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John S. Howard
Director- FERC Hydro Compliance

February 22, 2013

VIA ELECTRONIC FILING

Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Re: Northfield Mountain Pumped Storage Project, FERC Project No. 2485-063
Turners Falls Hydroelectric Project, FERC Project No. 1889-081
Draft Study Plan- Conduct Instream Flow Habitat Assessments in the Bypass Reach and Below Cabot Station

Dear Sir/Madam:

FirstLight Hydro Generating Company (FirstLight), Licensee of the Turners Falls Hydroelectric Project (FERC No. 1889) and the Northfield Mountain Pumped Storage Project (FERC No. 2485) has commenced the Federal Energy Regulatory Commission (Commission or FERC) relicensing process for the Projects with the filing and distribution of its Preliminary Application Document on October 31, 2012. On January 30 and 31, 2013, FERC held public scoping meetings in the Project area to identify issues and concerns. Pursuant to FERC's regulations, 18 C.F.R. § 5.9, interested parties have until March 1, 2013 to file their issues, concerns, and study requests in writing with FERC. Per 18 C.F.R. § 5.11, FirstLight is required to develop a Proposed Study Plan (PSP) for the relicensing of the Turners Falls Project and Northfield Mountain Project. The PSP will provide the stakeholders with a description of the studies proposed to be conducted by FirstLight, including methodologies, scopes, and schedules. Per 18 C.F.R. § 5.10, FirstLight must file and distribute the PSP no later than April 15, 2013.

After meetings to review the PSP and FirstLight's issuance of a Revised Study Plan (RSP) FERC will issue its Study Plan Determination letter on or before September 12, 2013. FERC's Study Plan Determination Letter will contain FERC's decision as to which studies are required in the event there are disagreements among FirstLight and the stakeholders. Field studies would then commence in 2014.

The purpose of this letter is to notify stakeholders that FirstLight is accelerating one study to commence and complete the field work in the summer of 2013. Specifically, FirstLight intends to conduct an instream flow habitat assessment in the Connecticut River bypass reach below the Turners Falls Dam, and in the Connecticut River below Cabot Station. FirstLight is expediting this specific study because its outcome is important to inform decisions regarding relicensing. FirstLight recognizes that this study would be developed and conducted in advance of the formal timelines of the Integrated Licensing Process, and thus respectfully requests your assistance in providing input on this proposed instream flow assessment study plan.

FirstLight has had two meetings with the state and federal resource agencies to obtain preliminary input sufficient to develop a draft study plan entitled "*Conduct Instream Flow Habitat Assessments in the Bypass Reach and Below Cabot Station.*" Based on this cooperative effort, we have uploaded the draft study plan to the http://www.northfieldrelicensing.com website and are electronically filing it as a draft study plan with the FERC. FirstLight would appreciate your review and input of the draft instream flow assessment study plan. We plan on holding a meeting at the Northfield Mountain Visitors Center (99 Millers Falls Road, Northfield, MA) on April 16, 2013 to review the study plan, seek input on proposed methods, and discuss your comments. If you cannot attend the meeting but would still like to offer written comments, please provide them via email to the following email address: firstlight@gomezandsullivan.com no later than April 5, 2013.

For future reference, FirstLight plans on utilizing the http://www.northfieldrelicensing.com website throughout the licensing process as the means of communicating with interested parties. Thus, it is important for you to join the mailing list on the website. By joining the mailing list, you will automatically be notified of any documents posted to the website. FirstLight will rely on the website for all communications.

If you have any questions regarding the study plan or proposed expedited schedule for this study, please feel free to contact me or Mark Wamser at Gomez and Sullivan Engineers at 603-428-4960.

Sincerely,

John Howard
Director- FERC Hydro Compliance

3.3.2 Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station

General Description of Proposed Study

A habitat-based field study, such as the Instream Flow Incremental Methodology (IFIM), is proposed to understand the relationship between the flow regime and aquatic habitat.

Study Goals and Objectives (18 CFR § 5.11(d)(1)

The purpose of the study is to assess the potential effects of discharges from Turners Falls Dam, Station No. 1 and Cabot Station on aquatic habitat suitability in the Connecticut River between Turners Falls Dam and Cabot Station (the bypass reach) and below Cabot Station.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals identified are to: 1) [PROVIDED BY AGENCIES]

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

In 2012, aquatic habitat mapping and water level monitoring was conducted at the following locations:

Habitat Mapping

- In the Connecticut River bypass reach from Turners Fall Dam to Cabot Station, and;
- In the Connecticut River from Cabot Station approximately 30 miles downstream to a natural hydraulic control located in the vicinity of the Dinosaur Footprints Reservoir (see Figure 3.3.2-1).

Water Level Recorders

- From approximately late April 2012 through mid August 2012, FirstLight installed continuously recording water level loggers that measured the change in water elevations. Two loggers were placed in the bypass reach from Turners Falls Dam to below Cabot Station (although vandalism was an issue), and three loggers were placed below Cabot Station (at the existing Montague USGS gage, at the Route 116 Bridge in Sunderland, and at Rainbow Beach in Northampton). See Figure 3.3.2-2 for a map showing the logger locations. All loggers were surveyed to a common datum to allow for comparison. Appendix E of the PAD contains weekly plots of the data obtained from these water level loggers.

The 2012 aquatic habitat mapping report entitled "*Aquatic Mesohabitat Assessment and Mapping*" prepared by FirstLight (2012) was filed with FERC on January 8, 2013. It also can be found on FirstLight's relicensing website at http://www.northfieldrelicensing.com.

Project Nexus (18 CFR § 5.11(d)(4))

Per the FERC license, FirstLight is required to release a continuous minimum flow of 1,433 cfs or inflow, whichever is less, below the Turners Falls Project year-round. FirstLight typically maintains the minimum flow requirement through discharges at Cabot Station and/or Station No. 1.

Per the FERC license, a continuous minimum flow of 200 cfs is maintained in the Connecticut River bypass reach starting on May 1, and increases to 400 cfs when fish passage starts by releasing flow

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through a bascule gate[1]. The 400 cfs continuous minimum flow is provided through July 15, unless the upstream fish passage season has concluded early in which case the 400 cfs flow is reduced to 120 cfs to protect shortnose sturgeon. A 120 cfs continuous minimum flow is maintained in the bypass reach from the date the fishways are closed (or by July 16) until the river temperature drops below 7°C, which typically occurs around November 15th. The 120 cfs flow release was determined in 1993 in consultation with MADFW, NMFS and USFWS to ensure that an adequate zone of passage exists in the reach during the months when sturgeon may be present and require volitional movement.

Approximately 87% of the inflow the Turners Falls Impoundment is controlled by discharges from the Vernon Hydroelectric Project. The majority of the remaining 13% percent of inflow to the Turners Falls Impoundment is from the Ashuelot and Millers Rivers. The Vernon Hydroelectric Project has a hydraulic capacity of 17,130 cfs, while the hydraulic capacity of the Turners Falls Project (Cabot and Station No. 1 combined) is approximately 15,938 cfs. When flows are within the hydraulic capacity of the Vernon Hydroelectric Project, inflows to the Turners Falls Impoundment reflect peaking discharges.

FirstLight operates the Turners Falls Project as a peaking facility when flows are in the hydraulic range of the Turners Falls Project and as a run-of-river facility when flows exceed the hydraulic capacity of the Project (15,938 cfs). The Northfield Mountain Project operates as a peaking project.

Project operations have the potential to influence aquatic habitat in the bypass reach and below Cabot Station. Based on water level monitoring studies conducted in 2012, it appears that hydraulic effects of peaking operations may extend downstream to Rainbow Beach, approximately 25 miles below Cabot Station; however, significant habitat effects attenuate rapidly below Sunderland, MA.

The Connecticut River immediately below Cabot Station has been identified as a major spawning area and overwintering area for the Endangered Species Act (ESA)-listed shortnose sturgeon. Other diadromous species such as American shad adults and juveniles, seasonally utilize habitat in this vicinity for spawning and rearing, and American eels and Atlantic salmon seasonally rely on this reach as a migration corridor.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Background

The scope of this study is to quantify the effects of Project flows on aquatic habitat suitability in the Connecticut River for the aquatic community and its managed fish resources, potentially including diadromous and resident fish species, and aquatic invertebrates. These data will then be used in conjunction with hydrologic, operational and other models to evaluate the costs and benefits of potentially providing alternate flows to the Connecticut River in the study area.

Task 1. Consult with Agencies and Interested Stakeholders to Determine Study Area, Study Reaches, and Habitat Suitability Index Curves

Study Area

The Connecticut River segment between the Turners Falls Dam and the confluence with the Holyoke Impoundment below Sunderland Bridge (Figure 3.3.2-1) was identified by the applicable state and federal

[1] The bascule gate used to pass the minimum flow is located at the Turners Falls Dam and is the one closest to the gatehouse.

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fishery agencies (agencies) as the study area for purposes of the habitat based study. Flow in this reach is cumulatively influenced by discharges from upstream tributaries, hydroelectric projects in the upper Connecticut River, the Turners Falls Project and the Northfield Mountain Project. Additional discharges to the study area immediately below Cabot Station include the Deerfield River, which contributes approximately 665 square miles (mi^2) of additional drainage area. The Deerfield River includes several FERC-licensed hydroelectric projects operating as peaking facilities and two seasonal regulated storage reservoirs- Somerset and Harriman Reservoirs in Vermont.

An IFIM study is proposed to develop an understanding of key habitat-flow relationships in the study area. This may be quantified by models such as Physical Habitat Simulation (PHABSIM) or its equivalent. The model(s) will be used to simulate habitat suitability at various flow increments representing selected anadromous and resident fish species, and aquatic biota (i.e., macroinvertebrates). One-dimensional (transect-based) and/or two dimensional (finite elements-based) hydraulic models are required to simulate river channel hydraulics in various areas of interest.

Consistent with IFIM protocol, a study team comprised of licensee and qualified fishery biologists will be formed for the purpose of making technical decisions regarding input parameters and review of study output. Specifically, that study team will collaboratively designate:

1. specific spatial and temporal habitat management goals,
2. boundaries of the study area and reaches,
3. locations of specific representative or critical study sites, and study site transects,
4. Habitat Suitability Index (HSI) criteria for applicable species and lifestages, and
5. calibration flows and range of flows to be assessed.

Study Reaches and Transect Selection (1-D and 2-D Modeling)

The proposed study methodology involves a phased approach beginning with review of recently-mapped mesohabitat distribution throughout the study area. The mapping and characterization of aquatic mesohabitat provides essential information regarding the extent, location, and composition of aquatic habitats that may be affected by Project operation.

Study reach boundaries are typically placed at significant breaks in geomorphic, hydrologic or habitat use in the study area (Bovee et al., 1998)[2]. The study team will consult to define study reaches and select applicable study sites within each reach, as well as transects in areas of 1-dimensional (1-D) modeling within each study site.

Study sites may represent typical and/or unique but critical habitats within each reach. For 1-D model applications, the study team will select upstream and downstream cell boundaries within each study site based on localized observed shifts in stream width, cover, substrate, and hydraulics. The field crew will subsequently locate a transect within each longitudinal cell.

Based on discussions with the agencies, due to complex flow patterns near the islands above the Cabot tailrace, a 2-D model is proposed from the upstream end of the islands to just below the Deerfield River confluence (specifically at the USGS Gage at Montague)..

[2] Differences in slope, geomorphology, substrate, and flow influence, suggest that five reaches may be justifiable.

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Project operations and configuration affect flow and habitat in distinct ways. For this reason, five study reaches are recommended for modeling purposes (see an overview of locations in Figure 3.3.2-1 and a close-up of the bypass reach area in Figure 3.3.2-3). The following study reaches are proposed:

- **Reach 1. Upper Bypass Reach**. This reach is approximately one mile long extending from the Turners Falls Dam downstream to the confluence with the Station No. 1 tailrace. Habitat and flow in this reach is influenced by discharges from the Turners Falls Dam, attraction and fishway flows for the Spillway fish ladder and the Fall River (see Figure 3.3.2-3 for location). Stream channel structure and geomorphology is controlled primarily by bedrock. From the Turners Falls Dam to the just below the Fall River confluence, the bypass channel is quite wide and the thalweg poorly defined, before starting to narrow just upstream of the Station No.1 tailrace. Mesohabitat in this reach includes pool, run and riffle with bedrock overlaid with rubble and cobble substrates.

- **Reach 2. Lower Bypass Reach**. This reach is approximately two miles long extending from the Station No. 1 tailrace downstream to an island complex and a geological feature including a natural ledge drop known as "Rock Dam". Flow is influenced by both the net discharge from Reach 1, as well as Station No. 1, when generating. Stream channel structure is controlled primarily by bedrock. Reach 2 channel morphology is relatively well defined, and includes pool, run and riffle mesohabitats with bedrock overlaid with rubble and cobble substrates.

- **Reach 3. Tailrace Reach**. The tailrace reach extends from the Rock Dam downstream to the USGS Gage No. 01170500 at Montague, which includes the confluence with the Deerfield River. Habitat in this reach is influenced by flows from Reaches 1 and 2 as well as generation at Cabot Station including backwatering around the island complex upstream to the Rock Dam vicinity. Stream channel structure is comprised of alluvial deposits, including a series of island and split channel complexes both upstream, across, and downstream from the Cabot Station powerhouse. Hydraulic effects are complex, and include backwatering from Cabot Station upstream to Rock Dam as well as flow between islands. Habitat is primarily riffle and run; substrate is dominated by gravel bars and cobble, and includes ledge outcrops at the General Pierce Bridge area.

- **Reach 4. Downstream Reach**. This reach extends from the Montague gage to the Sunderland Bridge (Route 116), which is where backwater influence of the Holyoke Project impoundment generally is detected. Flow is primarily influenced by Reaches 1-3 and contribution from the Deerfield River. This section of river is alluvial and low gradient, with well defined channel and embankments, and repeating patterns of pool and run habitat. Substrate varies but is dominated by cobble, gravel and fines.

- **Reach 5. Transition Reach.** This reach extends from the Route 116 Bridge downstream to Rainbow Beach. Flow is influenced by a combination of discharge from Turners Falls and other upstream inputs, but also from impoundment backwatering resulting from operations at Holyoke Dam. This section of river is alluvial, and low gradient, with well defined channel and embankments, and repeating patterns of pool and run habitat. Substrate varies but is dominated by cobble, gravel and fines.

Habitat Suitability Index Criteria

FirstLight anticipates the use of habitat suitability index curves (HSI) curves adopted primarily from those previously used in support of recent PHABSIM models conducted at study sites with similar geomorphic and ecoregion characteristics. HSI curves will be obtained and reviewed for applicability, discussed, modified as necessary and approved by the study team. Based on preliminary consultation with agencies, FirstLight proposes to evaluate the following HSI criteria:

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Study Reach	Species	Lifestage/criteria
Reach 1 and 2	American shad	zone of passage
	white sucker	zone of passage
	white sucker	spawning, fry, juvenile, adult
	fallfish	spawning, fry, juvenile, adult
	freshwater mussels	host fish zone of passage
	benthic macroinvertebrate	larvae
Reach 3	American shad	spawning and incubation
	shortnose sturgeon	spawning and incubation, overwintering juvenile, overwintering adult
	sea lamprey	spawning and incubation
Reach 4	American shad	spawning and incubation
	sea lamprey	spawning and incubation
	white sucker	spawning, fry, juvenile, adult
	fallfish	spawning, fry, juvenile, adult
	benthic macroinvertebrate	larvae
	shortnose sturgeon	Overwintering juvenile, overwintering adult
Reach 5	Eastern silvery minnow	adult [NOTE: Further discussion with MADFW is needed regarding this species]

Appendix A includes a draft set of proposed HSI curves. Table 3.3.2-1 includes the proposed velocity, depth and substrate habitat suitability criteria and sources. Note that for the American shad and shortnose sturgeon, the HSI curves were obtained from the Conowingo Hydroelectric Project relicensing on the Susquehanna River in Maryland. The HSI curves for the remaining species below will require further refinement.

Table 3.3.2-1 Proposed HSI Curves and Sources

Species	Velocity	Depth	Substrate
American shad[1, 2, 3]			
Spawning	Stier and Crance 1985.	Stier and Crance 1985.	ASMFC 2009.
Fry	Stier and Crance 1985.	Stier and Crance 1985.	Stier and Crance 1985.
Juvenile	Stier and Crance 1985.	Ross et al 1993. Greene et al. 2009.	Stier and Crance 1985.
Adult	Stier and Crance 1985.	Stier and Crance 1985.	Stier and Crance 1985.
Shortnose Sturgeon[4]			
Spawning	Crance, J.H. 1986	Crance, J.H. 1986	Crance, J.H. 1986
Fry	Crance, J.H. 1986	Crance, J.H. 1986	Crance, J.H. 1986
Juvenile	Crance, J.H. 1986	Crance, J.H. 1986	Crance, J.H. 1986
Adult	Crance, J.H. 1986	Crance, J.H. 1986	Crance, J.H. 1986
White Sucker[5]			
Spawning	Twomey, et al. 1984	Twomey, et al. 1984	Twomey, et al. 1984
Fry	Twomey, et al. 1984	Twomey, et al. 1984	Twomey, et al. 1984
Juvenile	Twomey, et al. 1984	Twomey, et al. 1984	Twomey, et al. 1984
Adult	Twomey, et al. 1984	Twomey, et al. 1984	Twomey, et al. 1984
Fallfish[6]			
Spawning	Gomez and Sullivan, 2007	Gomez and Sullivan, 2007	Gomez and Sullivan, 2007

Species	Velocity	Depth	Substrate
Fry	Gomez and Sullivan, 2007	Gomez and Sullivan, 2007	Gomez and Sullivan, 2007
Juvenile	Gomez and Sullivan, 2007	Gomez and Sullivan, 2007	Gomez and Sullivan, 2007
Adult	Gomez and Sullivan, 2007	Gomez and Sullivan, 2007	Gomez and Sullivan, 2007
Sea Lamprey			
Spawning	TBD	TBD	TBD
Fry	TBD	TBD	TBD
Juvenile	TBD	TBD	TBD
Adult	TBD	TBD	TBD
Benthic Macroinvertebrate	TBD	TBD	TBD

1) Stier, D.J., and J.H. Crance. 1985. Habitat suitability index models and instream flow suitability curves: American shad. United States Fish and Wildlife Service Biological Report 82(10.88). 34pp.

2) Ross, R.M.,T.W.W. Backman, and R.M.Bennett.1993. Evaluation of habitat suitability index models for riverine life satges of American shad, with proposed models for pre-migratory juveniles. U.S.Fish and Wildlife Service Biological Report 14.

3) Atlantic States Marine Fisheries Commission.2009. Atlantic coast diadromous fish habitat: A review of utilization, threats, recommendations for conservation, and research needs. Habitat Management Series No.9, Washington, D.C.

4) Crance, J.H. 1986. Habitat suitability information: Shortnose sturgeon. U.S. Fish Wildl. Serv. Biol. Rep.FWS/OBS-82/10.129. 31pp.

5) Twomey, K.A, K.L. Williamson, and P.C. Nelson., 1984. Habitat suitability information: white sucker. U.S. Fish Wildl. Serv. Biol. Rep.FWS/OBS-82/10.64. . 56pp.

6) Gomez & Sullivan Engineers, P.C. 2007. Glendale Hydroelectric Project FERC Project No. 2801. Final Report Bypass reach aquatic habitat and instream flow study. GSE, Weare, NH. 41 pp. plus Appendices.

<u>Task 2. Field Data Collection</u>

The second phase will quantify habitat-discharge relationships for selected species and lifestages in the study area, using standard PHABSIM data collection and flow modeling procedures (Bovee, 1982; Bovee *et al*., 1998). The modeling approach dictates what field data collection is necessary as explained below.

Data Collection in Reaches 1, 2, and 4 (1-D modeling)

It appears that a 1-D model approach using PHABSIM is suitable for Reaches 1, 2, and 4. A 1-D modeling approach will be based on hydraulic data developed from cross-sectional depth, velocity, and substrate measurements following Milhouse, et al. (1989), using PHABSIM for Windows (V 1.5.1), developed by the USFWS and distributed by the USGS Fort Collins (CO) Science Center.

The location of each transect will be field blazed with flagging or other appropriate means. Each study site and cell boundary will be mapped sufficiently to quantify the area represented by each transect. The transect headpin and tailpins will be located at or above the top-of-bank elevation, and secured by steel rebar or other similar means. Measuring tapes accurate to 0.1 ft will be secured at each transect to enable

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repeat field measurements to occur at specific stream loci[3]. Stream bed and water elevations tied to a known datum will be surveyed to the nearest 0.1 ft using standard optical surveying instrumentation and methods.

Depth, velocity, and substrate data will be gathered at intervals (verticals) along each transect. Each vertical will be located to the nearest 0.1 ft wherever an observed shift in depth or substrate/cover occurs. Between 20 and 99 verticals per transect will be established as necessary on each transect. Verticals will be positioned so that no more than 10% of the discharge passes between any pair, to enhance hydraulic model calibration. A staff gage will be located in each study site, and monitored at the beginning and end of each set of hydraulic measurements to verify stable flow during measurements. If flow is found to be insufficiently stable, the related data will be discarded and re-measured once stable flow is established.

Mean column velocity will be measured to the nearest 0.1 ft/second with either a calibrated electronic velocity meter mounted on a top-setting wading rod, or alternatively an Acoustic-Doppler Current Profiler (ADCP) transducer. In water less than 2.5 ft depth, velocity measurements will be made at 0.6 of total depth (measured from the water surface); at greater depths, paired measurements will be made at 0.2 and 0.8 of total depth and averaged.

Each calibration flow will be provided by scheduled releases from the Project via unit operation or in the case of the bypass reach through gate settings. Turbine rating curves, USGS gages, and study-site field gaging will be collectively used to estimate each calibration flow release. The 1-D hydraulic model will be developed from measurements gathered at a minimum of three calibration flows to facilitate extrapolation of hydraulic data across the range of interest. To accomplish calibration, a full set of depth, velocity and water surface elevation (WSEL) data will be gathered at the intermediate flow, and WSEL will be measured at each transect for the low and high flows to calibrate the hydraulic models. At transects with complex hydraulics such as riffles, and/or sites with unusual backwatering or eddy effects, supplemental velocity data may also be gathered at the low calibration flow. This will be determined in the field on a case-by-case basis.

For the 1-D model, each calibration flow should ideally be broadly separated to provide a suitable stage-discharge curve for the hydraulic model. The general rule of thumb is the hydraulic model, and hence depths and velocities, can be extrapolated from 40-250% of the calibration (measured) flow.

Thus, the following calibration flows and associated flow ranges can be evaluated in the 1-D and 2-D hydraulic models. The suggested calibration flows are listed below.

Reach(es)	**Calibration Flow**	**Extrapolated Flow Range**	**WSEL only or Both (WSEL and velocity measurements)**
1, 2, *4	300 cfs (low flow)	120 cfs to 750 cfs	Both, at complex hydraulics such as riffles
	900 cfs (intermediate flow)	360 cfs to 2,250 cfs	Both
	2,500 cfs (high flow)	1,000 cfs to 6,250 cfs	WSEL
3	2,500-9,000 cfs	1,433 cfs to 22,500 cfs	Both
5	Further discussion is needed as to what, if any, field work is needed in Reach 5.		
*Reach 4 calibration flows will be higher due to the contribution of the Deerfield River. FirstLight will need to			

[3] Supplemental transects may be located as needed to record water surface and bed elevation data at hydraulic controls to establish backwatering parameters necessary for hydraulic modeling.

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Reach(es)	**Calibration Flow**	**Extrapolated Flow Range**	**WSEL only or Both (WSEL and velocity measurements)**
work with TransCanada (Licensee of the Deerfield River Hydroelectric Project) during the data collection in Reach 4 such that a steady continuous flows is maintained from the Deerfield River.			

Data Collection in Reach 3(2-D Modeling)

A two dimensional (2-D) approach will best represent hydraulics in Reach 3 due to the complex channel characteristics and hydraulics.

For the 2-D model, a single calibration flow is required; the exact flow required is not critical but should be one that is representative of hydraulic conditions intermediate throughout the range of flows of interest, including "typical" generating from Cabot Station and an intermediate discharge through the bypass reach. The need for any additional calibration flow data will be evaluated on a case-by-case basis.

A 2-D model will be developed using a combination of terrain (LIDAR and/or 10m DEM, depending on availability) and bathymetric data. This will include a WSEL survey, and flow gaging at the inlet and/or outlet of the study site. To the extent possible, bathymetric data will be provisionally assembled from existing sources including past modeling, surveys, bridges, Project related information, and fishing/recreation maps. It is likely that additional bathymetric data will need to be collected to supplement the existing data coverage. These will be obtained through a combination of depth sounding and RTK-GPS (Real Time Kinematic), as required. In addition, it is expected that a high-level of bathymetric mapping will be obtained in the vicinity of the Cabot tailrace and existing fishway entrance in case future computation fluid dynamic (CFD) modeling are needed in the future.

Data Collection in Reach 5 (Water Surface Elevation)

To be determined via further consultation with stakeholders.

<u>Task 3.Hydraulic Modeling (Reaches 1-4)</u>

Model boundary conditions (input values for generation at Cabot and Station No. 1, river discharge, spill at Turners Falls Dam, and tributary inflows) will be obtained from observed flow and release records. Modeling scenarios will be developed and run in "steady state" mode to produce data required to support the PHABSIM analyses including water profiles, wetted area, depth and velocity at flow increments of interest.

1-D hydraulic modeling will be accomplished by calibration (correlating each surveyed WSEL set with discharge to develop a stage-discharge relationship for each transect). PHABSIM uses hydraulic models such as IFG4, MANSQ and WSP. Once this relationship is established, the model then calculates additional WSELs at other flow increments, and adjusts velocities obtained at calibration flows to other flow increments of interest for which defined water stages have been calculated. The model is then calibrated by comparing simulated hydraulics to empirical measurements taken at the calibration flows. Coefficients such as relative stream channel roughness (commonly referred to as Mannings n) are then iteratively adjusted as needed to optimize model accuracy across the full flow range.

2-D hydraulic modeling, while similar in many ways to 1-D modeling, requires an initial phase that is critical to model performance. This is development and testing of the model grid-space and arrangement. The process of developing and testing the model grid is iterative, with a goal of finding the best balance of model stability, accuracy, and performance. This will occur at a single test condition that represents a

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fairly common flow, features representative hydraulics, and has sufficient supporting input data (*e.g.*, most observations).

Following development and testing of the model grid, the model will then be calibrated and verified. The most common approach for calibration is to provide discharge as the upstream boundary condition while the downstream boundary relies on the measured WSEL. Measured WSELs at the survey transects will be used to directly calibrate to a specific steady flow analysis scenario. Calibration is achieved by adjusting the resistance terms in the model to provide predicted WSELs that best match measured WSELs, for a given discharge. Model verification will be conducted by running the calibrated model for other measured flow conditions and comparing the model-predicted results to the independent measured values.

Task 4. Habitat Modeling (Reaches 1-4)

Once the hydraulic model is calibrated, estimates of habitat suitability at each flow increment of interest will be generated by combining the HSI and hydraulic model data using the HABTAE and supporting programs within PHABSIM. These output Weighted Usable Area (WUA) for each transect at each flow increment, for each species and lifestage. WUA is an abstract habitat quality index generated from units of square feet of optimal habitat available per 1,000 feet of represented stream length. The habitat-flow curve across the flow range for all transects in a given study site are then weighted and summed at the study reach level, according to actual linear stream length that each site represents, as mapped in the field.

Task 5. Habitat Time Series (Reaches 3-4)

The WUA information (habitat versus flow) will be merged with the Montague City USGS gage hourly flow data to yield habitat time series based on current operations. To estimate habitat time series under alternative modes of operation, output from the operations model described later will be used. Specifically, the model's estimated hourly flow data will be matched with the WUA curves to produce varying habitat suitability in Reaches 3 and 4.

Task 6. Persistent Habitat Analysis and Mapping (Reaches 3-4)

A persistent habitat analysis will be conducted as part of this study. The objective of the persistent habitat analysis is to evaluate the relationship between short-term hydrologic variability (i.e., peaking flows) and immobile aquatic species' habitat. Immobile aquatic species are those that are considered unable to move from one location to a more suitable location in the time frame of a typical peaking cycle (e.g., mussels, incubating eggs, early fry, etc.). A persistent habitat analysis consists of first identifying "quality" habitat areas (i.e., a model node's combined habitat suitability ≥ 0.5) at each modeled flow, and then matching various low and high flow pairs (e.g., 1,000 cfs and 5,000 cfs) to find the common areas of quality habitat. "Persistent" habitat is then calculated for various flow pairs on a node-by-node basis, where a node is marked as persistent habitat for that flow pair if the high and low flows (as well as any flows in between) are considered quality habitat. The analysis results can be mapped to visualize what areas provide consistently good habitat throughout the target flow range. The results from this task will include a low/high flow habitat matrix for each target species/life stage and a series of maps depicting persistent habitat for a variety of flow ranges covering expected operation flows.

Task 7. Study Report

A draft report will be prepared for study team review and comment, documenting methods and results. The report will quantify flow/WUA relationships for applicable species and lifestages in each study reach. WUA and supporting hydraulic data will be presented in graphic and tabular form, along with an analysis of trends in the data, and documentation of study team consultation. Appendices will also include cross-

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sectional survey data and reference photographs of study sites. The report will be finalized following receipt of input from the study team.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The estimated cost for the study outlined in this plan is approximately $200,000-$250,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

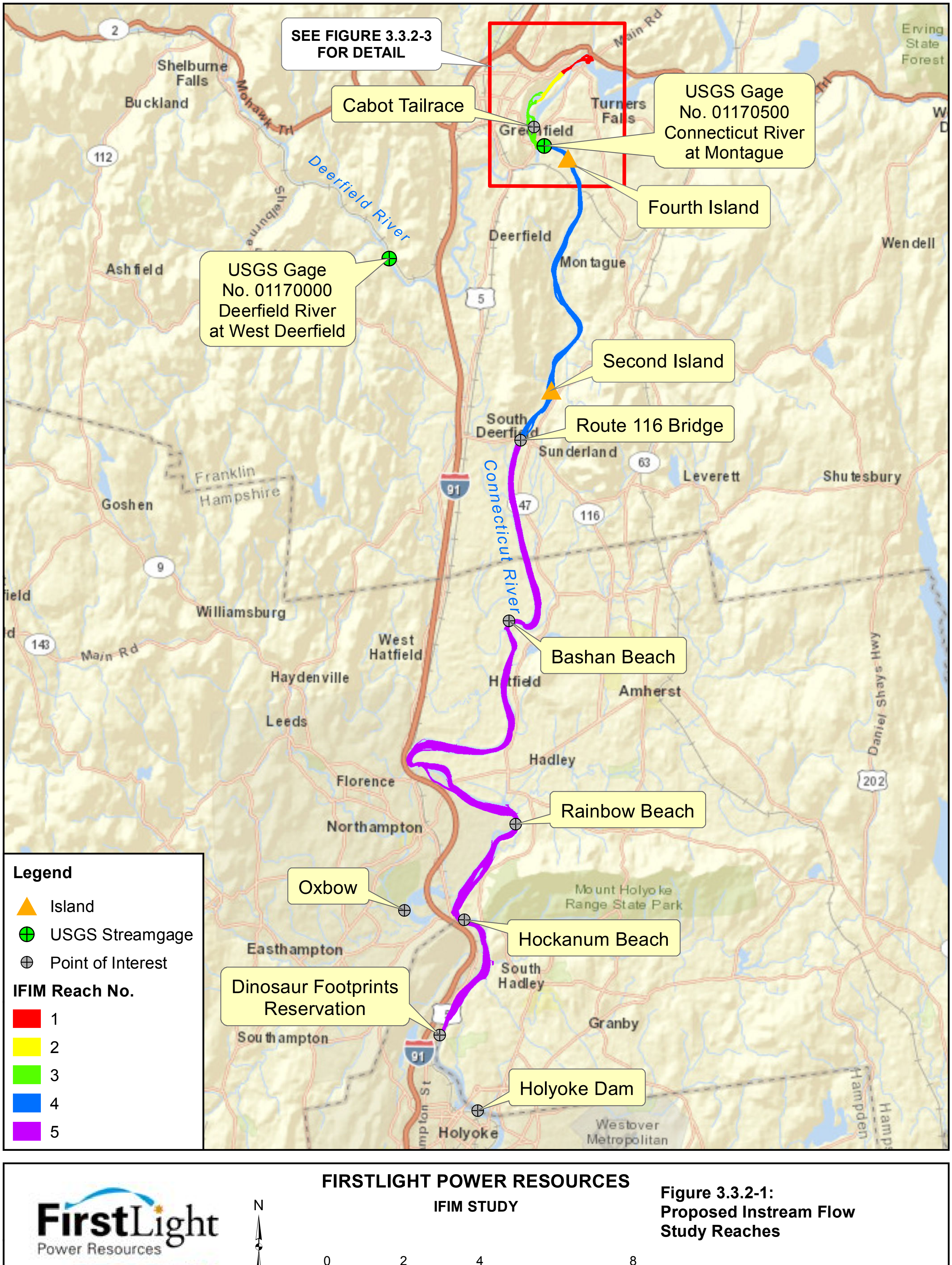
FirstLight is proposing to commence this study before the FERC Study Plan Determination is issued, which is due by September 12, 2013. In developing this study plan, meetings were held with the state and federal resource agencies including NOAA, USFWS, MADFW and MADEP to help jump-start the study planning.

However, to ensure all interested parties have input on the study plan, it will be provided to all parties on the mailing list and a meeting will be held to solicit and address issues on the plan on April 16, 2013 at the Northfield Mountain Visitor Center (99 Millers Falls Road, Northfield, MA). For those who cannot attend the meeting, FirstLight requests written comments be sent by April 5, 2013 to the following email address: firstlight@gomezandsullivan.com.

The accelerated schedule for this study is listed below.

TASK	COMPLETION DATE
Finalize flow targets, study reaches, species and lifestages	April, 2013
Finalize HSI curves to be used	May, 2013
Select study sites and cell boundaries	June, 2013
Collect hydraulic and bed profile data	July, 2013
Complete modeling	September, 2013
Issue draft report	October, 2013
Issue final report	December 1, 2013

DRAFT



FIRSTLIGHT POWER RESOURCES

IFIM STUDY

Figure 3.3.2-1: Proposed Instream Flow Study Reaches

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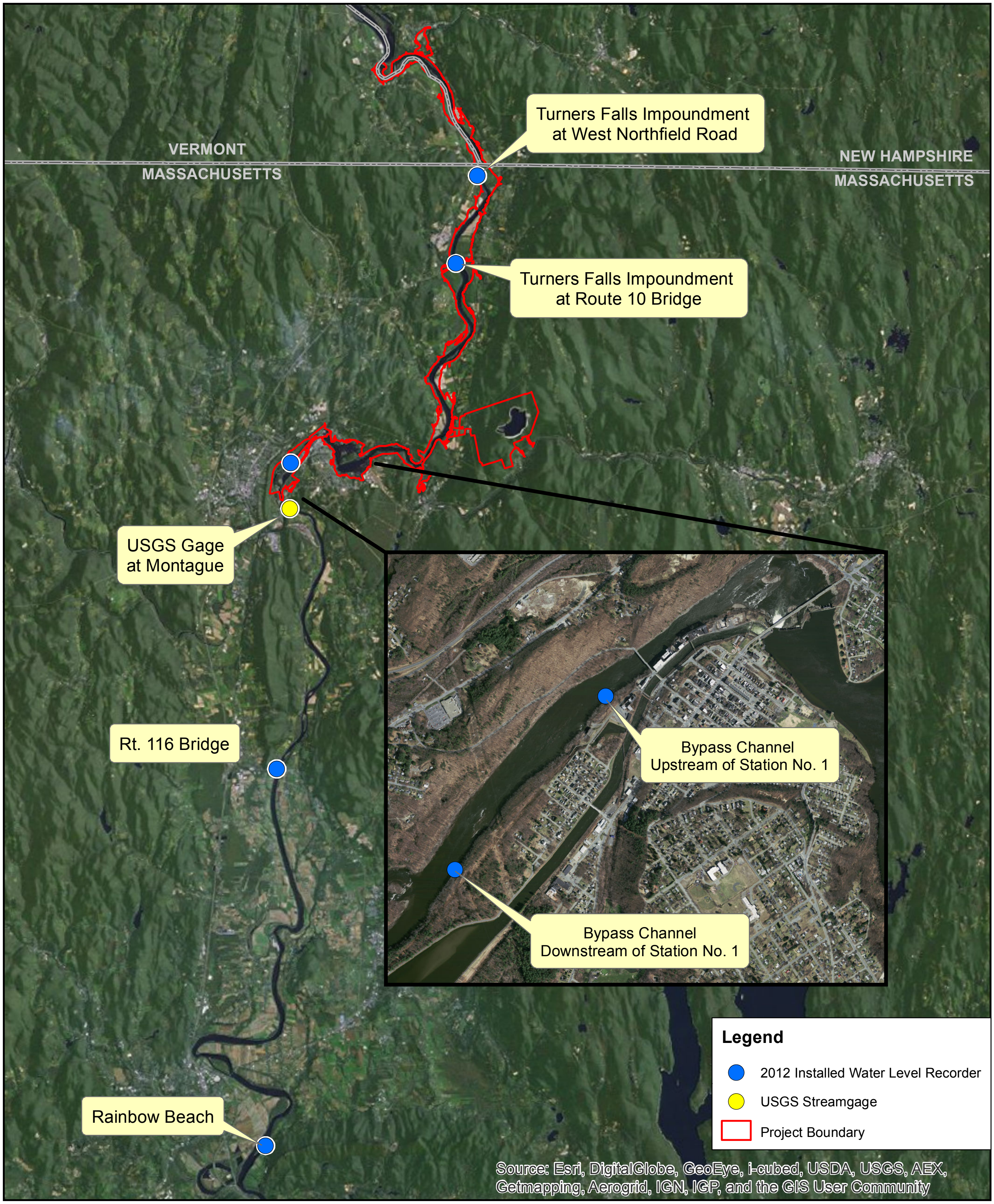

FirstLight Power Resources
GDF SUEZ

N

FIRSTLIGHT POWER RESOURCES

PRE-APPLICATION DOCUMENT

0 1.5 3 4.5 6 Miles

Figure 3.3.2-2
2012 Installed Water Level Recorder Locations

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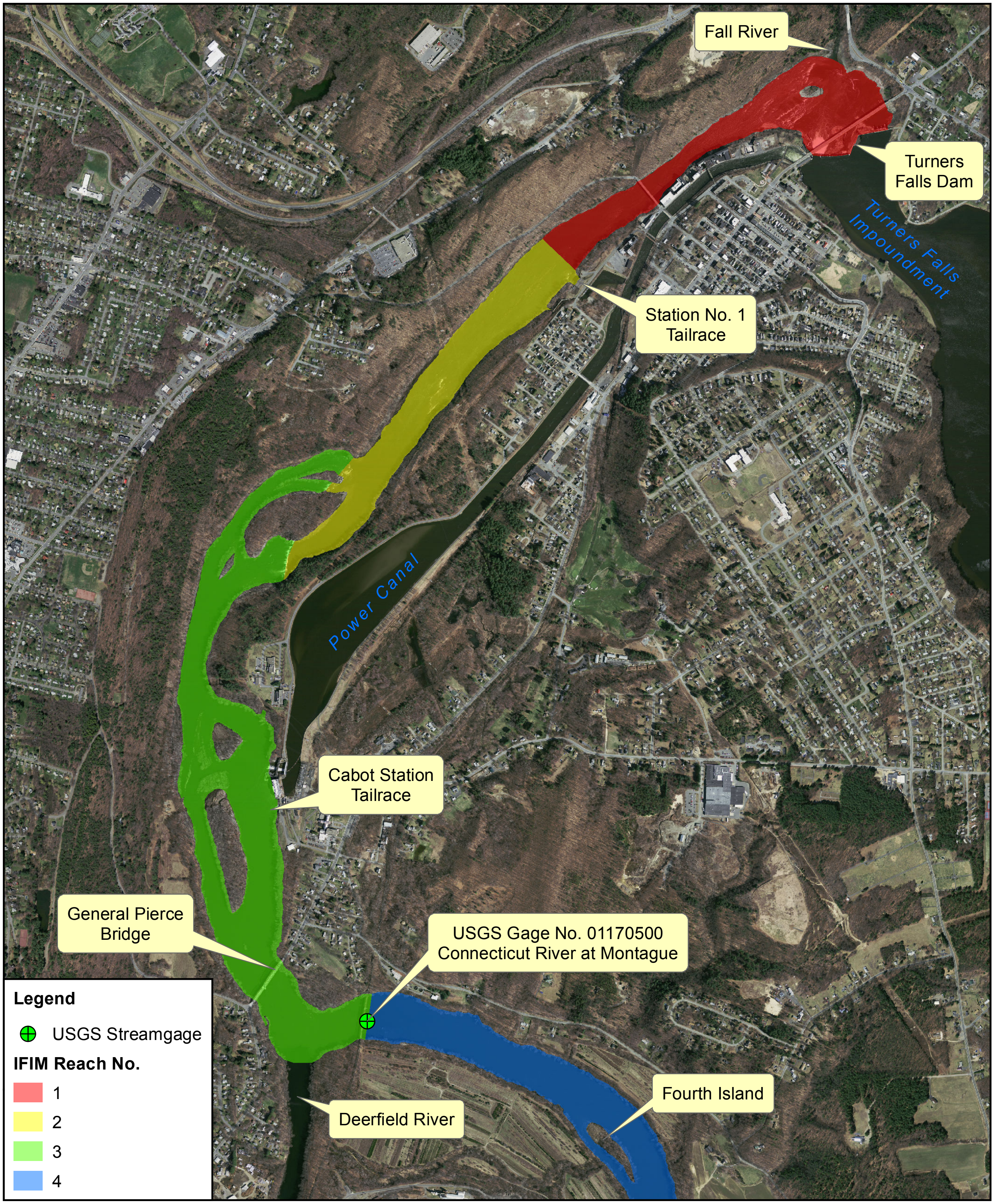
Path: W:\gis\maps\pad\figure_4_3_1_6_1.mxd



FIRSTLIGHT POWER RESOURCES

IFIM STUDY

Figure 3.3.2-3: Proposed Instream Flow Study Reaches - Bypass Reach Inset

N

0 0.25 0.5 1 Miles

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Path: W:\gis\maps\IFIM\figure_2_IFIM.mxd

APPENDIX A: PROPOSED HABITAT SUITABILITY INDEX CURVES

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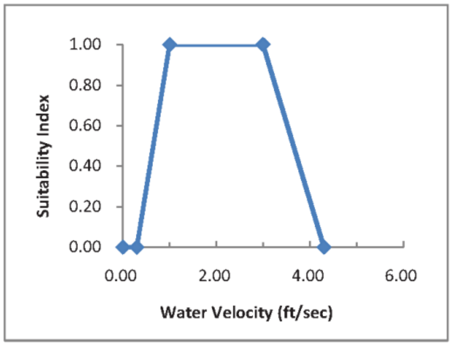
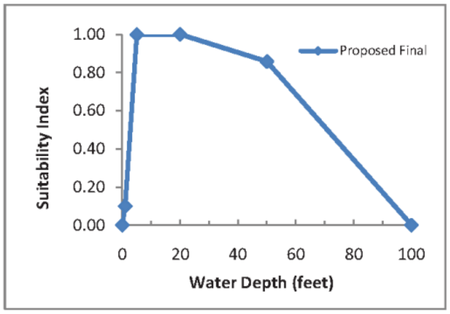
Species: American Shad
Lifestage: Spawning

Velocity	SI Value
0.00	0.00
0.30	0.00
1.00	1.00
3.00	1.00
4.30	0.00

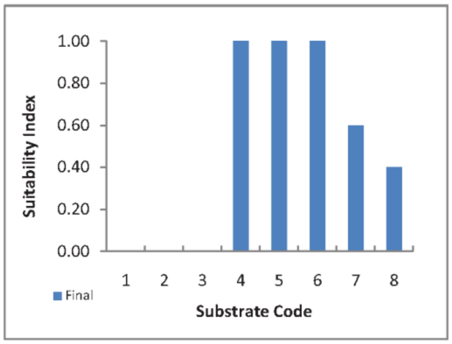


Proposed Final

Depth	SI Value
0.00	0.00
1.00	0.10
5.00	1.00
20.00	1.00
50.00	0.86
100.00	0.00

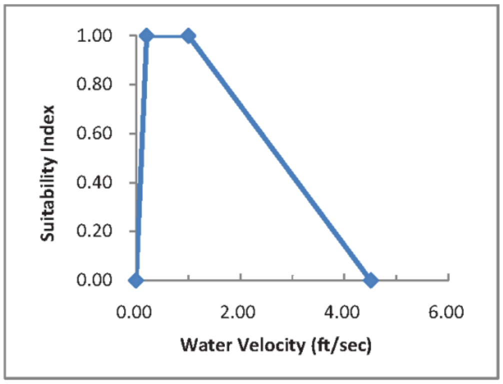


Code	Final SI Value	Type
1	0.00	Detritus
2	0.00	Mud
3	0.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	1.00	Cobble
7	0.60	Boulder
8	0.40	Bedrock

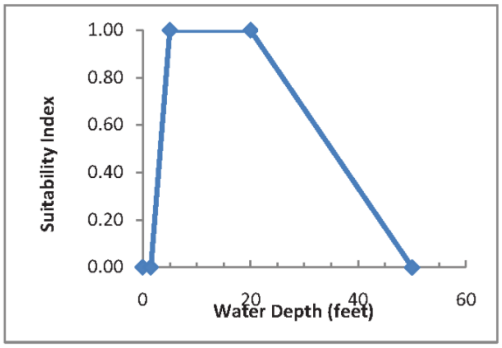


Species: American Shad
Lifestage: Fry

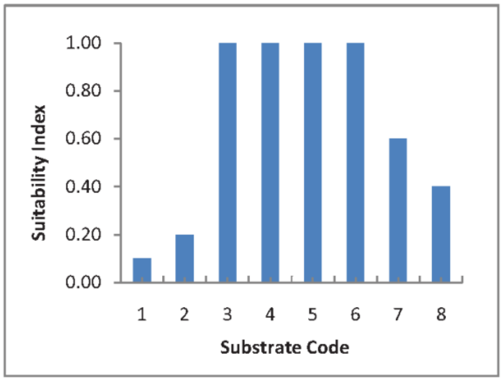
Velocity	SI Value
0.00	0.00
0.20	1.00
1.00	1.00
4.50	0.00



Depth	SI Value
0.00	0.00
1.50	0.00
5.00	1.00
20.00	1.00
50.00	0.00

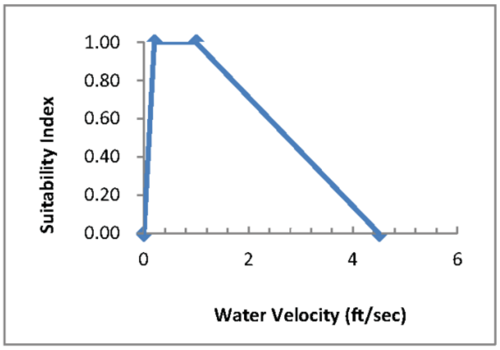


Code	SI Value	Type
1	0.10	Detritus/Organic
2	0.20	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	1.00	Cobble
7	0.60	Boulder
8	0.40	Bedrock

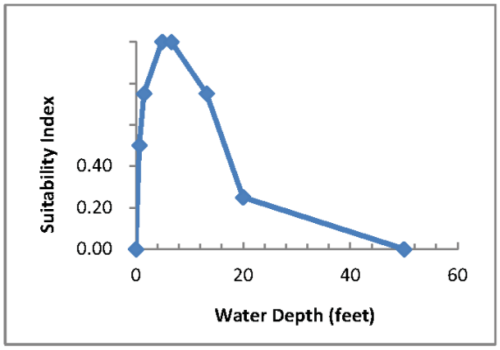


Species: American Shad
Lifestage: Juvenile

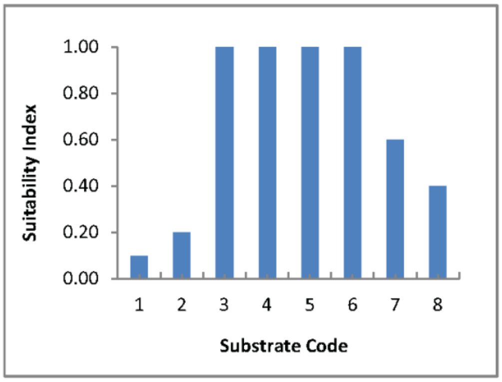
Velocity	SI Value
0.00	0.00
0.20	1.00
1.00	1.00
4.50	0.00



Depth	SI Value
0.00	0.00
0.66	0.50
1.50	0.75
4.90	1.00
6.60	1.00
13.20	0.75
20.00	0.25
50.00	0.00

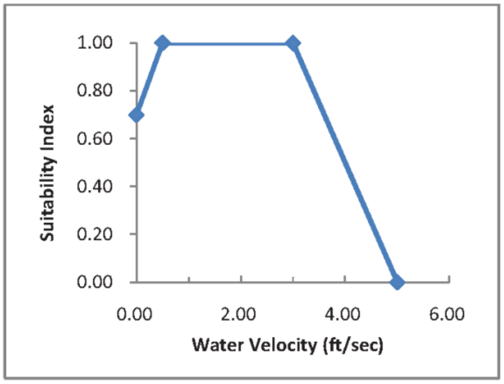


Code	SI Value	Type
1	0.10	Detritus/Organic
2	0.20	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	1.00	Cobble
7	0.60	Boulder
8	0.40	Bedrock

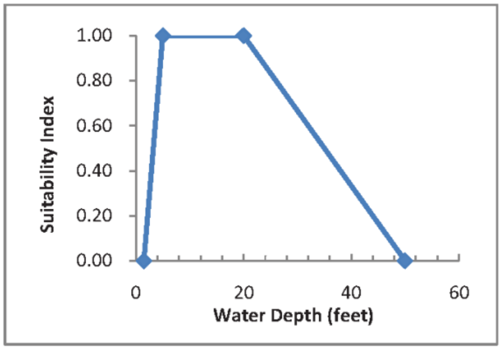


Species: American Shad
Lifestage: Adult

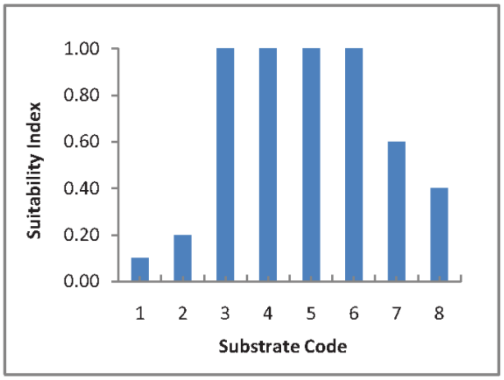
Velocity	SI Value
0.00	0.70
0.50	1.00
3.00	1.00
5.00	0.00



Depth	SI Value
0.00	0.00
1.50	0.00
5.00	1.00
20.00	1.00
50.00	0.00

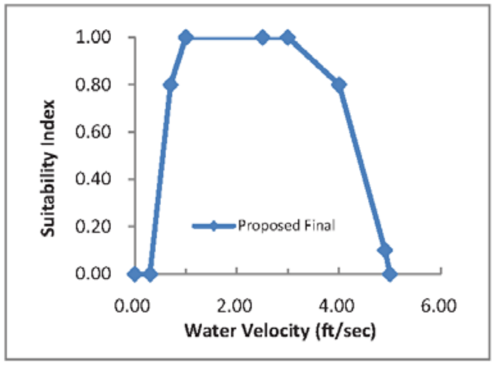


Code	SI Value	Type
1	0.10	Detritus/Organic
2	0.20	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	1.00	Cobble
7	0.60	Boulder
8	0.40	Bedrock

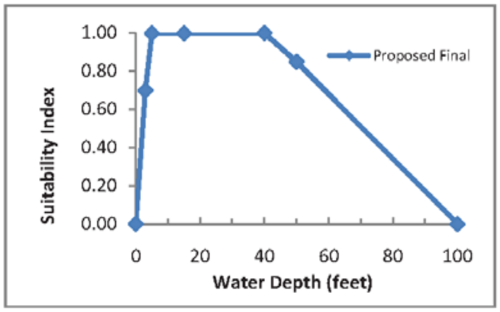


Species: Shortnose Sturgeon
Lifestage: Spawning

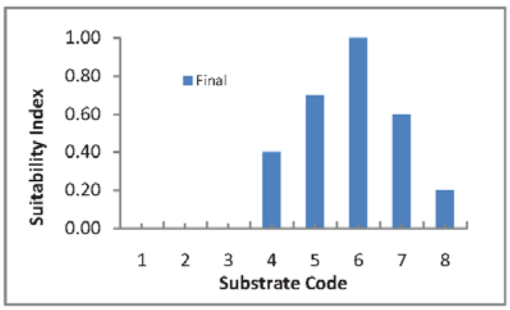
Velocity	Proposed Final SI Value
0.00	0.00
0.30	0.00
0.70	0.80
1.00	1.00
2.50	1.00
3.00	1.00
4.00	0.80
4.90	0.10
5.00	0.00



Depth	Proposed Final SI Value
0.00	0.00
3.00	0.70
5.00	1.00
15.00	1.00
40.00	1.00
50.00	0.85
100.00	0.00

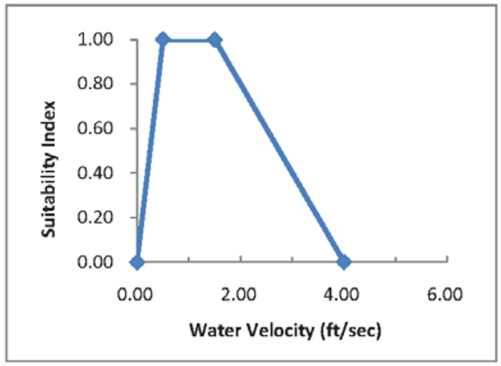


Code	Final SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.00	Silt
4	0.40	Sand
5	0.70	Gravel
6	1.00	Cobble/rubble
7	0.60	Boulder
8	0.20	Bedrock



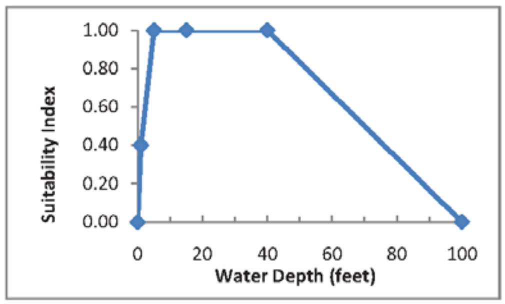
Species: Shortnose Sturgeon
Lifestage: Fry

Velocity	SI Value
0.00	0.00
0.50	1.00
1.50	1.00
4.00	0.00

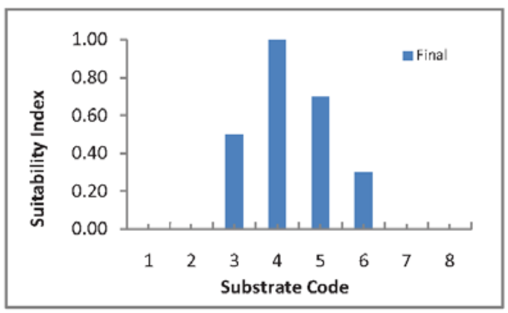


Proposed Final

Depth	SI Value
0.00	0.00
1.00	0.40
5.00	1.00
15.00	1.00
40.00	1.00
100.00	0.00

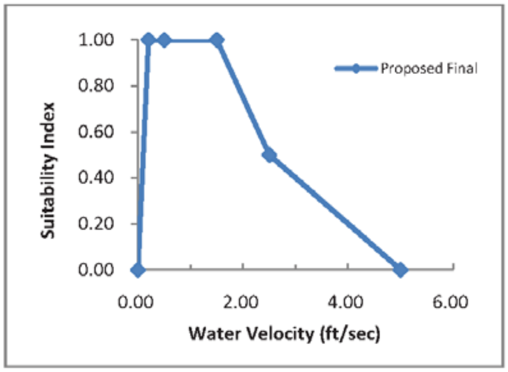


Code	Final SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.50	Silt
4	1.00	Sand
5	0.70	Gravel
6	0.30	Cobble/rubble
7	0.00	Boulder
8	0.00	Bedrock

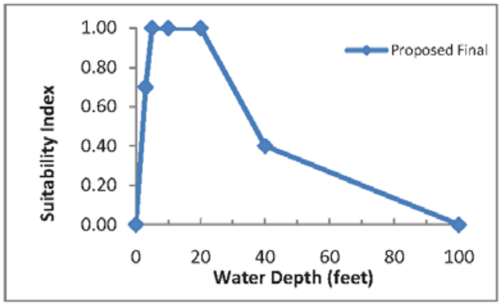


Species: Shortnose Sturgeon
Lifestage: Juveniles

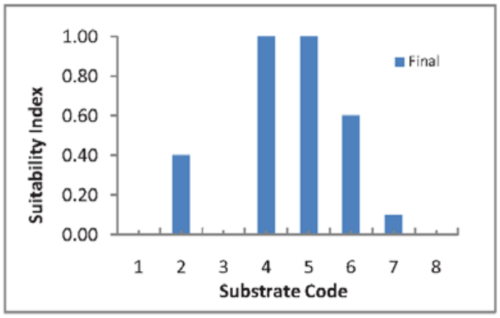
Velocity	Proposed Final SI Value
0.00	0.00
0.20	1.00
0.50	1.00
1.50	1.00
2.50	0.50
5.00	0.00



Depth	Proposed Final SI Value
0.00	0.00
3.00	0.70
5.00	1.00
10.00	1.00
20.00	1.00
40.00	0.40
100.00	0.00

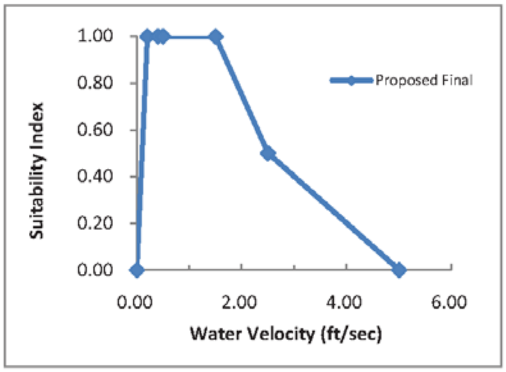


Code	Final SI Value	Type
1	0.00	Detritus/Organic
2	0.40	Mud/soft clay
3	0.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	0.60	Cobble/rubble
7	0.10	Boulder
8	0.00	Bedrock

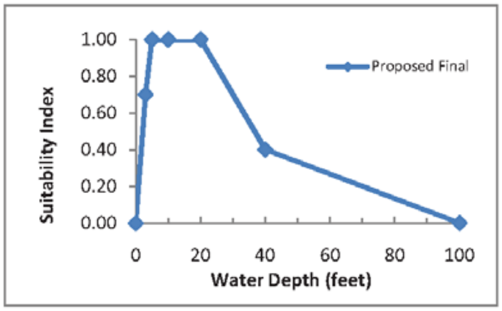


Species: Shortnose Sturgeon
Lifestage: Adults

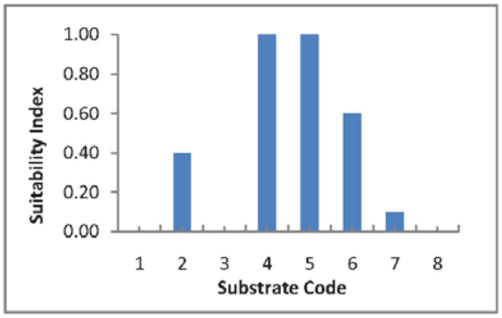
Velocity (Proposed Final)	SI Value (Proposed Final)
0.00	0.00
0.20	1.00
0.40	1.00
0.50	1.00
1.50	1.00
2.50	0.50
5.00	0.00



Depth (Proposed Final)	SI Value (Proposed Final)
0.00	0.00
3.00	0.70
5.00	1.00
10.00	1.00
20.00	1.00
40.00	0.40
100.00	0.00



Code	Final SI Value	Type
1	0.00	Detritus/Organic
2	0.40	Mud/soft clay
3	0.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	0.60	Cobble/rubble
7	0.10	Boulder
8	0.00	Bedrock

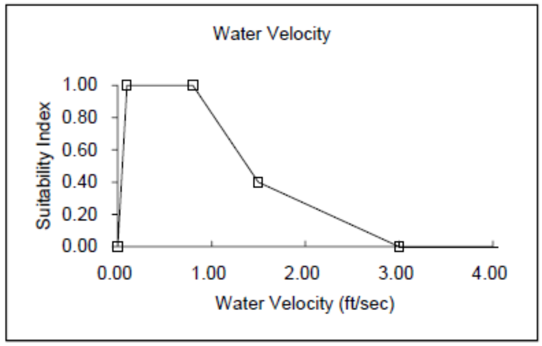


Fallfish. HSI source: *Glendale Hydroelectric Project, Housatonic River, MA*

Species: Fallfish
Lifestage: Adult

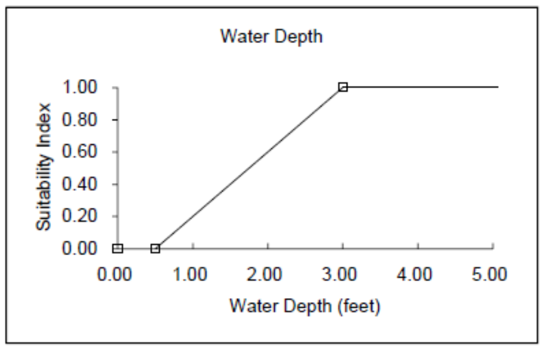
Velocity

Velocity	SI Value
0.00	0.00
0.10	1.00
0.80	1.00
1.50	0.40
3.00	0.00
100.00	0.00



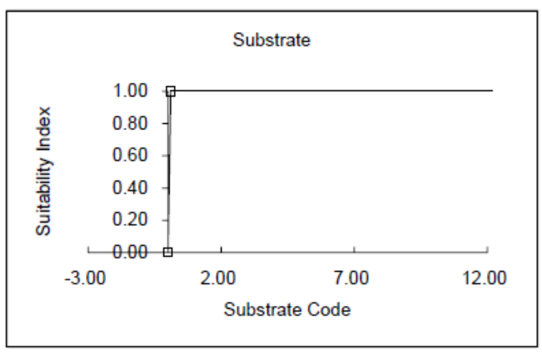
Depth

Depth	SI Value
0.00	0.00
0.50	0.00
3.00	1.00
100.00	1.00



Substrate

Substrate	SI Value
0.00	0.00
0.10	1.00
100.00	1.00

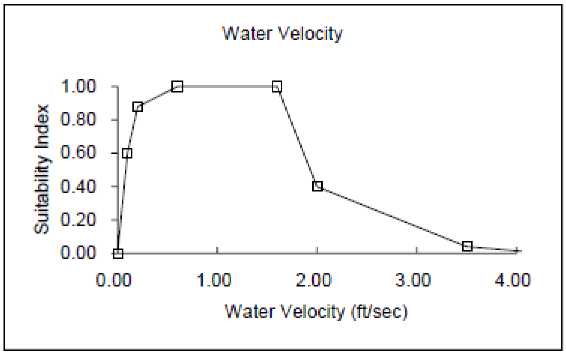


Reference: Modified and accepted by NYSDEC.

Species: Fallfish
Lifestage: Juvenile

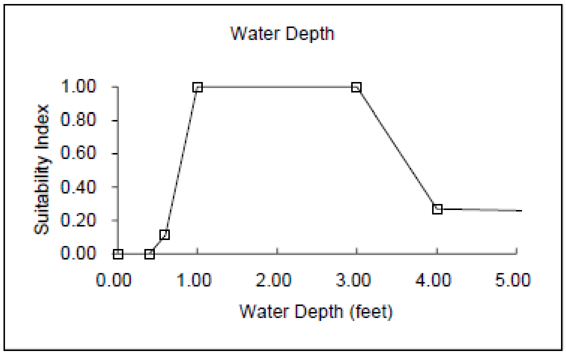
Velocity

Velocity	SI Value
0.00	0.00
0.10	0.60
0.20	0.88
0.60	1.00
1.60	1.00
2.00	0.40
3.50	0.04
4.30	0.00
100.00	0.00



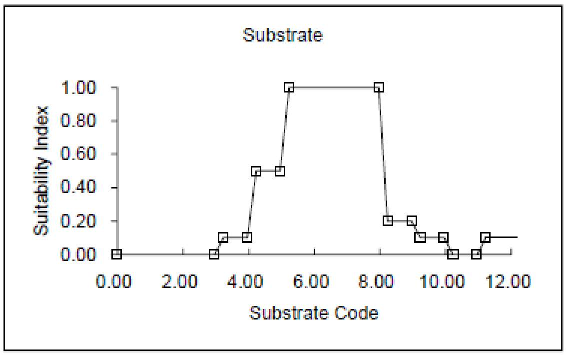
Depth

Depth	SI Value
0.00	0.00
0.40	0.00
0.60	0.11
1.00	1.00
3.00	1.00
4.00	0.27
7.00	0.24
8.00	0.07
100.00	0.07



Substrate

Substrate	SI Value
0.00	0.00
2.96	0.00
3.23	0.10
3.96	0.10
4.23	0.50
4.96	0.50
5.23	1.00
7.96	1.00
8.23	0.20
8.96	0.20
9.23	0.10
9.96	0.10
10.23	0.00
10.96	0.00
11.23	0.10
100.00	0.10

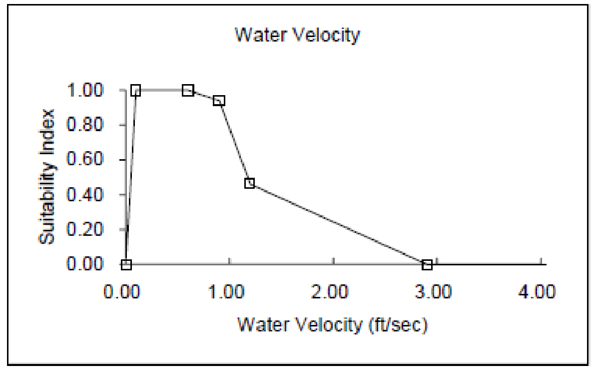


Reference: Velocity & Depth from Brook Trout Juvenile HSI Curve (Deerfield River Dephi Process)
Substrate developed by Charles Ritzi

Species: Fallfish
Lifestage: Fry

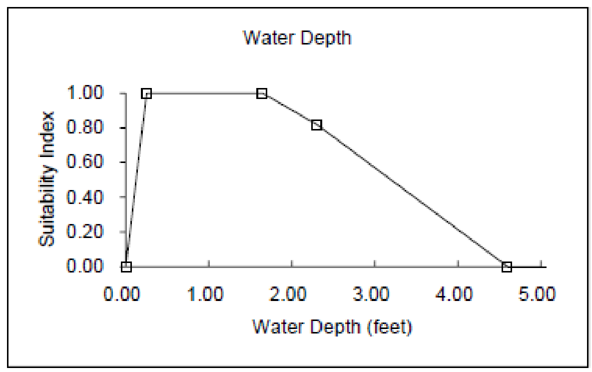
Velocity

Velocity	SI Value
0.00	0.00
0.10	1.00
0.60	1.00
0.90	0.94
1.20	0.46
2.90	0.00
100.00	0.00



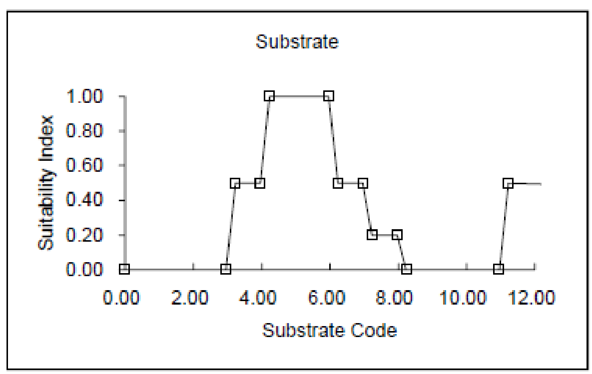
Depth

Depth	SI Value
0.00	0.00
0.25	1.00
1.65	1.00
2.30	0.82
4.60	0.00
100.00	0.00



Substrate

Substrate	SI Value
0.00	0.00
2.96	0.00
3.23	0.50
3.96	0.50
4.23	1.00
5.96	1.00
6.23	0.50
6.96	0.50
7.23	0.20
7.96	0.20
8.23	0.00
10.96	0.00
11.23	0.50
100.00	0.00

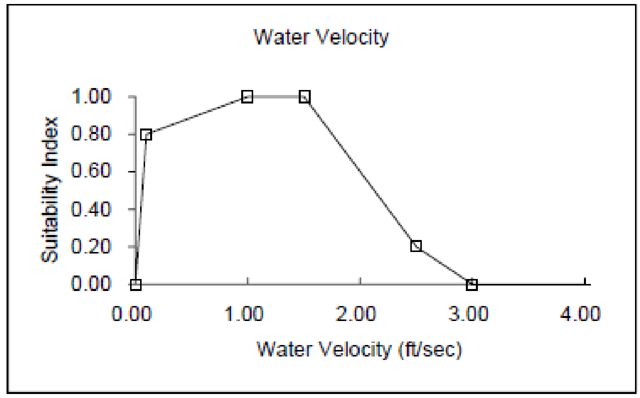


Reference: Velocity & Depth from Brook Trout Fry HSI Curve (Deerfield River Dephi Process)
Substrate developed by Charles Ritzi

Species: Fallfish
Lifestage: Spawning and Incubation

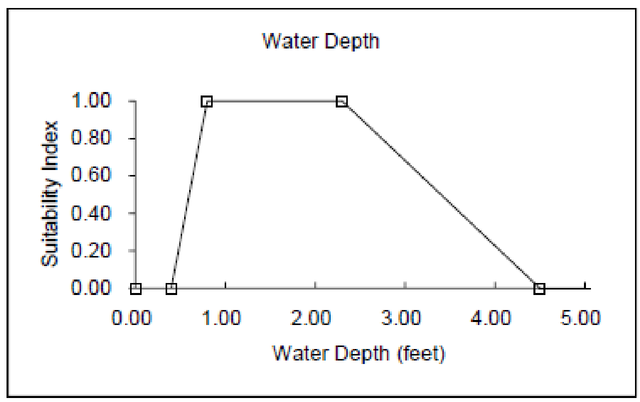
Velocity

Velocity	SI Value
0.00	0.00
0.10	0.80
1.00	1.00
1.50	1.00
2.50	0.20
3.00	0.00
100.00	0.00



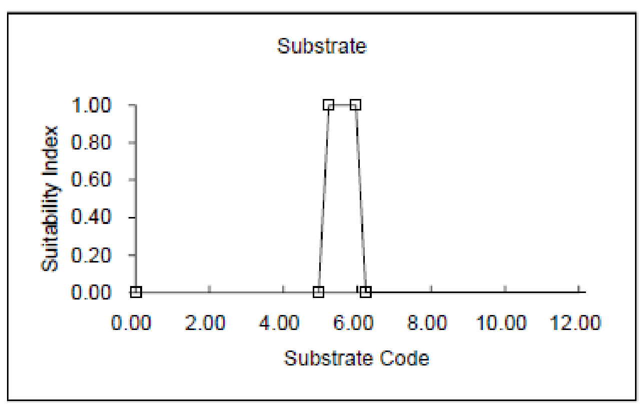
Depth

Depth	SI Value
0.00	0.00
0.40	0.00
0.80	1.00
2.30	1.00
4.50	0.00
100.00	0.00



Substrate

Substrate	SI Value
0.00	0.00
4.96	0.00
5.23	1.00
5.96	1.00
6.23	0.00
100.00	0.00



Reference: Modified and accepted by NYSDEC.

Substrate Coding System

Substrate Code	Embeddedness Code	Cover Code
1- Roots, Snags, Undercut Banks 2- Clay 3- Silt 4- Sand 5- Small Gravel (<2") 6- Gravel (2"-4") 7- Cobble (4"-10") 8- Boulder (10"-2') 9- Boulder (>2') 10- Ledge 11- Detritus, vegetation	.2- Embeddedness (0-25%) .5- Embeddedness (26-50%) .7- Embeddedness (51-75%) .9- Embeddedness (76-100%) Note: Embeddedness refers to the amount of fine material (such as sand) in interstitial spaces.	.03- Few Velocity Refuges .06-Abundant Velocity Refuges
Example Field Code: 5.53= Small Gravel (5), 26-50% Embedded (.5) with Few Velocity Refuges (.03)		

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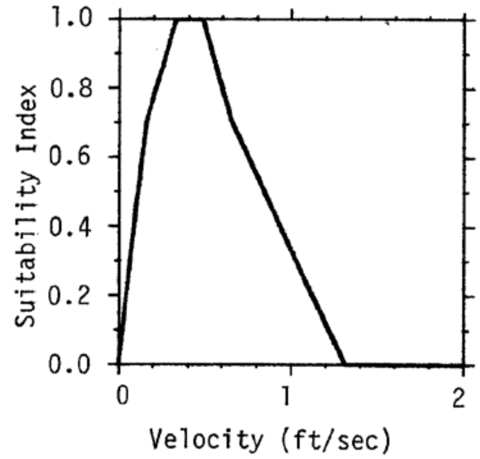
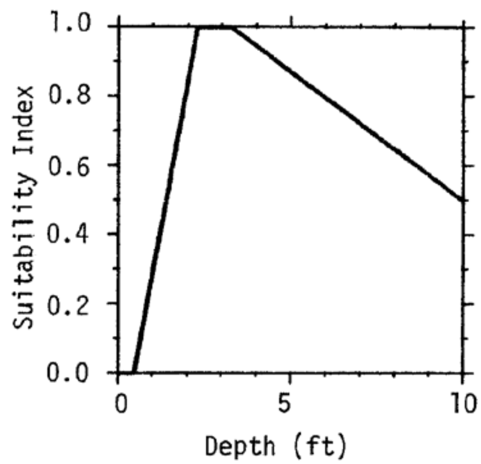
Coordinates

x	y
0.00	0.0
0.16	0.7
0.33	1.0
0.49	1.0
0.66	0.7
1.31	0.0
100.00	0.0



x	y
0.0	0.0
0.5	0.0
2.3	1.0
3.3	1.0
9.8	0.5
16.4	0.0
100.0	0.0



x	y
0.0	1.0
100.0	1.0

Based on assumption that all substrate types are suitable.

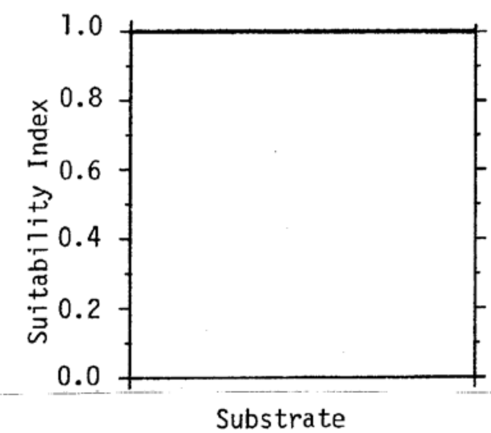


Figure 8. SI curves for white sucker adult velocity, depth, substrate, cover, and temperature.

Coordinates

x	y
0.0	0.1
40.0	1.0
75.0	1.0
100.0	0.5

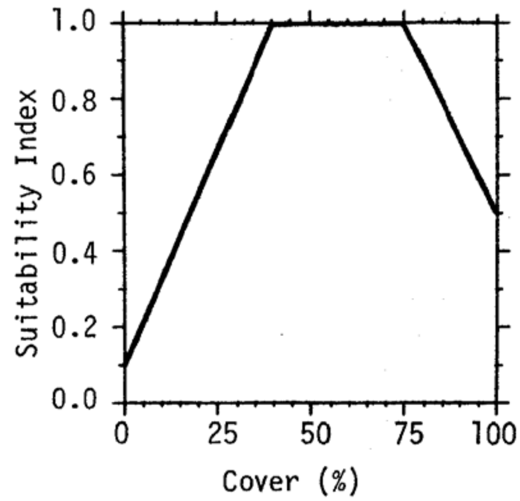


Figure 8 (concluded)

DRAFT

Coordinates

x	y
0.00	0.0
0.16	0.7
0.33	1.0
0.49	1.0
0.66	0.7
1.31	0.0
100.00	0.0

x	y
0.0	0.0
0.5	0.0
2.3	1.0
3.3	1.0
9.8	0.5
16.4	0.0
100.0	0.0

x	y
0.0	1.0
100.0	1.0

Based on assumption that all substrate types are suitable.

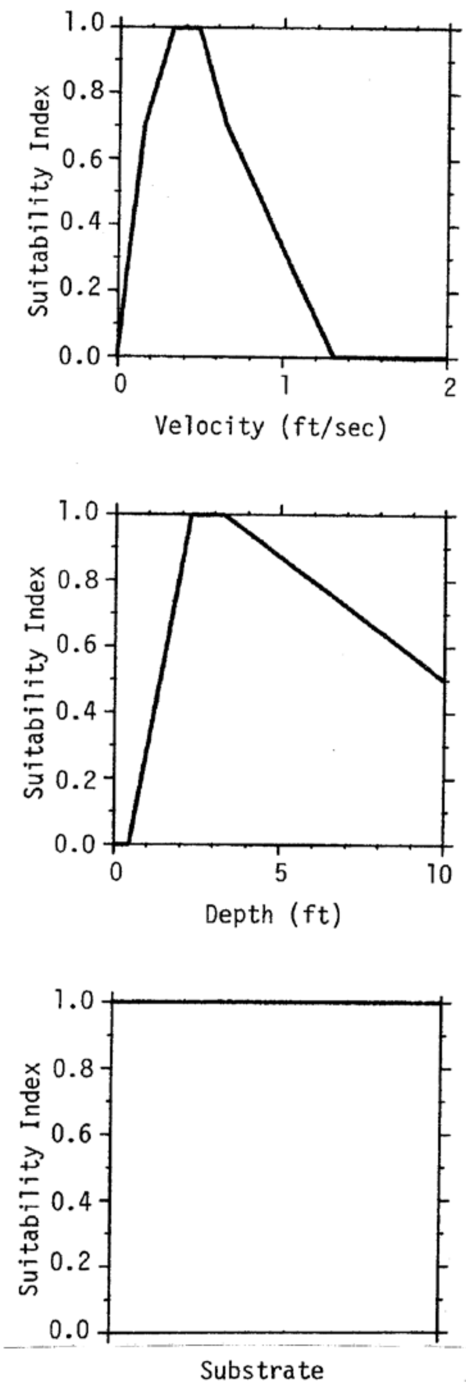


Figure 7. SI curves for white sucker juvenile velocity, depth, substrate, cover, and temperature.

Coordinates

x	y
0.0	0.1
40.0	1.0
75.0	1.0
100.0	0.5

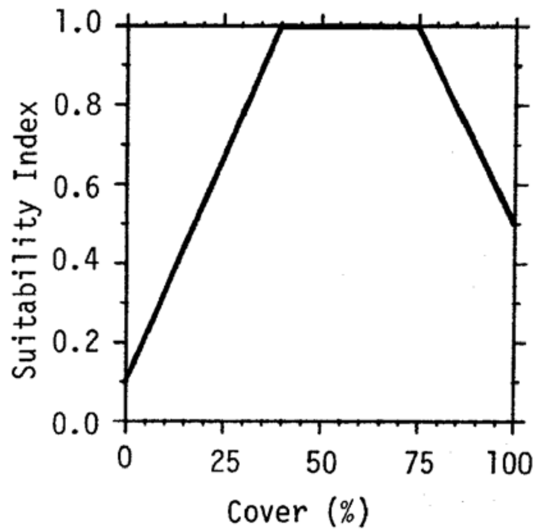
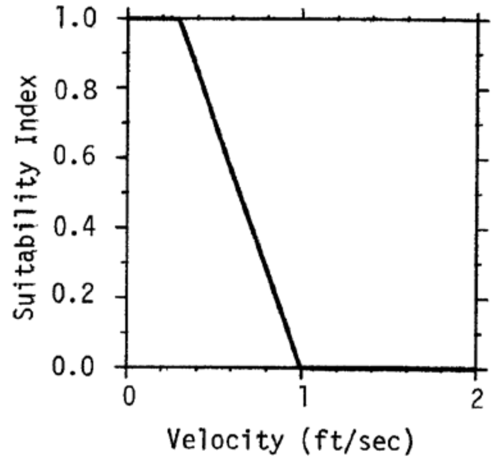


Figure 7 (concluded)

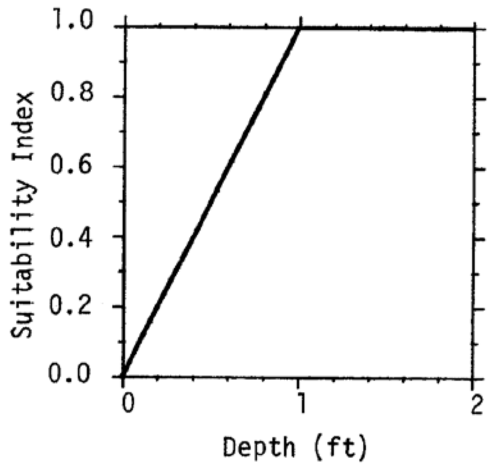
DRAFT

Coordinates

x	y
0.0	1.0
0.3	1.0
1.0	0.0
100.0	0.0



x	y
0.0	0.0
1.0	1.0
100.0	1.0



x	y
0.0	1.0
100.0	1.0

Based on assumption that all substrate types are suitable.

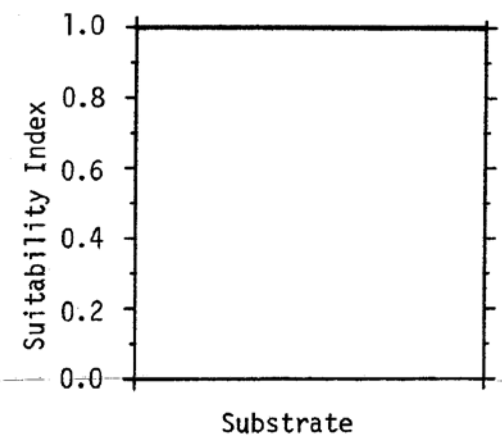


Figure 6. SI curves for white sucker fry velocity, depth, substrate, cover, and temperature.

Coordinates

x	y
0.0	0.1
40.0	1.0
75.0	1.0
100.0	0.5

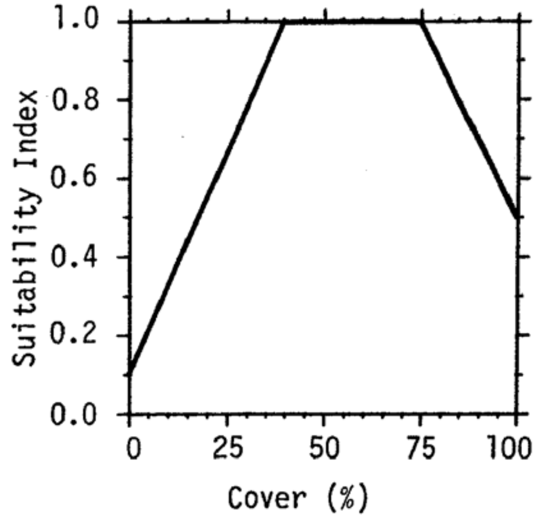


Figure 6 (concluded)

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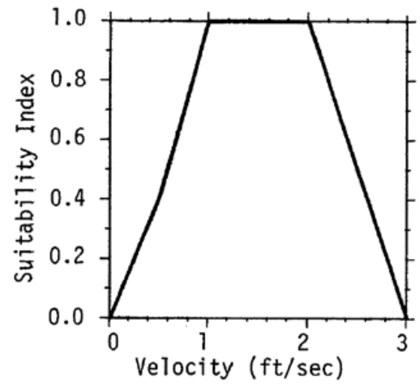
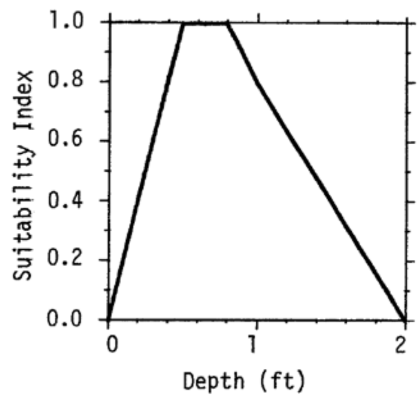
Coordinates

x	y
0.0	0.0
0.5	0.4
1.0	1.0
2.0	1.0
3.0	0.0
100.0	0.0



x	y
0.0	0.0
0.5	1.0
0.8	1.0
1.0	0.8
2.0	0.0
100.0	0.0



x	y
0.000	0.00
0.001	0.00
0.002	0.05
0.009	0.05
0.010	0.80
0.039	0.80
0.040	1.00
0.078	1.00
0.079	0.90
0.156	0.90
0.157	0.50
0.629	0.50
0.630	0.05
100.000	0.05

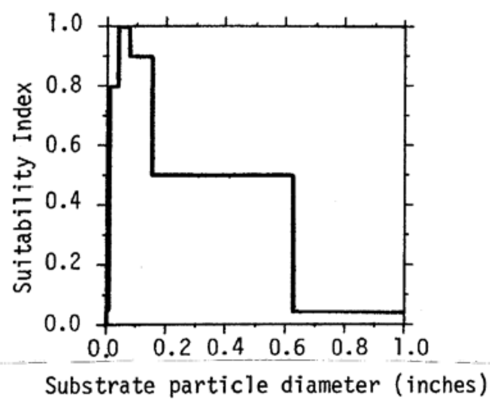


Figure 4. SI curves for white sucker spawning velocity, depth, substrate, cover, and temperature.

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