New Hampshire
Fish and Game Department

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Glenn Normandeau
Executive Director

February 27, 2013

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

RE: Study Requests for FERC project numbers P-1904 (Vernon), P-1855 (Bellows Falls), and P-1892 (Wilder).

Dear Secretary Bose:

As the agency responsible for protecting fish and wildlife resources in New Hampshire, the New Hampshire Fish and Game Department (NHFGD) monitors and attempts to reduce the impacts of hydroelectric facilities on fish and wildlife species and their habitats. The 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, and to provide the public with opportunities to use and appreciate these resources. The NHFGD's 1998-2010 Strategic Plan contains four goals relevant to the relicensing process under the Federal Energy Regulatory Commission (FERC). These goals are to ensure that New Hampshire:

1) has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.

2) has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.

3) has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.

4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

Participation in the relicensing process for hydroelectric projects falls under one of the many strategies outlined in New Hampshire's Wildlife Action Plan. Wildlife Action Plans, completed in 2005, were required from each state by the United States Congress as a proactive strategy to "conserve wildlife and vital natural areas before they become more rare and more costly to protect". New Hampshire's Wildlife Action Plan contains three objectives relevant to the hydropower relicensing process.

Objective 507: Restore or maintain natural flow regimes.
Objective 508: Restore and maintain watershed continuity.
Objective 701: Protect riparian / shoreland habitat and other wildlife corridors.

In addition to these objectives, the New Hampshire Wildlife Action Plan identifies a number of fish and wildlife species of concern, which may be impacted by the projects under review. We hereby submit the New Hampshire Wildlife Action Plan to the FERC for consideration in determining whether it qualifies as comprehensive plans pursuant to Section 10(a)(2)(A) of the Federal Power Act. The complete New Hampshire Wildlife Action Plan is available online at: http://www.wildlife.state.nh.us/Wildlife/wildlife_plan.htm.

The NHFGD has reviewed the Preliminary Application Documents and Scoping Documents for the relicensing of the following hydropower projects owned by TransCanada Corporation:

Vernon Hydroelectric Project
FERC Project No. 1904

Bellows Falls Hydroelectric Project
FERC Project No. 1855

Wilder Hydroelectric Project
FERC Project No. 1892

The NHFGD submits the following formal study requests to expand on the information presented in each Pre-Application Document (PAD) and lead to informed management decisions intended to reduce impacts on fish and wildlife. It is understood that there is overlap between some of the requested studies, and where appropriate, the NHFGD supports the combination of studies to reduce cost and effort as long as the goals and objectives within each individual study proposal are still achieved.

Thank you for this opportunity to comment.

Sincerely,

Glenn Normandeau
Executive Director

Study Request 1a: Recreational Survey and Enhancement Study at Wilder Hydroelectric Project (Docket Number p-1892)

Goal and Objective

The goal of this study is to determine if potential impacts from project operations at the Wilder Hydroelectric facility support the goals of the NH Fish and Game Departments' Public Boating Access program and the Vermont Water Quality Standards for recreational uses, and to identify operational modifications that could be performed to enhance recreational opportunities.

The objectives are to:

Survey recreational users and potential users to identify to what extent existing recreational opportunities are being utilized by the public within the project boundaries and why potential recreational users are not using the resource.

Identify how project operations impact recreational users and how operations could be modified to improve recreational opportunities.

Identify how recreational opportunities in the vicinity of the project could be developed to enhance future recreational opportunities, including, but not limited to, boat access, primitive camping sites, improvement in portage trails, etc.

Resource Management Goals

The Connecticut River is considered a Class B waters. Vermont Water Quality Standards requires that Class B waters be managed to provide full support for all recreational uses, including swimming and other primary contact forms of recreation and boating, fishing and other recreational uses.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998); which are relevant to this study request are:

5) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
6) New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
7) New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
8) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest Consideration

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

Existing Information

The PAD provides information on the existing recreational resources, but does not provide information on how project operations adversely affect recreational opportunities or perception of recreational users utilizing opportunities in the vicinity of the project.

Project Nexus

The project impounds 45 miles of river that would otherwise be free flowing. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 5 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (675 cfs), but can increase rapidly during times of power generation. Recreational resources and opportunities can be affected by the operations of the hydropower project. The PAD provides limited information on how project operations affect recreational users and opportunities within the project impoundment and tailrace. The NHFGD requests a study to assess how recreational opportunities are impacted by normal daily/seasonal operation of the project.

Proposed Methodology

The proposed study methodology should include an inventory of all the recreational facilities and opportunities within the project boundary, and a determination of the number of recreational users utilizing the resources. The study should include a component to survey an equal proportion of recreational users utilizing different activities to determine how project operations affect their recreational use and experience, and identify any safety issues associated with project operations or current recreational facilities. Potential recreational users in the area should be identified to determine why potential recreational users do not use the resource. An analysis of the recreational facilities should be conducted to identify future projects that could improve the recreational resources and/or the need to improve existing recreational facilities or access to the resource.

Level of Cost and Effort

The cost and effort of this study will be moderate, but is important to document the potential impact operations on recreational opportunities. This study will also identify opportunities for future enhancement of recreational resources in the vicinity of the project.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010), Concord, NH.

Study Request 1b: Recreational Survey and Enhancement Study at Bellows Falls Hydroelectric Project (Docket Number p-1855)

Goal and Objective

The goal of this study is to determine if potential impacts from project operations at the Bellows Falls Hydroelectric facility support the goals of the NH Fish and Game Departments' Public Boating Access program and the Vermont Water Quality Standards for recreational uses, and to identify operational modifications that could be performed to enhance recreational opportunities.

The objectives are to:

Survey recreational users and potential users to identify to what extent existing recreational opportunities are being utilized by the public within the project boundaries and why potential recreational users are not using the resource.

Identify how project operations impact recreational users and how operations could be modified to improve recreational opportunities.

Identify how recreational opportunities in the vicinity of the project could be developed to enhance future recreational opportunities, including, but not limited to, boat access, primitive camping sites, improvement in portage trails, etc.

Resource Management Goals

The Connecticut River is considered a Class B waters. Vermont Water Quality Standards requires that Class B waters be managed to provide full support for all recreational uses, including swimming and other primary contact forms of recreation and boating, fishing and other recreational uses.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998), which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest Consideration

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

Existing Information

The PAD provides information on the existing recreational resources, but does not provide information on how project operations adversely affect recreational opportunities or perception of recreational users utilizing opportunities in the vicinity of the project.

Project Nexus

The project impounds 26 miles of river that would otherwise be free flowing. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 3 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1083 cfs), but can increase rapidly during times of power generation. Recreational resources and opportunities can be affected by the operations of the hydropower project. The PAD provides limited information on how project operations affect recreational users and opportunities within the project impoundment and tailrace. The NHFGD requests a study to assess how recreational opportunities are impacted by normal daily/seasonal operation of the project.

Proposed Methodology

The proposed study methodology should include an inventory of all the recreational facilities and opportunities within the project boundary, and a determination of the number of recreational users utilizing the resources. The study should include a component to survey an equal proportion of recreational users utilizing different activities to determine how project operations affect their recreational use and experience, and identify any safety issues associated with project operations or current recreational facilities. Potential recreational users in the area should be identified to determine why potential recreational users do not use the resource. An analysis of the recreational facilities should be conducted to identify future projects that could improve the recreational resources and/or the need to improve existing recreational facilities or access to the resource.

Level of Cost and Effort

The cost and effort of this study will be moderate, but is important to document the potential impact operations on recreational opportunities. This study will also identify opportunities for future enhancement of recreational resources in the vicinity of the project.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 1c: Recreational Survey and Enhancement Study at Vernon Hydroelectric Project (Docket Number p-1904)

Goal and Objective

The goal of this study is to determine if potential impacts from project operations at the Vernon Hydroelectric facility support the goals of the NH Fish and Game Departments' Public Boating Access program and the Vermont Water Quality Standards for recreational uses, and to identify operational modifications that could be performed to enhance recreational opportunities.

The objectives are to:

Survey recreational users and potential users to identify to what extent existing recreational opportunities are being utilized by the public within the project boundaries and why potential recreational users are not using the resource.

Identify how project operations impact recreational users and how operations could be modified to improve recreational opportunities.

Identify how recreational opportunities in the vicinity of the project could be developed to enhance future recreational opportunities, including, but not limited to, boat access, primitive camping sites, improvement in portage trails, etc.

Resource Management Goals

The Connecticut River is considered a Class B waters. Vermont Water Quality Standards requires that Class B waters be managed to provide full support for all recreational uses, including swimming and other primary contact forms of recreation and boating, fishing and other recreational uses.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998), which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.

4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest Consideration

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

Existing Information

The PAD provides information on the existing recreational resources, but does not provide information on how project operations adversely affect recreational opportunities or perception of recreational users utilizing opportunities in the vicinity of the project.

Project Nexus

The project impounds 26 miles of river that would otherwise be free flowing. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 8 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1250 cfs), but can increase rapidly during times of power generation. Recreational resources and opportunities can be affected by the operations of the hydropower project. The PAD provides limited information on how project operations affect recreational users and opportunities within the project impoundment and tailrace. The NHFGD requests a study to assess how recreational opportunities are impacted by normal daily/seasonal operation of the project.

Proposed Methodology

The proposed study methodology should include an inventory of all the recreational facilities and opportunities within the project boundary, and a determination of the number of recreational users utilizing the resources. The study should include a component to survey an equal proportion of recreational users utilizing different activities to determine how project operations affect their recreational use and experience, and identify any safety issues associated with project operations or current recreational facilities. Potential recreational users in the area should be identified to determine why potential recreational users do not use the resource. An analysis of the recreational facilities should be conducted to identify future projects that could improve the recreational resources and/or the need to improve existing recreational facilities or access to the resource.

Level of Cost and Effort

The cost and effort of this study will be moderate, but is important to document the potential impact operations on recreational opportunities. This study will also identify opportunities for future enhancement of recreational resources in the vicinity of the project.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 2: Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival (Docket Number 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 First Light Power's Turners Falls and Northfield Mountain Pumped Storage 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 Northfield Mountain 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:

- Assessment of any migration delays resulting from the presence of the dam and peaking flow operations of the Turners Falls Project;
- 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 #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;
- Assess near field, attraction to and entrance efficiency of the Spillway Ladder by shad reaching the dam spillway, under a range of spill conditions;
- Evaluate the internal efficiency of the Turners Falls Spillway Ladder;
- 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;
- Evaluate modifications to the Cabot and/or Spillway fishways recommended by the Service if they are implemented;
- Assess upstream migration from Turners Falls to the Vernon Dam in relation to Northfield Mountain's pumping and generating operations and Vernon Project peaking generation operations. Typical existing and proposed project operation alterations should be evaluated;

- Assess near field, attraction to and entrance efficiency of the Vernon Dam Ladder;
- Assess internal efficiency of the Vernon Dam Ladder;
- 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)
- 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;
- 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;
- Assess impacts of Northfield Mountain operations on up- and downstream adult shad migration, including delays, entrainment, and behavioral changes and migration direction shifts under existing and proposed project operations;
- 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;
- Determine downstream passage route selection, timing/delay in the canal, Cabot Station fish bypass facility effectiveness, and survival of Cabot-bypassed adult shad that enter the Turners Falls Canal system;
- 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
- Utilize available data sets and further analyze raw data (e.g., 2003- 2012 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 samples 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 First Light by U.S. Geological Survey's Conte Anadromous Fish Research Center (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, Northfield Mountain 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, CT 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 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 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 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 objectives).

Besides 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 flow releases from the project increase from the required minimum flows to peak generation flows and when flows subside from peak generation flows to minimum flows and 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. (Table 1)

2. Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

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:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes and recommendations:

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 –
4. 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 New Hampshire Fish and Game Department (NHFGD) 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 movement and migration, the NHFGD's goals are:
1. 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.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study, in order to collect information holistically for the Connecticut River. Impacts associated with the operation of all the dams, both lower and upper on the Connecticut River, does contribute to the success of the State's management goals for fish and wildlife in New Hampshire. The requestor is a state natural resource agency.

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 Cabot and Spillway is poor (<10% in many years). Passage through the Gatehouse fishway is better, but still rarely exceeds 80%, despite the short length of this ladder. In addition to poor passage for fish entering the ladders, shad that ascend the Cabot 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% to over 50% 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 Gatehouse, experience similar delays in downstream passage, even after they have stopped trying to pass Gatehouse. Without spill, all outmigrating shad that have passed Gatehouse must enter the canal at the Gatehouse 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 2-dimensional array covering the canal just downstream of Gatehouse, 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 are 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 were not available at this time, but Dr. Castro-Santos stated similar patterns were noted in the data between the years on the topic of upstream delay (personal communication, Dr. Theodore Castro-Santos). Similarly, concerns relative to the downstream passage of spent shad also remain relative to delays, with existing unpublished USGS 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), the percent passage of American shad annually passed upstream of Turners Falls Dam compared to the number passed at the Holyoke Fish Lift has averaged 3.6% (1980-2012 data). The highest values for this metric has not exceed 11% and are well below the noted CRASC Management Plan target range for this objective noted earlier as 40-60% 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 Vernon compared to the number passed upstream of Turners Falls Dam (Gatehouse counts) has averaged 39.4%, ranging from 0.42% to 116.4% (> 100% due to 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), additional 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

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 U.S. Geological Survey's Conte Anadromous Fish Research Center, 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, 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 support assessment of the various operational and structural conditions in effect, to be modified in this period, and proposed conditions within the Turners Falls power canal relative to entrances to the Gatehouse fishway. A related request on CFD modeling in the Cabot Station tailrace, the upper power canal near Gatehouse, 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 Holyoke and tagged and release upstream of Turners Falls Dam, or tagged out of Gatehouse Ladder, would help to ensure an adequate sample size for evaluations in the vicinity of NMPS and to the Vernon Dam and the ability to address identified study objectives in those project areas. Additional tagged shad are expected to be required for release upstream of the Vernon Dam, which should ensure adequate sample for a separate study request, where shad spawn upstream of Vernon Dam as well as ensuring there is an adequate number of outmigrating spent adults to address related study objectives for adult outmigrants. The required number of tagged fish to address study objectives may be adjusted accordingly from area to area depending on target numbers (i.e., best information on resultant viable tagged fish and power analyses to detect effects) to account for typical passage rates, survival rates, and handling effects as examples.

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, ensuring adequate downstream adult fish sample sizes (to address project effect questions above) requires close consideration as expected losses of healthy tagged fish during upstream passage, natural mortality rates, and tagging related effects, are expected to reduce sample sizes on downstream passage objectives/questions as the season progresses. 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). This study will be coordinated with the proposed study request to evaluate ensonification as a shad behavioral deterrent at the Cabot Station tailrace which will be an additional treatment of the telemetry study.

In addition to the tagging studies, use of video monitoring of the Spillway Fishway would provide additional overall data on Spillway Fishway 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 Holyoke 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. Video monitoring of the Spillway fishway would add a modest cost to this study.

Due to the fact 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.

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Study Request 3: Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

Goals and Objectives

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

The objectives of this study are:

1. 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 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 watershed 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 FERC 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 New Hampshire Fish and Game Department (NHFGD) 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 downstream passage of American eel, the NHFGD'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 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.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest
The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural 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 presence of "eel-sized" acoustic targets have been collected (Haro et al. 1998) 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 United States Fish and Wildlife Service (USFWS) 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 USFWS 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. On September 29, 2011 the USFWS issued a substantial 90-day finding and initiated a 12-month status review. It is our understanding that the USFWS is still accepting new American eel information for the ongoing status review.
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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, 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.

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

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Study Request 4: Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and downstream from Bellow Falls Dam. (Docket Number 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) 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 Northfield Mountain Pump Storage 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:

- Determine areas utilized by American shad for spawning by conducting night-time visual observation of spawning activity, identify and define areas geospatially, and obtain data on physical habitat conditions effected by project operations (e.g., water depth, velocity, discharge, substrate, exposure and inundation of habitats);
- Determine project operation effects on observed spawning activity, under a range of permitted or proposed project operation conditions;
- 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;
- Quantify spawning activity as measured by night-time spawning/splash surveys and egg collection in areas of spawning activity, and downstream of these areas, to further determine project operation effects (location extent of exposure from changing water levels and flows and on associated habitats from project operations).

If it is determined that the Project operations are adversely affecting the spawning activity of American shad and impacting spawning area habitat, identify operational regimes that will reduce and minimize impacts spawning habitat and spawning success, within the project area. 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 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% of the spawning run (based on a 5-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:

2. Maximize the number of juvenile recruits emigrating from freshwater stock complexesand recommendations:
3. To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
4. 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.
5. 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.
6. When considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations to enhance river habitat.

The New Hampshire Fish and Game Department (NHFGD) 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 NHFGD's goals are:

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

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state 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 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 (Davis et al, 1970, 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 6 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, MA. 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 NHFGD 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).

First Light Power conducted studies in the late spring and summer of 2012, examining 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, MA (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 NHFGD is not aware of any studies being conducted specifically designed to determine if a relationship exists between spawning behavior, habitat use, and egg deposition and project operations effects of the Turners Falls, Northfield Mountain Pump Storage and Vernon projects and downstream of Bellows Falls Dam..

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

Methodology

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 first year 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, then 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.

Potential impacts to spawning behavior would best be studied by night-time 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, night time observations of splashing associated with shad spawning should be performed in each reach as sufficient numbers of shad are passed above each dam. Observations should be performed 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 First Light or TransCanada propose any studies to meet this need. Estimated cost for the study is expected to be moderate for each owner, with the majority of costs associated with fieldwork labor.

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Study Request 5: Bellows Falls Bypass Flow (Docket Number p-1855)

Goals and Objectives

The goal of this study is to determine an appropriate bypass flows 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.

Relevant Resource Management Goals

The New Hampshire Fish and Game Department (NHFGD) 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 NHFGD'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 meets 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.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Background and 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% of the time on an annual basis. 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 NHFGD to use in determining appropriate flows in the bypass reach.

Project Nexus

The Project includes a 3,500-foot-long bypass reach. Absent a mandated discharge at the dam, this habitat would reamin dewatered during those times when inflow was within the hydraulic capacity of the units (~70% 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 NHFGD 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 Commission.

Proposed methodology

The NHFGD 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 1 dimensional modeling may not be sufficient to assess the habitat suitability in the bypass reach but rather 2 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 and cost

The expected level of effort and anticipated costs will be comparable to that experienced on similar FERC relicensing projects of this size.

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-fieldwork data analysis would be a 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 that experienced on similar FERC relicensing projects (e.g., the Glendale Project, FERC No. 2801).

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

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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, pages 7-8, October 2007.

Study Request 6: Shad Population Model for the Connecticut River (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

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:

- Annual projections of returns to the Connecticut River;
- A deterministic and stochastic option for model runs
- Life history inputs of Connecticut River shad
- Understanding the effect of upstream and downstream passage delay at projects
- Calibration of the model with existing data
- Analysis of the sensitivity of model inputs
- Analysis of sensitivity to different levels of up- and downstream passage efficiencies at all projects
- 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% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

3 Maximize outmigrant survival for juvenile and spent adult shad.

The New Hampshire Fish and Game Department (NHFGD) 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 NHFGD's goals are:

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

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state 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 % 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 NHFGD 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

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 #405, RSP 3.4). The model is constructed in Microsoft Access

Specific parameters that would be included in the model:

- Upstream passage efficiency at Holyoke, Turners Falls (Cabot, Gatehouse and Spillway Ladders), Vernon fishways, and any impacts associated with Northfield Mountain.
- Distribution of shad approaching the Turners Falls project between the Cabot Ladder and the spillway at the dam
- Downstream passage efficiencies at Vernon, Northfield Mountain, Turners Falls, and Holyoke projects for juveniles and adults
- Entrainment at Mount Tom and Vermont Yankee
- Sex ratio of returning adults
- The proportion of virgin female adults returning at 4, 5, 6, and 7 years
- The proportion of repeat spawning females at 5, 6 and 7 years
- Spawning success of females in each reach
- Fecundity
- Percent egg deposition
- Fertilization success

- Larval and juvenile in-river survival
- Calibration factor to account for unknown parameters such as at sea survival
- Options for fry stocking and trucking as enhancement measures
- Start year and model run years
- Start population
- Rates of movement to and between barriers
- Temperature, river discharge, and other variable 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 First Light 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.

Literature cited:

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

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NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 7: American Eel Survey Upstream of the Vernon, Bellows Falls, and Wilder Dams (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

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.

Relevant Resource Management Goals

The Atlantic States Marine Fisheries Commission 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 FERC 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 New Hampshire Fish and Game Department (NHFGD) 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 eels, the NHFGD'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 area.
3. Minimize current and potential negative project operation effects on American eel inhabiting the project area and/or moving through the area 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 minimizing impacts of dams and other obstructions along the Richelieu, St. Lawrence, and Connecticut Rivers.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

Background and Existing Information

According to the PADs, 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 evaluate properly the need for, and timing of, downstream passage and protection measures for outmigrating silver phase eels.

We also note that within the past seven years, the United States Fish and Wildlife Service (USFWS) 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 USFWS 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. On September 29, 2011 the USFWS issued a substantial 90-day finding and initiated a 12-month status review. It is our understanding that the USFWS is still accepting new American eel information for the ongoing status review.

Project Nexus

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 PADs, 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, then 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).

Proposed methodology

The NHFGD 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 (Appendix A), the eel assessment for the Merrimack River completed by the Service's Central New England Fishery Resources Office (Appendix B), and the proposed study plan for the relicensing of the Eastman Falls Project (FERC No. 2457)[3].

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).

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[3] FERC Accession No. 20121214-5121

Level of effort and cost

The expected level of effort and anticipated costs will be comparable to that experienced on similar FERC 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).

Literature Cited

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, 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).

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 8: Channel Morphology and Benthic Habitat Impacts at the Vernon, Bellows Falls and Wilder Projects (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

It is well known that dams interrupt the downstream continuum of sediment supply and transport, which in turn can affect channel morphology and limit the amount of coarse (i.e. gravel/cobble) substrate available for aquatic biota. The Vernon, Bellows Falls and Wilder projects' effects on fluvial processes, channel formation and associated anadromous and riverine fish habitat, as well as aquatic invertebrate habitat, is unclear. This study request aims to provide information on coarse sediment supply and transport as it relates to aquatic benthic habitat (e.g. gravel bars). Results will be used to identify techniques to minimize and/or mitigate impacts to this valuable habitat.

Goals and Objectives

The goal of this study is to understand how the projects affect bedload distribution, particle size and composition as it relates to habitat availability (amount and size of coarse substrate material) for different life-history stages of anadromous (e.g. sea lamprey) and riverine fishes (e.g. walleye), as well as invertebrates (e.g., tiger beetles, mussels- such as the federally-endangered dwarf wedgemussel).

The study objectives include:

1. Assess the distribution and extent of the existing substrate types, including gravel and cobble bars within the project affected areas.

2. Identify the current conditions of the channel and determine the stability of the present substrate/benthic habitat and identify if flow or sediment measures are necessary to improve the aquatic benthic habitat.

Resource Management Goals

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. Furthermore, the Vermont Fish and Wildlife Department's (VTFWD) mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 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.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

Gravel/cobble habitat is utilized by various riverine fish species during different life history stages and seasons, as it provides sites for spawning, feeding, and refuge (Gore and Shields 1995). Many fish species and aquatic invertebrates (e.g., fresh water mussels, snails, worms, and aquatic insects) live on or near gravel habitat, because it provides a source of food and cover (Miller 1988). Gravel bars also play an important role in water quality, hydrology, and morphology of rivers (Lewis 2005).

As identified in Vermont's Wildlife Action plan (Kart et al. 2005), several state listed mussel species are known to utilize gravel-type substrate. Furthermore, sea lamprey (*Petromyzon marinus*) spawning occurs over substrate composed of a mixture of sand, gravel and rubble. The sea lamprey, 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 (Kart et al. 2005) is degraded spawning habitat, which is second to habitat fragmentation. In support of the VTFWD and the NHFGD's missions, and the Vermont Water Quality Standards, it is important to gain a better understanding of the benthic habitat present in project affected areas and how projects operations may be affecting this habitat.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

Existing Information

The PAD generally focuses on erosional impacts due to the projects' operations, but lacks specific information on fluvial geomorphic processes and substrate composition as it relates to impacts to aquatic benthic habitat. Recent studies assessing fluvial geomorphic process and substrate composition in Connecticut River tributaries have documented the impacts of regulated flows from dams on substrate composition, and the possible impacts on the mainstem of the river.

Curtis et al. (2010) utilized a combination of historical aerial photographs, mainstem- and tributary-channel pebble counts, and HEC-RAS flow modeling in the West and White River watersheds (tributaries to the Connecticut River). They documented the time series of post-regulation channel narrowing and associated bar growth due to the influx of tributary sediment. In the West River, Svendsen et al. (2009) quantified changes in channel bed morphology as a result of flow regulation. Utilizing bi-monthly cross-section data from the gauging stations they determined the mean water depth and bed elevation for each cross-section measurement during the pre-dam and post-dam periods. In addition, annual peak stream flow data for each station were used to calculate the flood recurrence, and surface grain distributions at sampling sites upstream and downstream of each tributary confluence using Wolman pebble counts. They found that the sediment load from tributaries are impacting the flow-regulated mainstem West River rather than ameliorating conditions, and that these impacts are reflected in the benthic community structure. These results indicate that environmental flows that mimic the natural hydrograph are needed in regulated reaches of river.

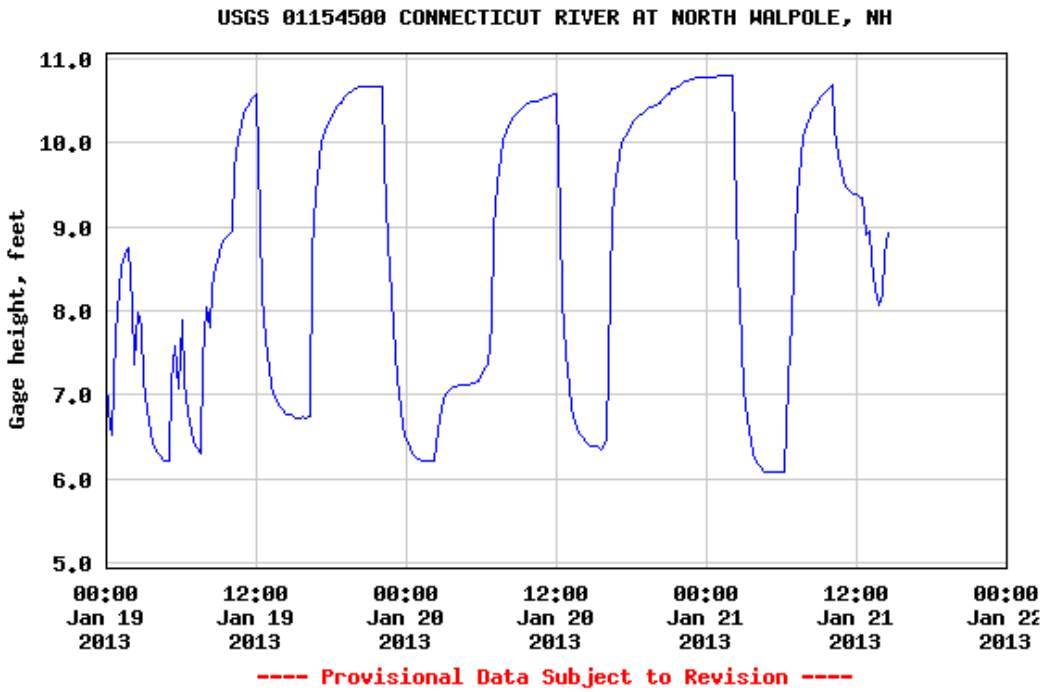
Nexus to Project Operations and Effects

Dams have major impacts on geomorphic processes, ecological function and in turn biotic communities. Changes to substrate composition can significantly affect aquatic life including stability of channel habitats, size distribution and embeddedness of substrate, and decreased habitat diversity and heterogeneity. The projects impound a large portion of the Connecticut River that otherwise would be free flowing and would transport fine sediment downstream leaving larger substrate material (gravel/cobble) exposed to be utilized by aquatic biota. By interrupting the downstream continuum of sediment supply and transport, dams can result in increased bed scour and bank erosion downstream (Kondolf and Matthews 1993). Given the large number of mainstem dams on the Connecticut River, any gravel coming in from tributaries becomes very important to the system. However, many of the tributaries in the project reach have also been dammed. Therefore, there is reason to be concerned about the effects the project dams are having on river processes and physical habitat.

Currently, the projects operate as hydro-peaking facilities as is evident from the USGS stream flow gauge at North Walpole, NH; with large water releases below the dam that increase shear stress on the river bed, substrate is mobilized that otherwise would only be moved during seasonal high flow events. Operations of the existing TransCanada hydroelectric projects likely affect channel morphology and fluvial processes including substrate mobility and particle size distribution. Project-induced changes to natural fluvial processes and channel morphology and substrate composition can have negative impacts on aquatic resources. For example, changes in

sediment composition could relocate or decrease important walleye or sea lamprey spawning habitat. In a similar fashion, project-induced changes could make some habitats unsuitable for aquatic invertebrates, including the federally-endangered dwarf wedgemussel. The NHFGD requests a study investigating the impacts of project operations on fluvial processes, substrate composition and stability as it relates to aquatic benthic habitat. Results of this study will be used to develop potential license requirements to protect aquatic habitat in the project-affected areas, and may be used to inform other studies that evaluate project effects on related resources. Possible mitigation measures could include gravel augmentation, changes in flow regulation, and instream channel restoration.

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



Methodology Consistent with Accepted Practice

Geomorphology studies are generally conducted during hydroelectric relicensing projects to determine channel condition, and substrate composition, and determine whether changes in project operations or sediment measures are necessary and/or whether channel restoration is necessary to improve aquatic benthic habitat.

The NHFGD recommends a methodology similar to previously approved FERC studies (FERC No. 2246 and 2206). Specific study methods include, but are not limited to, utilizing a combination of historical aerial photographs, pebble counts, and HEC-RAS flow modeling to document and compare temporal changes in morphology and sediment transport dynamics in the project affected areas.

Additional study methods can be found in the FERC Project No. 2246, Yuba County Water Agencies Study Plan Determination: Study 1.1. Lemonds (2006) also conducted an empirical-based study for the Yadkin-Pee Dee River Hydroelectric Project No. 2206.

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

At a minimum, the study would require a combination of historical aerial photographs, pebble counts, and HEC-RAS flow modeling. Cross-section data from the gauging stations could be used to determine the mean water depth and bed elevation for each cross-section measurement. TransCanada has not proposed any studies to meet this need. Costs would be low to moderate.

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

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residence time and benthic macroinvertebrate communities. Hydrological Processes. 23: 284–296.

Study Request 9: Downstream American Eel Passage Assessment at Vernon, Bellows Falls, and Wilder. (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

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 has developed two documents related to the management of American eel:

5 Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
6 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 watershed 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 FERC 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 New Hampshire Fish and Game Department (NHFGD) 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 downstream passage of American eel, the NHFGD'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.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural 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 United States Fish and Wildlife Service (USFWS) 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 USFWS 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. On September 29, 2011 the USFWS issued a substantial 90-day finding and initiated a 12-month status review. It is our understanding that the USFWS is still accepting new American eel information for the ongoing status review.

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 PADs, 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 that 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 Aug to mid Oct), 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.

Vernon Project Route Selection Study:

A minimum number of 50 telemetered eels (e.g., 5 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., 5 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 fish downstream fish bypass entrance and turbine intakes and in mainstem below Bellows Falls Station to assess passage via the following potential routes: entrainment into the canal; passage over the spillway; into the upstream fishway attraction water intake (this should operated during the study to assess its use by eels as it may be operational in the future for riverine or eel passage as addressed in the Resident Fish Passage study request); the downstream fish bypass; and station turbines.

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., 5 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., 5 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 1 then all possible route selection sites would need to be evaluated. If the balloon tag mortality component of the study occurs in Study Year 2, then results from the route selection study (Year 1) 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.

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

References:

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Study Request 10: In-stream Flow Habitat Assessment Downstream of Wilder, Bellows Falls, and Vernon Dams (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

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 wedge mussel.

Resource Management Goals

The New Hampshire Fish and Game Department (NHFGD) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.

- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

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

- 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.

- 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 area impacted by Project operations.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural 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%) 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, below Wilder Dam) and 01154500 (Connecticut River at North Walpole, NH, 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, 1300, and 1600 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 NHFGD 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 NHFGD 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 project's 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 wedge mussel, 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 NHFGD to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources below the Project.

Methodology Consistent with Accepted Practice

In-stream 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 NHFGD requests a flow study be conducted in the following areas: in the approximately 17 miles between the Wilder Dam and the headwaters of the Bellows Falls pool, in the approximately 6 miles between the Bellows Falls Dam and the headwaters of the Vernon pool, and in the 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 FERC 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-fieldwork data analysis would be a moderate cost and effort. We anticipate that the level of effort and costs will be comparable to that of other FERC relicensing projects of similar size to these projects.

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Study Request 11: Impacts of Water Fluctuations Downstream of the Vernon, Bellows Falls and Wilder Projects on Resident Fish Spawning (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

Goals and Objectives

The goal of this study is to determine if the full range of project induced flow and water level fluctuations in the project-affected areas below the Vernon, Bellows Falls and Wilder Dams negatively impact resident fish spawning (smallmouth bass, common white sucker, walleye and fallfish), and if impacts are found to occur, to develop appropriate mitigation measures.

Specific objectives include:

1) Conduct field studies in the project-affected areas downstream from the Vernon, Bellows Falls and Wilder Dams to assess timing and location of fish spawning. Nesting locations should be mapped.

2) Conduct field studies in the Project affected areas below the Vernon, Bellows Falls and Wilder Dams to evaluate potential impacts of the full range of project induced water level fluctuations on nest abandonment, spawning fish displacement and egg dewatering. The study should also evaluate if changes in fluctuation range would mitigate for identified impacts and/or if other mitigative measures would lessen these impacts.

Resource Management Goals

A mission of both the New Hampshire Fish and Game Department (NHFGD) 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 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.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.

4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

Existing Information

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

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, flow and 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. A study of a regulated river found temporal fluctuations of streamflow appeared to be the most important abiotic factor determining smallmouth bass nesting success or failure (Lukas and Orth 1995). Similarly, other research suggests stream discharge during and immediately after spawning could be important to smallmouth bass recruitment success (Smith et al. 2005). Current can also impact early survival of walleye by moving eggs and larvae from spawning sites (Humphrey et al. 2012).

Methodology Consistent with Accepted Practice

Common tools to evaluate fish spawning would be used including electrofishing, visual observations, and telemetry. Specific areas of interest are locations in project-affected areas below the Vernon, Bellows Falls and Wilder Dams where it is determined that the before mentioned fish species spawn. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort/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.

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Study Request 12: Effects of the Wilder and Bellows Falls Projects on the Dwarf Wedgemussel (*Alasmidonta heterodon*) (Docket Number p-1855) (Docket Number 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:

Objective 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.
Objective 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.
Objective 3:	Lay the groundwork for a long-term monitoring program.
Objective 4:	Document instream behavior of mussels during varying flow conditions.
Objective 5:	Determine how availability and persistence of dwarf wedgemussel habitat changes with water level and flow fluctuations.

Relevant Resource Management Goals

It is the goal of the U. S. Fish and Wildlife Service (USFWS) 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 in order before the species can be downlisted to threatened. The Upper Connecticut metapopulation is likely the largest remaining population in the world (USFWS 2007), and so its protection is essential to the recovery of the species as a whole.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

Existing Information and Need for Additional Information

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).

Need for additional information

The 2011 survey did not include the 17-mile free flowing stretch of the Connecticut River downstream of Wilder Dam. The dwarf wedgemussel has, in the past, been found within this river reach, although overall there has been limited survey work in the area. A better understanding of the distribution and abundance of the dwarf wedgemussel in this stretch of the

river is required before an evaluation of how the dam affects this species can be made. **This need is represented in Objective 1**.

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

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

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

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

Project Nexus

The dwarf wedgemussel is known to occur within the Wilder and Bellows Falls project areas and operations of these two dams may affect the viability of this species in the Connecticut River. This study plan will allow for a better understanding of how sub-daily flow and water level fluctuations influence dwarf wedgemussel abundance, available habitat, and behavior. This

information can be used to inform the development of license requirements that can ensure the continued existence of this species within the project-affected areas.

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

Proposed Methodology

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

Next, quantitative study plots should be established at sites throughout the two project-affected areas that are known to support the dwarf wedgemussel. Plots should be set up and surveyed using methodology that will allow for the estimation of population density and size. Smith et. al. (2001) have developed such a methodology, which is also outlined in Strayer and Smith (2003). It is based on a double-sampling design (visual inspection of the substrate surface plus excavation of a random subset of quadrats) using 0.25 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, NH (Nedeau 2004). A number of other recent studies have also made use of this protocol for different species of mussels (Fulton et. al. 2010, Crabtree & Smith 2009, Bradburn 2009).

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

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

differences among sampled sites. Sites should be selected based on those sampled to meet Objective 2, but should also include sites outside of the project area to fully evaluate project effect and to account for any natural variability that may be independent of project effect.

A long-term mussel monitoring program was devised as part of the study plan for the relicensing of the Lake Blackshear Hydroelectric Project (FERC no. 659) on the Flint River 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 & Layzer 2008, DiMaio & Corkum 1997). This phase of the study will likely take two field seasons in order to maximize the number of behavioral observations so that any trends can be identified and evaluated. **This proposed methodology corresponds to Objective 4**.

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

Level of Effort and Cost

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

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Study Request 13: Determine the Fish Assemblage in Vernon, Bellows Falls and Wilder Project-Affected Areas (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

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 includes 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
A mission of both the New Hampshire Fish and Game Department (NHFGD) 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 river's ecology and are the basis for the sport fishery. Furthermore, several of the states' SGCN have been documented in the project-affected area.

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's operations have on the species that reside there. As noted below, there is little information concerning riverine fish in the project-affected areas as related to this study request.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state 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 has 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 projects area 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 are needed in order to examine any potential project-related impacts.

It should be noted that the NHFGD does periodically conduct fish surveys on the Connecticut River in the vicinity of these projects. However, past surveys were not spatially wide spread enough nor conducted in a short enough time frame to meet the goals and objectives of this study request.

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 prove to be atypical (outside of 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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Study Request 14: Model River Flows and Water Levels Upstream and Downstream from the Wilder, Bellows Falls, and Vernon Stations and Integration of Project Modeling with Downstream Project Operations (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

Goals and Objectives

The goal of this study is to develop river flow models that permit the evaluation of the hydrologic changes to the 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 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 New Hampshire Fish and Game Department (NHFGD) 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 Project.

Specific to aquatic resources, the NHFGD'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 area impacted by Project operations.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

Existing Information

Available information in the PAD 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, 1,083, and 1,250 cfs (or inflows if less) for each facility, respectively, though in practice minimum flows are operated as 700, 1300, and 1600 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, 11,010, 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, below Wilder Dam) and 01154500 (Connecticut River at North Walpole, NH, 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 that experienced on similar FERC relicensing projects of this size (e.g., Conowingo, FERC No. 405).

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 15: Impacts of Water Level Fluctuations on Aquatic Vegetation, Including Invasive Species, in the Vernon, Bellows Falls and Wilder Project Impoundments and Riverine Reaches (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

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 and 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:

- Quantitatively describe and map wetland types within 200 feet of the shoreline, and describe associated wildlife;
- Delineate, quantitatively describe, and map all wetland types including invasive species and wildlife observed (e.g., bald eagle nesting, water fowl nesting) within 200 feet of the shoreline, and the extent of this habitat if it extends beyond 200 feet; and
- 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);

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

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

- The results of the field study in the form of maps and descriptions;
- 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
- Recommendations for any necessary plant, habitat type, or wildlife, protection and/or invasive species control measures.

Resource Management Goals

A mission of both the New Hampshire Fish and Game Department (NHFGD) 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 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 water bodies. The surface water quality criteria for Biological and Aquatic Community Integrity (Env-Wq 1703.19) are:

(a) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.
(b) 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. Aquatic vegetation in the areas affected by the project should be studied to demonstrate compliance with Env-Wq 1703.19.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as

amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest

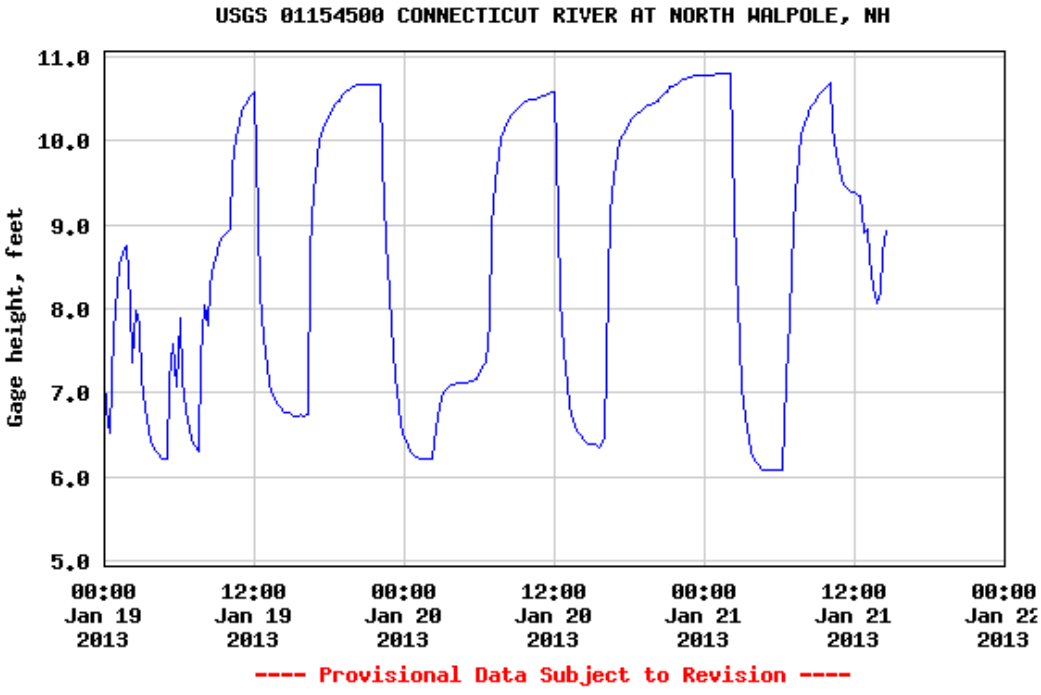
The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

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:

- Plant species composition, and their relative abundance/density and condition/structure (e.g., seedlings)
- Surveying for the federally Endangered Northeastern bulrush (*Scirpus ancistrochaetus*);
- Structured data, including estimates of average heights and aerial cover of each vegetation layer (specifically denoting invasive species);
- 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);
- Predominate land use(s) associated with each cover type;
- Wildlife sightings should be noted;
- 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.
- 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 prove to be atypical (outside of 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 PAD's 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.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 16: Impacts of the Vernon, Bellows Falls and Wilder Project Impoundment Water Fluctuations on Resident Fish Spawning (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

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 (smallmouth bass, largemouth bass, yellow perch, black crappie, common sunfish, bluegill, chain pickerel, northern pike, golden shiner, common white sucker, spottail shiner, walleye and fallfish) in the impoundments, and if impacts are found to occur, to develop appropriate mitigation measures.

Specific objectives include:

1) Conduct field studies in the mainstem, tributaries and backwaters of project affected areas to assess timing and location of fish spawning. Nesting locations should be mapped.

2) Conduct field studies in the mainstem, tributaries and backwaters of project-affected areas to evaluate potential impacts of impoundment fluctuation on spawning habitat, nest abandonment, spawning fish displacement and egg dewatering. The study 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

A mission of both the New Hampshire Fish and Game Department (NHFGD) 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 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 (Env-Wq 1703.19) are:

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

Resident riverine fish are important components of the ecology of the Connecticut River. Fish populations and habitats in the areas affected by the project should be studied to demonstrate compliance with Env-Wq 1703.19.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

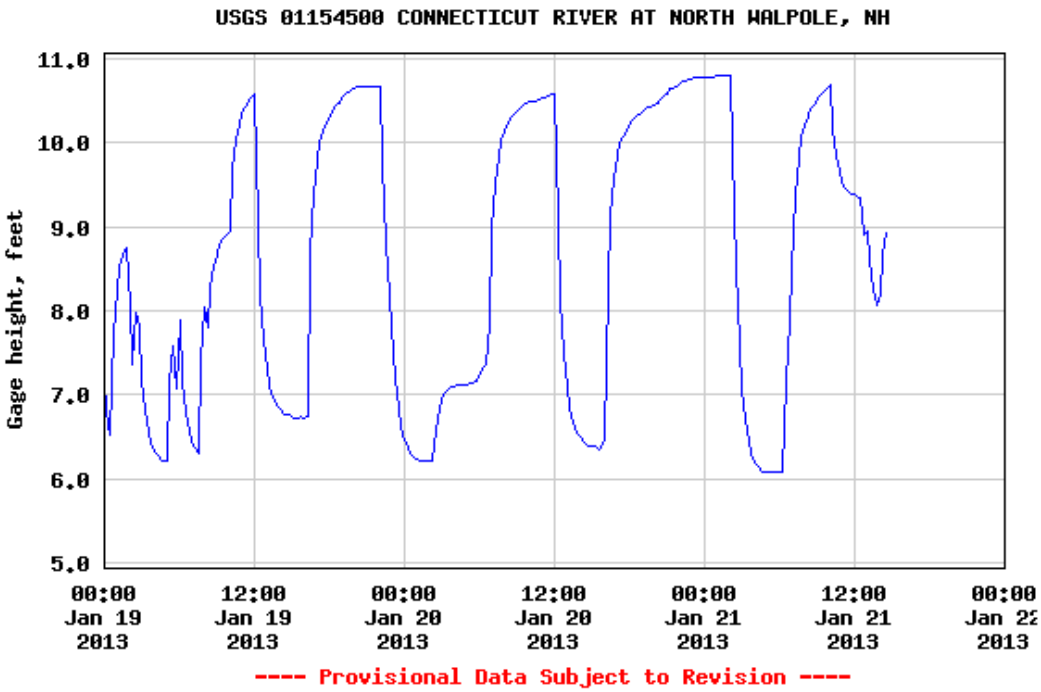
Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state 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 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 stantion 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 stantion bay replacement, need 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, 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 prove to be atypical (outside of 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.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 17: Impacts of the Vernon, Bellows Falls and Wilder Project Operations on Tributary and Backwater Area Access and Habitats. (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

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

A mission of both the New Hampshire Fish and Game Department (NHFGD) 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 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 (Env-Wq 1703.19) are:

a) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.
b) 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. Fish populations and habitats in the areas affected by the Project should be studied to demonstrate compliance with Env-Wq 1703.19.

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.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

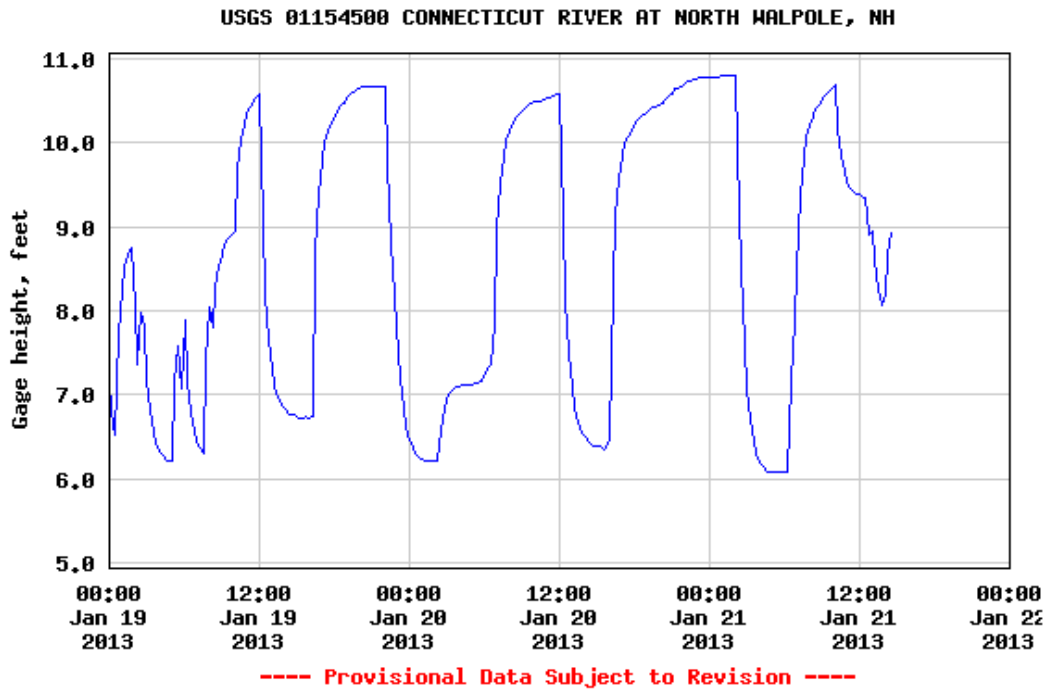
Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state 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 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.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 18: Impingment and Entrainment of Resident Fish Species at the Wilder, Bellows Falls and Vernon Intakes (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

Goals and Objectives

The goal of this study is to assess the adequacy of the intakes at Bellows Falls, Wilder, and Vernon projects to minimize fish mortality resulting from impingement and entrainment of resident fishes residing in the Connecticut River, and to recommend appropriate mitigative measures as necessary.

Specific objectives include:

- Describe the configuration of the intake at each project, including the forebay characteristics, size of the intakes, trashrack spacing and extent of coverage if the intakes, approach velocities and the influence of trashrack debris and cleaning protocols..
- Estimate the mortality rates for resident fish species and life stages that may result from impingement on project trashracks.
- Estimate the mortality rates for resident fish species and life stages that may result from entrainment and passage through the project turbines. Review existing Vermont Fish and Wildlife Department's (VTFWD) fish passage data to increase sample size and gain a better understanding of temporal variability.
- Determine structural and operational measures that could be reduce resident fish mortality.

Resource Management Goals

Vermont Water Quality Standards (VWQS) seek to provide high quality aquatic habitat necessary to support healthy aquatic communities and the associated uses such as fishing.

The Vermont Fish and Wildlife Department's goals related to aquatic natural resources and pertinent to this study request are to:

1. Provide for healthy, self-sustaining fish communities.

2. Minimize the potential negative effects of project operation on resident fish populations, and mitigate for losses.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

Existing Information

The Connecticut River and the project impoundments support a variety of resident fish species as well as angling. However, there is no information about resident fish mortality and the population effects resulting from project impingement and entrainment. The project PADs contain almost no information about the project trashracks. During the ILP site visits held in October 2012 the Agency was informed that the rack spacing was in most cases four inches (on center) and as much as six inches in some cases. Further, these trashracks do not cover the entire intake area in all cases. No information on approach velocities has been provided. Mortality rates of resident fish passing through the turbines are not known.

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. Fishes living in the impoundments will at times enter project forebays and come in close proximity to project intakes. Impingement or entrainment is certainly occurring but the extent of this impact is unknown. The wide rack spacing is likely to result in entrainment.

The projects include downstream fish passage facilities but their use and effectiveness for resident fish species is unknown. These facilities are operated seasonally and therefore will not mitigate impingement and entrainment at all times.

Methodology Consistent with Accepted Practice

Impingement, entrainment and turbine mortality studies have been conducted at numerous other hydropower projects and can be used to assess potential fish mortality based on results from other projects with similar configurations.

Approach velocities can be calculated and actual measurements can be taken to quantify variability by location and verify calculated results.

Turbine mortality should be assessed by releasing tagged fish for downstream recovery. The details of this type of study should be addressed during the study plan stage.

The contribution of existing downstream fish passage facilities to reducing impingement and entrainment of resident fishes should also be assessed.

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

The expected level of effort and anticipated costs will be comparable or less than those experienced on similar FERC projects of this size.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 19: Assessment of Adult Sea Lamprey (*Petromyzon marinus)* Spawning within the Wilder, Bellows Falls, and Vernon Project Areas. (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

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

Goals and Objectives

Assess the level of spawning activity by sea lamprey in the Wilder, Bellows Falls, and Vernon project areas and determine whether operations of these Projects are affecting the success (i.e survival to emergence) of this activity.

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

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.

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

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

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). 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 within the project area.

Resource Management Goals

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 (Kart et al. 2005) is degraded spawning habitat, which is second to habitat fragmentation.

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.

One of the conservation strategies identified in the Vermont Wildlife Action Plan, 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, identifying potential impacts that the Wilder, Bellows Falls, and Vernon Projects have on sea lamprey spawning is paramount. Results of the study will be used to develop flow-related license requirements and/or other mitigation measures that will optimize spawning habitat for a New Hampshire and Vermont SGCN.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state 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 at 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 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. 2012). 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).

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.

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 methods should follow Fox et al. (2010).

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

The estimated level of effort and costs for this recommended study is expected to be moderate to high. The applicant did not propose any alternative studies in its PAD to address this specific issue.

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Fox, M. J.C. Graham, and S. Frank. 2010. 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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Smith, S. J. and J. E. Marsden. 2009. Factors Affecting Sea Lamprey Egg Survival. North American Journal of Fisheries Management 29:859–868.

Study Request 20: Determine Upstream Passage Needs for Riverine Fish Species in the Bellows Falls, Wilder and Vernon Fishways (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

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:

- Identify the utilization and temporal distribution, of passage through the Bellows Falls, Wilder, and Vernon fishways by riverine and diadromous fish species
- Review existing Vermont Fish and Wildlife Department's (VTFWD) fish passage data to increase sample size and gain a better understanding of temporal variability.
- 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:

    1. Determine the appropriate operating windows of the fishways for riverine species

    2. Determine the appropriate operating windows of the fishways for diadromous species such as American eel and sea lamprey.

Resource Management Goals

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 Department'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.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards 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) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

In order to be consistent with both Department's 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 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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state 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 Vermont Fish & Wildlife Department. Fish passage video data that have been processed should be available for distribution in the future (Lael Will, Vermont Fish & Wildlife, 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 project has a direct impact on fish passage and limits 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 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 2 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 personal to read to 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.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 21a: Wilder Hydroelectric Project: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations (Docket Number p-1892)

1. ***Goals and Objectives***

   The goal of this study is to determine how project operations contribute to the shoreline erosion and riverbank failure within the impoundment and downstream of the Wilder Hydro Project.

   The objectives of this study are to:

   1. determine how water level fluctuations within the minimum and maximum operating range and discharges from peaking operations at the Wilder hydroelectric project contribute to shoreline erosion;
   2. identify and determine the effects of shoreline bank erosion and riverbank failure on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.);
   3. identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce on riverbank erosion within the impoundment and downstream of the tailrace.

2. ***Resource Management Goals***

   The Connecticut River is considered Class B water by the states of Vermont and New Hampshire. Vermont lists the section of the Connecticut River below the Wilder dam on the Section 303(d) impaired water list due to flow alterations resulting in the destabilization and eroding of shoreline impairing aquatic life and habitat. In Class B waters, Vermont's water quality standards state that water level fluctuation and flow alterations can only occur to the extent that it supports all uses and does not lead to degradation of the water resource or habitat.

   New Hampshire's surface water quality regulations state that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses." (Env-Wq 1703.01(d)). The specific New Hampshire water quality criteria for turbidity in Class B waters is not to exceed naturally occurring conditions by more than 10 NTUs (Env-Wq 1703.11).

   A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

3. Public Interest Consideration

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

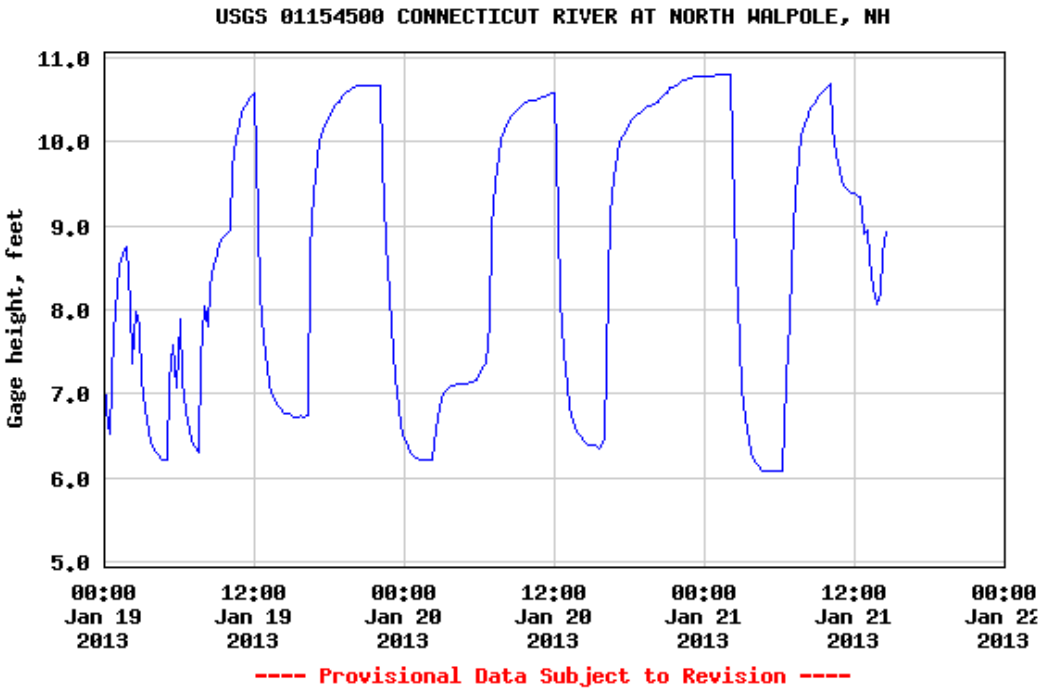
4. Existing Information

The PAD references several studies pertaining to shoreline erosion within the Connecticut River, including a study by US Army Corp of Engineers (Simion et al. 1979). This study evaluated the shoreline within the Wilder impoundment and identified water level fluctuation and periodic high flow events as causes of shoreline erosion. The PAD also discusses the erosion survey that TransCanada initiated in 2010 to inventory sites where erosion is occurring within the Wilder impoundment (Kleinschmidt 2011). Bank slumping was identified as the major type of shoreline erosion within the project impoundment. Bank slumping can occur when fluvial erosional forces known as soil piping are acting on the toe of the bank slope, increasing the angle between the slope of the bank and water surface. The PAD did not address how project related operations contribute to shoreline erosion, could be changed to mitigate impacts on shoreline erosion, or discuss the impacts of shoreline erosion on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.).

Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion (Lawson 1985). Sediment from shoreline erosion and riverbank failure is one of the major contributors

negatively affect water quality and habitat by increasing the turbidity and sedimentation, smothering aquatic habitat in United States. Vermont Surface Water Management Strategy identifies sediment from excessive channel erosion as a stressor on Vermont water and aquatic habitat. Additionally, Vermont lists this section of the Connecticut River on the Vermont Section 303(d) impaired water list due to flow alterations resulting from the destabilization and eroding of shoreline impairing aquatic life and habitat.

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



5. ***Project Nexus***

Wilder Hydroelectric Project operations currently result in daily water level fluctuation in the impoundment by as much as 2.5 feet, which affects shoreline erosion in the impoundment by increasing the rate of soil piping. The project is currently permitted to water level fluctuation in the impoundment by 5 feet. Additionally the project "peaking" operation could contribute to bank erosion downstream of the dam by increasing the shear stress on the bank toe. Furthermore, river profile operations during high flow events minimize overland flow by drawing down impoundment prior to high flows containing high velocity flows to the river channel, possibly increasing shoreline erosion rate within the impoundment. TransCanada is not proposing any changes to project operations.

6. ***Proposed Methodology***

The NHFGD recommends TransCanada complete a study similar to the study completed by Kleinschmidt (2011). The study should be designed to build on erosion survey that

was previously completed by determining the process causing erosion at a site, the extent erosion is negatively affecting other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.), and determining how erosion could be stabilized or mitigated by changing project operations. This study can be completed performing the following tasks.

Task 1: Determine erosion and riverbank failure process at identified sites

Shoreline erosion areas and riverbank failure sites were identified during the Kleinschmidt (2011) survey. Erosion sites that were identified during the previous survey should be revisited when the water level in the impoundment is at its lowest elevation, to collect information on erosion forces acting on the site, document if any additional erosion has occurred, and identified new sites of erosion within the impoundment. Erosion processes will be determined by field observations and applying site appropriate geology, geomorphic and hydrological principles. For each erosion site, the following erosion process element will be identified by determining soil type and subsoil characteristics (i.e. depth to bedrock, texture, rock content, signs of soil piping), reservoir water levels at the time of observation, water level fluctuation, climatic conditions, ground water seepage, wind-driven waves, boat waves, and recreation. Additional site characteristic to identify and record in the erosion survey will include but not be limited to an estimate of the length and average height of the erosional area, slope of the site, dominant vegetation cover types present, associated vegetation cover types present, an ocular estimate of total plant cover and total cover by plant class (tree, shrub, herbaceous) in surrounding undisturbed areas. Data from each shoreline erosion site will be recorded on a field form and entered into a database. In addition, a photograph or photographs will be taken of each site. Completion of this evaluation will allow for a determination as to whether the erosion is Project related, and if so, how Project operations may be impacting the site.

Task 2: Determining the effects of erosion on other resources

The effects of shoreline erosion and riverbank failure on other resources should be determined. This will required coordination between studies to determine the effects of erosion on riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, and recreation. Erosion sites identified as having an impact on resources will be assess to determine if project operations are causing erosion and a mitigation plan to protect the resource of interest should be developed.

Task 3: Development of a Shoreline Management Plan

The information that is collected during the study should be used to develop a Shoreline Management Plan for the impoundment. Sites that are determined to impact important resources should be further evaluated to determine if there is a feasible way to reduce or stabilize the area. This feasibility analysis will be based on field observations and knowledge of current erosion control and slope failure stabilization methods that may be suitable for the site. The analysis will provide a preliminary list of potential control measures necessary to reduce erosion at these sites. Detailed analyses for final design and construction of erosion and slope stabilization control measures will not be part of the study. As part of this process, the landowner should be identified for each of the erosion site and future mitigation and stabilization techniques should be presented.

The study area for the shoreline erosion study should extend from the upstream end of the impoundment above the Wilder Dam to the beginning of the impoundment below the Wilder Dam. Water level fluctuations caused by the Project may affect not only the impoundment but also the downstream river reaches below the dam.

7. ***Level of Effort and Cost***
   The cost and effort of this study will be moderate, but is important to document the potential impact project operations on shoreline erosion and riverbank failure, and to determine how this may impact other resources.

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USACE, New England Division.

Study Request 21b: Bellows Falls Hydroelectric Project: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations (Docket Number p-1855)

1. ***Goals and Objectives***

   The goal of this study is to determine how project operations contribute to the shoreline erosion and riverbank failure within the impoundment and downstream of the Bellows Falls Hydroelectric Project.

   The objectives of this study are to:

   1. determine how water level fluctuations within the minimum and maximum operating range and discharges from peaking operations at the Wilder hydroelectric project contribute to shoreline erosion;
   2. identify and determine the effects of shoreline bank erosion and riverbank failure on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.);
   3. identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce on riverbank erosion within the impoundment and downstream of the tailrace.

2. ***Resource Management Goals***

   The Connecticut River is considered Class B water by the states of Vermont and New Hampshire. Vermont list the section of the Connecticut River above and below Bellows Falls dam on the Section 303(d) impaired water list due to flow alterations resulting in the destabilization and eroding of shoreline impairing aquatic life and habitat. In Class B waters, Vermont's water quality standards state that water level fluctuation and flow alterations can only occur to the extent that it supports all uses and does not lead to degradation of the water resource or habitat. New Hampshire's surface water quality regulations state that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses." (Env-Wq 1703.01(d)). The specific New Hampshire water quality criteria for turbidity in Class B waters is not to exceed naturally occurring conditions by more than 10 NTUs (Env-Wq 1703.11).

   A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

3. Public Interest Consideration

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

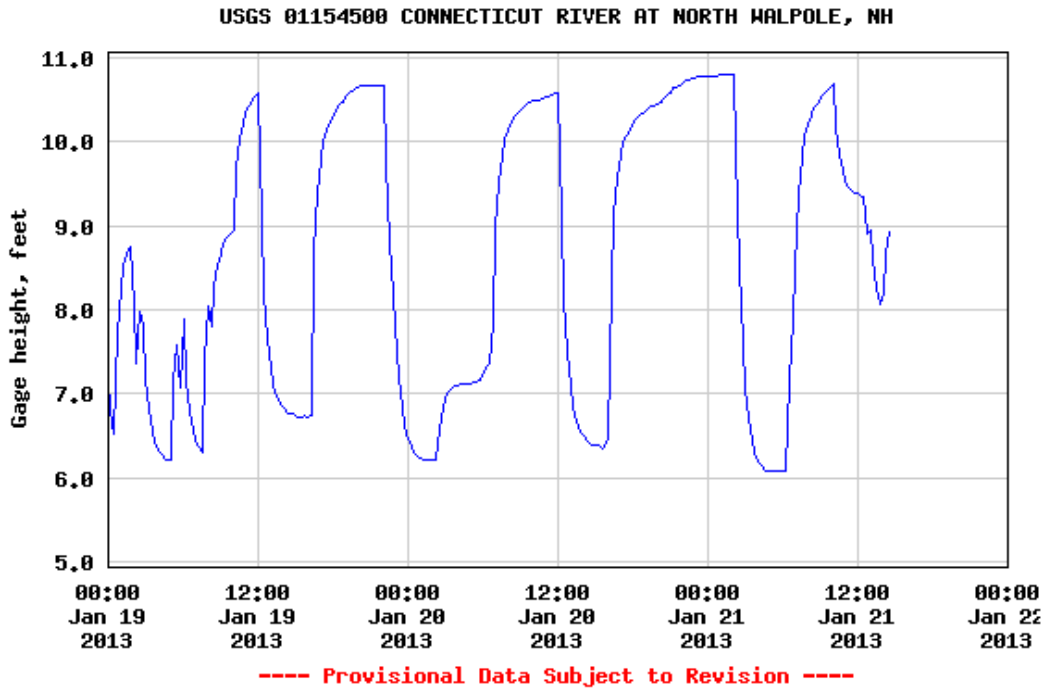
4. Existing Information

The PAD references several studies pertaining to shoreline erosion within the Connecticut River, including a study by US Army Corp of Engineers (Simion et al. 1979). This study evaluated the shoreline within the Wilder impoundment and identified water level fluctuation and periodic high flow events as causes of shoreline erosion. The PAD also discusses the erosion survey that TransCanada initiated 2010 to inventory sites where erosion is occurring within the Bellows Falls impoundment (Kleinschmidt 2011). Bank slumping was identified as the major type of shoreline erosion within the project impoundment. Bank slumping can occur when fluvial erosional forces known as soil piping are acting on the toe of the bank slope, increasing the angle between the slope of the bank and water surface. The PAD did not address how project related operations contribute to shoreline erosion, could be changed to mitigate impacts on shoreline erosion, or discuss the impacts of shoreline erosion on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.).

Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion (Lawson 1985). Sediment from shoreline erosion and riverbank failure is one of the major contributors negatively affect water quality and habitat by increasing the turbidity and sedimentation,

smothering aquatic habitat in United States. Vermont Surface Water Management Strategy identifies sediment from excessive channel erosion as a stressor on Vermont water and aquatic habitat. Additionally, Vermont lists this section of the Connecticut River on the Vermont Section 303(d) impaired water list due to flow alterations resulting from the destabilization and eroding of shoreline impairing aquatic life and habitat.

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



5. ***Project Nexus***

Bellows Falls Hydroelectric Project operations currently result in daily water level fluctuation in the impoundment by approximately 2 feet, which affects shoreline erosion in the impoundment by increasing the rate of soil piping. The project is currently permitted to water level fluctuation in the impoundment by 3 feet. Additionally the project "peaking" operation could contribute to bank erosion downstream of the dam by increasing the shear stress on the bank toe. Furthermore, river profile operations during high flow events the project impoundment is operated to minimize overland flow by drawing down impoundment prior to high flows containing high velocity flows to the river channel, possibly increasing shoreline erosion rate within the impoundment. TransCanada is not proposing any changes to project operations.

6. ***Proposed Methodology***

The NHFGD recommends TransCanada complete a study similar to the study completed by Kleinschmidt (2011). The study should be designed to build on erosion survey that was previously completed by determining the process causing erosion at a site, the extent erosion is negatively affecting other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.), and determining how erosion could be stabilized or mitigated by changing project operations. This study can be completed performing the following tasks.

Task 1: Determine erosion and riverbank failure process at identified sites

Shoreline erosion areas and riverbank failure sites were identified during the Kleinschmidt (2011) survey. Erosion sites that were identified during the previous survey should be revisited when the water level in the impoundment is at its lowest elevation, to collect information on erosion forces acting on the site, document if any additional erosion has occurred, and identified new sites of erosion within the impoundment. Erosion processes will be determined by field observations and applying site appropriate geology, geomorphic and hydrological principles. For each erosion site, the following erosion process element will be identified by determining soil type and subsoil characteristics (i.e. depth to bedrock, texture, rock content, signs of soil piping), reservoir water levels at the time of observation, water level fluctuation, climatic conditions, ground water seepage, wind-driven waves, boat waves, and recreation. Additional site characteristic to identify and record in the erosion survey will include but not be limited to an estimate of the length and average height of the erosional area, slope of the site, dominant vegetation cover types present, associated vegetation cover types present, an ocular estimate of total plant cover and total cover by plant class (tree, shrub, herbaceous) in surrounding undisturbed areas. Data from each shoreline erosion site will be recorded on a field form and entered into a database. In addition, a photograph or photographs will be taken of each site. Completion of this evaluation will allow for a determination as to whether the erosion is Project related, and if so, how Project operations may be impacting the site.

Task 2: Determining the effects of erosion on other resources

The effects of shoreline erosion and riverbank failure on other resources should be determined. This will required coordination between studies to determine the effects of erosion on riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, and recreation. Erosion sites identified as having an impact on resources will be assess to determine if project operations are causing erosion and a mitigation plan to protect the resource of interest should be developed.

Task 3: Development of a Shoreline Management Plan

The information that is collected during the study should be used to develop a Shoreline Management Plan for the impoundment. Sites that are determined to impact important resources should be further evaluated to determine if there is a feasible way to reduce or stabilize the area. This feasibility analysis will be based on field observations and knowledge of current erosion control and slope failure stabilization methods that may be suitable for the site. The analysis will provide a preliminary list of potential control measures necessary to reduce erosion at these sites. Detailed analyses for final design and construction of erosion and slope stabilization control measures will not be part of the study. As part of this process, the landowner should be identified for each of the erosion site and future mitigation and stabilization techniques should be presented.

The study area for the shoreline erosion study should extend from the upstream end of the impoundment above the Bellows Falls Dam to the beginning of the impoundment below the Bellows Falls Dam. Water level fluctuations caused by the Project may affect not only the impoundment but also the downstream river reaches below the dam.

7. ***Level of Effort and Cost***
   The cost and effort of this study will be moderate, but is important to document the potential impact project operations on shoreline erosion and riverbank failure, and to determine how this may impact other resources.

Literature Cited

Kleinschmidt (Kleinschmidt Associates, Inc.). 2011. Lower Connecticut River Shoreline Survey Report – 2010: Bellows Falls Project (FERC No. 1855), Wilder Project (FERC No. 1892), Vernon Project (FERC No. 1904). Draft Report March 2011. Prepared for TransCanada Hydro Northeast Inc.,Westborough, MA.

Lawson, D.E., 1985, Erosion of northern reservoir shores: An analysis and application of pertinent literature: US Army Corps of Engineers Cold Regions Research and Engineering Laboratory Monograph 85-1, 198 p.

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Simons, D.B., Andrews, J.W., Li, R.M., and Alawady, M.A. 1979. Connecticut River Streambank Erosion Study Massachusetts, New Hampshire, and Vermont. Prepared for USACE, New England Division.

Study Request 21c: Vernon Hydroelectric Project: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations (Docket Number p-1904)

1. ***Goals and Objectives***

   The goal of this study is to determine how project operations contribute to the shoreline erosion and riverbank failure within the impoundment and downstream of the Vernon Hydroelectric Project.

   The objectives of this study are to:

   1. determine how water level fluctuations within the minimum and maximum operating range and discharges from peaking operations at the Wilder hydroelectric project contribute to shoreline erosion;
   2. identify and determine the effects of shoreline bank erosion and riverbank failure on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.);
   3. identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce on riverbank erosion within the impoundment and downstream of the tailrace.

2. ***Resource Management Goals***

   The Connecticut River is considered Class B water by the states of Vermont and New Hampshire. Vermont lists the section of the Connecticut River above and below Vernon dam on the Section 303(d) impaired water list due to flow alterations resulting in the destabilization and eroding of shoreline impairing aquatic life and habitat. In Class B waters, Vermont's water quality standards state that water level fluctuation and flow alterations can only occur to the extent that it supports all uses and does not lead to degradation of the water resource or habitat. New Hampshire's surface water quality regulations state that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses." (Env-Wq 1703.01(d)). The specific New Hampshire water quality criteria for turbidity in Class B waters is not to exceed naturally occurring conditions by more than 10 NTUs (Env-Wq 1703.11).

   A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

3. Public Interest Consideration

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

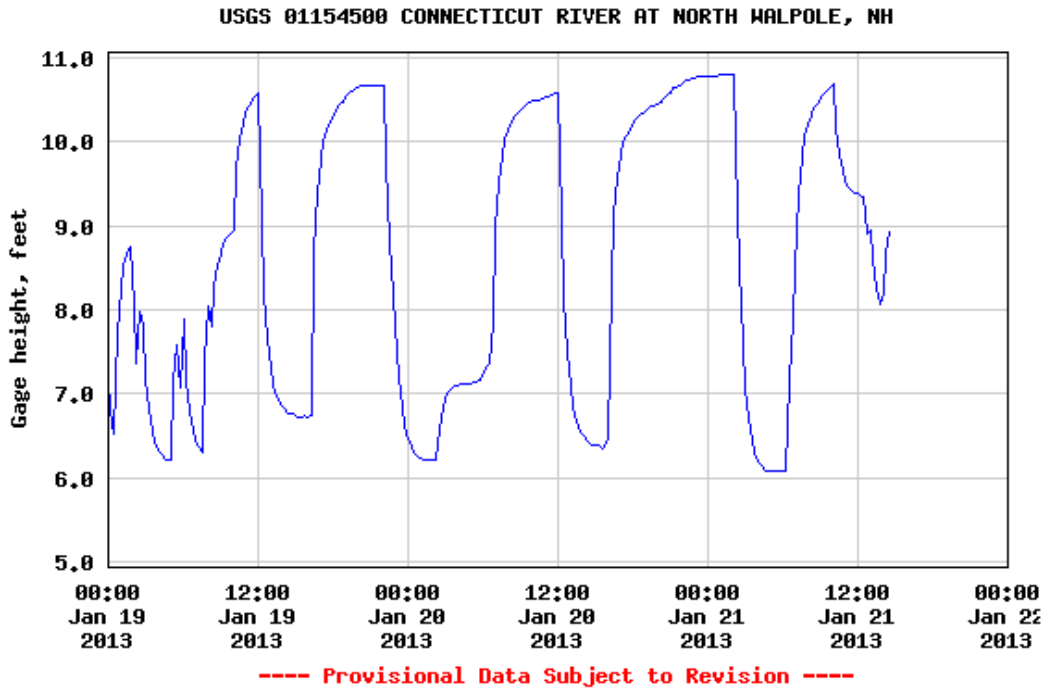
4. Existing Information

The PAD references several studies pertaining to shoreline erosion within the Connecticut River, including a study by US Army Corp of Engineers (Simion et al. 1979). This study evaluated the shoreline within the Wilder impoundment and identified water level fluctuation and periodic high flow events as causes of shoreline erosion. The PAD also discusses the erosion survey that TransCanada initiated 2010 to inventory sites where erosion is occurring within the Vernon impoundment (Kleinschmidt 2011). Bank slumping was identified as the major type of shoreline erosion within the project impoundment. Bank slumping can occur when fluvial erosional forces known as soil piping are acting on the toe of the bank slope, increasing the angle between the slope of the bank and water surface. The PAD did not address how project related operations contribute to shoreline erosion, could be changed to mitigate impacts on shoreline erosion, or discuss the impacts of shoreline erosion on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.).

Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion (Lawson 1985). Sediment from shoreline erosion and riverbank failure is one of the major contributors negatively affect water quality and habitat by increasing the turbidity and sedimentation,

smothering aquatic habitat in United States. Vermont Surface Water Management Strategy identifies sediment from excessive channel erosion as a stressor on Vermont water and aquatic habitat. Additionally, Vermont lists this section of the Connecticut River on the Vermont Section 303(d) impaired water list due to flow alterations resulting from the destabilization and eroding of shoreline impairing aquatic life and habitat.

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



5. ***Project Nexus***

Vernon Hydroelectric Project operations currently result in daily water level fluctuation in the impoundment by approximately 2 feet, which affects shoreline erosion in the impoundment by increasing the rate of soil piping. The project is currently permitted to water level fluctuation in the impoundment by 8 feet. Additionally the project "peaking" operation could contribute to bank erosion downstream of the dam by increasing the shear stress on the bank toe. TransCanada is not proposing any changes to project operations.

6. ***Proposed Methodology***

The NHFGD recommends TransCanada complete a study similar to the study completed by Kleinschmidt (2011). The study should be designed to build on erosion survey that was previously completed by determining the process causing erosion at a site, the extent erosion is negatively affecting other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat,

etc.), and determining how erosion could be stabilized or mitigated by changing project operations. This study can be completed performing the following tasks.

Task 1: Determine erosion and riverbank failure process at identified sites

Shoreline erosion areas and riverbank failure sites were identified during the Kleinschmidt (2011) survey. Erosion sites that were identified during the previous survey should be revisited when the water level in the impoundment is at its lowest elevation, to collect information on erosion forces acting on the site, document if any additional erosion has occurred, and identified new sites of erosion within the impoundment. Erosion processes will be determined by field observations and applying site appropriate geology, geomorphic and hydrological principles. For each erosion site, the following erosion process element will be identified by determining soil type and subsoil characteristics (i.e. depth to bedrock, texture, rock content, signs of soil piping), reservoir water levels at the time of observation, water level fluctuation, climatic conditions, ground water seepage, wind-driven waves, boat waves, and recreation. Additional site characteristic to identify and record in the erosion survey will include but not be limited to an estimate of the length and average height of the erosional area, slope of the site, dominant vegetation cover types present, associated vegetation cover types present, an ocular estimate of total plant cover and total cover by plant class (tree, shrub, herbaceous) in surrounding undisturbed areas. Data from each shoreline erosion site will be recorded on a field form and entered into a database. In addition, a photograph or photographs will be taken of each site. Completion of this evaluation will allow for a determination as to whether the erosion is Project related, and if so, how Project operations may be impacting the site.

Task 2: Determining the effects of erosion on other resources

The effects of shoreline erosion and riverbank failure on other resources should be determined. This will required coordination between studies to determine the effects of erosion on riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, and recreation. Erosion sites identified as having an impact on resources will be assess to determine if project operations are causing erosion and a mitigation plan to protect the resource of interest should be developed.

Task 3: Development of a Shoreline Management Plan

The information that is collected during the study should be used to develop a Shoreline Management Plan for the impoundment. Sites that are determined to impact important

resources should be further evaluated to determine if there is a feasible way to reduce or stabilize the area. This feasibility analysis will be based on field observations and knowledge of current erosion control and slope failure stabilization methods that may be suitable for the site. The analysis will provide a preliminary list of potential control measures necessary to reduce erosion at these sites. Detailed analyses for final design and construction of erosion and slope stabilization control measures will not be part of the study. As part of this process, the landowner should be identified for each of the erosion site and future mitigation and stabilization techniques should be presented.

The study area for the shoreline erosion study should extend from the upstream end of the impoundment above the Vernon Dam to at least the New Hampshire / Massachusetts border. Water level fluctuations caused by the Project may affect not only the impoundment but also the downstream river reaches below the dam.

7. ***Level of Effort and Cost***
   The cost and effort of this study will be moderate, but is important to document the potential impact project operations on shoreline erosion and riverbank failure, and to determine how this may impact other resources.

Literature Cited

Kleinschmidt (Kleinschmidt Associates, Inc.). 2011. Lower Connecticut River Shoreline Survey Report – 2010: Bellows Falls Project (FERC No. 1855), Wilder Project (FERC No. 1892), Vernon Project (FERC No. 1904). Draft Report March 2011. Prepared for TransCanada Hydro Northeast Inc.,Westborough, MA.

Lawson, D.E., 1985, Erosion of northern reservoir shores: An analysis and application of pertinent literature: US Army Corps of Engineers Cold Regions Research and Engineering Laboratory Monograph 85-1, 198 p.

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Simons, D.B., Andrews, J.W., Li, R.M., and Alawady, M.A. 1979. Connecticut River Streambank Erosion Study Massachusetts, New Hampshire, and Vermont. Prepared for USACE, New England Division.

Study Request 22a: Continuous water temperature monitoring (15 minute intervals) at various locations within the Wilder Hydroelectric Project Impoundment and Tailrace, and Connecticut River downstream of the Wilder Dam (Docket Number p-1892)

Goals and Objectives

The goal of this study is to determine the potential impacts (both project specific and cumulative) of the Wilder Hydroelectric Project operations on hourly/daily temperature fluctuations and spatial thermal distribution within the Wilder Hydroelectric Project Impoundment and Tailrace**,** and the Connecticut River downstream of the Wilder Dam.

The objectives of this study are to:

1. Obtain continuous temperature data (every 15 minutes) at various locations and depths throughout the project impoundment, tailrace, and downstream Connecticut River using temperature loggers;

2. Analyze data for hourly/daily shifts in temperature regime and thermal distribution (aquatic isotherm maps) associated project specific and cumulative impacts associated with project operations; and

3. Determine if any shifts in hourly temperature regime or thermal distribution are impacting aquatic habitat within the project impoundment and tailrace and lower Connecticut River (e.g., thermal blocks to migration, thermal stress, habitat degradation).

Resource Management Goals

Temperature is an important habitat consideration for many aquatic species including migratory fish and rare, threatened, endangered species. Temperature influences the distribution, behavior, metabolism, growth, reproduction, and survival of fishes (Diana 2004). The Connecticut River is considered a Class B waters 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. Additionally the Vermont Water Quality Standards states that in Class B cold water fish habitat, the total increase in from any activity or discharge should not result in a temperature increase that exceeds 1.0°F.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

Existing Information

The PAD provides limited information on impacts of project operations ("daily run-of-river") on temperature in the project impoundment, tailrace or lower Connecticut River. Hourly/daily temperature shifts associated with project operations at Wilder Dam can impact aquatic habitat rendering it unsuitable for some organisms. The information in the PAD does not define the spatial extent of temperatures (aquatic isotherm map) within the impoundment, lower Connecticut River. The PAD mainly indicates that in general, temperature did increase from upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment.

Nexus to Project Operations and Effects

The project impounds 45 miles of river that would otherwise be free flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 5 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (675 cfs). Water temperature can be affected by the operating mode of a hydropower project. The impounded water increases the water surface area of the river reach containing the project. The increased surface acts as a large solar radiation collector and the thermal mass of the impounded water acts a heat sink storing heat from solar radiation. At night the increased surface area may act as convective radiator that releases heat. Together these attributes may contribute to unnatural thermal properties in the project impoundment that may impact natural temperature regime and influence habitat conditions for fish, wildlife and plant resources (temperature tolerance, life cycle timing (e.g., reproduction or migration), and food availability).

The project discharges regulated Connecticut River flows ("daily run-of-river") from the impoundment to the downstream seventeen mile reach of the Connecticut River. The project can sporadically release large volumes of impoundment water that may be of a different temperature than the receiving water downstream of the dam. Unnatural and rapid shifts in temperature regimes in the downstream water can impact fish, wildlife and plant resources and instream habitat. The NHFGD requests that more recent temperature data is collected in a more intensive, systematic and scientific manner in order to assess project specific and cumulative impacts on fish, wildlife and plant resources at the project. Results from this study may be used to directly inform the evaluation of project effects on related resources, such as a fish and other aquatic species.

Methodology Consistent with Accepted Practice

Use of temperature loggers to gain information on thermal trends has been a standard technique to look at impacts of water storage associated with hydroelectric projects. We recommend that transects be established in the upper, middle, and lower project impoundment, as well as in the tailrace and downstream project. An additional transect should be established in the free flowing section of river above the impoundment to serve as a "reference site". Inexpensive temperature loggers should be deployed along each transects at a minimum of three locations: at depths of 1 meter subsurface, mid-depth, and 1 meter off the bottom (on buoy lines) where water depths permit. The temperature loggers should be deployed from April 1 – November 15 and be set to record temperature at 15 minute intervals. The temperature loggers should be checked and the data downloaded on the monthly basis. The data from the loggers should then be used to develop hourly/daily aquatic isotherm maps, and temperature change and distribution as a result of project and cumulative impacts should be assessed.

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

The effort and cost of this study is expected to be moderate to high, but the potential project specific and cumulative thermal alteration impacts have never been studied in a comprehensive manner and their potential impacts to aquatic habitat and fish, wildlife, and resources has not been adequately studied.

Literature Cited

Diana, J.S. 2004. Biology and Ecology of Fishes. 2nd edition. Biological Sciences Press.

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 22b: Continuous water temperature monitoring (15 minute intervals) at various locations within the Bellows Falls Hydroelectric Project Impoundment and Tailrace, and Connecticut River downstream of the Bellows Falls Dam (Docket Number p-1855)

Goals and Objectives

The goal of this study is to determine the potential impacts (both project specific and cumulative) of the Bellows Falls Hydroelectric Project operations on hourly/daily temperature fluctuations and spatial thermal distribution within the Bellows Falls Hydroelectric Project Impoundment and Tailrace**,** and the Connecticut River downstream of the Bellows Falls Dam.

The objectives of this study are to:

1. Obtain continuous temperature data (every 15 minutes) at various locations and depths throughout the project impoundment, tailrace, and downstream Connecticut River using temperature loggers.

2. Analyze data for hourly/daily shifts in temperature regime and thermal distribution (aquatic isotherm maps) associated project specific and cumulative impacts associated with project operations.

3. Determine if any shifts in hourly temperature regime or thermal distribution are impacting aquatic habitat within the project impoundment and tailrace and lower Connecticut River (e.g., thermal blocks to migration, thermal stress, habitat degradation).

Resource Management Goals

Temperature is an important habitat consideration for many aquatic species including migratory fish and rare, threatened, endangered species. Temperature influences the distribution, behavior, metabolism, growth, reproduction, and survival of fishes (Diana 2004). The Connecticut River is considered a Class B waters 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. Additionally the Vermont Water Quality Standards states that in Class B cold water fish habitat, the total increase in from any activity or discharge should not result in a temperature increase that exceeds 1.0°F.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

Existing Information

The PAD provides limited information on impacts of project operations ("daily run-of-river") on temperature in the project impoundment, tailrace or lower Connecticut River. Hourly/daily temperature shifts associated with project operations at Bellows Falls Dam can impact aquatic habitat rendering it unsuitable for some organisms. The information in the PAD does not define the spatial extent of temperatures (aquatic isotherm map) within the impoundment, lower Connecticut River. The PAD mainly indicates that in general, temperature did increase from upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment.

Nexus to Project Operations and Effects

The project impounds 26 miles of river that would otherwise be free flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 3 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1083 cfs). Water quality can be affected by the operating mode of a hydropower project. The PAD provides limited information on how project operations affect water quality within the project impoundment, bypass reach and tailrace. Water temperature can be affected by the operating mode of a hydropower project. The impounded water increases the water surface area of the river reach containing the project. The increased surface acts as a larger solar radiation collector and the thermal mass of the impounded water acts a heat sink storing heat from solar radiation. At night the increased surface area may act as convective radiator that releases heat. Together these attributes may contribute to unnatural thermal properties in the project impoundment that may impact natural temperature regime and influence habitat conditions for fish, wildlife and

plant resources (temperature tolerance, life cycle timing (e.g., reproduction or migration), and food availability).

The project discharges regulated Connecticut River flows ("daily run-of-river") from the impoundment to the downstream seventeen mile reach of the Connecticut River. The project can sporadically release large volumes of impoundment water that may be of a different temperature than the receiving water downstream of the dam. Unnatural and rapid shifts in temperature regimes in the downstream water can impact fish, wildlife and plant resources and instream habitat. The NHFGD requests that more recent temperature data is collected in a more intensive, systematic and scientific manner in order to assess project specific and cumulative impacts on fish, wildlife and plant resources at the project. Results from this study may be used to directly inform the evaluation of project effects on related resources, such as a fish and other aquatic species.

Methodology Consistent with Accepted Practice

Use of temperature loggers to gain information on thermal trends has been a standard technique to look at impacts of water storage associated with hydroelectric projects. We recommend that transects be established in the upper, middle, and lower project impoundment, as well as in the tailrace and downstream project. An additional transect should be established in the free flowing section of river above the impoundment to serve as a "reference site". Inexpensive temperature loggers should be deployed along each transects at a minimum of three locations: at depths of 1 meter subsurface, mid-depth, and 1 meter off the bottom (on buoy lines) where water depths permit. The temperature loggers should be deployed from April 1 – November 15 and be set to record temperature at 15 minute intervals. The temperature loggers should be checked and the data downloaded on the monthly basis. The data from the loggers should then be used to develop hourly/daily aquatic isotherm maps, and temperature change and distribution as a result of project and cumulative impacts should be assessed.

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

The effort and cost of this study is expected to be moderate to high, but the potential project specific and cumulative thermal alteration impacts have never been studied in a comprehensive manner and their potential impacts to aquatic habitat and fish, wildlife, and resources has not been adequately studied.

Literature Cited

Diana, J.S. 2004. Biology and Ecology of Fishes. 2nd edition. Biological Sciences Press.

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 22c: Continuous water temperature monitoring (15 minute intervals) at various locations within the Vernon Hydroelectric Project Impoundment and Tailrace, and Connecticut River downstream of the Vernon Dam (Docket Number p-1904)

Goals and Objectives

The goal of this study is to determine the potential impacts (both project specific and cumulative) of the Vernon Hydroelectric Project operations on hourly/daily temperature fluctuations and spatial thermal distribution within the Vernon Hydroelectric Project Impoundment and Tailrace**,** and the Connecticut River downstream of the Vernon Dam.

The objectives of this study are to:

1. Obtain continuous temperature data (every 15 minutes) at various locations and depths throughout the project impoundment, tailrace, and downstream Connecticut River using temperature loggers.

2. Analyze data for hourly/daily shifts in temperature regime and thermal distribution (aquatic isotherm maps) associated project specific and cumulative impacts associated with project operations.

3. Determine if any shifts in hourly temperature regime or thermal distribution are impacting aquatic habitat within the project impoundment and tailrace and lower Connecticut River (e.g., thermal blocks to migration, thermal stress, habitat degradation).

Resource Management Goals

Temperature is an important habitat consideration for many aquatic species including migratory fish and rare, threatened, endangered species. Temperature influences the distribution, behavior, metabolism, growth, reproduction, and survival of fishes (Diana 2004). The Connecticut River is considered a Class B waters 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. Additionally the Vermont Water Quality Standards states that in Class B cold water fish habitat, the total increase in from any activity or discharge should not result in a temperature increase that exceeds 1.0°F.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

Existing Information

The PAD provides limited information on impacts of project operations ("daily run-of-river") on temperature in the project impoundment, tailrace or lower Connecticut River. Hourly/daily temperature shifts associated with project operations at Vernon Dam can impact aquatic habitat rendering it unsuitable for some organisms. The information in the PAD does not define the spatial extent of temperatures (aquatic isotherm map) within the impoundment, lower Connecticut River. The PAD mainly indicates that in general, temperature did increase from upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment.

Nexus to Project Operations and Effects

The project impounds 26 miles of river that would otherwise be natural free-flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 8 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1250 cfs). Water temperature can be affected by the operating mode of a hydropower project. The impounded water increases the water surface area of the river reach containing the project. The increased surface acts as a larger solar radiation collector and the thermal mass of the impounded water acts a heat sink storing heat from solar radiation. At night the increased surface area may act as convective radiator that releases heat. Together these attributes may contribute to unnatural thermal properties in the project impoundment that may impact natural temperature regime and influence habitat conditions for fish, wildlife and plant resources (temperature tolerance, life cycle timing (e.g., reproduction or migration), and food availability).

The project discharges regulated Connecticut River flows ("daily run-of-river") from the impoundment to the downstream seventeen mile reach of the Connecticut River. The project can sporadically release large volumes of impoundment water that may be of a different temperature than the receiving water downstream of the dam. Unnatural and rapid shifts in temperature regimes in the downstream water can impact fish, wildlife and plant resources and instream habitat. The NHFGD requests that more recent temperature data is collected in a more intensive, systematic and scientific manner is needed to assess project specific and cumulative impacts on fish, wildlife and plant resources at the project. Results from this study may be used to directly inform the evaluation of project effects on related resources, such as a fish and other aquatic species.

Methodology Consistent with Accepted Practice

Use of temperature loggers to gain information on thermal trends has been a standard technique to look at impacts of water storage associated with hydroelectric projects. We recommend that transects be established in the upper, middle, and lower project impoundment, as well as in the tailrace and downstream project. An additional transect should be established in the free flowing section of river above the impoundment to serve as a "reference site". Inexpensive temperature loggers should be deployed along each transects at a minimum of three locations: at depths of 1 meter subsurface, mid-depth, and 1 meter off the bottom (on buoy lines) where water depths permit. The temperature loggers should be deployed from April 1 – November 15 and be set to record temperature at 15 minute intervals. The temperature loggers should be checked and the data downloaded on the monthly basis. The data from the loggers should then be used to develop hourly/daily aquatic isotherm maps, and temperature change and distribution as a result of project and cumulative impacts should be assessed.

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

The effort and cost of this study is expected to be moderate to high, but the potential project specific and cumulative thermal alteration impacts have never been studied in a comprehensive manner and their potential impacts to aquatic habitat and fish, wildlife, and resources has not been adequately studied.

Literature Cited

Diana, J.S. 2004. Biology and Ecology of Fishes. 2nd edition. Biological Sciences Press.

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 23: Project Effects on Populations of Tessellated Darter, *Etheostoma olmstedi* (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

Goals and Objectives

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

Objective 1: Determine the distribution and abundance of tessellated darter within project-affected areas; and
Objective 2: Determine the effects of project operations on the distribution and abundance of tessellated darter.

Relevant Resource Management Goals and Public Interest Considerations

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 for the following reasons:

- The USFWS 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.
- The tessellated darter appears to be more widespread than the slimy sculpin in the Bellow 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 USFWS 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 (NHFGD) 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. Tessellated darter is identified by New Hampshire as a Species of Greatest Concern.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Existing Information and Need for Additional Information

In the Preliminary Application Documents (PADs) for the Wilder, Bellows Falls, and Vernon projects, the applicant acknowledges that tessellated darter is one of the confirmed hosts of dwarf wedgemussel. It also identifies the occurrence of tessellated darter both upstream and downstream of each project. However, studies that specifically target small-bodied benthic species are lacking in project-affected areas. It is therefore likely that results of previous investigations are biased and underestimate true population size. An effective evaluation of project effects on a population will require robust, unbiased estimates of population parameters such as abundance or occupancy and similar estimates of population parameters under known conditions of low to no effect.

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

Project Nexus

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

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

Proposed Methodology

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

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

Level of Effort and Cost

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 and 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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Study Request 24: Upstream American Eel Passage Assessment at Vernon, Bellows Falls and Wilder Projects (Docket Number p-1904) (Docket Number p-1855) (Docket Number p-1892)

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 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 New Hampshire Fish and Game Department (NHFGD) 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 Project.

Specific to upstream passage of American eel, the NHFGD'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.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

Existing Information

The PAD contains 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 (the 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, pers. comm.). 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 United States Fish and Wildlife Service (USFWS) 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 USFWS 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. On September 29, 2011 the USFWS issued a substantial 90-day finding and initiated a 12-month status review. It is our understanding that the USFWS is still accepting new American eel information for the ongoing status review.

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 where eels are able to climb to, or where otherwise feasible. Temporary trap/passes should be purpose-designed and built for each location, and operated throughout the eel upstream migratory season (~1May 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 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.

The NHFGD 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 PAD.

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Study Request 25a: Wilder Hydroelectric Project: Water quality monitoring within the project impoundment and tailrace (Docket Number p-1892)

1. ***Goal and Objective***

   The goal of this study is to determine if the operational impacts of the Wilder Hydroelectric Project are causing or contributing to violations of New Hampshire and/or Vermont state water quality standards.

   The objective of this study will be to collect water temperature, dissolved oxygen, specific conductance, pH, nutrients, and chlorophyll-a data at multiple locations in the project area. This monitoring effort will consist of both instantaneous measurements and continuous data collected via multi-parameter dataloggers. Data should be collected under normal operating conditions and ambient conditions that include periods of low flow and higher water temperatures. Weekly profiles and grab samples should reflect various flow conditions. The water quality data will be compared to both Vermont and New Hampshire water quality standards to determine if the project is causing or contributing to water quality standard violations.

2. ***Resource Management Goals***

   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 project 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.

   A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

3. Public Interest Consideration

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

4. Existing Information

The PAD contains information on water quality monitoring that was completed between June 20, 2012 and September 11, 2012 in the tailrace and just upstream of the dam. The data indicated that Vermont Water Quality Standards for dissolved oxygen were not met during a seven day period in August. The PAD does not provide information on the water quality throughout the impoundment or how water quality is affected by project operations. The PAD does indicate that in general temperature, specific conductance, and pH did increase from upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment.

5. Project Nexus

The project impounds 45 miles of river that would otherwise be free flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 5 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (675 cfs). Water quality can be affected by the operating mode of a hydropower project. The PAD provides limited information on how project operations affect water quality within the project impoundment and tailrace.

Operations of the project must conform to Vermont and New Hampshire water quality standards. The NHFGD requests a study that will provide the data needed to determine if the Connecticut River in the vicinity of the Wilder Hydroelectric Project is or is not attaining the water quality standards of both states.

6. Proposed Methodology

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 dataloggers 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". At each designated datalogger monitoring location at least 10 days of data should be collected at 15 minute increments during a period of low flow ($\leq$3 x 7Q10) and high temperatures (preferably over 23 degrees C) between June 1 and September 30. Dataloggers deployed in the impoundment should be set at the bottom of the epilimnion (if stratified) or at 25% depth if not stratified. A vertical dissolved oxygen and water temperature profile should be conducted at the time of deployment of dataloggers in the impounded section to determine if river is stratified and thus the appropriate depth for deployment. Water quality results should be graphically compared to both state water quality standards and project operations, including the generation status, impoundment elevation, and discharge.

If low flow conditions are not met the first year of the study, a second year of data may be necessary.

It is preferable that the water quality monitoring for all three projects be coordinated so that sampling can occur at each location within each project during the same period of time and under the same operational, flow, and environmental conditions.

7. Level of Effort and Cost

The cost and effort of this study will be moderate, but is important to document the potential impact operations have on water quality and determine if they meet Vermont and New Hampshire water quality standards.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 25b: Bellow Falls Hydroelectric Project: Water quality monitoring within the project impoundment, bypass, and tailrace (Docket Number p-1855)

1. ***Goal and Objective***

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

   The objective of this study will be to collect water temperature, dissolved oxygen, specific conductance, pH, nutrients, and chlorophyll-a data at multiple locations in the project area. This monitoring effort will consist of both instantaneous measurements and continuous data collected via multi-parameter dataloggers. Data should be collected under normal operating conditions and ambient conditions that include periods of low flow and higher water temperatures. Weekly profiles and grab samples should reflect various flow conditions. The water quality data will be compared to both Vermont and New Hampshire water quality standards to determine if the project is causing or contributing to water quality standard violations.

2. ***Resource Management Goals***

   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 list the section of the Connecticut River above and below Bellows Falls dam on the Section 303(d) impaired water list due to flow alterations impairing aquatic life and habitat.

   All sections of the Connecticut River related to the project 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.

   A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine

resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

3. Public Interest Consideration

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

4. Existing Information

The PAD contains information on water quality monitoring that was completed between June 20, 2012 and September 12, 2012 in the tailrace, bypass reach and just 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 in the impoundment did not meet Vermont and New Hampshire water quality standards. The PAD does not provide information on the continuous water quality throughout the impoundment or how water quality is affected by project operations. The PAD indicates that in general temperature, specific conductance, and pH did increase from upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment.

5. Project Nexus

The project impounds 26 miles of river that would otherwise be free flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 3 feet,

with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1083 cfs). Water quality can be affected by the operating mode of a hydropower project. The PAD provides limited information on how project operations affect water quality within the project impoundment, bypass reach and tailrace.

Operations of the project must conform to Vermont and New Hampshire water quality standards. The NHFGD requests a study that will provide the data needed to determine if the Connecticut River in the vicinity of the Wilder Hydroelectric Project is or is not attaining the water quality standards of both states.

6. Proposed Methodology

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 dataloggers at multiple locations within the impoundment, the bypass reach, and tailrace. An additional site should be monitored in the 17 mile free flowing section of the river above the impoundment to serve as a "reference site". At each designated datalogger monitoring location at least 10 days of data should be collected at 15 minute increments during a period of low flow ($\leq$3 x 7Q10) and high temperatures (preferably over 23 degrees C) between June 1 and September 30. Dataloggers deployed in the impoundment should be set at the bottom of the epilimnion (if stratified) or at 25% depth if not stratified. A vertical dissolved oxygen and water temperature profile should be conducted at the time of deployment of dataloggers in the impounded section to determine if river is stratified and thus the appropriate depth for deployment. Water quality results should be graphically compared to both state water quality standards and project operations, including the generation status, impoundment elevation, and discharge.

If low flow conditions are not met the first year of the study, a second year of data may be necessary.

It is preferable that the water quality monitoring for all three projects be coordinated so that sampling can occur at each location within each project during the same period of time and under the same operational, flow, and environmental conditions.

7. Level of Effort and Cost

The cost and effort of this study will be moderate, but is important to document the potential impact operations have on water quality and determine if they meet Vermont and New Hampshire water quality standards.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 25c: Vernon Hydroelectric Project: Water quality monitoring within the project impoundment and tailrace (Docket Number p-1904)

1. ***Goal and Objective***

   The goal of this study is to determine if the operational impacts of at the Vernon Hydroelectric Project are causing or contributing to violations of New Hampshire and/or Vermont state water quality standards.

   The objective of this study will be to collect water temperature, dissolved oxygen, specific conductance, pH, nutrients, and chlorophyll-a data at multiple locations in the project area. This monitoring effort will consist of both instantaneous measurements and continuous data collected via multi-parameter dataloggers. Data should be collected under normal operating conditions and ambient conditions that include periods of low flow and higher water temperatures. Weekly profiles and grab samples should reflect various flow conditions. The water quality data will be compared to both Vermont and New Hampshire water quality standards to determine if the project is causing or contributing to water quality standard violations.

2. ***Resource Management Goals***

   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 above and below Vernon dam on the Section 303(d) impaired water list due to flow alterations impairing aquatic life and habitat.

   All sections of the Connecticut River related to the project 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.

   A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

3. Public Interest Consideration

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

4. Existing Information

The PAD contains information on water quality monitoring that was completed between June 20, 2012 and September 11, 2012 in the tailrace and just upstream of the dam. Temperature data indicated that it reached levels that would be critical threshold for salmonids, and above the natural regime for the river. The PAD does not provide information on the water quality throughout the impoundment or how water quality is affected by project operations. The PAD does indicates that in general temperature, specific conductance, and pH did increase from upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment on increase travel time in the river.

5. Project Nexus

The project impounds 26 miles of river that would otherwise be natural free-flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 8 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1250 cfs). Water quality can be affected by the operating mode of a hydropower project. The PAD provides limited information on how project operations affect water quality within the project impoundment and tailrace.

Operations of the project must conform to Vermont and New Hampshire water quality standards . The NHFGD requests a study that will provide the data needed to determine if the Connecticut River in the vicinity of the Wilder Hydroelectric Project is or is not attaining the water quality standards of both states.

6. ***Proposed Methodology***

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 dataloggers 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". At each designated datalogger monitoring location at least 10 days of data should be collected at 15 minute increments during a period of low flow ($\leq$3 x 7Q10) and high temperatures (preferably over 23 degrees C) between June 1 and September 30. Dataloggers deployed in the impoundment should be set at the bottom of the epilimnion (if stratified) or at 25% depth if not stratified. A vertical dissolved oxygen and water temperature profile should be conducted at the time of deployment of dataloggers in the impounded section to determine if river is stratified and thus the appropriate depth for deployment. Water quality results should be graphically compared to both state water quality standards and project operations, including the generation status, impoundment elevation, and discharge.

If low flow conditions are not met the first year of the study, a second year of data may be necessary.

It is preferable that the water quality monitoring for all three projects be coordinated so that sampling can occur at each location within each project during the same period of time and under the same operational, flow, and environmental conditions.

7. ***Level of Effort and Cost***

The cost and effort of this study will be moderate, but is important to document the potential impact project operations have on water quality and determine if they meet Vermont and New Hampshire water quality standards.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 26: Impact of Vernon Project Operations on Downstream Migration of Juvenile American Shad (Docket Number 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:

- Assess project operation effects of Vernon Dam on the timing, routes, migration rates, and survival of juvenile shad;
- 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;
- 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 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:

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

The New Hampshire Fish and Game Department (NHFGD) 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 NHFGD's goals are:

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

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally 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.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

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 Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The New Hampshire Fish and Game Department is requesting this study. The requestor is a state natural resource agency.

Existing Information

Adult shad are counted annually as they pass 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 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).

Although there were numerous studies of downstream passage facilities at the Vernon Project for Atlantic salmon smolts, passage studies for American shad were limited to tests in 1991 and

1992 of a high frequency sound field to guide fish to the fish pipe, the primary downstream fishway (RMC 1993). Although the 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.

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 high with the majority of costs associated with equipment (hydroacoustic gear, radio tags, radio receivers, and PIT readers) and related fieldwork labor.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

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.