

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

TRANSCANADA HYDRO NORTHEAST INC.

**Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)**

PUBLIC VERSION

**ILP Study 24
Dwarf Wedgemussel and Co-Occurring Mussel Study,
Phase 2 Progress Report**

MARCH 2, 2015

1. Introduction

TransCanada is conducting this Dwarf Wedgemussel and Co-occurring Mussel Study (ILP Study 24) to study the effects of Wilder and Bellows Falls Project operations on the federally endangered dwarf wedgemussel (DWM) (*Alasmidonta heterodon*). This study includes an adaptive, two-phase plan developed in collaboration with the aquatics working group throughout the design and implementation of the study. The study goals and objectives are as follows.

Goal 1: Assess the distribution, population demographics, and habitat use of DWM in the Wilder and Bellows Falls Project areas. This goal has three specific objectives:

- Objective 1 (Phase 1): Conduct an initial survey of the 17-mile-long reach of the Connecticut River from Wilder dam to the upstream end of the Bellows Falls impoundment to determine the distribution, relative abundance, and habitat of the DWM;
- Objective 2 (Phase 1): Determine the best sites for quantitative mussel sampling in areas where DWMs are known to occur in the Wilder and Bellows Falls Project areas and the reach surveyed for Objective 1; and
- Objective 3 (Phase 2): At sites identified in Objective 2, collect statistically sound and repeatable data, using quantitative methods, to determine density, age-class structure, and habitat for the DWM and co-occurring mussel species.

Goal 2: Assess the influence of flow regime (which includes water-level fluctuations) on the DWM, co-occurring mussel species, and mussel habitat. This goal has two specific objectives:

- Objective 4 (Phase 2): Observe and record behavior of the DWM and co-occurring mussel species *in situ* during varying flow conditions; and
- Objective 5 (Phase 2): Assess the potential effects of project operations on DWMs and their habitat.

The Revised Study Plan for this study was approved without modification in FERC's February 21, 2014, Study Plan Determination; however, the deadline for filing of the final study report was extended to March 1, 2015, in that determination. Because consultation on Phase 2 of the study is ongoing at this time, this report constitutes a study progress report rather than a final study report.

2. Study Progress

Phase 1 fieldwork was completed in September 2013, and the Phase 1 Study Report was prepared (Biodrawiversity et al., 2014a). The public version of the report was shared with the aquatics working group (Volume IV of the Initial Study Report (ISR)

filed September 15, 2014). The privileged version of the report containing specific DWM locations was provided to specific agency staff in August 2014, as requested. The privileged data from Appendix B of the report was filed as Volume V of the ISR.

A proposed Phase 2 Study Plan was developed, distributed, and discussed with the working group at a May 23, 2014, consultation meeting (Biodrawversity et al., 2014b) and following comments received via email from The Nature Conservancy (TNC) in June 2014, a working group conference call was held on July 1, 2014. The proposed Phase 2 Study Plan was subsequently revised in response to those comments (Biodrawversity et al., 2014c, included in Volume VI of the ISR filed September 15, 2014); however, it was not distributed prior to the 2014 field study because there was an indication that further comments were being prepared by US Fish and Wildlife Service (FWS), and the study plan might need to be revised again.

Based upon all initial comments received previously, it was anticipated that further comments would be slight modifications on the previous discussions and draft study plan. Because the study field work time table was at risk, TransCanada initiated field work based upon its undistributed Revised Phase 2 Study Plan, presuming that any issues remaining could be addressed rather easily, and while field work was in progress. However, FWS provided substantial new comments in the form of a “counter proposal” on September 4, 2014.

Fieldwork for Phase 2 relied on the Revised Phase 2 Study Plan and consisted of establishing twenty 50x1 meter monitoring transects distributed among six general locations in the Wilder impoundment, free-flowing reach, and upper Bellows Falls impoundment (transect locations are shown in Appendix F of the privileged version of this report). Most were surveyed in the period from August 20-29, and one pair (Cornish Covered Bridge – North) was surveyed on October 1. Data collection followed the methods outlined in the Revised Phase 2 Study Plan. The 2014 fieldwork also included quadrat surveys in the 2,400-meter reach that included Cornish Covered Bridge and Chase Island, as described in the Revised Phase 2 Study Plan. This work was completed under low-flow conditions and warm temperatures in September. A total of 405 2.25-m² quadrats were sampled in this reach; 385 were distributed in a systematic random pattern across the channel (bank to bank) and 20 additional quadrats were distributed in areas where mussel densities were higher. Counts for all mussel species, and several habitat parameters, were recorded for each quadrat as described in the Revised Phase 2 Study Plan.

A consultation meeting was held on October 9, 2014 to discuss the counter proposal (summary notes included as Attachment 4 of the ISR Meeting Summary filed October 14, 2014). FWS subsequently provided a revised counter proposal on November 14, 2014 (Appendix A), along with that agency's comments on the ISR. TNC also provided comments on the ISR on November 14, 2014. TransCanada provided a response to ISR comments on December 15, 2014, which addressed the numerous comments on Study 24 and reported that the revised FWS counter proposal was under review, and additional stakeholder consultation would occur once that review was completed.

On January 22, 2015, FERC issued a Determination on Requests for Study Modifications and New Studies in which the requested study modifications in the FWS revised counter proposal were not adopted at that time. FERC acknowledged that consultation on this study remains ongoing, and that specific methodologies for development of habitat suitability criteria (or “indices”. HSI) for DWM and/or other study methodologies are the subject of this consultation. A consultation conference call is scheduled for March 5, 2015; and this Progress Report as well as the proposed HSI methodology (Appendix B) will be provided to the working group prior to that conference call. FERC also noted on page 3 of its determination, “[i]f agreement cannot be reached on the phase 2 study methods, we recommend that TransCanada seek a determination from the Commission and file the comments received, a response to comments, and any updates to the phase 2 study plan at least 30 days prior to commencing any additional field work.”

3. Study Results to Date

Phase 1 of the study was completed (Biodiversity et al., 2014a), and that report was included as Volume IV of the ISR, with privileged data included separately in Volume V. The study sites were included as GIS layers in the privileged Study 24 geodatabase filed separately on DVD as Volume VIII of the ISR.

Phase 1: In the free-flowing reach downstream of Wilder dam, no live or dead DWM were found at the 39 survey sites in 2013, and the fluvial mussel species commonly associated with DWM (i.e., triangle floater and creeper) were also extremely rare. The 2011 and 2013 field studies detected few DWMs in the upper Wilder and Bellows Falls impoundments, and almost always at very low densities. They were found at only about one-fourth of the sites in both impoundments, and where they were found, a typical survey lasting 1 to 2 hours usually detected fewer than two or three animals. Co-occurring fluvial species (i.e., triangle floater and creeper) were also rare in both impoundments, although co-occurring generalist species (i.e., eastern elliptio and eastern lampmussel) were usually common in the impoundments and in parts of the free-flowing reach. Based on the 2011 and 2013 mussel surveys at 210 sites, and the existing mussel data from 1990-2010 (Gabriel, 1995; Nedeau, 2009), DWM populations were not considered large enough to permit certain types of quantitative sampling, monitoring, or analysis.

Phase 2 Transects: Live DWMs were found in five transects (max count = 2, total = 6), and shells were found in two additional transects (Appendix C, Table C-1, included in the privileged version of this report). Two other fluvial species, triangle floater and creeper were found at similar or lower frequency and density as DWM. Eastern elliptio was by far the most numerous (4,226 individuals), followed by eastern lampmussel (180 individuals). Brief qualitative surveys near transects documented an additional nine live DWM. The only locations where neither live nor dead DWMs were encountered in transects or qualitative searches included Sumner Falls (Transects 11 and 12) and Cornish Covered Bridge North (Transects 19 and 20). Numerous location, habitat, and biological parameters were recorded for each transect (and the 10 quadrats established along each transect); these parameters

have not been fully analyzed but are available in Appendix C of the privileged version of this report.

Phase 2 Quadrats: The quadrat survey documented low mussel densities throughout most of the 2,400-meter reach, with generally higher mussel densities near shorelines in depositional areas and hydraulic refugia. In total, only 251 mussels were found, including 222 eastern elliptio (88.5% of the total), 28 eastern lampmussel (11.2% of the total), and only one DWM and one triangle floater. Live DWMs were not found in any of the historic monitoring sites that were within this sampling reach, including Cornish Covered Bridge North and South, and Horseback Ridge. One live DWM was found in a depositional area where densities of eastern elliptio and eastern lampmussel were also high. DWMs (live and shell) were found during the Phase 2 Transect survey in parts of this reach, but were mostly undetected during the Phase 2 Quadrat survey. Numerous location, habitat, and biological parameters were recorded for each quadrat; these parameters have not been fully analyzed but are available in Appendix D of the privileged version of this report.

Representative photographs are included in Appendix E of the privileged version of this report. Figures showing transect locations are provided in Appendix F of the privileged version of this report, and privileged geo database of the transect figures is being filed with FERC separately and simultaneously with this report.

4. Remaining Activities

Additional consultation is scheduled for March 5, 2015. A methodology to develop HSIs and agreement on the need for any additional field surveys conducted in 2015 will be based on the outcome of that consultation. If needed, and in accordance with FERC's January 22, 2015 Determination, an update to the revised Phase 2 Study Plan will be prepared and distributed for comment to the working group.

An assessment of the potential effects of project operations will be included in the draft license applications because results from other studies will be needed to complete that assessment. Relevant studies include the Hydraulic Modeling Study (Study 4), and Operations Modeling Study (Study 5). These studies are not complete at this time.

5. Variance from Study Plan and Schedule

The original RSP (filed August 14, 2013) was adaptive, and although objectives and proposed methods were modified based on Phase 1 results and the subsequent re-evaluation of tasks needed to accomplish the Phase 2 objectives, there were few deviations from the main objectives of the study plan or the schedule to this point. The FWS revised counter proposal, received November 14, 2014 well after the 2014 field season, necessitates additional consultation and potentially, additional field work in 2015, pending the outcome of that consultation which is anticipated to be conducted in February 2015.

The Revised Phase 2 Study Plan called for mapping and ground-truthing hydromorphological units (HMUs) within the 2,400-meter reach from the Cornish Covered Bridge to below Chase Island using existing data and aerial imagery. Using randomly generated numbers to provide systematic coverage, 400 sampling locations were to be allocated among the HMUs proportional to their area, with additional sampling locations within areas that may be small yet disproportionately important to mussels. However, during ground-truthing it became evident that there was little variation in habitat (low HMU diversity), and it was difficult to delineate different HMUs because there was considerable overlap, and HMUs often changed as the stage of the river changed (i.e., they were different at high flows versus low flows). Consequently, sample sites were not allocated among HMUs proportional to their area. Instead, the process for obtaining random systematic coverage within the survey reach is described in Appendix D of the privileged version of this report.

The Revised Phase 2 Study Plan called for using video technology (i.e., a GoPro mounted at fixed locations with a good view of the study reach) to record changes in wetted area and other key habitat parameters during daily water-level fluctuations. However, it was subsequently determined that the 2D modeling proposed in this reach in Study 9 – Instream Flow Study would capture this information more effectively and in a more quantitative form than mounting GoPros and generating large video files. Consequently, video technology was not used during the Phase 2 field work.

6. Literature Cited

- Biodrawiversity, LBG, and Normandeau (Biodrawiversity, LLC; The Louis Berger Group, Inc.; and Normandeau Associates, Inc.). 2014a. ILP Study 24 – Dwarf Wedgemussel and Co-occurring Mussel Study, Phase 1 Report (Public Version). Draft for Stakeholder Review. Prepared for TransCanada Hydro Northeast Inc. May, 2014.
- Biodrawiversity, LBG, and Normandeau. 2014b. ILP Study 24 - Dwarf Wedgemussel and Co-occurring Mussel Study, Proposed Phase 2 Study Plan. Prepared for TransCanada Hydro Northeast Inc. May, 2014.
- Biodrawiversity, LBG, and Normandeau. 2014c. ILP Study 24 - Dwarf Wedgemussel and Co-occurring Mussel Study, Revised Phase 2 Study Plan. Prepared for TransCanada Hydro Northeast Inc. September, 2014.
- Gabriel, M. 1995. Preliminary monitoring plan for the dwarf wedgemussel (*Alasmidonta heterodon*) in the Connecticut River in New Hampshire and Vermont: a discussion of methods. Report submitted to the Vermont Nongame and Natural Heritage Program and the U.S. Fish and Wildlife Service.
- Nedeau, E.J. 2009. Distribution, Threats, and Conservation of the Dwarf Wedgemussel (*Alasmidonta heterodon*) in the Middle and Northern Macrosites of the Upper Connecticut River. Submitted to the Vermont Fish and Wildlife Department and the New Hampshire Fish and Game Department.

APPENDIX A

US Fish and Wildlife Service Revised Counter Proposal

STUDY 24
DWARF WEDGEMUSSEL AND CO-OCCURRING MUSSEL STUDY
USFWS REVISED PROPOSED PHASE 2 STUDY PLAN
(filed with USFWS ISR comments on 11/14/14)

Goals and Objectives

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

Goal 1: Assess the distribution, population demographics, and habitat use of the dwarf wedgemussel (DWM) in the Wilder and Bellows Falls project areas.

- Objective 1 (Phase 1): conduct an initial survey of the 17-mile-long reach of the CT River from Wilder dam to the upstream end of the BF impoundment to determine the distribution, relative abundance, and habitat of the DWM.
- Objective 2 (Phase 1): Determine the best sites for quantitative mussel sampling in areas where DWM are known to occur in the Wilder and BF project areas and the reach surveyed for Objective 1; and
- Objective 3 (Phase 2): At sites identified in Objective 2, collect statistically sound and repeatable data, using quantitative methods, to determine density, age-class structure, and habitat for DWM and co-occurring mussel species.

Goal 2: Assess the influence of flow regime on DWM, co-occurring mussel species, and mussel habitat.

- Objective 4 (Phase 2): Observe and record behavior of DWM and co-occurring mussel species in situ during varying flow conditions; and
- Objective 5 (Phase 2): Assess the potential effects of flow regime on DWM and their habitat.

Relevant Resource Management Goals and Public Interest Considerations

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

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

It is the goal of the U.S. Fish and Wildlife Service (USFWS) to recover the dwarfwedgemussel so that it can be removed from the Endangered Species list in the future. According to the Recovery Plan (USFWS 1993), the Connecticut River dwarfwedgemussel population is one that must be demonstrated to be viable before the species can be downlisted to threatened. The Upper

Connecticut metapopulation is considered to be the largest remaining population in the world (USFWS 2007), and so its protection is essential to the recovery of the species as a whole.

Public Interest

The requestor is a resource agency.

Existing Information and Need for Additional Information

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

In 2011, Biodrawvrsity, LLC conducted a freshwater mussel survey throughout the Vernon, Bellows Falls, and Wilder project areas (Biodrawvrsity 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 DWM in the project areas. Dwarfwedgemussel 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).

In 2013, Biodrawvrsity, LLC conducted a second freshwater mussel survey and the combined results of both surveys are presented in the 2013 Mussel Study Phase 1 Rep01i (Biodrawvrsity and LBG 2014). In general, the 2013 survey found fewer sites with DWM and lower CPUE of those sites with DWM, relative to the 2011 survey (Table 1).

Table 1. Summary results of Appendix B (Mussel Survey Data) in the 2013 Mussel Study Phase 1 Report (Biodrawvrsity and LBG 2013)

Survey Year	2011	2013
# Sites Surveyed	140	70
% Occurrence	15.7	12.9
Average CPUE	2.22	1.09
Max CPUE (# obs. / hr.)	8	3

The PERC-approved Revised Study Plan (RSP) for Study 24 was designed to use an adaptive, two-phase approach; Phase I would focus on surveying sites throughout the project-affected reach of the Connecticut River and based, on those results, Phase II would identify a subset of sites with sufficiently large DWM populations to conduct quantitative sampling, behavioral assessments and project effects analyses.

Unfortunately, results of the 2011 and 2013 surveys indicate that it will not be possible to meet the study goals using all of the original objectives. Given the relatively low densities and the location of those sites with the highest densities of DWM, it appears that Objective #4 should be

removed. However, the Service continues to believe that Objectives 3 and 5 can still be achieved, with the modified methodology proposed herein.

Project Nexus

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

The dwarf wedgemussel is known to occur within the Wilder and Bellows Falls project-affected 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 DWM abundance, distribution, and habitat suitability. 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.

Methodology Consistent with Accepted Practice

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

Task I - Quantitative Habitat Data: Quantitative habitat metrics should be collected from a number of sites representing low, medium and high CPUE based on current or historical data.

- Determine how many sites will be surveyed- tentatively, propose that a minimum of two sites within each proposed abundance category (Table 2), plus Cornish Covered Bridge (north and south) and Sumner Falls, for a total of n=9 sites.

Table 2 Example of proposed locations for 2015 quantitative sampling.

Location	Site	CPUE in TC surveys	Proposed Abundance Category
Black River	BF26	3.0	MED
Hubbard Island	BF 39-41	0.5-1.5	LOW
Jarvis Island	BF 48-49	1-2.4	LOW-MED
Below Chase Is.	BF 60,62	1-1.33	LOW
Cornish Covered Bridge	FF 3-5	0.0 (1.4-9.5 in 90s)	
Sumner Falls	FF26	0.0 (1.5-24.3 in 90s)	
Bradford	W31,33	4.8-5.0	HIGH
Downstream BBSP	W48	5.0	HIGH

Bedell Bridge SP	W 52,53	1.0	LOW
Upstream of BBSP	W 58,60	4.0-8.0	HIGH

- Data collection will entail sampling 1-meter² (m²) quadrats along transects, similar to what was proposed in Task 3, Part I of the Proposed Phase 2 Study Plan. At each site, the total number of quadrats will be equivalent to the average channel width in meters divided by 5, rounded up to the nearest multiple of 9, or N = 27, whichever is greater. There will always be 9 quadrats per transect. The number of transects will be equivalent to the total number of quadrats divided by 9; however, there will be a minimum of 3 transects per site.
- Each transect will be placed *perpendicular* to flow (bank to bank), 10 meters apart. Along each transect, quadrats will be selected in a stratified-random fashion, with 3 random quadrats selected and sampled in each of three lateral channel sections: right bank, mid-channel, and left bank. The division between the sections will be based on depth (e.g., maximum channel depth)/2, or a mutually-agreeable alternative), with a minimum section width of 3 meters. Selection of transects and random selection of quadrats will occur formally and prior to the day of field sampling, using a random number generator or similar technique.
- For each quadrat, a 0.25 m² will be excavated to a depth of 10 cm and sieved through a 10-mm sieve to estimate density of sub-surface DWM.
- In addition, observations will be made between quadrats and within 1 m of each side of each transect to survey and collect data for additional DWM.
- For *each site* (n=21), the following data will be collected:
 - stream shading
 - bank angle
 - bankfull width
 - bankfull cross sectional area
 - bankfull mean and maximum depth
 - width to depth ratio
 - bank erosion hazard index
 - median particle size (D50), D16 and D84
 - continuous hourly temperature @ 10 cm above, 5 cm below and 15 cm below interface
 - watershed area
 - land use
 - riparian land use (15 and 30m buffers)
 - ecoregion
 - geologic rock type
 - stream power
- For *each quadrat* and for *each transect*, the start and end time of sampling (to determine CPUE- #/quadrat and #/observation hours- as well as to correlate to flow and/or WSE) will also be recorded.
- For *each quadrat*, the following additional data will be collected:
 - Number of DWM
 - Presence and number of tessellated darters
 - Co-occurring mussel species

- Species composition and percent cover of aquatic vegetation
- Percent cover of woody debris
- For *each quadrat* (with or without DWM) and for each DWM encountered outside of a quadrat¹, the following additional data will be collected:
 - GPS coordinates
 - Distance to shore (specify bank)
 - Presence of groundwater seeps or other groundwater inflow
 - Variables necessary to calculate shear velocity, shear stress, Froude number and Reynolds number
- For *each individual DWM* encountered on the surface (within quadrats, outside of quadrats, or along the sides of each transect), and for *quadrats without DWM* (on the surface or at all), the following additional data will be collected:
 - water depth
 - mean column water velocity (m/s)
 - bottom water velocity (m/s)
 - embeddedness/substrate penetrability
 - substrate roughness
 - bottom temperature
 - dominant and subdominant substrate
 - distance to nearest cover and nearest cover type (per Pandolfo, cover in this context is the nearest material that could slow water velocity or potentially provide shelter or habitat for DWM)
- For *each individual DWM* encountered within each quadrat (surface and subsurface), between quadrats, and along the sides of each transect, the following data will be collected:
 - Shell length and width. According to Baginski et al. (2009), DWM can be accurately assigned as male or female based on length-width ratios.
 - Shell condition
 - Location (transect, quadrat or location along transect, surface or subsurface)

Water level loggers should be placed at each site prior to initiating field work and should remain in place until the end of the summer. River flow should be measured, estimated or calculated during each sampling event. If bathymetric data do not exist at a given survey site (e.g., those outside of the project affected area or in free-flowing reaches within the project affected area) then it should be collected.

Data collection should take place in early summer, 2015 (June and July). To the extent practicable, surveys should occur during base flow conditions.

Task 2- Data Analysis:

Habitat

This methodology is based on Pandolfo (Chapter 4, 2014²). In general, the analysis components include:

¹ If DWM encountered outside of transects are at densities > 1 m², one measurement point may be taken per 1 m² (equivalent to the size of a quadrat).

- Microhabitat suitability:
 - o Suitability calculated by dividing microhabitat use at a site by availability at that site over range of values for each parameter.
 - o Bootstrap two-sided Kolmogorov-Smirnov test to test for significant differences between use and availability distributions for each habitat parameter (i.e., non-random use of habitat by DWM).
- Assessment of relationship between abiotic/biotic factors and DWM density, using correlation and linear regression techniques.

HSC Development

Using the data from the quadrat task as well as other relevant data from DWM studies conducted both within and outside of the Connecticut River basin, a DELPHI panel of DWM experts will develop habitat suitability curves. These curves will then be used in the instream flow study (1D and 2D) for the free-flowing reaches within the project affected area (including steady state analysis, habitat time-series analysis, and habitat persistence analysis). For impounded reaches, the potential for water surface elevation fluctuations to influence relevant habitat metrics, both spatially and temporally, should also be analyzed.

The proposed methodology is consistent with accepted practice (Table 3):

Table 3 Gray and peer-reviewed literature supporting use of FWS proposed methodologies.

Study	Methodology
Allen and Vaughn (2010)	Cross-river transect placement; univariate and multiple regression model analysis
Maloney et al. (2012)	Quadrat-based data collection; habitat persistence analysis using 2D, hydrodynamic model
Pandolfo (2014)	Cross-river transect placement to collect reach-level habitat data; bank to bank mussel survey; detailed biological and micro habitat data collection;
B Idigo et al. (2003-2004)	Reach level habitat and hydraulic data collection at points along transects spaced set river widths apart; correlation and simple linear and partial multiple regression analysis
FERC (2014)	Use of Delphi approach to develop HSI criteria for rare mussels downstream of the Turners Falls Project

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

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

The expected level of effort for the data collection and analyses will be moderate. Costs are estimated to be between \$50,000 and \$80,000.

² Pandolfo, T.J. 2014. Biotic and abiotic influences on common and imperiled freshwater mussels at multiple spatial and temporal scales with inferences to global change. PhD dissertation, North Carolina State University, Raleigh, North Carolina. 179 pp.

The FERC-approved study goals and objectives include:

Goal 1: Assess the distribution, population demographics, and habitat use of the dwarf wedgemussel (DWM) in the Wilder and Bellows Falls project areas.

- Objective 1 (Phase 1): conduct an initial survey of the 17-mile-long reach of the CT River from Wilder dam to the upstream end of the BF impoundment to determine the distribution, relative abundance, and habitat of the DWM.
- Objective 2 (Phase 1): Determine the best sites for quantitative mussel sampling in areas where DWM are known to occur in the Wilder and BF project areas and the reach surveyed for Objective 1; and
- Objective 3 (Phase 2): At sites identified in Objective 2, collect statistically sound and repeatable data, using quantitative methods, to determine density, age-class structure, and habitat for DWM and co-occurring mussel species.

Goal 2: Assess the influence of flow regime on DWM, co-occurring mussel species, and mussel habitat.

- Objective 4 (Phase 2): Observe and record behavior of DWM and co-occurring mussel species in situ during varying flow conditions; and
- Objective 5 (Phase 2): Assess the potential effects of flow regime on DWM and their habitat.

The Service and TC are in agreement that, given the overall low DWM densities and location of DWM observed within the survey area (typically in deeper water that is beyond the influence of daily fluctuations in water surface elevation), there would be limited benefit to conducting video observations to assess behavior under different operational regimes; therefore, Objective 4 should be omitted. This leaves Objectives 3 and 5 to be addressed by the Phase 2 Study Plan.

TransCanada has proposed to collect detailed quantitative habitat and demographic data on DWM and co-occurring mussels (eastern elliptio, eastern lampmussel, creeper and triangle floater) using two different methodologies: within quadrats placed along 20 transects located in six discrete areas where DWM have been found previously and within 400 randomly chosen quadrats occurring throughout a stretch of river from Cornish Covered Bridge to below Chase Island. Collected data would be used to characterize DWM demographics within the study area, to develop habitat suitability criteria, and to use those criteria to quantify changes in habitat suitability/availability over a range of flows, in both the ID and 2D study areas.

For the reasons stated below, the Service does not believe that the proposed methodology will be sufficient to meet the study goals and objectives.

- I. In order to produce data-driven HSI criteria, a sufficient number of observations across a range of mussel density and habitat conditions is needed.³ Based on the information

³FERC Study Plan Determination for FirstLight's Turners Falls Project (FERC No. 1889), dated February 21, 2014. Page B-77.

provided in the Phase I Report (Biodrawversity 2014) and at the October 10,2014 meeting, very few DWM were found during both qualitative surveys (Table 3) and the 2014 quantitative effort. The lack of a range of densities means there is no way to assess the relative suitability of the habitat.

Table 4. Summary of Phase I Report data (Biodrawversity 2014).

Location	Site	CPUE in TC surveys
Hubbard Island	BF 39-41	0.5-1.5
Jarvis Island	BF 48-49	1-2.4
Below Chase Is.	BF 60,62	1-1.33
Cornish Covered Bridge	FF 3-5	0.0 (1.4-9.5 in 90s)
Sumner Falls	FF26	0.0 (1.5-24.3 in 90s)
Bedell Bridge SP	W 52,53	1.0

The Service's proposed methodology would quantitatively sample at sites covering a range of DWM density categories.

2. According to the protocol outlined in the Revised Phase 2 Study Plan, flow velocity will be estimated. Visual estimates will not be of sufficient resolution for the analyses that will be conducted. For example, Pandolfo (2014) found that DWM were found at velocities of 0.00 to 0.02 m/s. In addition, the protocol specifies that embeddedness will be measured. The Service's counter proposal recommends collecting embeddedness and substrate penetrability, which has been shown to be an important habitat parameter for freshwater mussels (Van Hassel 2007; Pandolfo 2014).

The Service's proposed methodology would utilize standard flow measuring equipment and collect substrate penetrability data.

3. In 2014, TC collected transect-based quantitative data within six areas. The number of transects at each area varied from two to four. Given the rarity of this species, more intensive effort is needed in order to collect enough data to conduct effects analyses.

The Service's proposed methodology bases the number of transects at a given site on the river width at that site (with a specified minimum number of transects per site). This will result in more transects at wider sections of river, and an overall greater level of effort that will increase the likelihood of detection. A number of studies have stressed the necessity of increasing effort for rare mussel species (Metcalf-Smith et al. 2000; Smith 2006; Thompson 2004).

4. The 2014 quantitative data collection effort used transects placed parallel to the river flow. This will restrict the types of habitats encountered (i.e., narrower range of water depth, velocity, substrate, etc.) and limit the habitat analyses that can be conducted.

The Service's proposed methodology will place multiple transects cross-channel. This will allow for collecting biological and physical data over a range of habitat conditions and mussel densities that will enable analyses such as habitat preference to be conducted (which requires knowing what habitat is being used in relation to the total amount of habitat available at a given site).

5. In the Revised Phase 2 Study Plan, TC states that **it** will complete Task 5 using DWM and co-occurring mussel data; the justification being that (1) DWM may be rare or absent from certain areas and (2) DWM can occupy all of the same water depths and habitat types as other species. The Service disagrees with this premise; DWM is listed as an endangered species because of limiting factor(s) that are not acting on other species (or at least not to the same extent). Therefore, habitat suitability for co-occurring species may not be reflective of suitability for DWM.

The Service's proposed methodology calls for conducting effects analyses only for DWM, in order to best determine which habitat parameters are most important and how those habitats are affected by project operations.

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APPENDIX B

TransCanada's Proposed Habitat Suitability Index Methodology

TransCanada will develop Habitat Suitability Index (HSI) criteria for dwarf wedgemussel (*Alasmodonta heterodon*) and co-occurring mussel species; these will be hybrids of Category I (qualitative) and Category II (quantitative, using empirical data), depending on the amount of data available for each parameter. HSI criteria will be developed by reviewing and synthesizing existing data, and by soliciting input from regional experts.

Approach

1. Gather, review, and synthesize available information on the distribution and habitat of dwarf wedgemussel and co-occurring mussel species. Sources: journal articles, government and consultant reports, case studies and insight from regional experts, the mussel field data collected by TransCanada (2011 to 2014), and habitat data collected by TransCanada for other relicensing studies (e.g., Studies 7 and 9).
2. Draft HSI criteria framework for key parameters, and provide a written rationale for each criterion. Draft a questionnaire to solicit opinion of regional experts using the Delphi process.
3. Identify regional experts willing to be part of the Delphi panel (i.e., to provide opinions, insight, and data on the HSI criteria). Provide experts background information and the questionnaire.
4. Fine-tune, eliminate, or add HSI criteria based on responses from experts. Summarize the first round of responses, and send revised HSI criteria to experts for final review and to resolve any outstanding issues raised during the first round. Finalize the HSI criteria following the second round of comments from experts.
5. All sources of information, the process used to develop the final HSI criteria, and the final HSI criteria will be summarized in a written document and submitted to stakeholders for final review.

Proposed Schedule

- Teleconference with stakeholders to agree on proposed HSI approach. **March 5, 2015.**
- Identify regional experts willing to assist with the Delphi process or to otherwise provide insight on HSI criteria for target species. Compile available data, establish key criteria and rationale for each, and develop and submit a questionnaire to the Delphi panel. **Goal Date: 4/15/15.**
- Based on the input from the Delphi panel, modify HSI criteria and develop a new questionnaire to resolve outstanding issues that were raised during the first round. Submit questionnaire to Delphi panel for a second round. **Goal Date: 6/1/15.**

- Receive responses on Round 2, resolve any outstanding issues, and finalize HSI criteria. All sources of information, the process used to develop the final HSI criteria, and the final HSI criteria will be summarized in a written document and submitted to stakeholders for final review. **Goal Date: 8/1/15.**

**PRIVILEGED DATA CONTAINED IN
APPENDICES C, D, E, and F**

are included in:

**TransCanada Study 24 – Dwarf Wedgemussel and Co-occurring Mussel
Survey – Phase 2 Progress Report (Privileged Version)**

Filed March 2, 2015