985; Blinn *et al.* 1995; Freeman *et al.* 2001). There are at least 23 miles of lotic (flowing) habitat below the projects' discharge that are impacted by peaking operations from these projects. This section of the Connecticut River contains habitat that supports native riverine species, including the federally endangered dwarf wedgemussel, and could include spawning and rearing habitat for migratory fish such as American shad. While the existing licenses of the

Wilder, Bellows Falls, and Vernon projects do require a continuous minimum flow of 675, 1,083, and 1,250 cfs, respectively, we do not believe this flow sufficiently protects the aquatic resources, including endangered species, of these river reaches, especially in the context of the magnitude, frequency, and duration of changes in habitat that likely occur due to hydropeaking operations.

Results of the flow study will be used by the Service to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources below the Project.

Methodology Consistent with Accepted Practice

Instream flow habitat assessments are commonly employed in developing operational flow regimes that will reduce the impacts or enhance habitat conditions downstream of hydroelectric projects.

The Service requests a flow study be conducted in the following areas: within an area approximately 17 miles between the Wilder Dam and the headwaters of the Bellows Falls pool, within an area approximately 6 miles between the Bellows Falls Dam and the headwaters of the Vernon pool, and within an area approximately 1.5 miles between 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).

Given the length of river reach (23+ miles) impacted by project operations, we believe a study methodology that utilizes an IFIM approach is appropriate for this context. Similar protocols have been used and accepted by the Federal Energy Regulatory Commission (Commission) in numerous other licensing proceedings.

The study design should involve collecting wetted perimeter, depth, velocity, and substrate data along transects in the deep, straight-channel areas of the specified river reaches mentioned above. Two-dimensional hydraulic modeling should be conducted in the sections of river with more complex features such as islands, braiding, falls, and shallow-water shoals. The measurements should be taken over a range of flows sufficient to model the full extent of the operational flow regime. This 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 identified by the fisheries agencies. 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 quality and location of habitat for target species changes over the range of flows that occur as part of the operational flow regime.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

Field work for instream flow studies can be reasonably 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-field work data analysis would result in a moderate cost and effort.

We anticipate that the level of effort and costs will be comparable to those of other Commission relicensing projects of similar size to these projects.

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Cushman, R.M. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. North American Journal of Fisheries Management 5: 330–339.

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TransCanada Study Request #3

Bellows Falls Bypass Flow
(Bellows Falls, P-1855)

Goals and Objectives

The goal of this study is to determine an appropriate bypass flow that will protect and enhance the aquatic resources of the Bellows Falls bypass reach.

The objective of the study will be to evaluate the relationship between flow and habitat suitability in the bypass reach.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the project.

Specific to aquatic resources within the Bellows Falls bypass reach, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide appropriate flows in the bypass reach that meet the life history requirements of resident fish and wildlife, including freshwater mussels and other benthic invertebrates.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a natural resource agency.

Existing Information

The Bellows Falls Project bypasses a 3,500-foot-long section of the Connecticut River. Presently, this bypass reach only receives flow when inflow exceeds the hydraulic capacity of the Bellow Falls station. According to exceedance curves provided in the PAD, on a monthly basis, the bypass reach receives flow the following amount of time:

Month	**% Time Flow > 11,000 cfs**	**Month**	**% Time Flow >11,000 cfs**
Jan.	15	July	10
Feb.	15	August	8
March	50	Sept.	4
April	90	Oct.	20
May	60	Nov.	35
June	20	Dec.	26

No information exists on the adequacy of the existing bypass flow regime to protect water quality and aquatic life. The bypass reach receives flow less than 30 percent of the time on an annual basis. While TransCanada did conduct a preliminary water quality study in the summer of 2012 that indicated water quality at the bypass reach sample station was not meeting state water quality standards, only a summary of the data is provided in the PAD. It does not indicate where the sonde was located, nor the bypass reach conditions during the study period (e.g., what was the flow into the bypass reach during the study? was the sonde located in the only wetted area of the bypass reach?). Further, the PAD provides no detailed description of the physical or biological characteristics of the bypass reach.

An empirical study is needed to provide information on the relationship between flow and habitat in the bypass reach for the Service to use in determining appropriate flows in the bypass reach.

Nexus to Project Operations and Effects

The project includes a 3,500-foot-long bypass reach. Absent a mandated discharge at the dam, this habitat would remain dewatered during those times when inflow was within the hydraulic capacity of the units (~70 percent of the time on an annual basis). The existing license does not require any flow through the bypass reach. The current situation does not sufficiently protect the aquatic resources inhabiting or potentially inhabiting the bypass reach.

The Connecticut River in the project vicinity is dominated by sections that are impounded, backwatered from downstream impoundments, or otherwise deep and slow-flowing. In contrast, the Bellows Falls bypass channel is very irregular and diverse, consisting of both coarse substrate of various sizes and in the more downstream segment, jagged, irregular ledge. Given an adequate flow regime, the bypass could provide habitat types that are now rare and therefore of great importance.

Results of the flow study will be used by the Service to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources in the bypass reach for the duration of any new license issued by the Federal Energy Regulatory Commission (Commission).

Methodology Consistent with Accepted Practice

The Service requests a bypass flow study be conducted at the project. Bypass flow habitat assessments are commonly employed in developing flow release protocols that will reduce impacts or enhance habitat conditions in reaches of river bypassed by hydroelectric projects.

Given the size of the bypass reach (3,500 feet long) and the rareness of the habitat types it contains in this portion of the Connecticut River, we believe a study methodology that utilizes an IFIM approach is appropriate for this site. This same protocol was used during the relicensing of the Housatonic River Project (FERC No. 2576),[1] and has been accepted by the Commission in other licensing proceedings.[2]

Given the unique channel formation habitat modeling using standard PHABSIM one dimensional modeling may not be sufficient to assess the habitat suitability in the bypass reach, but rather two dimensional, 2D modeling may be needed to better characterize flows and velocities in this reach. We recommend that the approach to habitat modeling be determined during the study plan development stage based on consultations between the Applicant and the resource agencies.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

Field work for flow studies can be reasonably 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. Post-field work data analysis would result in moderate cost and effort. Field work associated with this study could be done in conjunction with the Instream Flow Study Request. We anticipate that the level of effort and costs will be comparable to those experienced on similar Commission relicensing projects (e.g., the Glendale Project, FERC No. 2801).

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

2 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, pp. 7-8, October 2007.

TransCanada Study Request #4

Impact of the Operations of the Turners Falls, Northfield Mountain Pumped Storage, Vernon and Bellows Falls Projects on Shad Spawning, Spawning Habitat, and Egg Deposition

(Turners Falls, P-1889; Northfield Mountain, P-2485; Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Conduct a field study of spawning by American shad in the Connecticut River mainstem downstream of Turners Falls Dam, in the Turners Falls Dam impoundment, in the Vernon Dam Project area, and downstream of Bellows Falls Dam to determine if project operations (including operations of the Northfield Mountain Pump Storage) (NMPS) negatively impact shad spawning behavior, spawning habitat use, areal extent and quality of those spawning areas, and spawning activity in terms of egg deposition in those areas.

Goals and Objectives

Determine if project operations (under the permitted and proposed operational ranges) affect American shad spawning site use and availability, spawning habitat quantity and quality, and spawning activity in the river reaches downstream from Cabot Station and in the project bypass reach of Turners Falls Dam, in the Turners Falls Dam impoundment, and in relation to NMPS operations, downstream and upstream of the Vernon Dam, and in the project area downstream of Bellows Falls Dam. The following objectives will address this request:

1. determine areas utilized by American shad for spawning by conducting nighttime visual observation of spawning activity, identify and define areas geospatially, and obtain data on physical habitat conditions affected by project operations (e.g., water depth, velocity, discharge, substrate, exposure and inundation of habitats);
2. determine project operation effects on observed spawning activity, under a range of permitted or proposed project operation conditions;
3. quantify effects (e.g., water velocity, depths, inundation, exposure of habitats) of project operation on identified spawning areas for a range of conditions, over the complete period of spawning activity; and
4. quantify spawning activity as measured by nighttime spawning/splash surveys and egg collection in areas of spawning activity, and downstream of these areas, to further determine project operation effects (location and extent of exposure from changing water levels and flows).

If it is determined that the project operations are adversely affecting the spawning activity of American shad and impacting spawning habitat, identify operational regimes that will reduce and minimize impacts to spawning habitat and spawning success. This study will require two years of field data to capture inter-annual variability to river discharge and water temperatures and to allow for evaluation of alternative flow regimes if year one studies determine that the present peaking regime negatively affects spawning.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Achieve annual passage of 4 percent to 60 percent of the spawning run (based on a five-year running average) at each successive upstream barrier on the Connecticut River mainstem.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, includes the following objective:

Maximize the number of juvenile recruits emigrating from freshwater stock complexes:

1. to mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting instream flows;
2. natural river discharge should be taken into account when instream flow alterations are being made to a river (flow regulation) because river flow plays an important role in the migration of diadromous fish;
3. ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account instream flow needs for American shad migration, spawning, and nursery use, and minimize deviation from natural flow regimes; and
4. when considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations to enhance river habitat.

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to American shad, the Service's goal is:

Minimize current and potential negative project operation effects on American shad spawning and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), the Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794), the Federal Power Act (16 U.S.C. §791a, *et seq.*), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Public Interest

The requestor is a resource agency.

Existing Information

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764, and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad population, and numbers of shad passing Turners Falls and Vernon Dam have not met CRASC management plan objectives. Population number and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers over the last 10 years of 211,850. Since historically approximately half of the returning population of shad to the river passed upstream of Holyoke, recent returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

American shad broadcast spawn in congregations over shallow flats and rocky or sandy substrates (Mansuetti and Kolb 1953) at depths less than 10 feet and often far shallower with spawning fish swimming vigorously near the surface in a closely packed circle (Marcy 1972; MacKenzie *et al.* 1985). Fertilized eggs drift downstream until hatching (MacKenzie *et al.* 1985).

American shad are known to spawn downstream from the Turners Falls Project. Layzer (1974) identified six spawning sites from an area below the mouth of the Deerfield River (river mile 191.9) to river mile 161.7 below the Mill River in Hatfield, Massachusetts. Kuzmeskus (1977) verified 16 different spawning sites ranging from downstream of the Cabot tailrace to just upstream of the Holyoke Dam (river mile 87.1). The only parameter that all spawning sites had in common was current (Kuzmeskus 1977). The Service is not aware of any more recent studies that document whether these 16 sites are still viable spawning locations for shad. We are not aware of any studies that have determined American shad spawning habitat or spawning sites upstream of Vernon Dam to Bellows Fall Dam (historic extent of upstream range).

FirstLight Power conducted studies in the late spring and summer of 2012, and examined habitat conditions downstream of the Turners Falls Dam. The study documented that in low flow conditions, Cabot Station project operations produced fluctuations in water level elevations that

can range over 4 feet in magnitude (daily operation) at the USGS Montague Gage Station, to lower values of 2 to 3 feet at the Route 116 Bridge, Sunderland, Massachusetts (PAD). Similar short-term, limited monitoring in the upper Turners Falls Dam impoundment identified water level changes due to project operations that cyclically varied several feet on a sub-daily frequency.

Nexus to Project Operations and Effects

American shad are known to spawn at five locations downstream from the Turners Falls Project from an area below the mouth of the Deerfield River (river mile 191.9) and ten other locations downstream to river mile 161.7 below the Mill River in Hatfield (Layzer 1974; Kuzmeskus 1977).

Shad spawning is likely influenced by river flow, which fluctuates greatly due to the project's peaking mode of operation. These fluctuations may impact shad spawning activity by altering current velocities and water depth at the spawning sites. Effects on spawning behavior could include suspension of spawning activity, poor fertilization, flushing of eggs into unsuitable habitat due to higher peaking discharges, eggs dropping out into unsuitable substrate and being covered by sediment deposition, and/or eggs becoming stranded on dewatered shoal areas as peak flows subside.

While a number of shad spawning and egg deposition studies were conducted in the 1970s, that research was aimed at assessing the potential impact of developing a nuclear power station in the Montague Plains section of the Connecticut River. The Service is not aware of any studies being conducted to assess the relationship between spawning behavior, habitat use and egg deposition, and operations of the Turners Falls, NMPS, Vernon and Bellows Falls projects.

The Service is concerned that peaking operations may be altering spawning behavior and contributing to the failure of the Connecticut River shad population to meet management targets.

Methodology Consistent with Accepted Practice

The first year of study should examine known spawning areas downstream of the Turners Falls Dam project, to determine operation effects on shad spawning behavior, activity, and success. In areas upstream of Turners Falls Dam to the Bellow Falls Dam tailrace, the study should identify areas utilized for spawning by American shad. In the second year, should results from year one determine project operations affected spawning activity, access to habitat, or success downstream of Turners Falls Dam, an identical more detailed assessment (identified objectives) should be conducted in spawning areas upstream of Turners Falls Dam to the Bellows Falls Dam tailwater. Measures to reduce or eliminate any documented project operation impacts should be explored and evaluated in year two downstream of Turners Falls Dam.

The impacts to spawning behavior would best be studied by nighttime observations of actual in-river spawning behavior (Ross *et al.* 1993). Project discharge increases or decreases during actual observed spawning activity will provide empirical evidence of change in behaviors. The observational methodology should follow the protocol specified in Layzer (1974) and/or as described in Ross *et al.* (1993). The analysis should utilize the observational field data in

conjunction with operational data from the projects (station generation and spill on a sub-hourly basis). To assess the impacts of changes in generation flows, the study should include scheduled changes in project operation to ensure that routine generation changes that occur during the nighttime spawning period affect downstream spawning habitats selected for study while shad are spawning. Stier and Crance (1985) provide optimal water velocities during spawning to range between 1 to 3 ft/sec.

In areas used for spawning, the characteristics of those areas (e.g., location, depth, flow, substrate) should be recorded. The effect of project operations (discharge, water velocity, inundation and exposure) should be assessed. Drift nets will be used to collect eggs to quantify egg production before and after flow changes at the spawning site.

In the reaches above the Turners Falls Dam, nighttime observations of splashing associated with shad spawning should be done in each reach as sufficient numbers of shad are passed above each dam. Observations should be done regularly until the end of the spawning season. The use of radio-tagged adult shad from a separate study request will aid in this effort. An estimate of the total area used for spawning and an index of spawning activity should be recorded for each site.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

Neither FirstLight nor TransCanada propose any studies to meet this need. Estimated cost for the study is expected to be moderate (up to $40,000) for each owner, with the majority of costs associated with field work labor.

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TransCanada Study Request #5

Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival

(Turners Falls, P-1889; Northfield Mountain, P-2485; Bellows Falls, P-1855; Vernon, P-1904)

Goals and Objectives

Assess behavior, approach routes, passage success, survival, and delay by adult American shad as they encounter the projects during both upstream and downstream migrations, under permitted project operations conditions, proposed operational conditions, and study treatment operational conditions at FirstLight Power's Turners Falls and Northfield Mountain Pumped Storage (NMPS) projects and TransCanada's Vernon Project. There are multiple fishways and issues related to both upstream and downstream passage success at the projects. Some of these issues at the Turners Falls Project are similar to and/or pertain directly to the NMPS and Vernon projects. Therefore, it is reasonable to address passage issues at all projects in a similar manner.

Telemetry Study - This requested study requires use of radio telemetry using both radio and Passive Integrated Transponder (PIT) tag types to provide information to address multiple upstream and downstream fish passage issues. The following objectives shall be addressed in these studies:

1. assessment of any migration delays resulting from the presence of the dam and peaking flow operations of the Turners Falls Project;
2. determine route selection and behavior of upstream migrating shad at the Turners Falls Project under various spill flow levels (e.g., movement to the dam, attraction to Cabot Station, attraction to Station 1 discharge, movement between locations, delay, timing, etc.). A plan and schedule for dam spill flow releases will need to be developed that provides sufficient periods of spill flow conditions, and various generating levels from Turners Falls #1 Station coupled with Cabot Station generation flows (e.g., treatments will require multiple days of consistent discharge). Evaluated spill flows should include flows between 2,500–6,300 cfs, which relate to bypass flows identified as providing spawning opportunities for shortnose sturgeon in the lower bypass reach at the Rock Dam (Kieffer and Kynard 2012). Sturgeon spawning and upstream shad passage occur concurrently;
3. assess near field, attraction to and entrance efficiency of the spillway ladder by shad reaching the dam spillway, under a range of spill conditions;
4. evaluate the internal efficiency of the Turners Falls spillway ladder;
5. continue data collection of Cabot Station ladder and gatehouse ladder efficiency, to include rates of approach to fishway entrances, entry into fishways, and passage through them, under different operational conditions that occur in these areas;
6. evaluate modifications to the Cabot Station and/or spillway fishways recommended by the U.S. Fish and Wildlife Service (Service) if they are implemented;

7. assess upstream migration from Turners Falls to the Vernon Dam in relation to NMPS's pumping and generating operations and Vernon Project peaking generation operations. Typical existing and proposed project operation alterations should be evaluated;
8. assess near field, attraction to and entrance efficiency of the Vernon Dam ladder;
9. assess internal efficiency of the Vernon Dam ladder;
10. assess upstream passage past Vermont Yankee's thermal discharge (also located on the west bank of the river 0.45 mile upstream of fish ladder exit);
11. assess upstream migration from Vernon Dam in relation to the peaking generation operations of the Bellows Falls Project. Typical existing and proposed project operation alterations should be evaluated;
12. determine post-spawn downstream migration route selection, passage efficiency, delays and survival related to the Vernon Project, including evaluation of the impact of the Vermont Yankee heated water discharge plume on downstream passage route, migrant delay/timing, efficiency and survival;
13. assess impacts of NMPS operations on up- and downstream adult shad migration, including delays, entrainment, and behavioral changes and migration direction shifts under existing and proposed project operations;
14. determine downstream passage route selection, timing/delay, and survival under varied project operational flows into the power canal and spill flows at Turners Falls Dam;
15. determine downstream passage route selection, timing/delay in the canal, Cabot Station fish bypass facility effectiveness, and survival of Cabot Station-bypassed adult shad that enter the Turners Falls canal system;
16. compare rates and or measures of delay, movement and survival, etc., among project areas or routes utilized (e.g., spill at dam vs. power canal) under the range of permitted and proposed conditions; and
17. utilize available data sets and further analyze raw data (e.g., 2003-2012 U.S. Geological Survey's Conte Anadromous Fish Research Center [Conte Lab] studies) where possible to address these questions and inform power analyses and experimental design.

Information to address all of these questions would rely on the tagging of upstream migrating adult shad at Holyoke Dam and releasing them to migrate naturally from Holyoke through the Turners Falls and Vernon projects and back downstream after spawning. Additional tagged individuals would likely need to be released farther upstream (Turners Falls canal, upstream of Turners Falls Dam, and upstream of Vernon Dam) to ensure that enough tagged individuals encounter project dams on both upstream and downstream migrations, that these individuals are exposed to a sufficient range of turbine and operational conditions to test for project effects, and to provide adequate sample sizes for statistically valid data analyses to address the many objectives listed. This study will require two years of field data collection to attempt to account for inter-annual variability in river discharge and water temperatures.

Evaluation of Past Study Data - In addition to collection and analysis of new telemetry data, substantial data has already been collected at Turners Falls from multiple years of passage assessments conducted for FirstLight by Conte Lab researchers, and there are also data from the 2011 and 2012 full river study conducted by the Conte Lab that address Turners Falls, NMPS and Vernon project migration and passage questions that have not yet been analyzed. These data include several million records each year from more than 30 radio telemetry receivers deployed

between Middletown, Connecticut and Vernon Dam. This data will provide substantial information free from the field data collection costs and therefore should be analyzed as part of this study. This data analysis should be completed in 2013 to help inform the design of subsequent field studies.

Evaluation of Methods to Get Shad Past Cabot Station for Spillway Passage at the Turners Falls Dam – The poor passage efficiency of the Cabot Station ladder, the first and most used fishway encountered by shad arriving at the Turners Falls Project, and at the entrance to the gatehouse ladder, which all Cabot Station fishway-passed fish must use, has resulted in very poor overall shad passage efficiency at the project. An alternative to passing fish at the Cabot Station is to install a fish lift at the dam that would put fish directly into the Turners Falls pool, thereby eliminating problems with the Cabot Station fishways, and the gatehouse fishway entrance and the variable passage efficiency of the gatehouse fishways. For this to be effective, attraction of shad to the Cabot Station discharge and associated delays would need to be overcome. It is possible that spillway flow releases coupled with behavioral measures at Cabot Station that dissuade shad from that tailrace could achieve this end. In order to assess the possibilities, we recommend the following study:

1. A literature search and desk-top assessment of the possible behavioral measures that could be effective in getting shad to pass Cabot Station tailrace and continue upstream to the dam.
2. Based on results of the desk-top assessment, possible evaluation of behavioral measures that are likely to be effective.
3. Field evaluation of the effect of different levels of spill at the dam that would induce fish to move past the Cabot Station into the bypass reach and up to the dam (as noted in Goals and Objectives).

In addition to passage success and delays at passage facilities, these studies would assess the impacts of project operations on migration passage delay, route, timing, injury, mortality, and passage structure attraction, retention, and success. Of particular interest will be fish behavior: during periods when project flow releases increase from the required minimum to peak generation flows, when they subside from peak generation to minimum flows, and in response to the operation of NMPS in pumping and generation modes.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually;
2. achieve annual passage of 40 to 60 percent of the spawning run (based on a five-year running average) at each successive upstream barrier on the Connecticut River mainstem; and
3. maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, includes the following objective:

Maximize the number of juvenile recruits emigrating from freshwater stock complexes:

Upstream Passage –

1. American shad must be able to locate, enter, and pass the passage facility with little effort and without stress.
2. Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.
3. Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Downstream Passage –

To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines,, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the least delay and best survival rate.

Based on the CRASC plan, the Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to American shad movement and migration, the Service's goal is:

Minimize current and potential negative project operation effects such as migration delays, false attraction, turbine entrainment, survival of project passage routes, and trashrack impingement that could hinder management goals and objectives.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), the Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794), the Federal Power Act (16 U.S.C. §791a, *et seq.*), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Public Interest

The requestor is a federal natural resource agency. Migratory species of fish are a trust resource for the Service due to their interjurisdictional movements. Protection and restoration of these fish is a key objective for the Service.

Existing Information

Passage of adult shad at the Turners Falls fishway complex has been the subject of intense study by the Conte Lab since before 1999. These studies have clearly demonstrated that passage through the existing fishways at the Cabot Station and spillway is poor (<10 percent in many years). Passage through the gatehouse fishway is better, but still rarely exceeds 80 percent, despite the short length of this ladder. In addition to poor passage for fish entering the ladders, shad that ascend the Cabot Station fishway experience extensive delays before entry into the gatehouse fishway. Shad that ascend spillway frequently fall back into the canal and are also subject to these upstream delays. A new entrance to the gatehouse fishway installed in 2007 led to dramatic improvements in passage out of the canal (from 5 percent to over 50 percent in 2011), but passage still falls well short of management goals. In addition, shad spend considerable time (up to several weeks) attempting to pass. These delays likely influence spawning success and survival. Adult shad, unable to pass the gatehouse fishway, experience similar delays in downstream passage, even after they have stopped trying to pass the gatehouse fishway. In addition, if there is no spill, all outmigrating shad that have passed upstream must enter the power canal and may be subject to delays exiting the canal.

During the course of these studies, a very large dataset has been compiled that could yield useful information for further improving passage of shad out of the canal in both the upstream and downstream directions. A unique feature of these data is a two-dimensional array covering the canal just downstream of the gatehouse fishway, documenting fine scale movements and occupancy of this zone. These data should be combined with computational fluid dynamics (CFD) and real-time hydraulic data to determine how canal hydraulics influence the ability of shad to locate and enter the fishway, and to identify modifications that are likely to lead to improvements in approach and entry rates. A separate CFD modeling study is requested that includes modeling of the gatehouse fishway entrance area at the head of the power canal.

In addition, whole-river shad telemetry studies performed in 2011 and 2012 will likely provide useful information and should be analyzed. These data should allow quantification of delay below Turners Falls, and could help guide studies requested above. Preliminary analyses of data through 2011 have been made available to FirstLight and the resource agencies (Castro-Santos and Haro 2005; Castro-Santos and Haro 2010).

The whole-river studies have also shown that, at least in 2011, most shad that pass Turners Falls rapidly progress upstream to Vernon Dam where extensive delays also occur. Data from the 2012 study are not available at this time, but Dr. Castro-Santos stated that similar patterns in upstream passage delay were noted in the data from both years (Dr. Theodore Castro-Santos, Conte Lab, personal communication). There are similar concerns relative to downstream passage

delays of spent shad, with existing unpublished telemetry data sets suggesting this is an issue within the Turners Falls canal.

Since the first year of operation of the Turners Falls upstream fishways (1980), an average of only 3.6 percent of American shad that passed upstream of the Holyoke Dam have successfully passed the Turners Falls Dam. The highest values for this metric has not exceed 11 percent, and are well below the noted CRASC Management Plan target range for this objective, noted earlier as 40-60 percent on a five-year running average.

Since the first year of operation of the Vernon Dam upstream fish ladder (1981), the percent passage of American shad annually passed at the Vernon Project compared to the number passed upstream of Turners Falls Dam (gatehouse counts) has averaged 39.4 percent, ranging from 0.42 percent to 116.4 percent (>100 percent due to a counting error at one or both facilities, unknown).

Nexus to Project Operations and Effects

Existing project operations (peaking power generation) and limited bypass flows have a direct impact on instream flow and zones of passage (migration corridors). Project flow releases affect passage route selection, entry into fishways, and create delays to upstream migration. Inefficient downstream bypasses can result in migration delays and increased turbine passage. Mortality of adult shad passing through these turbines is expected to be high (Bell and Kynard 1985). In addition, stresses associated with passage and delay may cause mortality as shad are unable to return to salt water in a timely manner. The project's upstream and downstream passage facilities need to be designed and operated to provide timely and effective upstream and downstream fish passage to meet restoration goals of passage to upstream habitat and maximize post-spawn survival. These factors are all critically important to the success of restoration efforts.

Methodology Consistent with Accepted Practice

Use of radio, including passive-integrated transponder (PIT) telemetry, is widely accepted as the best method to assess fish migratory behavior and passage success, and has been used extensively to assess migration and passage issues at Turners Falls, as well as other Connecticut River projects. These studies include one conducted in 2011 and 2012 by the Service and the Conte Lab, which has provided substantial information related to some of the issues identified here. The requested study will build and expand on the information collected over the past two years.

The study design must specify sample sizes, tag configurations and receiver configurations, to ensure that rates of entry and exit to the tailraces, fishways, downstream bypasses, and the bypassed reach can be calculated with sufficient precision to determine effectiveness of flow and ensonification treatments (separate study request). For project assessments at Turners Falls (e.g., Cabot Station, spillway and gatehouse ladder attraction and entry, route selection, operational effects), double-tagged (radio and PIT) shad will be required for release from Holyoke Dam. Additional shad must be released directly into the Turners Falls canal to adequately assess the

various project generation and fish passage operational and structural conditions likely to be encountered by shad.

A related request on CFD modeling in the Cabot Station tailrace, the upper power canal near the gatehouse fishway, and in the area around the entrance of the spillway ladder, will address related project operational effects that will also address identified objectives in this telemetry request. Shad captured at the Holyoke Project and tagged and released upstream of Turners Falls Dam, or tagged out of the gatehouse ladder, would help to ensure an adequate sample size to evaluate the impacts of the NMPS and Vernon projects on passage and delay.

Additional tagged shad are expected to be required for release upstream of the Vernon Dam to ensure adequate sample size to assess where shad spawn upstream of Vernon Dam (see separate study request), as well as to ensure that there is an adequate number of outmigrating spent adults to address downstream passage questions.

Existing information on captured, handled, tagged fish performance (e.g., percent that drop back, unsuitable for tracking) and factors such as timing of tagging and potentially transport, must all be carefully considered to ensure an adequate sample size of healthy (e.g., viable to characterize behavior, survival, etc.) tagged fish is available to address the many questions identified in this request (as supported by a statistical power analysis). Additionally, it will be important to ensure that an adequate number of tagged shad are available to address the downstream passage questions above, as expected losses of healthy tagged fish during upstream passage, natural mortality rates, and due to tagging-related effects are expected to reduce fish available for these assessments. The use of single PIT-tagged fish can help improve sample sizes, but will be of limited use to answer some of the passage questions we have identified.

Due to environmental variability, two years of study work will be necessary. A large array of stationary monitoring stations (radio and PIT) will be needed to address the issues identified among the project areas. A sufficient level of radio receiver and PIT reader coverage will be required, to provide an appropriate level of resolution, for data analyses, to answer these questions on project operational effects. The study will provide information on a variety of structural and operational aspects of fish migration, relative to route selection, timing, survival, and up- and downstream passage attraction, retention, delay, efficiency, survival as some examples at three projects (Turners Falls, NMPS, and Vernon). The use of video monitoring may also be utilized for specific study areas such as the spillway ladder to provide additional information on shad entrance activity, with the understanding of some data limitations associated with this approach (fish identification, water visibility).

In addition to the tagging studies, use of video monitoring of the spillway fishway would provide additional overall data on its efficiency as all shad attempting to pass could be monitored versus just those shad that have been tagged.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

The requested study is extensive and will require a substantial effort and cost to capture, PIT tag, and radio tag a sufficient number of shad at the Holyoke Project to release at upstream locations. We are not aware of any other study technique that would provide project-specific fish behavior and migration information to adequately assess existing project operations and provide insight in possible alternative operations and measures needed to address observed negative impacts to fish migration success. Cost for the entire multi-project tagging, tracking and data analysis are expected to range from $400,000 to $500,000, based on past Turners Falls studies and the 2011 and 2012 shad telemetry studies. Video monitoring of the spillway fishway would add a modest cost to this study.

Due to the fact that tagged shad will move throughout the larger five project area, to varying degrees, there will be expected cost savings (e.g., radio tags) to both owner/operators, provided cooperation in study planning and implementation occurs.

REFERENCES

Atlantic States Marine Fisheries Commission. 2010. Amendment #3 to the interstate fishery management plan for shad and river herring (American shad management). Washington, D.C.

Bell, C. E. and B. Kynard. 1985. Mortality of adult American shad passing through a 17-megawatt Kaplan turbine at a low-head hydro-electric dam. North American Journal of Fisheries Management, 5:33-38.

Castro-Santos, T. and A. Haro. 2005. Turners Falls fish passage studies 2005: results from PIT and radio telemetry studies. CAFRC Internal Report # 2005-04.

Castro-Santos, T. and A. Haro. 2010. Gatehouse fishway telemetry studies: progress report, 2008-2010. USGS CAFRC Internal Report.

Kieffer, M. and B. Kynard. 2012. Spawning and non-spawning migrations, spawning, and effects of river regulation on spawning success of Connecticut River shortnose sturgeon. In Life history and behavior of Connecticut River shortnose sturgeon and other sturgeons. B. Kynard, P. Bronzi and H. Rosenthal Editors. World Sturgeon Conservation Society: Special Publication #4. Norderstedt, Germany.

TransCanada Study Request #6

Impact of Vernon Project Operations on Downstream Migration of Juvenile American Shad

(Vernon, P-1904)

Conduct a field study of juvenile American shad outmigration at the Vernon Dam to determine if project operations negatively impact juvenile shad survival and production.

Goals and Objectives

Determine if project operations affect juvenile American shad outmigration survival, recruitment, and production. The following objectives will address this request:

1. assess project operation effects of Vernon Dam on the timing, routes, migration rates, and survival of juvenile shad;
2. determine the proportion of juvenile shad that, as a downstream passage route, choose or are directed to existing downstream bypass structures, gate structures, or are entrained into the station turbines, and assess delay, survival, timing, and related impacts with these locations under a full range of operational conditions over the period of outmigration; and
3. determine survival rates for juvenile shad entrained into Vernon Station units.

If it is determined that the project operations or related effects are adversely affecting juvenile shad survival, migration timing, or other deleterious population effects are noted, identify operational solutions or other solutions that will reduce and minimize impacts, within the project affected area. This study will require two years of field data to capture inter-annual variability of river discharge, water temperature, and variability in run size and juvenile production (and timing of developmental stages) and variability in outmigration timing which may relate to spring, summer and fall conditions.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASM) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, includes the following objective:

Maximize the number of juvenile recruits emigrating from freshwater stock complexes.

The U. S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the project.

Specific to American shad, the Service's goal is:

Minimize current and potential negative project operation effects on juvenile American shad survival, production, and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a resource agency.

Existing Information

Adult shad are counted annually as they pass above the Vernon Dam. Juvenile American shad production has been monitored upstream of the Vernon Dam and immediately downstream of that dam by Vermont Yankee Nuclear as part of an annual monitoring program using both boat electrofishing (since 1991) and beach seining (since 2000). A seasonal average annual index of juvenile American shad standing crop in the Vernon reservoir has been calculated since 2000. Estimates of juvenile shad growth rates in the Vernon impoundment have been calculated annually beginning in 2004, and also in a study conducted in 1995 (Smith and Downey 1995).

Numerous studies of the effectiveness of downstream passage facilities at the Vernon Project have been conducted for Atlantic salmon smolts. Studies of American shad passage were limited to tests in 1991 and 1992 of a high frequency sound field to guide fish to the fish pipe, the primary downstream fishways in 1991 and 1992 (RMC Environmental Services, Inc. 1993) and an attempt to determine passage route of juvenile shad using hydroacoustics in 2010 following the replacement of units 5 through 8.

Although the high frequency sound studies were deemed incomplete, the technology indicated some level of response by juvenile shad. However, despite that conclusion, there is no indication that this technology or other downstream passage studies with juvenile shad were subsequently pursued.

The hydroacoustic assessment of passage route was conducted to fulfill a requirement of the 2006 license amendment that authorized the unit replacements to assess downstream passage effectiveness for juvenile shad. The hydroacoustic study was deemed unsuccessful, but no follow-up assessment was made, due to the limited viable assessment tools available at that time. However, new, very small radio tags make assessment of juvenile shad passage now achievable.

Nexus to Project Operations and Effects

Juvenile American shad production occurs in the river reach between the Vernon Dam and the Bellows Falls Dam, which is thought to be the historic upstream limit of the shad migration in the Connecticut River. Juvenile American shad require safe and timely downstream passage measures to have the opportunity to contribute to the restoration target population size.

There is little information available regarding the total impact of the Vernon Project on downstream migration of juvenile shad. Migration delays, increased predation, mortality during passage over the dam or through turbines, and changes in route selection under different flow conditions are potential influences of the Vernon Dam on the juvenile shad population in the upper Connecticut River. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management restoration goals for the Connecticut River, particularly in the upstream reaches. Delays in juvenile American shad outmigration may affect survival rates in the transition to the marine environment (Zydlewski *et al.* 2003).

Methodology Consistent with Accepted Practice

The impact to juvenile shad outmigrants would be best studied by a combination of approaches, including hydroacoustics, radio telemetry (including passive integrated transponder [PIT] telemetry), and turbine balloon tags. Project discharge adjustments at the dam should be examined relative to timing, duration, and magnitude of juvenile shad migration to and through the dam, with hydroacoustic equipment for natural/wild fish information. In addition, study fish should be collected and tagged (PIT, radio, balloon) to then empirically determine rates of survival for fish passed through the project under varied operations, from minimum flows up to full spill conditions. The release of tagged fish (radio, PIT) at a number of potential sites will provide data on delay and route selection as juvenile shad move through the Vernon project area. The number and location of release sites will depend on the availability of tagged fish.

Additional hydroacoustic assessment immediately upstream and downstream of the Vernon Dam will provide information on the timing of migration to and through this area. A more focused survival study, using balloon tags, PIT tags, or other appropriate methods, should be conducted in the second year based upon the first year of study findings relative to the frequency, magnitude, timing, and route selection of juvenile American shad through the Vernon Project.

Level of Effort/Cost, and Why Alternative Studies will not suffice

TransCanada does not propose any studies to meet this need. Estimated cost for the study is expected to be up to $150,000, with the majority of costs associated with equipment (hydroacoustic gear, radio tags, radio receivers, and PIT readers) and related field work labor.

REFERENCES

RMC Environmental Services, Inc. 1993. Effect of ensonification on juvenile American shad movement and behavior at Vernon Hydroelectric Station, 1992 – Draft Report, March 1993.

Smith, R. L. and P. C. Downey. 1995. Vermont Yankee/Connecticut River System Analytical Bulletin 69: Relative density and growth of juvenile American shad in the Connecticut River near Vernon, Vermont, 1995.

Zydlewski, J., S. D. McCormick and J. G. Kunkel. 2003. Late migration and seawater entry is physiological disadvantageous for American shad juveniles. Journal of Fish Biology #63, 1521-1537.

TransCanada Study Request #7

Shad Population Model for the Connecticut River

(Turners Falls, P-1889; Northfield Mountain, P-2485;
Bellows Falls, P-1855; Vernon, P-1904)

Develop an American shad annual step, mathematical simulation population model for the Connecticut River to quantify how project operations and potential restoration/mitigation measures impact the population of shad in the Connecticut River.

Goals and Objectives

The goal of the model is to assess impacts of both upstream and downstream passage at each of the Connecticut River projects and potential management options for increasing returns to the river.

Specific objectives include:

1. annual projections of returns to the Connecticut River;
2. a deterministic and stochastic option for model runs;
3. life history inputs of Connecticut River shad;
4. understanding the effect of upstream and downstream passage delay at projects;
5. calibration of the model with existing data;
6. analysis of the sensitivity of model inputs;
7. analysis of sensitivity to different levels of up- and downstream passage efficiencies at all projects; and
8. multiple output formats including a spreadsheet with yearly outputs for each input and output parameter.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Achieve annual passage of 40 to 60 percent of the spawning run (based on a five-year running average) at each successive upstream barrier on the Connecticut River mainstem.
3. Maximize outmigrant survival for juvenile and spent adult shad.

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to American shad, the Service's goal is:

Minimize current and potential negative project operation effects on American shad spawning and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a natural resource agency.

Existing Information

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad populations, and numbers of shad passing Holyoke, Turners Falls and Vernon Dam have not met CRASC management goals.

Population and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers since 2000 of 229,876. Whole river population estimates have shown that approximately half of the returning population of shad pass upstream of Holyoke. Recent returns to Holyoke are far below management goals. Average passage efficiency of shad at Turners Falls (gatehouse counts) and Vernon since 2000 has been 3.1 and 20.4 percent, respectively. These too are well below the CRASC management goals.

Safe, timely and effective up- and downstream passage, along with successful spawning and juvenile production, are necessary to help achieve shad management goals for the Connecticut River.

Nexus to Project Operations and Effects

Existing project operations and fish ladder efficiencies have a direct effect on shad populations in the Connecticut River. Poor upstream passage efficiencies and delays restrict river access to returning shad. Fish unable to reach upriver spawning grounds may not spawn or have reduced

fitness or survival of young. Poor downstream passage survival and downstream passage delays affect outmigration and consequently repeat spawning, an important ecological aspect of the iteroparous Connecticut River shad population (Limberg *et al.* 2003).

The Service is concerned that poor passage efficiencies and delays at projects may be limiting access to upstream reaches of the river, altering spawning behavior, decreasing outmigration survival and contributing to the failure of the Connecticut River shad population to meet management targets (Castro-Santos and Letcher 2010).

Development of a population model will allow an assessment of individual project impacts on the population as well as the cumulative impacts of multiple projects. The model will allow managers to direct their efforts in the most efficient manner toward remedying the conditions that most impact the shad population.

Methodology Consistent with Accepted Practice

Population models are commonly used to assess anthropomorphic and natural impacts and are consistent with accepted practice. A model similar to this request was constructed for the Susquehanna River by Exelon (FERC No. 405). The model is constructed in Microsoft Access.

Specific parameters that would be included in the model:

1. upstream passage efficiency at Holyoke, Turners Falls (Cabot, gatehouse and spillway
2. ladders), Vernon fishways, and any impacts associated with Northfield Mountain Pumped Storage;
3. distribution of shad approaching the Turners Falls Project between the Cabot ladder and the spillway at the dam;
4. downstream passage efficiencies at Vernon, Northfield Mountain Pumped Storage, Turners Falls, and Holyoke projects for juveniles and adults;
5. entrainment at Mount Tom Power Plant and Vermont Yankee Nuclear Power Plant;
6. sex ratio of returning adults;
7. the proportion of virgin female adults returning at 4, 5, 6, and 7 years;
8. the proportion of repeat spawning females at 5, 6 and 7 years;
9. spawning success of females in each reach;
10. fecundity;
11. percent egg deposition;
12. fertilization success;
13. larval and juvenile in-river survival;
14. calibration factor to account for unknown parameters such as at sea survival;
15. options for fry stocking and trucking as enhancement measures;
16. start year and model run years;
17. start population;
18. rates of movement to and between barriers; and
19. temperature, river discharge, and other variables of influence to migration and other life history events.

The model should be adaptable to allow the input of new data and other inputs.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

Neither FirstLight nor TransCanada have proposed any study to meet this need. Estimated cost for the study is expected to be low to moderate. As the model describes the impacts of multiple projects and two owners, both project owners would share the cost of model development.

REFERENCES

CRASC (Connecticut River Atlantic Salmon Commission). 1992. A management plan for American shad in the Connecticut River basin. Sunderland, MA.

Castro-Santos, T. and B. H. Letcher. 2010. Modeling migratory bioenergetics of Connecticut River American shad (*Alosa sapidissima*): implications for the conservation of an iteroparous anadromous fish. Can.J.Fish.Aquat.Sci. 67: 806-830.

Limberg, K. E., K. A. Hattala and A. Kahne. 2003. American shad in its native range. Pages 125-140 in K. E. Limberg and J. R. Waldman, editors. Biodiversity, status and conservation of the world's shads. American Fisheries Society, Symposium 35, Bethesda, Maryland.

TransCanada Study Request #8

American Eel Survey
Upstream of the Vernon, Bellows Falls, and Wilder Dams
(Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

The goal of this study is to provide baseline data relative to the presence of American eel upstream of the Vernon, Bellows Falls, and Wilder dams.

The objective of the study is to determine the relative abundance and distribution of American eel upstream of the Vernon, Bellows Falls and Wilder dams in both riverine and lacustrine habitat.

Resource Management Goals

The Atlantic States Marine Fisheries Commission (ASMFC) has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watersheds where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel, and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the Federal Energy Regulatory Commission (Commission) relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. protect and enhance eel populations where they currently exist;
2. where practical, restore populations to waters where they had historical abundance;
3. provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and

4. comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to American eels, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Understand the baseline condition with respect to the presence of American eel within and upstream of the project areas.
3. Minimize current and potential negative project operation effects on American eel inhabiting the project areas and/or moving through the areas during upstream and downstream migrations.

The American eel (*Anguilla rostrata*) is also listed as one of both New Hampshire's and Vermont's Species of Greatest Conservation Need (SGCN). The status for conservation need in Vermont is listed as high priority (Kart *et al.* 2005), and the species is listed as "vulnerable" in New Hampshire. As identified in Vermont's Wildlife Action Plan (Kart *et al.* 2005), threats to the species include the construction of large dams on rivers which obstruct juvenile fish access to critical rearing habitats, as well as mortality associated with passing through hydroelectric facilities' turbines during their outmigration to sea.

As outlined in Vermont's Wildlife Action Plan (Kart *et al.* 2005), research and monitoring needs for this SGCN include determining their distribution and abundance, as the contribution of eels in northern regions to overall stock is unknown. One of the conservation strategies for this species is to support efforts to enhance access of American eels to Vermont waters by eliminating or minimizing impacts of dams and other obstructions along the Richelieu, St. Lawrence, and Connecticut rivers.

Our study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requester is a natural resource agency.

Background and Existing Information

According to the PAD, very few American eels were collected in the Fish Assemblage and Habitat Assessment of the Upper Connecticut River (Yoder *et al.* 2009). In the Vernon Project area upstream of the dam, only one eel was collected; no eels were collected from the Bellows Falls pool, and none were found upstream of the Wilder Dam. However, in 2012, over 200 eels were documented using the upstream fish ladder at the Vernon Project, and the New Hampshire Fish and Game Department has observed eels upstream of the Bellows Falls and Wilder dams. More recently, eels have been observed in Lake Morey, Vermont, which is located upstream of Wilder Dam (Lael Will, VDFW, personal communication). Therefore, while it is clear that some eels are passing all three dams (Vernon, Bellows Falls, and Wilder), it remains unknown how many eels may be rearing in the mainstem habitat upstream of the dams or in tributaries and lakes and ponds that feed into the mainstem river.

No targeted eel surveys have been conducted to determine the abundance and distribution of American eels in riverine and lacustrine habitat upstream of the three projects. This information gap needs to be filled so resource agencies can properly evaluate the need for, and timing of, downstream passage and protection measures for outmigrating silver phase eels.

It should be noted that within the past seven years, the Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005, the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011, the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. It is likely that the Service's 12-month finding on the latest petition will be made prior to any new licenses being issued for the projects.

Nexus to Project Operations and Effects

The project configurations present problems with respect to providing safe, timely and effective passage for outmigrating eels. The intakes are deep and, while no specification for the trashracks were provided in the PAD, it is unlikely that they would prevent impingement and/or entrainment of eels. Existing anadromous downstream passage facilities at the projects also would not be expected to be effective for eels; the target anadromous species are surface-oriented, while eels tend to move much deeper in the water column. If eels are utilizing habitat upstream of the dams, appropriate protection and downstream passage measures will be needed.

In order to understand the need for, and timing of, downstream eel passage at the projects, we are requesting that TransCanada undertake eel surveys in the Connecticut River upstream of the

three dams and in tributaries feeding into the mainstem river within the project areas. Surveying tributary habitat is necessary because surveying the mainstem alone may lead to an underestimation of eel abundance, particularly if there are relatively short tributary streams that lead to a lake or pond (where eels may accumulate, leading to true high densities).

Methodology Consistent with Accepted Practice

The Service requests an eel survey be conducted in the mainstem river and tributaries upstream from the three projects. The methodology should be similar to that used in the relicensing of the Saluda Hydroelectric Project, FERC No. 516,[1] the eel assessment for the Merrimack River completed by the Service's Central New England Fishery Resources Office, and the proposed study plan for the relicensing of the Eastman Falls Project (FERC No. 2457).[2]

In general, a combination of electroshocking (backpack in wadeable rivers and boat-mounted in larger rivers and lakes) and eel pots should be used to collect eels and determine catch rates. Sampled habitat should include: the mainstem Connecticut River from upstream of Vernon Dam to below the Ryegate Dam; tributaries to the Connecticut within that stretch where eels have been collected previously; and lakes and ponds (such as, but not limited to, Spofford Lake and Lake Morey) where eels have been collected previously. Sampling should occur during the summer (July through September).

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

The expected level of effort and anticipated costs will be comparable to those experienced on similar Commission projects of this size. A study plan recently submitted for the Eastman Falls Project (FERC No. 2457) on the Pemigewasset River in New Hampshire, which is utilizing a similar methodology, estimated that sampling a nine-mile-long impoundment with shocking and eel pots would cost $25,000. They estimated the effort to be two nights for the electrofishing survey. Given the much larger area that will need to be sampled under this request, we estimate moderate cost and effort will be required (20 days of shocking mainstem habitat plus another 5-10 days for tributaries and associated lake/pond habitat).

REFERENCES

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar and B. Popp, editors. 2005. Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife. com/ swg_cwcs_report.cfm. (Accessed September 10, 2012).

Yoder, C.O., L.E. Hersha and B. Appel. 2009. Fish assemblage and habitat assessment of the Upper Connecticut River: preliminary results and data presentation. Final Project Report to: U.S. EPA, Region 1, Boston, MA. Center for Applied Bioassessment & Biocriteria. Midwest Biodiversity Institute. Columbus, OH.

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[1] In a letter from the U.S. Fish and Wildlife Service on the Eastman Falls Project, FERC 2457, FERC Accession No. 20121031-0007.

[2] FERC Accession No. 20121214-5121.

TransCanada Study Request #9

Upstream American Eel Passage Assessment at Vernon, Bellows Falls and Wilder Projects

(Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

This study has two objectives:

1. Conduct systematic surveys of eel presence/abundance at tailrace and spillway locations at the Vernon, Bellows Falls, and Wilder projects to identify areas of concentration of eels staging in pools or attempting to ascend wetted structures that would potentially establish the most effective locations to place upstream eel passage facilities.

2. Collect eels with temporary trap/pass devices from areas identified from surveys as potential locations of eel concentration to assess whether eels can be collected/passed in substantial numbers, and whether locations are viable sites for permanent eel trap/pass structures.

Resource Management Goals

The Atlantic States Marine Fisheries Commission (ASMFC) has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed the draft document: A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. protect and enhance eel populations where they currently exist;
2. where practical, restore populations to waters where they had historical abundance;
3. provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the three projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to upstream passage of American eel, the Service's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize project-related sources of upstream passage delay, injury, and stress in order to facilitate access to historical rearing habitat.

The American eel (*Anguilla rostrata*) is also one of New Hampshire and Vermont's Species of Greatest Conservation Need (SGCN). The status for conservation need in Vermont is listed as high priority (Kart *et al.* 2005), and the species is listed as "vulnerable" in New Hampshire. As identified in Vermont's Wildlife Action Plan (Kart *et al.* 2005), threats to the species include the construction of large dams on rivers which obstruct juvenile fish access to critical rearing habitats, as well as mortality associated with passing through hydroelectric facilities' turbines during their outmigration to sea.

As outlined in Vermont's Wildlife Action Plan (Kart *et al.* 2005), research and monitoring needs for this SGCN include determining their distribution and abundance, as the contribution of eels in northern regions to overall stock is unknown. One of the conservation strategies for this species is to support efforts to enhance access of American eels to Vermont waters by eliminating or minimizing impacts of dams and other obstructions along the Richelieu, St. Lawrence, and Connecticut rivers.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requester is a natural resource agency.

Existing Information

The PADs contain no information relative to areas where eels seeking to move upstream concentrate downstream of the three dams, or annual numbers of eels attempting to ascend past the dams. While eels have been known to ascend the Vernon and Bellows Falls fish ladders, their efficiency for passing eels is unknown, and they are only operated during the American shad passage season (from April 15 through July 15). Eels are currently able to pass Vernon, Bellows Falls, and Wilder dams (as evidenced by documented presence of eels upstream), but the total number of eels attempting to pass all three dams and the proportion successfully passing each

project is unknown (but suspected to be low). The downstream Holyoke Project has operated upstream eel passage facilities since 2004. Last year, these facilities passed over 40,000 juvenile eels. While the next dam upstream (Turners Falls Project, FERC No. 1889) has no dedicated upstream eel passage facilities, eels have been known to ascend the Cabot Station fish ladder (A. Haro, U.S. Geological Survey, personal communication). Although there is rearing habitat in between the Turners Falls and Vernon dams, some eels will attempt to continue upstream, and passage needs to be provided so these fish can access historical habitat.

These information gaps need to be filled so resource agencies can determine the best locations to site upstream eel passage facilities and assess whether operating the existing anadromous ladders would be an effective mechanism to move juvenile eels upstream past the projects.

We also note that within the past seven years, the Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005, the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011, the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the projects.

Nexus to Project Operations and Effects

The three projects generate hydropower on the head created by the Vernon, Bellows Falls, and Wilder dams. These dams create barriers to upstream migrating eels. While some eels are able to pass dams, some are not, and the passability of a given dam depends on factors such as its height, hydraulics, presence of climbable surfaces, presence of predators, risk of exposure to heat or drying while climbing a dam, etc. All three dams are high (Vernon: 58 ft. high; Bellows Falls: 30 ft. high; and Wilder: 60 ft. high), and the majority of the dam faces are dry during most of the upstream eel passage season. Design of the dams is not currently amenable to passage of eels by climbing. As mentioned earlier, the existing anadromous passage facilities are not designed to pass eels, and even if some eels are able to ascend the ladders, they may incur delays (in attraction or passage rates), be size-selective (e.g., velocity barrier for small eels presented by ~8 ft/sec flow through weirs and orifices), present a potential predation risk (predators in or near the fishways), and are not operated throughout the upstream eel passage season.

Methodology Consistent with Accepted Practice

1. Objective 1: Systematic Surveys

Surveys of eel presence and relative abundance should be conducted at regular intervals throughout the eel upstream migratory season (~1 May to ~15 October, or when river

temperatures exceed 10°C). Surveys should consist of visual inspection and trapping in likely areas where eels may concentrate as they attempt to climb structures wetted by significant spill or leakage flow below the dams and associated structures. These locations include the upstream fish ladders at all three projects (dewatered state) and leakage or overflow points along the downstream faces of all three dams, including spillways. Methods should include visual surveys (on foot, from a boat, or snorkeling) and trapping using small mesh (< 1/8"-clear opening) baited eel pots. Visual surveys should be performed once per week, at night, preferentially during precipitation events. Trap sets should be performed once per week, with an overnight soak time. Recorded data should include location, observation of eels (presence, absence, relative numbers, relative sizes, behaviors, time/date of observation), and survey method.

2. Objective 2: Trap/Pass Collections

Areas identified from Systematic Surveys as having significant number of eels present should be targeted as potential areas for permanent eel trap/passes, and should be initially assessed using temporary/portable trap passes. At a minimum (regardless of survey results), temporary trap passes should be installed at stilling basins and/or lower sections of fishways supplied with minimal attraction flow (0.5-1.0 cfs) during dewatered conditions at all three projects, as these locations may be supplemented with additional attraction flow and have high potential for being concentration points for upstream migrant eels. Similarly, traps should also be placed at spillway or bypass channel locations where eels have a potential to climb wetted (e.g., via leakage) flow zones, at the highest points to which eels are able to climb, or where otherwise feasible. Temporary trap/passes should be purpose-designed and built for each location, and operated throughout the eel upstream migratory season (~1 May to 15 October, or when river temperatures exceed 10°C). Ramp-type traps with supplementary attraction flow are preferred temporary trap/pass designs. Traps should operate daily, with catches quantified every two to three (2-3) days. Recorded data should include location, trapping interval, absolute numbers of eels trapped, relative eel sizes, and hydraulic and environmental conditions during the trapping period.

All collected eels from surveys should be released at their point of capture; those eels collected from trap/pass collections should be transported to and released into the headponds upstream of where they were collected.

These methodologies are consistent with accepted practice.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

The level of cost and effort for the survey component of the study would be low for each individual project (moderate for all three projects combined); a minimal number of personnel may be able to conduct the weekly surveys. The trap/pass component would require low to moderate cost and effort. We estimate $40,000 per project to conduct this study.

The Service is not aware of any previously conducted or ongoing studies related to upstream eel passage. The Applicant did not propose any studies to meet this need in the PADs.

REFERENCES

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar and B. Popp, editors. 2005. Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com/swg_cwcs_report.cfm. (Accessed September 10, 2012).

TransCanada Study Request #10

Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River

(Turners Falls, P-1889; Northfield Mountain, P-2485; Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

The goal of this study is to better understand migration timing of adult, silver-phase American eels in relationship to environmental factors and operations of mainstem hydropower projects on the Connecticut River.

The objective of this study is:

Quantify and characterize the general migratory timing and presence of adult, silver-phase American eels in the Connecticut River relative to environmental factors and operations of mainstem river hydroelectric projects.

Resource Management Goals

The Atlantic States Marine Fisheries Commission (ASMFC) has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watersheds where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance, but may now be absent, by providing access to inland waters for glass eel, elvers, and yellow eel, and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the Federal Energy Regulatory Commission relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. protect and enhance eel populations where they currently exist;
2. where practical, restore populations to waters where they had historical abundance;
3. provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to downstream passage of American eel, the Service's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize project-related sources of downstream passage delay, injury, stress, and mortality in order to maximize the number of silver eels migrating to the spawning grounds.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requester is a resource agency.

Existing Information

Data on timing of downstream migratory movements and rates of American eels in the mainstem Connecticut River are sparse and relatively incomplete. Preliminary data on the presence of "eel-sized" acoustic targets have been collected (Haro *et al.* 1999) within the Turners Falls Project's Cabot Station forebay that were somewhat confirmed by video monitoring at the Cabot Station downstream fish bypass; however, these were short-term studies, with acoustic

monitoring only performed from 17 September to 5 October and video monitoring only conducted between 18 September to 22 October.

Some daily monitoring of the downstream bypass at the Holyoke Dam (canal louver array) was performed in 2004 and 2005 (Kleinschmidt, Inc. 2005, 2006, Normandeau Associates 2007); these studies also were of relatively short duration (spanning from October 5 to November 10 in 2004 and September 9 to November 11 in 2005) and the sampler was only operated at night.

To date, no other directed studies of eel migratory movements have been conducted at any location on the Connecticut River mainstem. This information gap needs to be filled, as it relates directly to when downstream passage and protection measures need to be operated.

We also note that within the past seven years, the Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005, the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011, the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the projects.

Nexus to Project Operations and Effects

The timing of downstream migration of adult eels is poorly defined for the Connecticut River; therefore, the general effects of hydroelectric project operations on eel survival to the ocean are unknown. Although separate study requests have been submitted to address project-specific downstream passage route selection, delays, and mortality of eels, general characteristics of river flow and environmental conditions may have significant relationships with project operation and eel migratory success and survival. For example, eels may tend to move immediately before or during periods of significant precipitation (or consequently river flow), times at which projects may be generating at maximum capacity or spilling, which may (or may not) present a higher passage risk to eels. Conversely, periods of low flow may be associated with a significant proportion of total river flow passing through turbine units, which present additional (or different) passage risk to eels. If discrete conditions which promote eel downstream migration are known, it may be possible to take actions with respect to project operations which reduce or minimize passage risk; i.e., operation of a bypass, reduction of intake approach velocities, directed spillage through a "safe" route, etc. These studies should provide baseline information on river-specific downstream migration to predict when silver-phase eels are expected to be migrating in the mainstem Connecticut River, from which project operations could be modified to minimize passage risks.

The studies are proposed for a single or multiple sites; the results will be relevant to all sites on the Connecticut River mainstem.

Methodology Consistent with Accepted Practice

Quantification of downstream movements of American eels in river systems requires systematic sampling of migrants throughout the migratory season. This can be accomplished with traditional active trapping methods; i.e., fyke or stow net sampling, weirs, or eel racks, but these methods are technically challenging on larger mainstem rivers, due to the scale of flows that need to be sampled, difficulties in operation throughout all flow conditions, and high debris loading during fall flows. Passive monitoring of migrant eels using hydroacoustic methods offers an alternative to active trapping. However, this form of passive monitoring requires verification of potential acoustic targets with some level of active (collection) or visual (traditional optical or acoustic video) sampling.

Two potential locations offer opportunities to conduct simultaneous passive and active sampling: the Cabot Station (Turners Falls Project) canal/forebay and the Holyoke Dam forebay and canal louver/bypass system. Each location possesses a route of downstream passage which conducts a significant proportion of river flow (Cabot canal and Holyoke forebay or canal), and each has a proximal bypass equipped with a sampler so that fish can be concentrated/collected from the passage route and identified to species. Project operations do influence the relative proportion of flow (and thus numbers of downstream migrant eels) in each passage route, so numbers of eels sampled in each route represent only a proportion of the total number of eels migrating downstream within the entire river. Because the absolute proportion of eels using a specific route at any one time is unknown, numbers of eels quantified within a route must serve as a relative index of the degree of migratory movement.

This study shall quantify eel movements in either one, or preferably both, locations for two consecutive years (since environmental conditions strongly influence migratory timing of eels, which can vary significantly from year to year) (Haro 2003). Eels will be quantified using methods similar to Haro *et al.* (1999), by continuously monitoring a fixed location at the projects with hydroacoustics. Because eels tend to concentrate in areas of dominant flow (Brown *et al.* 2009; EPRI 2001), the zone to be monitored should pass a dominant proportion of project flow throughout most periods of operation (i.e., forebay intake area). Hydroacoustic monitoring shall encompass the entire potential migratory season, beginning in mid-August and ending in mid-December, and shall operate 24 hours per day. Data will be recorded for later processing and archiving.

Systematic active quantification of eels at downstream bypass samplers shall be performed simultaneously with passive hydroacoustic monitoring, to verify presence of eels and relative abundance of eel-sized hydroacoustic targets from the hydroacoustic data. Although daily operation of the bypass sampler could be performed, a more comprehensive technique is to monitor eels entering the bypass with an acoustic camera (i.e., DIDSON, BlueView, etc.). The acoustic camera will afford positive visual identification of eels as they enter the bypass, which is a concentration point for migrating eels. Acoustic camera monitoring will also allow monitoring to be performed 24 hours a day, and will be relatively unaffected by water turbidity

(which influences effectiveness of traditional optical video monitoring). The acoustic camera system will be operated during the same time period as acoustic monitoring, and images will be recorded for later processing and archiving.

Data analyses of hydroacoustic, acoustic camera, bypass sampling, and environmental/ operational data will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

The level of cost and effort for the downstream migrant eel migratory timing study would be moderate, given the level of cost for instrumentation, deployment, and data review/analysis. Cost is estimated at $50,000 per year for the study.

The Applicant did not propose any studies to meet this need in the PAD.

REFERENCES

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TransCanada Study Request #11

Downstream American Eel Passage Assessment at the Vernon, Bellows Falls, and Wilder Projects

(Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

The goal of this study is to determine the impact of three hydroelectric projects on the outmigration of silver eels in the Connecticut River. Entrainment at the conventional turbines at the Vernon, Bellows Falls, and Wilder projects can result in mortality or injury. It is important to understand the passage routes at each project and the potential for delay, injury, and mortality to assess alternative management options to increase survival.

The objectives of this study are:

1. Quantify the movement rates (including delays) and relative proportion of eels passing via various routes at the projects (i.e., through the turbines, through the downstream bypasses; spilled at the dams, etc.).
2. Evaluate instantaneous and latent mortality and injury of eels passed via each potential route.

Resource Management Goals

The Atlantic States Marine Fisheries Commission (ASMFC) has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watersheds where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel, and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the Federal Energy Regulatory Commission relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. protect and enhance eel populations where they currently exist;
2. where practical, restore populations to waters where they had historical abundance;
3. provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to downstream passage of American eel, the Service's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize project-related sources of downstream passage delay, injury, stress, and mortality in order to maximize the number of silver eels migrating to the spawning grounds.

The American eel (*Anguilla rostrata*) is also one of New Hampshire and Vermont's Species of Greatest Conservation Need (SGCN). The status for conservation need in Vermont is listed as high priority (Kart *et al.* 2005), and the species is listed as "vulnerable" in New Hampshire. As identified in Vermont's Wildlife Action Plan (Kart *et al.* 2005), threats to the species include the construction of large dams on rivers which obstruct juvenile fish access to critical rearing habitats, as well as mortality associated with passing through hydroelectric facilities' turbines during their outmigration to sea.

As outlined in Vermont's Wildlife Action Plan (Kart *et al.* 2005), research and monitoring needs for this SGCN include determining their distribution and abundance, as the contribution of eels in northern regions to overall stock is unknown. One of the conservation strategies for this species is to support efforts to enhance access of American eels to Vermont waters by eliminating or minimizing impacts of dams and other obstructions along the Richelieu, St. Lawrence, and Connecticut Rivers.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requester is a resource agency.

Existing Information

The PAD contains information on the biology and life history of the American eel. It also summarizes eel collection data within the Vernon and Bellows Falls project areas. Eels have been collected both upstream and downstream of the Vernon Project and also have been counted passing the upstream anadromous fish ladder. Eels also have been documented upstream of the Bellows Falls and Wilder projects.

To date, no directed studies of eel entrainment or mortality have been conducted at any of the projects. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations on outmigrating eels and develop adequate passage and protection measures to meet management goals and objectives.

We also note that within the past seven years, the Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005, the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011, the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the projects.

Nexus to Project Operations and Effects

The Vernon, Bellows Falls, and Wilder projects operate as peaking facilities, except during periods when inflow exceeds the hydraulic capacities of the stations. Silver eels outmigrate during the mid-summer through late fall, a time of year when flows are generally within the operating capacities of the stations. Therefore, the projects would be expected to spill infrequently during the silver eel outmigration.

The project configurations present problems with respect to providing safe, timely and effective passage for outmigrating eels. The intakes likely are deep and, while no specification for the trashracks were provided in the PAD, it is unlikely that they would prevent impingement and/or entrainment of eels. Existing anadromous downstream passage facilities at the projects also would not be expected to be effective for eels; the target anadromous species are surface-oriented, while eels tend to move much deeper in the water column. Eels are known to occur upstream of the dams; therefore, it is necessary to understand how eels move through the projects and the level of injury or mortality caused by entrainment through the projects' turbines.

Methodology Consistent with Accepted Practice

In order to understand the movements of outmigrating silver eels as they relate to operations at the Vernon, Bellows Falls, and Wilder projects, radio telemetry technology should be utilized. Radio telemetry is an accepted technology that has been used for a number of studies associated with hydropower projects, including at the Muddy Run Project (FERC No. 2355).

Studies should be designed to investigate route selection (i.e., entrainment vs. spill) independently from estimation of mortality/injury, because these metrics require different telemetric methodologies. Studies also will likely benefit from data collected over both study years (especially route selection studies, which may be more significantly affected by environmental conditions during a given season than mortality/injury studies). It is also envisioned that results from route selection studies can guide design of turbine mortality studies. Therefore, it is proposed, at a minimum, that route selection studies be conducted in multiple years, but mortality/injury studies may be conducted after the first year of route selection studies has been completed.

1. Objective 1: Route Selection

This study will involve systematic releases of radio-tagged silver phase eels at strategic points above areas of interest, to assess general routes of passage (i.e., via spill, bypass, or turbines). Active downstream migrants should be collected within-basin if possible (i.e., Cabot or Holyoke bypass samplers), but fish sourced from out of basin may be acceptable to meet sample size demands. Experimental fish must meet morphometric (e.g., eye diameter relative to body size) criteria to ensure they are migrant silver phase. Collections should be made within the migratory season (late August to mid-October), and eels should be tagged and released within 21 days after capture, but preferably within seven days (particularly if the test eels are from out-of-basin).

All telemetered eels will be radio and passive integrated transponder (PIT) tagged. PIT antennas will be installed at bypasses at Vernon and Bellows Falls and monitored continuously to verify passage of eels via bypass channels.

<u>Vernon Project Route Selection Study</u>:

A minimum number of 50 telemetered eels (e.g., five separate groups of approximately 10 eels each) will be required to maximize the data return. Tagged eels should be released at least 5 km upstream of the Vernon Project. Groups of

eels should be released during spill and non-spill periods, if possible. Telemetry receivers and antennas should be located to assess passage via the following potential routes: Vernon spillway; fishway attraction water intake (if operational); Vernon downstream bypasses; and Vernon station turbines.

Eels from the Bellows Falls route studies migrating to the Vernon Dam may be used to supplement (but not serve in lieu of) these release groups.

Bellows Falls Dam Route Selection Study:

A minimum number of 50 telemetered eels (e.g., five separate groups of approximately 10 eels each) will be required to maximize the data return. Groups of eels should be released during spill (if any) and non-spill and during periods of low, moderate, and high generation conditions, if possible. Tagged eels should be released at least 5 km upstream of the Bellows Falls Dam. If significant spillage occurs during releases, up to 50 additional eels should be released in the upper canal and allowed to volitionally descend through the canal to assure that sufficient number of eels are exposed to canal and powerhouse intake conditions.

Telemetry receivers and antennas should be located upstream and downstream of the spillway, at the canal entrance, within the canal, in the downstream fish bypass entrance turbine intakes, and station tailrace. These locations will permit assessment of passage via the following potential routes: the power canal; spillway; downstream fish bypass; station turbines; and upstream fishway attraction water intake. The attraction water intake should be operated during the study to assess its use by eels, as it may be operated in the future for riverine and/or eel passage, as addressed in the resident fish passage study request. Eels from the Wilder route study migrating to the Bellow Falls Project may be used to supplement (but not serve in lieu of) these release groups.

Wilder Project Route Selection Study:

A minimum number of 50 telemetered eels (e.g., five separate groups of approximately 10 eels each) should be required to maximize the data return. Tagged eels should be released at least 5 km upstream of the Wilder Project. Groups of eels should be released during spill and non-spill periods if possible. Telemetry receivers and antennas should be located to assess passage via the following potential routes: Wilder spillway; fishway attraction water intake (if operational); Wilder downstream bypasses; and Wilder station turbines.

Mobile tracking (i.e., via boat) in river reaches between release sites and several km downstream of Vernon Station will be performed at regular intervals during and after releases to confirm routes and fates of passed fish, or fish lost to follow-up.

Movement rates (time between release and detection at radio antenna locations, and between radio antenna locations) of eels passing the projects by various routes will also be quantified.

The route selection portion of this study should occur in both study years.

2. Objective 2: Spill, Bypass, and Turbine Mortality/Injury Studies

Spill, bypass, and turbine mortality will be assessed using a radio-telemetric balloon tag method. A minimum number of 50 tagged eels (e.g., five separate groups of approximately 10 eels each) will be required at each location (dam spillways, downstream bypasses, and station turbines) to maximize the data return.

For spill mortality sites (dam spillways and downstream bypasses), tagged eels will be injected or released into spill flow at points where water velocity exceeds 10 ft/sec to minimize the possibility of eels swimming upstream into the headpond or canal. Passed balloon-tagged eels will be recovered below areas of spill and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

For turbine mortality sites (Vernon, Bellows Falls, and Wilder stations), tagged eels will be injected into intakes of units operating at or near full generation at points where intake water velocity exceeds 10 ft/sec to minimize the possibility of eels swimming back upstream through the intakes. Passed balloon-tagged eels will be recovered in the tailrace and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

If the balloon-tag mortality component of the study occurs in study year one, all possible route selection sites would need to be evaluated. If the balloon-tag mortality component of the study occurs in study year two, results from the route selection study (year one) could be used to inform which sites need to be evaluated for mortality. Eels recovered from balloon tag studies should not be used for route selection studies.

Data analyses of route selection and turbine mortality (instantaneous and latent) will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

The level of cost and effort for the downstream eel passage study would be moderate to high; silver eels would need to be collected, tagged, and released in several locations over the course of the migration season. Antennas and receivers would need to be installed at the intakes of all stations, as well as at the dam spillways and station bypasses, and monitored regularly. Data would need to be retrieved periodically, then analyzed. A multi-site route selection study conducted by the USGS Conte Lab on the Shetucket River in Connecticut cost approximately $75,000 for the first year of study. Costs are estimated at $100,000 per year for the route selection studies and $75,000 per year for the spill, bypass, and turbine mortality/injury studies for each project.

The Applicant did not propose any studies to meet this need in the PAD.

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Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar and B. Popp, editors. 2005. Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com /swg_cwcs_report.cfm. (Accessed September 10, 2012).

TransCanada Study Request #12

Assessment of Adult Sea Lamprey (*Petromyzon marinus)* Spawning within the Wilder, Bellows Falls, and Vernon Project Areas

(Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Perform a study to investigate potential impacts of the Wilder, Bellows Falls and Vernon project operations on sea lamprey spawning success.

Goals and Objectives

1. Identify areas within the Wilder, Bellows Falls, and Vernon project areas where suitable spawning habitat exists for sea lamprey.

2. Conduct a telemetry study of sea lamprey during their upstream migration period in the spring, focusing on areas of suitable spawning habitat, and areas of known spawning.

3. Conduct spawning ground surveys to observe the utilization of this habitat for spawning purposes, and hence, confirm suitability.

4. Obtain data on redd characteristics, including location, size, substrate, depth and velocity.

5. Determine if the operations at the Wilder, Bellows Falls and Vernon projects are adversely affecting these spawning areas (i.e., if flow alterations are causing dewatering and/or scouring of sea lamprey redds).

6. If it is determined that the operations of the projects are adversely affecting the spawning success of sea lamprey, identify operational regimes that will reduce and minimize impacts to sea lamprey spawning habitat and spawning success.

Resource Management Goals

The U.S. Fish and Wildilfe Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to aquatic resources, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.

2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by project operations.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

The sea lamprey (*Petromyzon marinus*), within the Connecticut River drainage, is one of New Hampshire and Vermont's Species of Greatest Conservation Need (SGCN). The conservation status of sea lamprey in New Hampshire is listed as "vulnerable." One of the threats identified in Vermont's Wildlife Action Plan (VWAP) (Kart *et al.* 2005) is degraded spawning habitat, which is second to habitat fragmentation.

As outlined in the VWAP, research and monitoring needs for SGCN include monitoring and assessing populations and habitats for current conditions and future changes, and identifying and monitoring problems for species and their habitats. One of the conservation strategies identified in the VWAP is protecting and restoring aquatic and riparian habitats through improved water quality; flow, water level and temperature regimes; sediment reduction; establishment of streamside buffers; and suitable aquatic habitat structure, diversity and complexity.

In support of conservation strategies and research needs listed above, potential impacts that the Wilder, Bellows Falls, and Vernon projects have on sea lamprey spawning need to be evaluated. Results of the study may be used to develop flow-related license requirements and/or other mitigation measures that will optimize lamprey spawning habitat and spawning success.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a natural resource agency.

Existing Information

It is known that sea lamprey spawn in the Connecticut River main stem at least as far upstream as Wilder Dam, as well as tributary waters including the West, Williams, Black and White rivers (Kart *et al.* 2005).

The PAD discusses sea lamprey distribution as: "FWS (2012) lists the current upstream extent of sea lamprey range as Bellows Falls Dam, noting, however, that reproduction has been documented as far north as the White River, Vermont, in the Wilder Project area. In certain years hundreds to thousands of sea lamprey have been recorded passing upstream of Bellow Falls Dam, and in at least one year (2008), sea lamprey were documented passing upstream via the

Wilder Dam fish ladder. In 2008 surveys, Yoder *et al.* (2009) documented sea lamprey just downstream of the confluence of the White River."

In 2012, a total of 99 sea lamprey were observed passing the Bellows Falls Dam, and a total of 696 sea lamprey were observed passing the Vernon Dam.

To date, no studies have been conducted that aim to identify spawning habitat and spawning activity of sea lamprey within in the Wilder, Bellows Falls, and Vernon project areas and to identify whether project operations are affecting these activities.

Nexus to Project Operations and Effects

The operation of the Wilder, Bellows Falls and Vernon projects, including minimum flows and large and rapid changes in flow releases from the dam, have the potential to cause direct adverse effects on spawning habitat and spawning activity downstream of the dam. If adult sea lampreys are actively spawning in the project area, it is important to assess whether operations of the projects are having any adverse effects (i.e., dewatering and scouring) on these activities.

Methodology Consistent with Accepted Practice

Although a relatively new practice, the tagging and tracking of adult Pacific lamprey to determine final destination has been successfully conducted in the Columbia River (Noyes *et al.* 2011). Similarly, from 2005-2009, radio telemetry was used to determine adult lamprey overwintering and spawning habitats, and spawn timing in the lower Deschutes River Subbasin (Fox *et al.* 2009). These techniques should be applicable to use with sea lamprey.

In Vermont, factors affecting sea lamprey survival were examined (Smith and Marsden 2009). It was found that predation, water currents, and displacement of eggs from the nest played a role in survival.

As part of the Wells Hydroelectric project (FERC No. 2149), Pacific lamprey spawning ground surveys were conducted to determine project effects on spawning success (Le and Kreiter 2008).

In 2010, redd surveys were completed in Shitike and Beaver Creeks to identify recent redds for placement of an experimental redd cap. The purpose of capping lamprey redds was to enumerate emerging larvae and to document timing of emergence with respect to estimated date of redd construction and water temperature (Fox *et al.* 2010). Therefore, to determine project effects on the spawning success of sea lamprey, study methods should follow those described in Fox *et al.* (2010).

Level of Effort/Cost, and Why Alternative Studies will not suffice

The level of effort and costs for this study will be based on the final study plan, developed in consultation with the resource agencies. Variables that affect study cost and effort include the number of lamprey tagged and the number of nests and amount of suitable habitat found. The Applicant did not propose any alternative studies in its PAD to address this specific issue.

REFERENCES

Fox, M. J.C. Graham and S. Frank. 2009. Determining Adult Pacific Lamprey Abundance and Spawning Habitat in the Lower Dechutes River Sub-Basin, Oregon. Department of Natural Resources Confederated Tribes of the Warm Springs Reservation, Oregon.

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Le, Bao and S. Kreiter. 2008. An assessment of Adult Pacific Lamprey Spawning within the Wells Project. Wells Hydroelectric Project No. 2149.

Noyes, C.J., C.C. Caudill, T.S. Clabough, D.C. Joosten, E.L. Johnson, M.L. Keefer and G.P. Naughton. 2011. Adult Pacific lamprey migration behavior and escapement in the Bonneville Reservoir and Lower Columbia River monitored using the juvenile salmonid acoustic telemetry system (JSATS). Technical Report 2012-4-Draft.

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Yoder, C.O., L.E. Hersha and B. Appel. 2009. Fish assemblage and habitat assessment of the Upper Connecticut River: preliminary results and data presentation. Final Project Report to: U.S. EPA, Region 1, Boston, MA. Center for Applied Bioassessment and Biocriteria. Midwest Biodiversity Institute. Columbus, OH.

TransCanada Study Request #13

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

(Bellows Falls, P-1855; Wilder, P-1892)

Goals and Objectives

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 goal of this study is to evaluate the effects that the Wilder and Bellows Falls hydroelectric projects have on populations of the federally endangered dwarf wedgemussel (*Alasmidonta heterodon*). In addition, the results of the study can be used 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; and
5. determine how availability and persistence of dwarf wedgemussel habitat changes with water level and flow fluctuations.

Resource Management Goals

The dwarf wedgemussel is a federally endangered species. As such, this study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures and protection, mitigation, and enhancement measures for the species pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*).

It is the goal of the U. S. Fish and Wildlife Service to recover the dwarf wedgemussel so that it can be removed from the endangered species list in the future. According to the Recovery Plan (USFWS 1993), the Connecticut River dwarf wedgemussel population is one that must be demonstrated to be viable before the species can be downlisted to threatened. The upper Connecticut River metapopulation is likely the largest remaining population in the world (USFWS 2007), therefore its protection is essential to the recovery of the species as a whole.

Public Interest

The requestor is a natural resource agency.

Existing 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.

Nexus to Project Operations and Effects

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.

Methodology Consistent with Accepted Practice

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 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 m^2 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, New Hampshire (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 and 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) (Ecological Specialists, Inc. 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 in 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 and Layzer 2008; DiMaio and 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 rivers (T. Moburg, The Nature Conservancy, personal communication). 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/Cost and Why Alternative Studies Will Not Suffice

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 those of similar Federal Energy Regulatory Commission relicensing projects of this size.

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TransCanada Study Request #14

Project Effects on Populations of Tessellated Darter, *Etheostoma olmstedi*
(Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

The goal of this study is to evaluate the effects of project operations on populations of the 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 the tessellated darter within project-affected areas; and
2. determine the effects of project operations on the distribution and abundance of the tessellated darter.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the project.

Specific to aquatic resources, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by project operations.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

The tessellated darter is one of only three fish species in the upper Connecticut River that serve as hosts for the glochidia of the federally endangered dwarf wedgemussel, the others being the slimy sculpin (*Cottus cognatus*) and the Atlantic salmon (*Salmo salar*) (Wicklow 2005). Tessellated darters may be the most important hosts for the dwarf wedgemussel in the upper Connecticut River for the following reasons:

1. The Service has decided to end its program of stocking hatchery-reared salmon in the Connecticut River basin and accordingly it is unlikely that salmon parr will be available as potential hosts.
2. The tessellated darter appears to be more widespread than the slimy sculpin in the Bellows Falls and Wilder project areas where the dwarf wedgemussel is known to exist. Yoder *et al.* (2009) found the darter in the project areas upstream and downstream of both dams, while the sculpin was not found in either project area.

It is the goal of the Service to recover the dwarf wedgemussel so that it can be removed from the endangered species list in the future. Populations in the upper Connecticut River are dependent on healthy tessellated darter populations, and therefore a better understanding of how dam operations affect the darter is crucial to the recovery of the dwarf wedgemussel.

A mission of both the New Hampshire Fish and Game Department and the Vermont Fish and Wildlife Department is to protect and conserve fish and wildlife and their habitats. Riverine fish species are an important component of the river's ecology. The tessellated darter is identified by New Hampshire as a Species of Greatest Concern.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a natural resource agency.

Existing Information

In the PADs for the Wilder, Bellows Falls, and Vernon projects, the Applicant acknowledges that the tessellated darter is one of the confirmed hosts of the dwarf wedgemussel. The PADs also identify the occurrence of the 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 *et al.* 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.

Nexus to Project Operations and Effects

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 wedgemussel.

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

Methodology Consistent with Accepted Practice

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 the tessellated darter are different in project-affected areas and, if so, which measured factors or flow characteristics are most important in describing these differences.

Level of Effort/Cost and Why Alternative Studies Will Not Suffice

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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TransCanada Study Request #15

Determine the Fish Assemblage in Vernon, Bellows Falls and Wilder Project-Affected Areas

(Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

The goal of this study request is to determine the occurrence, distribution, and relative abundance of fish species present in the project-affected areas of the Vernon, Bellows Falls and Wilder projects, which potentially include Species of Greatest Conservation Need (SGCN) for both New Hampshire and Vermont.

Specific objectives include:

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

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to aquatic resources, the Service's goals are:

1. Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the areas impacted by project operations.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

A mission of both the New Hampshire Fish and Game Department and the Vermont Fish and Wildlife Department is to protect and conserve fish and their habitats. Riverine fish species are an important component of the Connecticut River's ecology and are the basis for the sport fishery. Furthermore, several of the states' SGCN have been documented in the project-affected areas.

Determining species occurrence, distribution and abundance will help address research and monitoring needs for species whose populations are poorly known. For example, as outlined in Vermont's Wildlife Action Plan (Kart *et al.*2005), research and monitoring needs for SGCN include monitoring and assessing populations and habitats for current conditions and future changes, and identifying and monitoring problems for species and their habitats.

A study that aims to provide a comprehensive investigation that documents which fish species are utilizing the project-affected areas in relation to spatial, temporal and environmental gradients (i.e., temperature, dissolved oxygen, pH, turbidity) will allow for a fuller understanding and examination of potential impacts that the Vernon, Bellows Falls and Wilder project operations have on the species that reside there. As noted below, there is little information concerning riverine fish in the project-affected areas related to this study request.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a natural resource agency.

Existing Information

A thorough and comprehensive assessment of the fish assemblage present in the project-affected areas of the Bellows Falls and Wilder projects is lacking. The PAD for the Bellows Falls Project acknowledges that "Little comprehensive information is available regarding characterization of the fish community in relation to the Project." The PAD for the Wilder Project states "No targeted studies have been conducted to characterize the fish community in relation to the Project."

The most relevant fish study related to the Bellows Falls and Wilder project-affected areas is a Connecticut River electrofishing survey conducted in 2008 (Yoder *et al.* 2009). While some sampling was conducted in both project-affected areas during the 2008 survey, this survey did not have the same goals and objectives as those outlined above. Additionally, both the Bellows Falls and Wilder PADs acknowledged that fish species assemblage data are limited and that the synthesized data may not be a full representation of species occurrence in the project-affected areas. Although fish data have been collected by Vermont Yankee for many years in the Vernon Dam project-affected area, objectives and methodology for those 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. It is unknown if other species may inhabit or utilize aquatic habitats in the project areas that to this date have not been documented by previous surveys. It follows that without more information on the fish community in the project-affected areas, project impacts on fish species are also unknown.

Nexus to Project Operations and Effects

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 or change available habitat, thus limiting productivity of important game fish species by direct impacts to their spawning success or indirectly by limiting the spawning success of forage fish species. Furthermore, several of New Hampshire and Vermont's SGCN have been documented in the project-affected area. Accordingly, a thorough understanding of the current fish assemblage structure and associated metrics is needed in order to examine any potential project-related impacts.

Methodology Consistent with Accepted Practice

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 most upstream area influenced by the Wilder Dam to the most downstream area influenced by the Vernon Project. Sampling should occur at each selected site across multiple seasons (spring, summer, and fall). Digital photographs should be taken to avoid misidentifying 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, flow, 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 other factors as determined by a qualified biologist. Species detection, occurrence, and/or abundance as related to 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).

Based on first year study results, specific 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 proves to be atypical (outside of the 25-75th percentile of average weekly flow values) during the study period.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

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. Provided the collected data are of high quality, analysis and synthesis should take approximately 10-20 days. TransCanada did not propose any studies specifically addressing this issue

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TransCanada Study Request #16

Determine Upstream Passage Needs for Riverine Fish Species in the Bellows Falls, Wilder and Vernon Fishways

(Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

The goal of this study is to determine the adequacy of the existing Bellows Falls, Wilder, and Vernon fish ladders in passing riverine species and determine the appropriate operation period for these fishways to pass riverine and diadromous fish.

Specific objectives include:

1. identify the utilization and temporal distribution of passage through the Bellows Falls, Wilder, and Vernon fishways by riverine and diadromous fish species;
2. review existing Vermont Fish and Wildlife Department's (VTFWD) fish passage data to increase sample size and gain a better understanding of temporal variability; and
3. operate and monitor the fishways year-round (or until otherwise infeasible) to assess fishway use over a longer period than the fishways have traditionally been operated to:

    a. determine the appropriate operating windows of the fishways for riverine species; and
    b. determine the appropriate operating windows of the fishways for diadromous species such as American eel and sea lamprey.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to aquatic resources, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the areas impacted by project operations.

3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

The VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Vermont's Wildlife Action Plan 2005).

Two of the VTFWD's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

The VTFWD's Strategic Plan (2002-2010) focuses on four major areas of concern: resource conservation, fish- and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

A mission of the New Hampshire Fish and Game Department (NHFGD) is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats.

Three of the NHFGD's goals are to ensure:

1. New Hampshire has a wide range of naturally occurring habitats and health, functioning ecosystems.
2. New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3. New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.

In order to be consistent with both Departments' missions and goals, and to promote healthy fish populations, connectivity within a river system is important. By allowing fish to move through the fishway during different times of the year, and during different life history stages, access to available riverine aquatic habitat is increased. Fish are able to seek the best available habitat and food resources, as well as avoid predator interactions. Furthermore, movement within a river system promotes genetic diversity. Currently upstream resident fish passage at the Bellows Falls, Wilder, and Vernon dams is precluded most of the year due to fishway closure.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a natural resource agency.

Existing Information

No such information exists that will allow for a comprehensive assessment of existing year round fishway utilization by resident species. The VTFWD has several years (2007-2012) of seasonal passage data that have not yet been analyzed. These data are in the form of .avi files, but only include the spring and summer months (typically May-July).

The PAD acknowledges that "Resident species have also been recorded using the Bellows Falls and Wilder fish ladder." Those data are available from the VTFWD. Fish passage video data that have been processed should be available for distribution in the future (Lael Will, VTFWD, personal communication). Although not comprehensive, analysis of these data would assist in filling this data gap.

In 2012, VTFWD staff documented resident species passage at the Vernon fishway. Species observed utilizing the fishway included bluegill (N = 555), common carp (N = 209), channel catfish (N = 37), trout sp. (N = 2), walleye (N = 54), white sucker (N = 102), and American eel (N =262). However, these analyses were conducted during one year and did not include any monitoring outside of the spring spawning run.

Nexus to Project Operations and Effects

The Bellows Falls, Wilder and Vernon dams span across the Connecticut River, acting as a physical impediment to fish passage. Therefore, the projects have a direct impact on fish passage and limit fish from accessing available aquatic habitat located upstream of the dam.

The PAD acknowledges that "river fragmentation can reduce or obstruct fish and aquatic community connectivity and therefore genetic diversity and stock structure. However, those impacts are reduced by the provision of fish passage and the length of the impoundment. Upstream and downstream fish passages, designed for Atlantic salmon, are likely used by other migratory and resident species, providing connectivity; however, fish counts are limited, unknown or unavailable for resident species." In fact, it is known that riverine and diadromous species use the fishways, but there has been limited analysis of this data and fishway monitoring was limited to the spring period.

Therefore, in order to determine the level of riverine fish passage through the existing fishways, and the appropriate operation period for the fishway, review of existing data and further monitoring of the fishways is warranted.

Methodology Consistent with Accepted Practice

Fishway monitoring has been conducted annually by VTFWD dating back to 1985. Monitoring was focused on Atlantic salmon, American shad and American eel. Resident species were recorded periodically, but were not monitored outside the spring anadromous fish migration period.

Fishway monitoring has been used to assess existing and proposed project operations, and to develop appropriate operating windows for fisheries resources.

In addition to fish window count data, monitoring should include monitoring of the hydraulic conditions in the fishways and fishway entrances, and periodic fish observations should be made over the length of the fishways. If count data or observations of the fishways indicate the need for fishway operation changes or for more specific information on fish movement through the fishways, changes to the monitoring plan for year two monitoring would need to be implemented.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

This study will require video monitoring equipment, appropriate software (e.g., salmon soft), and personnel to read files and manage the equipment. Some information already exists in the form of .avi files and past count data and are readily available from VTFWD. No other tool (e.g., radio telemetry) is more appropriate or cost effective for these types of assessments. Cost is relatively low.

TransCanada Study Request #17

Impacts of the Vernon, Bellows Falls and Wilder Project Impoundment Level Fluctuations on Resident Fish Spawning

(Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

The goal of this study is to determine if the full range of water level fluctuations in the Vernon, Bellows Falls and Wilder hydroelectric projects negatively impact resident fish species in the impoundments, and if impacts are found to occur, to develop appropriate mitigation measures.

Specific objectives include:

1. delineate, quantitatively describe (e.g., substrate composition, vegetation type and abundance) and map shallow water aquatic habitat types subject to inundation and exposure due to project operations, noting and describing additional areas where water depths at lowest operational range are wetted to a depth less than one foot (flats, near shore areas, gravel bars, with very slight bathymetric change);
2. conduct analyses of the impacts of the normal operation and the maximum permitted reservoir fluctuation range on the suitability of littoral zone habitats for all life stages of target species likely to inhabit these areas;
3. conduct field studies to assess timing and location of fish spawning;
4. conduct field studies to evaluate potential impacts of impoundment fluctuation on nest abandonment, spawning fish displacement and egg dewatering, and
5. evaluate potential impoundment fluctuation ranges and how implementation of such changes would mitigate for identified impacts.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to aquatic resources, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.

2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the areas impacted by project operations.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

A mission of both the New Hampshire Fish and Game Department and the Vermont Fish and Wildlife Department is to protect and conserve fish and their habitats. Resident fish species are an important component of the Connecticut River's ecology and in some cases are the basis for a sport fishery. This requested study will help protect and conserve resident fish species by ensuring project operations do not negatively impact their spawning success.

The New Hampshire Department of Environmental Services is responsible for ensuring that surface water quality standards are met in all surface water bodies. The surface water quality criteria for Biological and Aquatic Community Integrity are:

1. The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms and have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.
2. Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

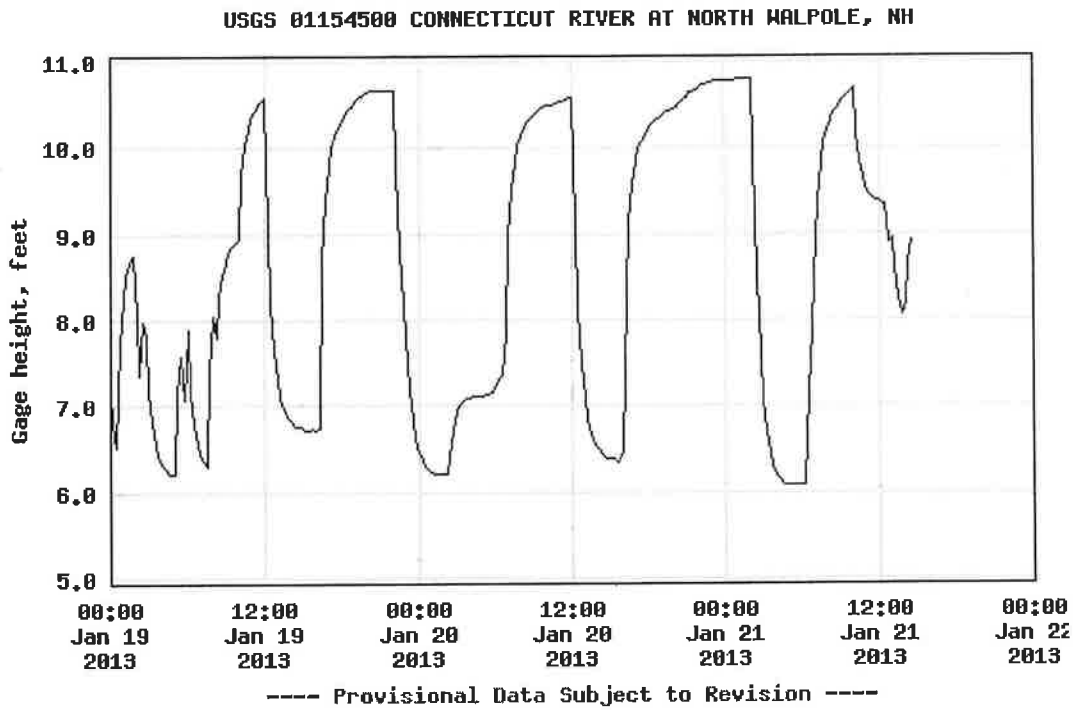
Public Interest

The requestor is a federal natural resource agencies.

Existing Information

To our knowledge, no information exists related to this requested study.

An example of the water level fluctuations that occur in the lower Connecticut River due to hydropower generation is shown below.



Nexus to Project Operations and Effects

Project operations have the potential to impact fish species by influencing spawning success and spawning habitat quality and quantity. For example, water level changes due to project operations could create conditions where fish eggs are exposed to air, where quality spawning habitat is dewatered, and/or where fish abandon nests containing eggs. The New Hampshire Fish and Game Department has received several calls in past springs regarding "acres" of yellow perch eggs being dewatered in the Bellows Falls Impoundment.

The projects operate within normal, permitted and flood-condition reservoir fluctuation limits that include, during high flow events, the dropping of stanchion bays that cannot be raised without a subsequent drawdown of the impoundment beyond normal project operating ranges. The full range of reservoir fluctuations, including periodic drawdowns for stanchion bay replacement, needs to be addressed in this study.

Methodology Consistent with Accepted Practice

Common tools to evaluate fish spawning and habitat would be used, including, but not limited to, electrofishing, visual observations, telemetry and habitat measurements. The study area for this request includes all impounded waters, including tributaries and backwaters, within the project-affected areas of the Vernon, Bellows Falls and Wilder hydroelectric projects. 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 proves to be atypical (outside of the 25-75th percentile of average weekly flow values) during the study period.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

TransCanada does not propose any studies to meet this need. Estimated cost for the study is moderate to high but is dependent on the amount of field study that is needed.

TransCanada Study Request #18

Impacts of the Vernon, Bellows Falls and Wilder Project Operations on Tributary and Backwater Area Access and Habitats

(Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

One goal of this study is to determine if water level fluctuations from the Vernon, Bellows Falls and Wilder hydroelectric projects result in a barrier(s) to fish movement in and out of tributaries and backwaters to the impoundments and riverine reaches below dams.

A second goal is to determine if water level fluctuations in the Vernon, Bellows Falls and Wilder project impoundments impact water levels, available fish habitat and water quality in tributaries and backwaters to the impoundments and riverine reaches below dams, and if impacts are found, to ascertain how spatially far reaching they are and develop mitigation measures.

Results of this study may also be used to help determine the adequacy of existing downstream minimum flow requirements.

Specific objectives include:

1. Conduct a field study of tributaries and backwaters, including water velocity and habitat data where appropriate, to evaluate potential impacts of impoundment fluctuation on fish access to tributaries and backwater areas. The study should also evaluate if changes in impoundment fluctuation range would mitigate for any identified impacts and if other mitigative measures would improve access.

2. Conduct a field study to examine potential impacts of impoundment fluctuations on water levels, available habitat and water quality in tributaries and backwaters. The evaluation should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to aquatic resources, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the areas impacted by project operations.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

A mission of both the New Hampshire Fish and Game Department and the Vermont Fish and Wildlife Department is to protect and conserve fish and their habitats. Diadromous and resident riverine fish species are an important component of the Connecticut River's ecology and in some cases are the basis for a sport fishery. Furthermore, two of the states' Species of Greatest Conservation Need (SGCN) that would potentially be impacted have been documented in the project-affected areas.

The New Hampshire Department of Environmental Services is responsible for ensuring that surface water quality standards are met in all surface water bodies. The surface water quality criteria for Biological and Aquatic Community Integrity are:

1. The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms and have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.
2. Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

Diadromous and resident riverine fish are important components of the ecology of the Connecticut River.

This requested study will help promote tributary and backwater access and protect valuable fish habitat, and maintain appropriate water quality conditions for diadromous and riverine fish species in project-affected areas. Maintaining connectivity between the mainstem of the Connecticut River and tributaries and backwaters is vital to the fish populations in these systems, as many fish species utilize these areas for spawning, rearing, refuge, and feeding.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

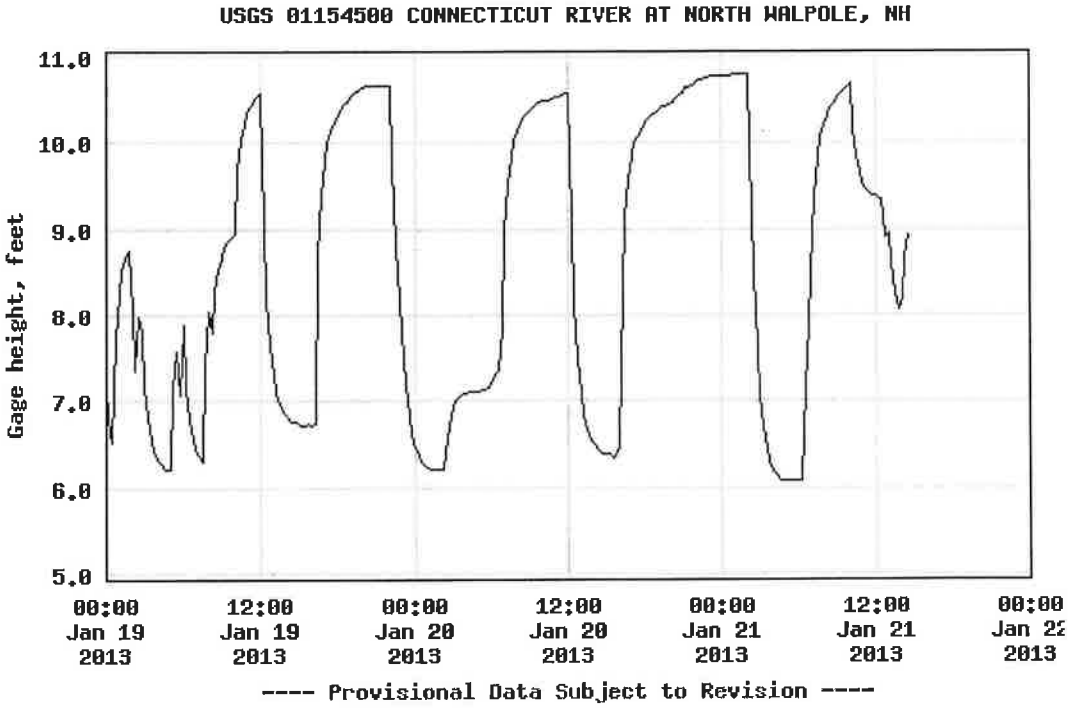
Public Interest

The requestor is federal natural resource agency.

Existing Information

To our knowledge, no information exists related to this requested study.

An example of the water level fluctuations that occur in the lower Connecticut River due to hydropower generation is shown below.



Nexus to Project Operations and Effects

Project operations have the potential to impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, water level changes due to project operations could create conditions that could impede free movement of fish between tributaries/backwaters and the mainstem of the Connecticut River, thus limiting access to spawning habitat and/or growth opportunities. Additionally, water level changes could also alter tributary and backwater fish habitat quality, quantity, and also water quality, thus decreasing productivity and available habitat. Furthermore, two of New Hampshire and Vermont's SGCN that could be impacted have been documented in the project-affected areas.

Methodology Consistent with Accepted Practice

Common tools to evaluate water level impacts would be used, including bathymetric mapping, substrate, depth and velocity measurements, and water quality information (dissolved oxygen, temperature, turbidity, and pH). Studies should be conducted throughout the year.

The study area for tributary and backwater fish sampling should cover all tributaries and backwaters within the project-affected areas of the Vernon, Bellows Falls and Wilder hydroelectric projects. 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 the 25-75th percentile of average weekly flow values) during the study period.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

TransCanada does not propose any studies to meet this need. Estimated cost for the study is relatively low.

TransCanada Study Request #19

Impacts of Water Level Fluctuations on Aquatic Vegetation, Including Invasive Species, in the Vernon, Bellows Falls and Wilder Project Impoundments and Riverine Reaches

(Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

The goal of this study is to determine if the full range of water level fluctuations from the Vernon, Bellows Falls and Wilder hydroelectric projects negatively impact emergent aquatic vegetation (EAV) and submerged aquatic vegetation (SAV) and their habitats in the impoundments and riverine reaches below the dams.

The objective is to conduct field studies in mainstem littoral zones, tributaries and backwaters to determine if EAV and SAV species distribution and abundance, and their habitats, are impacted by current water level fluctuations permitted under the TransCanada projects' licenses; whether aquatic vegetation and its habitats can be enhanced by modifications to project operations or other mitigation measures; and whether there is any unique or important shoreline or aquatic habitats that should be protected. Results of this study may also be used to help determine the adequacy of existing downstream minimum flow requirements.

The specific objectives of the field study, at a minimum, include:

1. quantitatively describe and map wetland types within 200 feet of the shoreline, and describe associated wildlife;
2. delineate, quantitatively describe, and map all wetland types including invasive species and wildlife observed (e.g., bald eagle nesting, waterfowl nesting) within 200 feet of the shoreline, and the extent of this habitat if it extends beyond 200 feet; and
3. quantitatively describe (e.g., substrate composition, vegetation type and abundance) and map shallow water aquatic habitat types subject to project operation inundation and exposure, noting and describing additional areas where water depths at lowest operational range are wetted to a depth less than one foot (flats, near shore areas, gravel bars, with very slight bathymetric change).

The field study should produce a habitat inventory report that includes:

1. the results of the field study in the form of maps and descriptions;
2. an assessment of project effects on wetland, riparian, littoral zone vegetation and shallow water habitats, invasive plant species, and wildlife habitat at the project; and
3. recommendations for any necessary plant, habitat type, or wildlife, protection and/or invasive species control measures.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to aquatic resources, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

A mission of both the New Hampshire Fish and Game Department and the Vermont Fish and Wildlife Department is to protect and conserve fish and their habitats. Riverine fish species are an important component of the Connecticut River's ecology and in some cases are the basis for a sport fishery. Aquatic vegetation is crucial fish habitat, as the majority of fish in the project impoundments utilize EAV and SAV at some point during their life history. This requested study will help enhance EAV and SAV in the project impoundments.

The New Hampshire Department of Environmental Services is responsible for ensuring that surface water quality standards are met in all surface waterbodies. The surface water quality criteria for Biological and Aquatic Community Integrity are:

1. The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms and have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.
2. Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

Aquatic vegetation, such as EAV and SAV, is an important component of the ecology of the Connecticut River.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

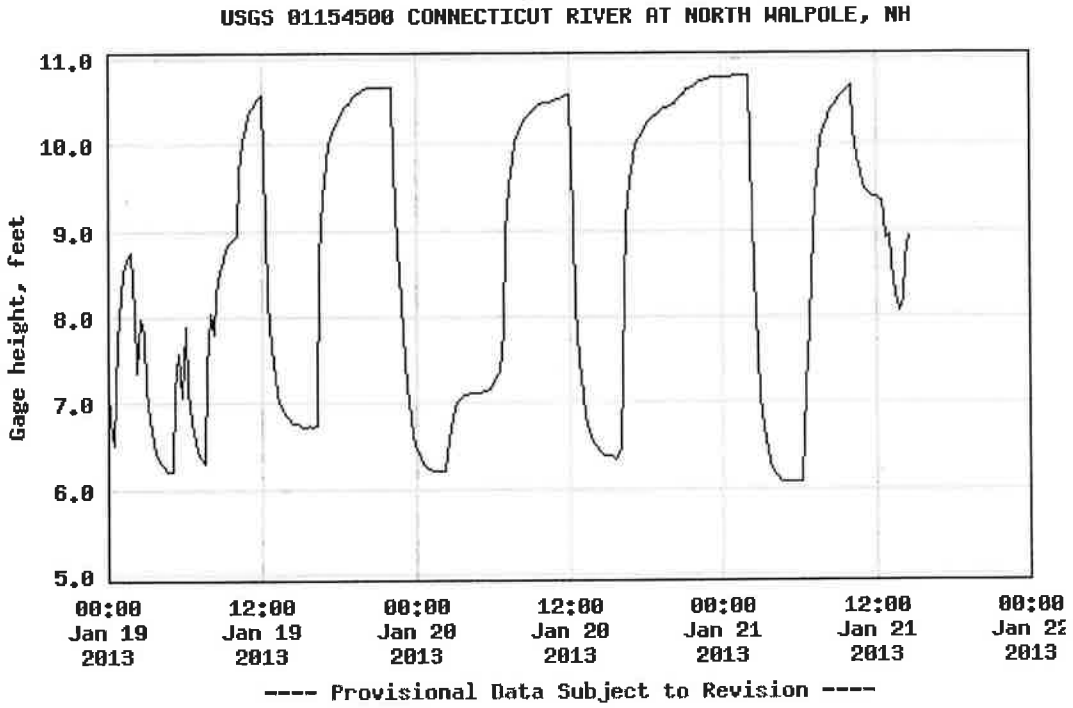
Public Interest

The requestors are natural resource agencies.

Existing Information

Existing information in the PADs does not quantify EAV and SAV. However, the Applicant acknowledges that water level fluctuations caused by the project have the potential to affect fringing wetland and littoral areas: "The average daily water level fluctuation of 2.5 vertical feet has resulted in a zone of sparse vegetation along most of the shorelines of the impoundment. Wetland and littoral resources in this zone are limited by the frequent wetting and drying." (Wilder PAD, p. 3-104; see also similar language in the Bellows Falls PAD, p. 3-115, and the Vernon PAD, p. 3-143).

An example of the water level fluctuations that occur in the lower Connecticut River due to hydropower generation is shown below.



Nexus to Project Operations and Effects

Water level fluctuations due to project operations have the potential to influence fish species life history requirements, biological interactions, and habitat quantity and quality by impacting EAV and SAV. For example, water level changes due to project operations could create conditions where EAV and SAV abundance is diminished, thus negatively impacting a habitat used by riverine fish for spawning, rearing, feeding, and cover. Additionally, water level fluctuations due to project operations could influence EAV and SAV habitat in the project impoundments and

promote invasive plants over native species. This study needs to take into account existing and potential future limits on impoundment level fluctuations intended to limit recreation impacts, and the interactions of any changes in pond level fluctuation range or frequency and discharge changes.

Methodology Consistent with Accepted Practice

Vegetation mapping and mapping of littoral zones in relation to water level fluctuations are common tools for identifying EAV and SAV that may be impacted by changes in water levels. The study should include field surveys designed to describe the characteristics of each mapped wetland, riparian, littoral and shallow water habitat, including plant species composition, relative abundance/density, habitat quality, and land use. These surveys should be conducted to describe these habitats at the lowest water level operational range permitted on a daily operation schedule, under low flow conditions. Information collected should include:

1. plant species composition, and their relative abundance/density and condition/structure (e.g., seedlings);
2. surveying for the federally endangered Northeastern bulrush (*Scirpus ancistrochaetus*);
3. structured data, including estimates of average heights and aerial cover of each vegetation layer (specifically denoting invasive species);
4. aquatic habitat substrate composition, quantity (i.e., percent types and area), wood structure (relative abundance measure applied by area), water depths (inundated, exposed, and water less than one foot);
5. predominate land use(s) associated with each cover type;
6. notation of wildlife sightings;
7. field-verified wetland, riparian, and littoral and shallow water habitats and invasive species occurrences (should be geo-referenced as polygons and overlain on orthophoto at a suitable scale); and
8. identification (mapped location, total area) of any EAV, SAV or other fish habitat (i.e., wood, rocks, etc.) that is dewatered at the lowest water level operational range permitted on a daily operation schedule, under low flow conditions.

Bathymetric mapping of the littoral zone will be needed to model the extent of this zone that will be affected by different water fluctuation scenarios.

The study area is from the most upstream area influenced by the Wilder Dam to the most downstream area influenced by the Vernon Dam. Water level fluctuations caused by the projects may affect not only the impoundments, but also the downstream river reaches below the dams. Studies would occur in the main river littoral zone and in backwater areas during spring, summer and fall. 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 proves to be atypical (outside of the 25-75th percentile of average weekly flow values) during the study period.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

Although the PADs acknowledge that project operations have the potential to impact littoral resources, TransCanada did not propose any studies concerning aquatic vegetation. Analysis as described above is needed to understand potential impacts of the projects on these resources. Estimated cost for the study is moderate due to the need for field assessment.

TransCanada Study Request #20

Water Quality Monitoring
(Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

The goal of this study is to determine if the operational impacts of the Vernon, Bellows Falls and Wilder hydroelectric projects are causing or contributing to violations of New Hampshire and/or Vermont state water quality standards.

The specific objectives of this study are as follows:

1. Characterize water quality in the impoundments, Bellows Falls bypass reach, Bellows Falls canal and project tailraces.
2. Evaluate the potential effects of project operations on water quality parameters such as temperature and dissolved oxygen (DO) in conjunction with various other water uses.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to water quality within the project areas, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a natural resource agency.

Existing Information

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont water quality standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Vermont lists the section of the Connecticut River below the Wilder dam on the Section 303(d) impaired water list due to flow alterations, aquatic life and habitat.

All sections of the Connecticut River related to the projects are classified by New Hampshire as Class B. It should be noted that although the classification name is the same as Vermont's, New Hampshire surface water criteria for Class B waters are, in some cases, different from Vermont's.

New Hampshire surface water quality standards (Env-Wq 1703.01) state that the surface water quality criteria for all surface waters shall be restored to meet the water quality criteria for their designated classification, including existing and designated uses, and to maintain the chemical, physical, and biological integrity of surface water.

The PADs contain information on water quality monitoring that was completed by TransCanada between June 20, 2012 and September 11, 2012 within the project areas.

Vernon Project: Continuous water quality data were collected in the tailrace and immediately upstream of the dam. Additionally, weekly water column profiles were collected at three locations within the impoundment. Results indicated that water temperature reached critical threshold levels for salmonids. Summary results presented in the PAD indicate that, in general, temperature and pH increased from upstream to downstream while DO decreased, reflecting the impacts of the impoundment on increased travel time in the river.

Bellows Falls Project: Continuous water quality data were collected in the tailrace, bypass reach, and immediately upstream of the dam. Additionally, weekly water column profiles were collected at three locations within the impoundment. The data indicated that Vermont and New Hampshire water quality standards for DO were not met in the bypass reach and in the impoundment. Furthermore, pH readings collected in water profile measurements indicated that in two different locations during two separate events, the impoundment did not meet Vermont and New Hampshire water quality standards. Summary results presented in the PAD indicate that, in general, temperature and specific conductivity increases from upstream to downstream within the impoundment.

Wilder Project: Continuous water quality data were collected in the tailrace and immediately upstream of the dam. Additionally, weekly water column profiles were collected at three locations within the impoundment. The data indicated that Vermont water quality standards for DO were not met during a seven-day period in August. Summary results presented in the PAD indicate that, in general, temperature and specific conductivity increased from upstream to downstream while DO decreased, reflecting the impacts of the impoundment.

All projects: The way the results are presented in the PADs does not allow for an adequate understanding of how water quality is affected by project operations.[1] Further, the results that were presented indicate that water quality standards are not being met at certain times at some of the projects. TransCanada does not propose to continue the water quality monitoring effort it began last summer. Additional monitoring is needed so that resource agencies can properly evaluate the potential impact of project operations on water quality.

Nexus to Project Operations and Effects

The projects impound many miles of river that would otherwise be free flowing (26 miles each at Vernon and Bellows Falls, and 45 miles at Wilder). All projects currently operate in a peaking mode, with allowable impoundment fluctuations from three feet at Bellows Falls up to eight feet at Vernon, with proposals to continue as such. The below-project flow requirement at each project is equal to 0.20 csm. There is no flow requirement for the 3,500-foot-long bypass reach at the Bellows Falls Project. Water quality can be affected by the operating mode of a hydropower project. The PADs provide limited information on how project operations affect water quality within the project areas.

Operation of the projects must conform to Vermont and New Hampshire water quality standards. The Service requests a study that will provide the data needed to determine if the Connecticut River in the vicinity of the projects is or is not attaining the water quality standards of both states.

Methodology Consistent with Accepted Practice

The methodology for this study should be similar to TransCanada's water quality monitoring in 2012, including weekly vertical profiles within the impoundment, weekly water quality samples of nutrients and chlorophyll-a for laboratory analysis and the deployment of multi-parameter continuous data loggers at multiple locations within the impoundment and tailrace. An additional site should be monitored in the free-flowing section of the river above the impoundment to serve as a "reference site." In order to ensure that data are collected during a time of important biological thresholds and anticipated "worst case" conditions for DO (low flow, high temperature, antecedent of any significant rainfall event), we recommend deploying continuous data loggers at all locations, with biweekly vertical profiles taken at the deep impoundment locations from April 1 through November 15. Results should include date, time of sampling, sunrise time, GPS location, generation status (estimated flow through power stations, spillway gates and Bellows Falls bypass reach), precipitation data, water temperature, DO concentration, and percent saturation. Water quality results should be graphically compared to both state water quality standards and project operations, including the generation status, impoundment elevation, and discharge.

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[1] With the exception of trends in water temperature. Monitoring results show that both the mean and median temperature increased by 10°F (6°C) from the uppermost monitoring station in the Wilder impoundment down to the Vernon tailrace station. The cumulative impact of the three long impoundments on water temperature is of concern to the Service, particularly in the context of climate change.

If river flow and temperature conditions are representative of an "average" or "low" water year, then one year of data collection should be sufficient to perform the study. If conditions are not representative (i.e., a "wet" or cool year), a second year of data collection may be necessary.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

The cost and effort for this study will be moderate. It is expected to take two technicians approximately three days to deploy the loggers, twelve days to collect the vertical profiles, three days to remove the loggers, three days to download the data, and two weeks to write the report. TransCanada has proposed no studies to address this information need.

TransCanada Study Request #21

Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects

(Turners Falls, P-1889; Northfield Mountain, P-2485; Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

The goal of this study is to determine how climate change relates to the continued operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage (NMPS), and Turners Falls projects.

The objectives of this study are:

1. Quantify the amount of thermal loading contributed by each respective impoundment (including the NMPS upper reservoir).
2. Using climate change prediction models, calculate how much warmer the project impoundments are projected to get in the next 30-50 years.
3. Model the effect of various project modifications on river temperature under current conditions and climate change predictions (e.g., converting to run-of-river, deep-water releases, dam removal, large-scale riparian revegetation, etc.).
4. Using climate change prediction models, determine if the projects actually provide an environmental benefit with respect to mitigating against climate change impacts (vis a vis warming of air and water temperatures) by producing low greenhouse gas emitting energy. The NMPS assessment must be based on net energy production (i.e., NMPS generates 1,143,038 MWh annually, but consumes 1,567,506 in its pumping operations, for a net consumption of 424,468 MWh annually).
5. Determine how climate change predictions will impact management of high flow events at the three projects and evaluate if changes to dam structures would mitigate adverse impacts of the existing flood management protocols.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to climate change, the Service's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize deep headpond drawdowns associated with the loss of stanchion logs during high flow events, which are predicted to increase due to climate change.
3. Minimize project-related sources of thermal increases to Connecticut River waters to mitigate against predicted climate change impacts.

The Service, along with the National Oceanic and Atmospheric Administration (NOAA) and the Association of Fish and Wildlife Agencies, developed a draft *National Fish, Wildlife and Plants Climate Adaptation Strategy* (Strategy) in 2012. The public comment period closed on March 5, 2012, and the agencies are working to finalize the document. Goal #7 of the Strategy calls for reducing non-climate stressors to help fish, wildlife, plants, and ecosystems adapt to a changing climate. The Strategy notes that some stressors (such as habitat loss and fragmentation and pollution) "are not only some of the things decision makers can control, they are also likely to interact with climate change to magnify negative impacts on fish, wildlife, and plants."

Goal #7 contains a number of strategies and associated actions, including:

Strategy 7.1: Slow and reverse habitat loss and fragmentation

Actions:

1. Consider application of offsite habitat banking linked to climate change habitat priorities as a tool to compensate for unavoidable onsite impacts and to promote habitat conservation or restoration in desirable locations.
2. Identify options for redesign and removal of existing structures/barriers where there is the greatest potential to restore natural processes.

Strategy 7.2: Slow, mitigate, and reverse where feasible ecosystem degradation from anthropogenic sources through…water resource planning, pollution abatement…

Actions:

1. Work with….water resource…planners to identify potentially conflicting needs and opportunities to minimize ecosystem degradation resulting from development and land and water use.
2. Reduce existing pollution and contaminants and increase monitoring of air and water pollution.
3. Increase restoration, enhancement, and conservation of riparian zones and buffers in agricultural and urban areas to minimize non-point source pollution.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requester is a resource agency.

Existing Information

The PAD contains no information relative to climate change and how climate change predictions may impact future operation of the hydroelectric plants, nor of how the projects either mitigate for or exacerbate predicted climate change impacts to freshwater ecosystems.

TransCanada's PAD provides a summary of water quality data collected in 2012. Table 1 below is a synthesis of the temperature data collected by TransCanada. It should be noted that the upper and mid-impoundment stations at each project represent the average of temperature readings taken over the entire water column, while the continuous loggers (Lower Cont. and TR) were located near the water surface. These data indicate that from the upstream end of the Wilder headpond to the Vernon tailrace, water temperature increased approximately 6°C.

Table 1. Median water temperature at monitoring stations located within the impoundments and tailraces of the three hydropower projects.

	Median Water Temperature °C			
Project	Upper Imp.	Mid-Imp.	Lower Cont.	TR
Wilder	20.86	21.83	24.08	23.59
Bellows Falls	22.43	23.67	24.86	24.38
Vernon	23.81	24.49	26.73	26.35

Relative to existing flood management protocols at each station, TransCanada's PAD identifies that all three dams utilize stanchion bays (two at Vernon, three at Bellows Falls, and four at Wilder). When inflows to each dam reach certain levels, the stanchion bays are removed, and cannot be replaced until inflows subside. The depth of these bays and the flows at which they are removed are outlined in Table 2 below.

Table 2. Summary of pertinent stanchion bay information for the Vernon, Bellows Falls, and Wilder projects.

Project	Stanchion Height (feet)	Flow Complete Removal	Triggering Stanchion
Wilder	17	145,000 cfs	
Bellow Falls	13	50,000 cfs	
Vernon	10	105,000 cfs	

The PAD provides no information on the history of stanchion removal at any of the projects (frequency, duration, timing), nor a discussion of how predicted climate change might alter management of the stanchion bays in the future (with respect to the frequency and seasonality of occurrence). There also is no discussion of potential impacts to headpond resources that occur as a result of stanchion bay removal. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations with respect to the Service's management goals and objectives, including those identified in the Strategy.

Data provided by NOAA, Climate Data Center, illustrates long-term increasing air temperatures in the Northeast (Figure 1). Long-term, monthly mean water temperature data for the Vernon Dam impoundment, monitored by Vermont Yankee, has shown significant differences over time (ANOVA analyses, $P < 0.05$) that when plotted and further analyzed by linear regression, show a significant increasing trend for the period 1974–2010 for the months of January, September, and October (Figure 2). These analyses were performed with data from Vermont Yankee, analyzed by the Massachusetts Department of Environmental Protection.

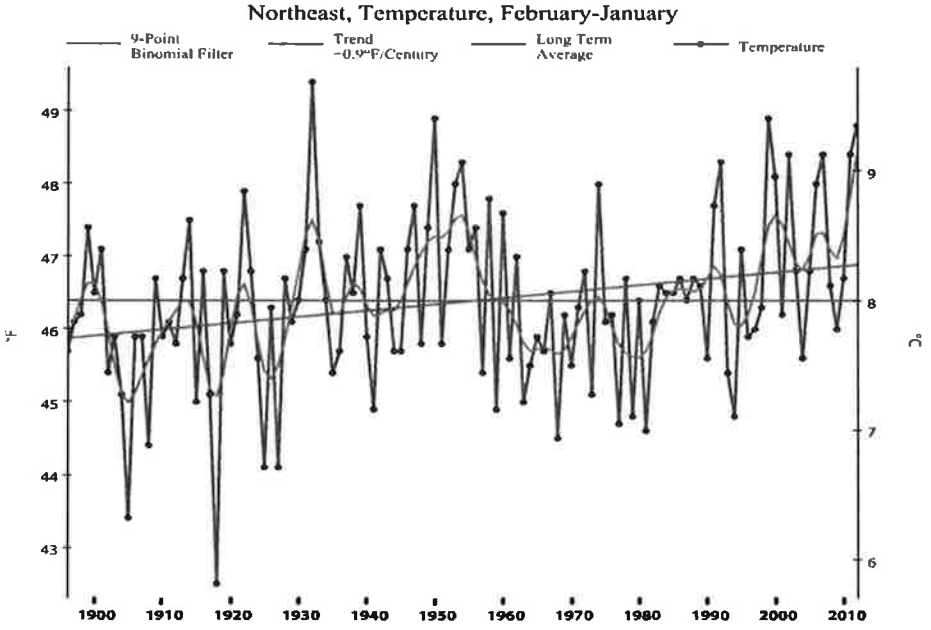

Figure 1. NOAA National Climate Data Center, Northeast 12-month average temperature for the period 1896 through 2012.

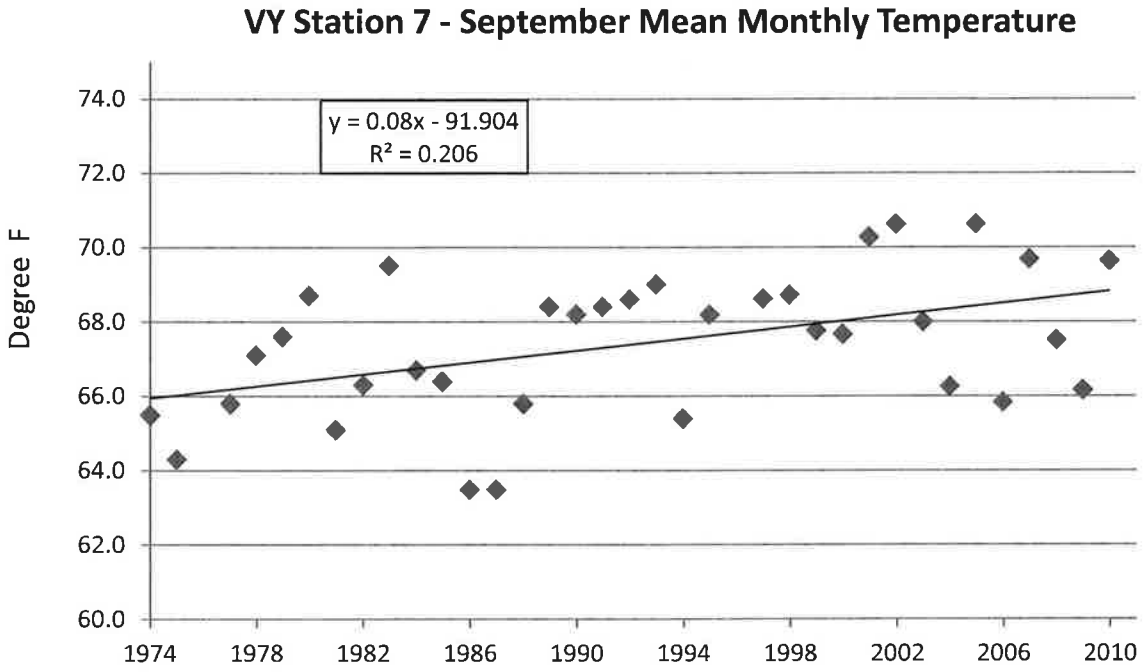

Figure 2. A plot of September's mean temperatures for Vermont Yankee's Station 7 (excludes outlier 1996 data point) for the period 1974 through 2010.

The PAD for the Turners Falls and NMPS projects provides a summary of existing water quality data compiled by FirstLight, including water temperature data obtained from the Service. The PAD also notes a 1991 study by the former licensee that modeled thermal effects of pumping to the upper reservoir. That model reported a maximum temperature difference attributable to NMPS operation of 0.21°C in the Turners Falls reach of the Connecticut River in low flow (4,000 CFS) simulation.

Nexus to Project Operations and Effects

The four mainstem projects have very long impoundments capable of storing large volumes of water (Table 3 below). These impoundments effectively have converted large portions of the Connecticut River into a series of in-river "lakes." Because water velocities slow in these impounded sections of the river, it allows for increased thermal loading and resultant higher water surface temperatures than in free-flowing sections of the river.

Table 3. Relevant characteristics of the reservoirs behind the Wilder, Bellows Falls, Vernon, Turners Falls dams and NMPS.

Project	Headpond Length (miles)	Gross Storage Volume (acre-ft.)	Average Depth (ft.)	Surface Area (acres)	Flushing Rate (days)
Wilder	45	34,350	11	3,100	3
Bellows Falls	26	26,900	10	2,804	<2
Vernon	26	40,000	16	2,550	2
Turners	20	21,500		2,110	
NMPS	n.a.	17,,050		246	n.a.

Depending on where the hydropower intakes withdraw water, these warmer surface waters may be discharged downstream, raising the temperature of those waters as well (the data in Table 1 above suggest that the projects do draw water from the upper levels of the reservoirs). This effect may be felt for miles downstream. If there are a series of impoundments (like on the Connecticut River), the cumulative impact is an overall warming of the river. Even small run-of-river dams have been shown to elevate downstream water temperature (Lessard and Hayes 2003; Saila *et al.* 2005). The most recent climate change prediction models specific to the Northeast forecast warmer air temperatures, more frequent high precipitation events, more heat waves, and an increase in the incidence of short-term droughts (Karl *et al.* 2009).

Resource concerns related to this project effect include the potential impacts to populations (reductions in abundance, structure, condition) or loss of species not tolerant of increases in temperature and other effects related to physiology such as energetic costs with warmer temperatures (Leggett 2004). As one example, American shad restoration target numbers for fish passage at mainstem dams into upstream historic habitat could be negatively impacted from artificially increased water temperatures. Water temperature has been identified as a factor in the timing (i.e., duration) of this species migration, as well as its role in gonad development and spawning (Glebe and Leggett 1981; Leggett 2004). These factors can be logically reasoned to result in accelerated rates of energy reserve use and a reduced migration window, possibly reducing the ability of fish to reach up-river habitats and further reducing the ability to survive downstream outmigration.

With respect to project operations during high flow events, all TransCanada projects have stanchion bays that are used to manage water during high flow events. Each time these stanchion bays are removed, the headponds are lowered substantially (from 10 to 17 feet, depending on the project) and must remain lowered until inflows subside. Depending on the timing and duration of these deep drawdowns, headpond resources could be negatively impacted.

All of the dams also contain other mechanisms for managing flows, such as tainter gates, sluice gates, roller gates, skimmer gates and hydraulic flood gates. All of these gates have an advantage over stanchion bays in that they do not require flows to subside significantly before they can be closed to return impoundment levels back to normal. One climate change prediction for the

Northeast is that we will see more frequent high precipitation events which will result in high flow conditions on rivers. Therefore, it is likely that the stanchion bay removal protocol will have to be employed more frequently in the future.

Methodology Consistent with Accepted Practice

1. In order to quantify the amount of thermal loading contributed by each respective impoundment, detailed bathymetry will need to be collected. This bathymetry, combined with storage volume, tributary hydrology, and project operations, should be used to calculate the thermal loading of each headpond. The individual and cumulative increase in surface water temperature due to the impoundments should then be used to predict future warming based on climate change models.

2. Analyze different mitigation strategies to understand which have the greatest benefit in terms of building resilience against the impacts of climate change on water temperature. Potential scenarios to analyze include converting the projects to run-of-river, implementing deep-water releases, removing one or more dams, conducting large-scale riparian revegetation, etc.).

3. Input to climate change models the amount of GHG emissions that would be generated if fossil fuel plants were producing the equivalent amount of net energy as the five hydropower projects to determine the impact on air and surface water temperatures.

4. Climate change prediction model output should be assessed to determine if the frequency and timing of high flow events are likely to change in the future. If high flow events that necessitate initiating the stanchion bay removal protocol are predicted to increase in frequency and/or shift in timing, the Applicant should evaluate structural and/or operational alternatives that would mitigate adverse impacts of the existing flood management protocols.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

The level of cost and effort for the thermal loading analysis would be low to moderate. Collecting bathymetry in the three TransCanada headponds would take two staff members less than one week to collect (it took the Kansas Biological Survey two days to collect bathymetry at a 3,500-acre lake; Jakubauskas *et al.* 2011). Bathymetry for the Turners Falls pool and NMPS upper reservoir already exist. The remaining work would be desk-based, loading relevant information into an appropriate thermal loading model to compute the estimated thermal loading of each headpond and then comparing this information to surface water data from climate change prediction models.

The high flow flood protocol study is a desktop analysis that should require low cost and effort. Climate change models already exist and that output would be downloaded and analyzed. The remaining analysis requires a review of alternative means of managing flows without the use of stanchion bays.

The Applicant did not propose any studies to meet this need in the PAD.

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