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NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7 CONSULTATION
BIOLOGICAL OPINION

AGENCY:	Federal Energy Regulatory Commission
ACTIVITY CONSIDERED:	New License Order for the Holyoke Hydroelectric Project (FERC #2004) per the terms of a Multiparty Settlement Agreement
CONDUCTED BY:	National Marine Fisheries Service Northeast Regional Office
DATE ISSUED:	JAN 27, 2005
APPROVED BY:	

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This is the National Marine Fisheries Service's (NOAA Fisheries) biological opinion (BO) on the effects of the Federal Energy Regulatory Commission's proposal to issue a new License Order for the Holyoke Hydroelectric Project (Holyoke Project) on the Connecticut River in Massachusetts on threatened and endangered species in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). The Federal Energy Regulatory Commission's (FERC) April 15, 2004 request initiated formal consultation with NOAA Fisheries.

This BO is based on information provided in the April 1999 Draft Environmental Impact Statement (DEIS), the July 1999 Final Environmental Impact Statement (FEIS), the August 20, 1999 FERC license to the Holyoke Water Power Company (HWP; now Holyoke Gas and Electric (HG&E)), numerous correspondence commencing on April 27, 1995, the August 2000 BO issued by NOAA Fisheries to FERC, a multiparty Settlement Agreement submitted to FERC in March 2004, a Biological Assessment submitted on April 27, 2004 and other sources of information. A complete administrative record of this consultation will be kept at NOAA Fisheries Northeast Regional Office [Consultation No. F/NER/2003/01660]. The issuance of this BO withdraws the BO submitted to FERC on August 18, 2000 on the effects of the Holyoke Project.

CONSULTATION HISTORY

In 1980, NOAA Fisheries concluded consultation with FERC under section 7 of the ESA on proposed changes to the Holyoke Dam/Hadley Falls Project and potential effects on endangered shortnose sturgeon (*Acipenser brevirostrum*). Based on preliminary data from less than one year of radio-tracking work, NOAA Fisheries concluded that the project was not likely to adversely affect shortnose sturgeon. At that time, the best available information on the population structure of shortnose sturgeon population in the Connecticut River indicated that there were two

spawning subpopulations in the river: one isolated and self-sustaining group above Holyoke Dam and a separate group below the Dam. NOAA Fisheries specifically stated that the previous section 7 consultation would be subject to revision as new information became available.

In a letter dated April 27, 1995, NOAA Fisheries requested that FERC reinitiate section 7 consultation for the Holyoke Project in response to new information on project impacts. On January 21, 1997, NOAA Fisheries repeated this request. On April 17, 1997, FERC responded by providing a summary of a March 18, 1997 meeting between FERC, NOAA Fisheries, U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey (USGS), the Massachusetts Division of Fish and Wildlife (MA DFW), HWP, and Holyoke Gas and Electric Department of the City of Holyoke. The purpose of the March meeting was to assess the information deficiencies for shortnose sturgeon in the Connecticut River and to facilitate completion of licensing studies to address these gaps. FERC stated its belief that operation of the Holyoke Project did not adversely affect the Connecticut River population of shortnose sturgeon. FERC based this belief on the fact that upstream and downstream population estimates for shortnose sturgeon had remained stable for more than 20 years (Kynard 1997).

On September 2, 1997, the HWP filed an application to relicence the existing 43.756 megawatt Holyoke Project on the Connecticut River. HG&E, Ashburnham Municipal Light Plant and Massachusetts Municipal Wholesale Electric Company filed a competing application for the license to operate the Holyoke Project.

In order to help assess the impacts of the Holyoke Project on shortnose sturgeon, a Connecticut River Shortnose Sturgeon Work Group (Work Group) was formed during the relicensing phase of this project. The Work Group is composed of representatives from NOAA Fisheries, USFWS, MA DFW, the Connecticut Department of Environmental Protection (CT DEP), the U.S. Geological Survey Conte Lab, HWP, and HG&E. The Work Group agreed that the following questions would need to be answered as part of the Holyoke Project relicensing before a final decision on shortnose sturgeon passage needs and designs could be made: (1) what, if any, is the biological value of the potential downstream spawning sites; (2) how does the lifting of lower river sturgeon affect the status of the population; and (3) what is necessary to provide safe and efficient passage of sturgeon at the project.

Dr. Boyd Kynard of the USGS presented a study proposal that was adopted by the Work Group. The objectives of the shortnose sturgeon study plan were identified as to: (1) determine the movement patterns of adults passed upstream in the Holyoke fish lifts and estimate the probability that lifted fish continue upstream to join other shortnose sturgeons or move back downstream; (2) determine downstream movement timing, exit routes of adults at the Holyoke Dam, and estimate the survival probability of adults passing the dam; (3) evaluate the spawning success of migrant adults at the Holyoke Dam; and (4) characterize adult migrants at the Holyoke Dam for general movement patterns, sex, reproductive state, total length, weight and condition. A fifth objective was added to determine the guidance efficiency of vertical bar trashracks with 2-inch spacing for guiding juvenile shortnose sturgeon from the entrance of turbine intakes.

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On April 19, 1999, FERC sent a letter to NOAA Fisheries concluding, based on its findings and analysis in the April 1999 DEIS, that relicensing the Holyoke Project (with the staff's recommended measures) was likely to have a net beneficial effect on shortnose sturgeon habitat, passage, and movement in the Connecticut River. In a letter dated May 25, 1999, NOAA Fisheries advised FERC that it did not concur with this determination and asked FERC to initiate formal consultation to assess the project's effects on endangered shortnose sturgeon, and the effects of incidental and unauthorized taking of shortnose sturgeon associated with the project. In addition, NOAA Fisheries reminded FERC that it should not make any irreversible or irretrievable commitment of resources that would prevent NOAA Fisheries from developing or FERC from implementing any reasonable and prudent alternatives that might be necessary to avoid the likelihood of jeopardizing shortnose sturgeon. On June 4, 1999, FERC staff initiated formal consultation and cited sections within the DEIS containing the information required for its biological assessment. FERC further requested that the formal consultation be completed by July 15, 1999, despite the schedules established in the section 7 regulations that allow NOAA Fisheries 90 days to complete formal consultation and another 45 days to complete a biological opinion.

On June 3, 1999, NOAA Fisheries submitted a Federal Power Act Section 18 Fishway Prescription to FERC for inclusion in any license that might be issued. Several provisions of NOAA Fisheries' Section 18 Fishway Prescription were not included in the August 20, 1999 license. In July 1999 FERC issued a FEIS and a new license to HWP on August 20, 1999, without completing formal consultation on the project. Because consultation had not been completed prior to license issuance, FERC reserved its authority to revise the terms and conditions of the license to incorporate any measures necessary to comply with the ESA, in light of any forthcoming biological opinion.

In the August 1999 license, FERC concluded that compliance with the license provisions would potentially enhance, and not adversely alter, the environmental *status quo*, and would not make irreversible or irretrievable commitments of resources which would have the effect of foreclosing the formulation or implementation of any reasonable and prudent alternative measures. NOAA Fisheries did not concur with FERC's conclusion for the following reasons:

1. When the original license expired and FERC elected to issue a new license for an existing hydropower project, FERC determined that the *new* license represented a *new* commitment of resources. Without the issuance of this license by FERC, the utility could not have continued to operate the station or utilize the dam for power generation. NOAA Fisheries believed that a section 7 analysis of the project's direct and indirect effects on listed species should have been conducted as it would for a new project (USFWS and NOAA Fisheries 1998).

2. "Status quo" is not an accepted and appropriate baseline for section 7 consultation because this situation is resulting in unauthorized lethal and nonlethal take of shortnose sturgeon.

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Consequently, NOAA Fisheries evaluated the potential impact of the proposed project (existing structures, all aspects of facility operation and proposed enhancements) against the current environmental and operational conditions of the Connecticut River as they would be without the presence of the Holyoke Dam or the Hadley Falls generating station.

On August 18, 2000, NOAA Fisheries issued a BO on the operation and maintenance of the Holyoke Project under the terms of the 1999 License. In the BO, NOAA Fisheries concluded that the project as proposed was likely to jeopardize the continued existence of shortnose sturgeon in the Connecticut River and as such, would jeopardize the species as a whole. Included with this BO were two Reasonable and Prudent Alternatives (RPA) which when implemented would ensure that the Holyoke Project would not jeopardize the continued existence of shortnose sturgeon. The RPAs included an Incidental Take Statement with several Reasonable and Prudent Measures (RPMs) and Terms and Conditions. One RPA called for FERC to repeal the Dams license; however, NOAA Fisheries determined that this RPA was not feasible. The second RPA called for FERC to amend the 1999 License to incorporate the Fishway Prescriptions provided by NOAA Fisheries per Section 18 of the Federal Power Act. FERC did not respond to this BO and the 1999 License was not amended to incorporate this RPA or the reasonable and prudent measures and terms and conditions of the accompanying Incidental Take Statement. However, the current owners of the Holyoke Project (i.e., HG&E) have complied with many of the Reasonable and Prudent Measures issued as part of the Incidental Take Statement accompanying the second RPA in the 2000 BO.

Also in 1999, in response to FERC's license order and the issuance of the Section 401 Water Quality Certificate by the Commonwealth of Massachusetts Department of Environmental Protection (MADEP), a number of parties, including NOAA Fisheries, filed with FERC requests for rehearing on the terms and conditions in the August 1999 license order. In February 2001 the MADEP issued a final WQC based on a settlement of the state administrative appeal of the 1999 WQC. As a result of the rehearing request, and following the transfer of license from HWP to HG&E (approved by FERC in September 2001 and effective in December 2001), HG&E initiated a cooperative consultation team (CCT) process with several interested parties, including NOAA Fisheries, USFWS, MADEP, MADFW, Trout Unlimited, the Connecticut River Watershed Council, and the Town of South Hadley, to attempt to resolve the issues on rehearing, including the procedural aspects of section 7 consultation. The goal of the CCT process was to present to FERC a comprehensive settlement which addressed all issues pending on rehearing. Resolution of shortnose sturgeon issues, including those addressed in the 2000 BO, was an integral part of the comprehensive settlement negotiations. By letter dated December 19, 2002, HG&E notified FERC that it and the principal parties to the licensing proceedings had entered into settlement negotiations, with the expectation of completing and filing a comprehensive settlement agreement with FERC. By notice issued January 28, 2003, FERC acknowledged the settlement negotiations.

By letter to NOAA Fisheries dated October 9, 2003, FERC staff concluded that no formal consultation was required with respect to the effects of the Project on shortnose sturgeon because operation of the Project, with the measures proposed pursuant to the proposed comprehensive settlement, were "not likely to adversely affect the shortnose sturgeon in the Connecticut River,

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and would not jeopardize the continued existence of the species." The letter further stated that in the event that NOAA Fisheries did not concur that formal consultation was not required, FERC was submitting a BA evaluating the impact of the 1999 License Order and the proposed settlement on the Connecticut River population of shortnose sturgeon, and requested that NOAA Fisheries issue a new BO.

NOAA Fisheries responded to this letter in a letter dated November 7, 2003, indicating that there remained several outstanding issues that had not yet been resolved in the settlement negotiation process and, therefore, NOAA Fisheries did not have all the necessary information to initiate consultation. NOAA Fisheries also indicated that they were unable to concur with the determination that the Project was not likely to adversely affect shortnose sturgeon and that as such formal consultation was necessary as take of shortnose sturgeon was likely to continue at the Project despite the additional measures mandated in the settlement. NOAA Fisheries also stated that FERC should resubmit its request for consultation when the final Settlement Agreement was submitted to FERC.

On March 12, 2004, pursuant to FERC's Rule 602(c)(i), HG&E and the CCT filed a Settlement Agreement and accompanying Appendices. Included with the Settlement Agreement were proposed license articles to replace those in the 1999 License Order. In a letter dated April 15, 2004, FERC requested section 7 consultation on the proposed license amendments as outlined in the Settlement Agreement. As NOAA Fisheries had all the information necessary for consultation at that time, this date serves as the initiation of formal consultation. As outlined in the Settlement Agreement (see specifically section 2.4), FERC is to defer issuance of an order approving the Settlement until section 7 consultation is complete.

BACKGROUND ON THE ACTION

The Holyoke Project is owned and operated by the City of Holyoke Gas and Electric Department. The Holyoke Project, located on the Connecticut River at river kilometer 140 in Massachusetts, currently operates under the license issued by FERC in 1999 to HG&E's predecessor (Holyoke Water Power Company). The main project facilities are located in the city of Holyoke and the town of South Hadley, Massachusetts. As requested in the Settlement Agreement, FERC will issue a new License Order pursuant to section 18 of the Federal Power Act (16 U.S.C. 791a et seq.). The issuance of the new License, per the terms of the March 2004 Settlement Agreement, will be the subject of this consultation.

The project consists of a single dam structure, a three-level canal system, an impoundment, upstream and downstream fish passage facilities, six powerhouses (Hadley Falls Station, Boatlock Station, Beebe-Holbrook Station, Skinner Station, Riverside Station, and Chemical Station), and appurtenant facilities. The Project currently consists of a 30-foot high, 985-foot long dam topped by five 3.5-foot high inflatable rubber dam sections (installed in November 2001). The Project impounds a 2290-acre reservoir with a normal maximum surface elevation of 100.6 feet National Geodetic Vertical Datum (NGVD). The Project includes 22 generating units and several upstream and downstream fish passage facilities. A three-level canal system extends from the Canal Gatehouse located on the impoundment adjacent to the Hadley Falls Generating Station of the Project through the lower areas of the City of Holyoke and provides water for

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industrial and hydropower generation. The canal system also provides water to sixteen other hydroelectric generating stations. HG&E owns four of those canal stations and the other twelve are privately owned. HG&E is required to provide water to these facilities according to industrial water rights agreements. The canal system in the city of Holyoke was completed in 1905, the existing stone masonry dam was built between 1895 and 1900, and the existing generating facilities were added in the early to mid 1900s. Presently, the project has a total installed capacity of about 43.8 megawatts.

Just below the Dam, the bypass reach is a wide, moderate to high gradient section of the Connecticut River channel characterized by bedrock, boulder, and cobble that is well armored and scoured of finer sediments. Immediately below the Dam, a narrow channel between the spillway apron and an angular bedrock ledge (Spillway Channel) that runs parallel to the base of the Dam acts as a hydraulic control influencing how flows are released into the bypass reach. Water released over the Dam enters the Spillway channel that is composed of three progressively larger pools, interconnected by shallow, swift water flowing over bedrock ledges. At low to moderate flows, this channel funnels all discharge from the Dam to the South Hadley side of the bypass reach, unless discharge is sufficient to raise the water elevation in the channel to the point that it flows over the bedrock ledge. Water directed to the South Hadley site is dispersed into three channels separated by long low islands. The three channels (Holyoke, Middle and South Hadley) vary in width and gradient, but all are dominated by bedrock and boulder substrates with occasional areas of cobble.

As mentioned above, the Project is currently operated in accordance with the 1999 License Order and the 2001 WQC, to provide continuous minimum flows in the bypass reach and canal system, and to maintain pond level fluctuations within specified limits upstream of the Dam. During fish passage seasons, flows in the bypass reach and canal system are increased. Once these requirements are met, the Project generates the available river flows up to its 14,250 cubic feet per second (cfs) hydraulic capacity. When river flows exceed the hydraulic capacity of the Project, the five rubber dam sections are lowered sequentially to control pond levels upstream. When river flows reach 36,700 cfs, all five rubber dam sections are fully deflated and the Project passes all flows as received.

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The 1999 License issued by FERC was for a period of 40 years (expiring in 2039). Several of the license articles specifically relate to shortnose sturgeon and are briefly described below.

- **Article 204** reserves FERC's authority to require the licensee to conduct studies, modify minimum flow releases, or otherwise make reasonable provisions for modifying project facilities or operations for shortnose sturgeon as necessary to comply with the ESA.
- **Article 405** requires the licensee to operate the project in a run-of-river mode. The licensee is required at all times to act to minimize the fluctuation of the impoundment surface elevation by maintaining a continuous discharge from the project so that flows immediately downstream of the project tailrace approximate the sum of the inflows to the project impoundment.

- Within 180 days after the issuance of the license, the licensee is required to file a plan to monitor fish and aquatic habitat and fish populations within the bypassed reach and the Holyoke canals (**Article 410**). The plan is required to include methods to monitor and assess the adequacy of bypassed reach flows to provide a safe zone-of-passage for anadromous fish through the bypassed reach, the occurrence of fish stranding in the bypassed reach, and fish populations in the bypassed reach. As part of the monitoring plan, the licensee is required to determine the need for additional measures to ensure or enhance the safe passage of shortnose sturgeon through the bypassed reach as required by **Articles 412** and **416**. As a result of this plan and monitoring, the licensee must provide better access to the spillway fishlift entrance for improved shortnose sturgeon passage. According to Article 410, the licensee is to work in conjunction with the Connecticut River Shortnose Sturgeon Work Group and/or its findings to determine the most beneficial project modifications that would meet plan requirements and protection measures for the shortnose sturgeon.

- **Article 411** requires the licensee to install, operate and maintain downstream fish passage facilities at the Holyoke Project to provide efficient downstream fish passage for a variety of fish species, including shortnose sturgeon. The licensee is required to operate the downstream fish passage facilities for adult shortnose sturgeon from April 1 to November 15. The plan for fish passage must be filed within 180 days of the date of the license and this plan must include a construction schedule that provides for installation of all required facilities and structures within two years of the license issuance. This article also requires the assessment of the effectiveness of the existing surface bypass and partial depth louver structure (downstream fishway) in the First Level Canal for downstream migrating shortnose sturgeon, as well as provisions for making changes to the louver facility, if deemed necessary.

- **Article 412** requires the licensee to install, operate and maintain upstream fish passage facilities for a variety of fish species, including shortnose sturgeon. The upstream season for shortnose sturgeon passage is identified as June 1 to November 15. The plan for upstream passage must be submitted to FERC within 180 days of the date of the license and this plan must include a construction schedule that provides for installation of all required facilities and structures within two years of the license issuance.

- **Article 416** requires the licensee, within one year of the date of issuance of the license, to file for FERC's approval a Threatened and Endangered Species Protection Plan (T&E Plan) for the Holyoke Project. The T&E Plan is required to include measures to protect and enhance shortnose sturgeon habitat consistent with the measures developed as the result of the on-going shortnose sturgeon studies and the provisions of Articles 405, 406, 411 and 412.

- Appendix A (number 26) of the license states that within one year after NOAA Fisheries (in accordance with the ESA) develops its final recommendations, the licensee will submit to the Massachusetts Department of Environmental Protection (MA DEP) a plan to meet sturgeon upstream and downstream passage need, timing and measures and a schedule for implementation in consultation with MA DFW, the USFWS and NOAA Fisheries. The licensee is required to implement the plan as approved by the MA DEP

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and within one year after installation, the licensee shall conduct and submit to the MA DEP a study of the effectiveness of the measures taken.

As mentioned above, on June 3, 1999, before FERC initiated consultation, NOAA Fisheries submitted a Federal Power Act Section 18 Fishway Prescription to FERC for inclusion in any license that might be issued. However, some provisions of NOAA Fisheries' Section 18 Fishway Prescription were not included in the August 20, 1999 license. Specifically omitted or modified were:

- A license requirement specific to shortnose sturgeon upstream and downstream passage
- Continuous minimum zone-of-passage flow of 1300 cfs[1], deemed necessary for the safe and timely access of shortnose sturgeon to the fishlifts at the base of the dam.

Since taking ownership of the Project in December 2001, HG&E, independent of any FERC order or mandate, has completed a number of measures that may have an effect on shortnose sturgeon populations. These measures include the following:

- Installation of 15° full depth louvers at the Holyoke Canal Louver Facility. Installed in 2002, the full-depth louvers and an existing wedge-wire ramp at the downstream end of the louver array leading to the entrance of the bypass pipe are intended to provide guidance for both bottom and surface oriented species. Clear spacing between the steel louver slats is two inches, presenting a physical barrier to large fish and a behavioral barrier to smaller fish. Timbers were installed between the canal bottom and the steel frame supporting the louver panels to prevent fish from passing underneath the louver array. A rake was installed in 2003 to remove debris from the louver structure.

- Installation of a shortnose sturgeon exclusion device in the attraction water entrance gate. The exclusion device at the attraction water intake installed in October 2002 prevents shortnose sturgeon from entering the system that supplies attraction water to upstream passage facilities at the Dam spillway and the Hadley Falls Station tailrace. The source of the attraction water is a pair of low-level outlet gates on the First Level Canal. These gates previously did not have any fish exclusion provisions and occasionally passed shortnose sturgeon into the attraction water system. The new device is equipped with 1-inch clear opening screening. The average water velocity at the screen is less than 2 feet/second at full attraction water flow.

- Implementation of minimum flows in the bypass reach. The 1999 license order prescribes two flow regimes, depending on the season. One regime is the "zone of passage" (ZOP) flow which sets forth water surface elevations, velocities and depths for the upstream migration season. The ZOP flow is currently set at a minimum flow of 1300cfs. The "habitat" flow sets forth water surface elevations, velocities and depths whenever the ZOP flow is not required. The habitat flow is currently set at a minimum of 840cfs[2].

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1 As per the Settlement Agreement, it is agreed that flows achieving a water surface elevation of 62.85 +/- 0.1 feet National Geodetic Vertical Datum (NGVD) at the Texon Gage (as defined in (a)(3) below) satisfy this requirement
2 As per the Settlement Agreement , it is agreed that flows achieving a water surface elevation of 62.3 +/- 0.1 feet NGVD at the Texon Gage [as defined in (a)(3) above] satisfy this requirement

- Construction and operation of a rubber dam across the crest of the Holyoke Dam. The wooden flashboards along the crest of the Dam were replaced in fall of 2001 with an inflatable rubber fabric dam system, consisting of three main sections each approximately 310 feet long and 3 ½ feet high.
- Removal of the rock outcropping at the west tailrace fishway entrance. In the fall of 2001, approximately 350 cubic yards of bedrock were removed from the west side of the tailrace in the area adjacent to the Hadley Falls Unit 2 fish entrance.
- Installation of a backlit panel in the viewing window. In early 2002, a backlit panel was installed to aid in the enumeration and identification of fish passing by the viewing window during periods of high turbidity typically experienced during higher river flows.

DESCRIPTION OF THE ACTION

According to the terms of the Settlement Agreement, once section 7 consultation is complete, the 2000 BO is withdrawn, and HG&E and the CCT notify FERC that the Settlement is not to be reopened based on the 2004 BO, FERC will issue an order approving the Settlement. FERC will then issue a new License Order pursuant to section 18 of the Federal Power Act (16 U.S.C. 791a et seq.). The issuance of the new License, per the terms of the March 2004 Settlement Agreement, will be the subject of this consultation.

As in the 1999 license, there are several license articles that affect shortnose sturgeon. These articles are outlined below (see Appendix A for full text of these articles):

- **Article 401**: requires the licensee to operate and maintain the inflatable rubber dam
- **Article 405**: requires the licensee to operate the Project in a run-of-river mode and maintain a minimum impoundment elevation of 100.4 feet NGVD +/- 0.2 feet. The licensee will also conduct an evaluation of potential modifications to run-of-river operations. This article also provides a procedure should it be determined that a modification to the run-of-river operation requirement is needed.
- **Article 406**: requires the licensee to release seasonally-adjusted minimum flows into the bypass reach and into the canal system. The flows released into the bypass reach when the fish lifts are not operational shall be of an amount that is determined to ensure an adequate water level in all bypass channels for fish habitat and that protects shortnose sturgeon from injury or impairment to essential behavioral patterns. The flows released into the bypass reach when the fish lifts are operational shall be of an amount that is determined to ensure safe and successful passage of fish without injury or impairment to essential behavioral patterns. This article also provides details on canal system outage procedures and flow prioritization.
- **Article 407**: requires the licensee to implement the Comprehensive Operations and Flow Plan including run-of-river operation, bypass flows, and fish passage operational flows.
- **Article 408**: requires the licensee to operate the Project to protect and enhance water quality and mussel populations in the canal system. This article also provides measures for general canal operations; operation of the full depth louvers and exclusion racks;

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requires studies of the full depth louvers; and includes procedures for consulting with other parties.

- **Article 409**: requires the licensee to implement the Fish and Aquatic Habitat Plan, to monitor fish and aquatic habitat and fish populations within the bypass reach and the Holyoke canals. This article also includes measures for modifying the plan.

- **Article 410**: requires the licensee to install, operate, and maintain downstream fish passage facilities at the Holyoke Project that safely and successfully pass diadromous and resident fish without injury or significant impairment to essential behavioral patterns. The downstream fish passage facilities are to be designed, constructed and operated to: (1) prevent entrainment or impingement in the Project intake system, (2) prevent injury to fish if passed over or through the dam onto the spillway, and (3) ensure that all downstream migrating diadromous and resident fish that appear on the upstream side of the dam shall be passed downstream without injury or significant impairment to essential behavioral patterns. This article also describes the implementation procedures for installing fish passage facilities and the deadlines for compliance. This article further requires:

  (a)Downstream fish passage. The licensee shall implement the Downstream Fish Passage Plan to cover the operation, maintenance, and evaluation of the existing downstream fish passage facilities at the Holyoke Project until modification of that plan is authorized by FERC under paragraph (b) below.

  (b)Downstream fish passage enhancements. Within 60 days after the date of the order approving the Comprehensive Settlement and modifying the License Articles, the licensee shall file with FERC, for approval, a plan to enhance the existing downstream fish passage facilities at the Holyoke Project that includes:

    (1)Phase 1 – 2004-2005. During the period 2004 through 2005, the licensee shall implement operational changes to prioritize canal flow during Fall evening hours, shall implement modifications to the Downstream Sampling Facility, and shall potentially implement modifications to the Louver Bypass Discharge Pipe (as set forth below); and the licensee shall conduct research and studies (as set forth below). Based on such research, in 2005 the licensee, shall determine whether to implement Phase 2A or Phase 2B (as described below). The Phase 1 work will include:

      (A) To minimize the potential for injury to shortnose sturgeon if they enter the Downstream Sampling Facility, the licensee will develop a plan to modify the Downstream Sampling Facility with such modifications to be completed by April 15, 2004, and to test the effectiveness of such modifications thereafter in 2004. HG&E will operate the Downstream Sampling Facility in accordance with the Downstream Sampling Facility Operating Protocol (see Appendix B).

      (B) The licensee will evaluate the effect of the height of the drop of the Louver Bypass Discharge Pipe to the tailrace on shortnose sturgeon through a radio tracking study. If it is necessary to reduce the height of

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the drop from the Louver Bypass Discharge Pipe to the tailrace to enhance the survival of shortnose sturgeon, the licensee shall propose how best to modify the Louver Bypass Discharge Pipe in a plan that provides for such modifications to be implemented in 2005, to be operational for the Spring 2006 Upstream Passage Season, and effectiveness testing of the modifications in 2006 after the modifications are implemented.

(C) The licensee will develop a plan to change flow prioritization from the Hadley Falls units to the Canal during nighttime periods from October 1 through the later of: (i) the time when the river temperature reaches 5° C., or (ii) November 30 [unless the agencies and parties, in consultation pursuant to paragraph (c) below, agree to an earlier time], with prioritizing the Canal first and then regulating the Hadley Falls Station. The licensee shall file the plan with the Commission and the MADEP on or before December 31, 2004, and shall implement the plan as approved in writing by the Commission and the MADEP.

(D) The licensee shall conduct a Louver Field Study: (i) to evaluate effectiveness of the full depth louvers to guide shortnose sturgeon and American eels; and (ii) to evaluate the behavior of shortnose sturgeon and American eels at the ramp and the entrance to the bypass pipe.

(E) The licensee shall conduct computational fluid dynamics (CFD) modeling: (i) of the Hadley Falls intakes to evaluate the potential of modifying the existing Hadley Falls intake racks to be an effective interim (and potentially long-term) device to prevent entrainment and impingement of fish at the Hadley Falls; and (ii) of a potential bottom weir to evaluate if such a weir would produce flow patterns conducive to guide bottom migrants into the Canal.

(F) The licensee shall conduct a USGS Flume Study in 2004: (i) to determine the swimming depth and behavior of yearling and adult shortnose sturgeon at a bar rack structure; (ii) to determine the threshold velocity for avoidance of impingement/entrainment of yearling, juvenile, and adult shortnose sturgeon at conditions present at the proposed modified Hadley Falls intake racks with 2-inch spacing; and (iii) to determine if yearling, juvenile, and adult shortnose sturgeon can avoid impingement/entrainment at conditions present at a potential alternative bar rack facility (2-inch spacing and velocities of 2 fps).

(G) The licensee shall conduct a USGS Flume Study in 2005: (i) to determine how shortnose sturgeon would respond to a bottom weir for guidance; and (ii) to determine how shortnose sturgeon would respond to a bypass entrance, integral with a rack structure.

(H) The licensee shall conduct a Bascule Gate Analysis (comprised of a desk-top study): (i) to identify potential solutions to the interference of the Bascule Gate discharge on the entrance to the spillway fishway; (ii) to evaluate the feasibility of using/modifying the Bascule Gate or rubber dam

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#5 (adjacent to the Bascule Gate) to pass shortnose sturgeon, American eels and other migratory fish; and (iii) to investigate the safety of downstream passage through the Bascule Gate over the spillway and onto the spillway apron.

(J) In consultation pursuant to paragraph (c) below, the licensee shall conduct a Spawning Study to identify potential shortnose sturgeon spawning sites downstream of the dam.

(2)Decision Point – 2005. Based on the results of the Phase 1 research, on or before September 30, 2005, the licensee will distribute to the agencies and parties a recommendation on whether to implement Phase 2A or Phase 2B, as described below. It is the intent that the licensee will implement Phase 2A as set forth in paragraph (b)(3) below if: (i) if the results of the Phase 1 studies (described above) demonstrate that the licensee can modify the existing Hadley Falls intake racks to be an effective interim (and potentially long-term) device to achieve the threshold velocity for avoidance of entrainment and impingement of fish; and (ii) there is a potential solution to the Bascule Gate discharge interference on the spillway fishway and a means of providing safe passage down the spillway and over the apron have been identified. If the two elements (i) and (ii) above are not confirmed by the FWS, NOAA Fisheries, MADEP and MADFW pursuant to the process described below, then the licensee shall implement Phase 2B.

The process for determining whether the licensee will implement Phase 2A or Phase 2B, as described below, shall be as follows: After circulation by the licensee of the study results and the licensee's recommendation for Phase 2A or Phase 2B, the licensee shall consult pursuant to paragraph (c) below. On or before December 31, 2005, the Resource Agencies (FWS, NOAA Fisheries, MADEP and MADFW) shall notify the licensee if they all agree with the licensee's recommendation; in which case, the licensee shall implement that recommendation. If FWS, NOAA Fisheries, MADEP and MADFW do not all agree with the licensee's recommendation, they will so notify the licensee by December 31, 2005, and the licensee will then implement Phase 2B.

(3)Phase 2A – 2006-2010. Based on the Phase 1 research and in consultation pursuant to paragraph (c) below, the licensee shall implement the work and research as outlined below for further enhancements of the downstream fish passage facilities. The goals of Phase 2A are for the licensee: (i) to install and construct an interim (and potentially long-term) device that prevents entrainment and impingement at the Project based on modifications of the Hadley Falls intake racks and installation of a new trash rake structure connected with the intake racks completed by the end of 2006; (ii) to perform feasibility studies of selected options to modify the Bascule Gate for safe passage and to solve interference of Bascule Gate discharge on spillway fishway, build prototype and field test in 2006, with engineering/permitting in 2007, and construction in 2008; (iii) to undertake additional research during the period 2006 to 2010 to ensure that the downstream passage facilities are effective for exclusion and guidance; (iv) based on the results of the additional research and effectiveness studies, to design, engineer, and permit an alternative exclusion and/or passage device and modifications to rubber dam #5

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(adjacent to the Bascule Gate) for safe passage in 2008 (if the modifications to the Hadley Falls intake racks are not successful as a long-term exclusion device), with construction completed in 2009, and with effectiveness testing started in 2010; and (v) to implement a long-term monitoring program for shortnose sturgeon after 2010 to the end of the Project License. The license article includes a specific schedule for implementation of this phase.

(4) *Phase 2B – 2006-2009.* Based on the Phase 1 research, consistent with the decision made pursuant to paragraph (b)(2) above, and in consultation pursuant to paragraph (c) below, the licensee shall implement the work and research as outlined below for further enhancements of the downstream fish passage facilities. Under Phase 2B the licensee shall: (i) to continue to implement operational changes commenced in 2005 to enhance downstream passage of shortnose sturgeon; (ii) to continue studies and research to determine the appropriate alternative exclusion and passage device(s), including an angled bar rack; (iii) to design/permit measures and modifications in 2007 for: (A) an alternative exclusion device, and (B) an alternative passage device (in the vicinity of Rubber Dam Section No. 5) to safely and successfully pass fish without injury or significant impairment to essential behavioral patterns and avoid any potential flow interference problems with the spillway fishway, construct these facilities in 2008, and start effectiveness testing of these facilities in 2009; (iv) to undertake additional research and additional measures from 2006 to 2009 to ensure that the downstream passage facilities are effective for exclusion and guidance as described below; and (v) to implement a long-term monitoring program for shortnose sturgeon from 2010 to the end of the Project License. The license article includes a specific schedule for implementation of this phase.

- **Article 411**: requires the licensee to install, operate, and maintain upstream fish passage facilities at the Holyoke Project that ensure that all upstream migrating diadromous and resident fish are able to safely and successfully pass upstream of the Project without injury or significant impairment to essential behavioral patterns. The licensee is required to implement and enhance upstream fish passage as outlined in Phase 1 and Phase 2 below.

  Phase 1 - Requires the licensee to continue to operate the tailrace and spillway fish lift facilities during Upstream Passage Season (April 1 – November 15 of each year), provided that the fish lifts shall not be operational for the period from July 15 to September 15 of each year until such time as: (i) NOAA Fisheries determines that upstream passage of shortnose sturgeon over the dam is appropriate; or (2) MADFW and FWS determine that resident fish passage during this time of year is necessary. The article also requires:

  - that except for Fall 2004, the licensee will not interrupt fish lift operations during the Upstream Passage Season
  - when shortnose sturgeon appear at the fish lift facilities but are not to be lifted, the licensee shall follow the Shortnose Sturgeon Handling Plan (see Settlement Appendix E; Appendix C to the BO)

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- the licensee to implement measures and procedures to operate the No. 2 overflow in such a manner to avoid releasing water when fish lifts are operational
- provisions for maintaining the fish passage facilities
- provision for allowing agency personnel access to the project site and to pertinent project records, for the purpose of inspecting the fish passage facilities.

Phase 2 – This article requires several measures to be completed by the Spring 2005 Upstream Passage Season including:

- Replacement of the tailrace lift tower, auxiliary equipment and hopper to accommodate 33 cubic feet per minute (cfm) capacity
- Modifications to both lifts for 40,000 cfs operation. The licensee is required to raise fishway equipment and structures in the tailrace area approximately 18 inches to provide for 12 inches of free board at operations of 40,000 cfs total river flow.
- Modifications to fish lift attraction water. The licensee is required to modify the existing attraction water supply flume, energy dissipate and gates to provide 200 cfs to the spillway fishway entrance and 240 cfs to the tailrace fishway entrances. Together the existing attraction water distribution structure will provide the required 440 cfs. Hydraulic control features will be provided to distribute and regulate the required range of flows to the crowder and bypass channels of the spillway and tailrace fishways.
- Replacement of the tailrace fish lift and tower replacement. The licensee is required to enlarge the existing tailrace fishlift tower and hoist to accommodate a new hopper, with a volume of 350 cubic feet. This is about one-third larger than the existing hopper. Each tailrace will be designed to discharge flows up to 120 cfs, for a total of 240 cfs.
- Replacement of the spillway tower, auxiliary equipment and hopper to accommodate 46 cfm capacity. The licensee will install a new hopper with a volume of 330 cubic feet which is twice the size of the old hopper. The transport channel will be lengthened from 30 feet to approximately 80 feet. The crowding channel will be increased from the existing 10 feet to approximately 35 feet. A new spillway fishway tower and hoist will be built adjacent to the tailrace fishlift to accommodate the larger hopper. The width of the flume will be expanded to accommodate the new location of the spillway tower. The existing attraction water system will be modified to accommodate flows up to 200cfs for the existing spillway fishway entrance. The width of the spillway transport channel will be increased to an average width of 6 feet
- Increase the width of the fish exit channel. The licensee is required to widen the existing elevated fish exit flume to accommodate the release operation of the spillway fishway. The exit flume is triangular in cross section, wider at the downstream end with a width of at least 14 feet and narrower at the upstream end with a minimum width of 7 feet. Within the exit flume through the intake structure, weirs are currently installed that reduce the width of the exit flume to

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approximately 3 feet. The removal of these weirs will increase the width of the flume to 7 feet. To maintain velocities in the range of 0.5 to 1.0 feet/second, hydraulic gates and a flow inducer will be installed in the flume to define the directional flow. The flow rates will be adjustable with the use of butterfly valves.

- Increase of the width of the fish exit channel up to a maximum of 14 feet between the lift towers and the fish counting station
- Installation a high capacity adjustable drain valve in the flume
- Addition of a second fish trap and viewing window in the exit flume
- Expansion of the fish counting station to include both fish traps
- Modification of the fish trapping and hauling system to provide up to 200 cfs at the spillway entrance and 120 cfs at each of the tailrace entrances
- A contingency plan to be developed for unexpected delays in construction
- The article also requires effectives testing of upstream fish passage facilities including:
- Evaluation of operation and attraction flows
- Evaluation of the adequacy and effectiveness of the 7-foot wide exit channel upstream of the counting station, the existing 4.5-foot wide spillway entrance, and the existing 6-foot wide spillway entrance channel to provide upstream fish passage
- Evaluation of the ability to achieve the target design populations for upstream fish passage at the Project (including an estimated 500 shortnose sturgeon)

If based on the study plan and results, HG&E concludes that the upstream passage facilities and measures are not accomplishing the objectives, or if HG&E does so conclude but the MADEP, MADFW, FWS and/or NOAA Fisheries do not concur, the licensee will develop plans to modify the upstream fish passage facilities including, if necessary:

- Increasing the width of the exit channel upstream of the counting station to 10 feet
- Increasing the width of the spillway entrance to 8 feet; and/or
- Increasing the width of the spillway entrance channel to 8 feet

The article also includes requirements for extending the studies if the parties are unable to determine whether or not the new upstream fish passage facilities are effective or what modifications are necessary to the facilities in order to meet the goal of safe and successful upstream fish passage.

- **Article 413**: requires the licensee to monitor the use and effectiveness of upstream and downstream fish passage facilities.

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- **Article 414**: requires the licensee to prepare an annual construction plan for fishway construction to be undertaken in that coming year. This article requires the licensee to design the construction plan to avoid interruption of the fish lifts at the Project.
- **Article 415**: reserves FERC's authority to require the Licensee to construct, operate, and maintenance, or to provide for the construction, operation, and maintenance of, such fishways as may be prescribed by the Secretary of the Interior or the Secretary of Commerce, as appropriate, pursuant to Section 18 of the Federal Power Act.
- **Article 416**: requires the licensee to implement the Threatened and Endangered Species Protection Plan.
- **Article 420**: requires the licensee to comply with the conditions imposed upon it in Part IV of the Settlement (and the Appendices referenced therein). This article outlines procedures for review of plans or descriptions of work by the resource agencies, including NOAA Fisheries.

Action Area

The action area is defined in 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The action area for this consultation encompasses the immediate area of the Holyoke Project as well as the portion of the Connecticut River that shortnose sturgeon inhabit. The direct and indirect effects of the Holyoke Project include not only effects at the dam but effects at the upstream overwintering and spawning grounds and the downstream overwintering and foraging grounds. These affected areas range from the spawning grounds near Turners Falls to the foraging grounds in the Connecticut River/Long Island Sound estuary. As such, the action area encompasses this entire range, which corresponds to the entire range of shortnose sturgeon in the Connecticut River, which extends from the mouth at river kilometer 0 to Turners Falls at river kilometer 200.

The Connecticut River is the longest river in New England, originating 2,625 feet above sea level in the Fourth Connecticut Lake and accumulating water from several major tributaries as it flows south at a slope of about 6 feet per mile. The waterway serves as the boundary between New Hampshire and Vermont, then runs through Massachusetts and Connecticut before emptying into Long Island Sound, over 400 miles from its source. An area of about 8,309 square miles is drained by the river at the Holyoke Dam.

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STATUS OF SPECIES

The only endangered or threatened species under NOAA Fisheries' jurisdiction in the Action Area is the endangered shortnose sturgeon (*Acipenser brevirostrum*). No critical habitat has been designated for shortnose sturgeon.

Shortnose sturgeon life history

Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. They feed on a variety of benthic and epibenthic invertebrates including molluscs, crustaceans (amphipods, chironomids, isopods), and oligochaete worms (Vladykov and Greeley 1963; Dadswell 1979 *in* NOAA Fisheries 1998). Shortnose sturgeon have similar lengths at maturity (45-55 cm fork length) throughout their range, but, because sturgeon in southern rivers grow

faster than those in northern rivers, southern sturgeon mature at younger ages (Dadswell et al. 1984). Shortnose sturgeon are long-lived (30-40 years) and, particularly in the northern extent of their range, mature at late ages. In the north, males reach maturity at 5 to 10 years, while females mature between 7 and 13 years. Based on limited data, females spawn every three to five years while males spawn approximately every two years. The spawning period is estimated to last from a few days to several weeks. Spawning begins from late winter/early spring (southern rivers) to mid to late spring (northern rivers) when the freshwater temperatures increase to 8-9°C. Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse et al. 1987; Crowder et al. 1994; Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes.

Total instantaneous mortality rates (Z) are available for the Saint John River (0.12 - 0.15; ages 14-55; Dadswell 1979), Upper Connecticut River (0.12; Taubert 1980b), and Pee Dee-Winyah River (0.08-0.12; Dadswell et al. 1984). Total instantaneous natural mortality (M) for shortnose sturgeon in the lower Connecticut River was estimated to be 0.13 (T. Savoy, Connecticut Department of Environmental Protection, personal communication). There is no recruitment information available for shortnose sturgeon because there are no commercial fisheries for the species. Estimates of annual egg production for this species are difficult to calculate because females do not spawn every year (Dadswell et al. 1984). Further, females may abort spawning attempts, possibly due to interrupted migrations or unsuitable environmental conditions (NOAA Fisheries 1998). Thus, annual egg production is likely to vary greatly in this species. Fecundity estimates have been made and range from 27,000 to 208,000 eggs/female (Dadswell et al. 1984).

At hatching, shortnose sturgeon are blackish-colored, 7-11mm long and resemble tadpoles (Buckley and Kynard 1981). In 9-12 days, the yolk sac is absorbed and the sturgeon develops into larvae which are about 15mm total length (TL; Buckley and Kynard 1981). Sturgeon larvae are believed to begin downstream migrations at about 20mm TL. Laboratory studies suggest that young sturgeon move downstream in a 2-step migration; a 2 to 3-day migration by larvae followed by a residency period by young-of-the-year (YOY), then a resumption of migration by yearlings in the second summer of life (Kynard 1997). Juvenile shortnose sturgeon (3-10 years old) reside in the interface between saltwater and freshwater in most rivers (NOAA Fisheries 1998).

In populations that have free access to the total length of a river (e.g., no dams within the species' range in a river: Saint John, Kennebec, Altamaha, Savannah, Delaware and Merrimack Rivers), spawning areas are located at the farthest upstream reach of the river (NOAA Fisheries 1998). In the northern extent of their range, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding, and overwintering activities. In spring, as water temperatures rise above 8°C, pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas. Spawning occurs from mid/late March to mid/late May depending upon location and water temperature. Sturgeon spawn in upper, freshwater areas and feed and overwinter in both fresh and saline habitats. Shortnose sturgeon

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spawning migrations are characterized by rapid, directed and often extensive upstream movement (NOAA Fisheries 1998).

Shortnose sturgeon are believed to spawn at discrete sites within the river (Kieffer and Kynard 1996). In the Merrimack River, males returned to only one reach during a four year telemetry study (Kieffer and Kynard 1996). Squieres (1982) found that during the three years of the study in the Androscoggin River, adults returned to a 1-km reach below the Brunswick Dam and Kieffer and Kynard (1996) found that adults spawned within a 2-km reach in the Connecticut River for three consecutive years. Spawning occurs over channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell et al. 1984; NOAA Fisheries 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the peak spring freshet, water temperatures ranging from 8 - 12°C, and bottom water velocities of 0.4 to 0.7 m/sec (Dadswell et al. 1984; NOAA Fisheries 1998). For northern shortnose sturgeon, the temperature range for spawning is 6.5-18.0°C (Kieffer and Kynard in press). The eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell et al. 1984). Between 8° and 12°C, eggs generally hatch after approximately 13 days. The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week old larvae to be photonegative and form aggregations with other larvae in concealment.

Adult shortnose sturgeon typically leave the spawning grounds soon after spawning. Non-spawning movements include rapid, directed post-spawning movements to downstream feeding areas in spring and localized, wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Young-of-the-year shortnose sturgeon are believed to move downstream after hatching (Dovel 1981) but remain within freshwater habitats. Older juveniles tend to move downstream in fall and winter as water temperatures decline and the salt wedge recedes. Juveniles move upstream in spring and feed mostly in freshwater reaches during summer. Juvenile shortnose sturgeon generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface (Dadswell et al. 1984; Hall et al. 1991). Non-spawning movements include wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Adult sturgeon occurring in freshwater or freshwater/tidal reaches of rivers in summer and winter often occupy only a few short reaches of the total length (Buckley and Kynard 1985). Summer concentration areas in southern rivers are cool, deep, thermal refugia, where adult and juvenile shortnose sturgeon congregate (Flourney et al. 1992; Rogers and Weber 1994; Rogers and Weber 1995; Weber 1996). While shortnose sturgeon are occasionally collected near the mouths of rivers and often spend time in estuaries, they are not known to participate in coastal migrations and are rarely documented in their non-natal river.

The temperature preference for shortnose sturgeon is not known (Dadswell et al. 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2 to 3°C (Dadswell et

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al. 1984) and as high as 34°C (Heidt and Gilbert 1978). However, temperatures above 28°C are thought to adversely affect shortnose sturgeon. In the Altamaha River, temperatures of 28-30°C during summer months create unsuitable conditions and shortnose sturgeon are found in deep cool water refuges.

Shortnose sturgeon are known to occur at a wide range of depths. A minimum depth of 0.6m is necessary for the unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30m but are generally found in waters less than 20m (Dadswell et al. 1984; Dadswell 1979). Shortnose sturgeon have also demonstrated tolerance to a wide range of salinities. Shortnose sturgeon have been documented in freshwater (Taubert 1980; Taubert and Dadswell 1980) and in waters with salinity of 30 parts-per-thousand (ppt) (Holland and Yeverton 1973; Saunders and Smith 1978). Mcleave et al. (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 10ppt within a two hour period. The tolerance of shortnose sturgeon to increasing salinity is thought to increase with age (Kynard 1996). Shortnose sturgeon typically occur in the deepest parts of rivers or estuaries where suitable oxygen and salinity values are present (Gilbert 1989).

Status and Trends of Shortnose Sturgeon Rangewide

Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Although the original listing notice did not cite reasons for listing the species, a 1973 Resource Publication, issued by the US Department of the Interior, stated that shortnose sturgeon were "in peril...gone in most of the rivers of its former range [but] probably not as yet extinct" (USDOI 1973). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. In the late nineteenth and early twentieth centuries, shortnose sturgeon commonly were taken in a commercial fishery for the closely related and commercially valuable Atlantic sturgeon (*Acipenser oxyrinchus*). More than a century of extensive fishing for sturgeon contributed to the decline of shortnose sturgeon along the east coast. Heavy industrial development during the twentieth century in rivers inhabited by sturgeon impaired water quality and impeded the recovery of both of these species; possibly resulting in substantially reduced abundance of shortnose sturgeon populations within portions of the species' ranges (e.g., southernmost rivers of the species' range: Santilla, St. Marys and St. Johns Rivers). A shortnose sturgeon recovery plan was published in December 1998 to promote the conservation and recovery of the species (see NOAA Fisheries 1998). Shortnose sturgeon are listed as "vulnerable" on The World Conservation Union's (IUCN) Red List.

Although shortnose sturgeon are listed as endangered range-wide, in the final recovery plan NOAA Fisheries recognized 19 separate populations occurring throughout the range of the species. These populations are in New Brunswick Canada (1); Maine (2); Massachusetts (1); Connecticut (1); New York (1); New Jersey/Delaware (1); Maryland and Virginia (1); North Carolina (1); South Carolina (4); Georgia (4); and Florida (2). NOAA Fisheries has not formally recognized distinct population segments (DPS)[3] of shortnose sturgeon under the ESA. Although

3 The definition of species under the ESA includes any subspecies of fish, wildlife, or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature. To be considered a DPS, a population

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genetic information within and among shortnose sturgeon occurring in different river systems is largely unknown, life history studies indicate that shortnose sturgeon populations from different river systems are substantially reproductively isolated (Kynard 1997) and, therefore, should be considered discrete. The 1998 Recovery Plan indicates that while genetic information may reveal that interbreeding does not occur between rivers that drain into a common estuary, at this time, such river systems are considered a single population compromised of breeding subpopulations (NOAA Fisheries 1998).

More recent studies have provided evidence that suggests that years of isolation between populations of shortnose sturgeon have led to morphological and genetic variation. Walsh et al. (2001) examined morphological and genetic variation of shortnose sturgeon in three rivers (Kennebec, Androscoggin, and Hudson). The study found that the Hudson River shortnose sturgeon population differed markedly from the other two rivers for most morphological features (total length, fork length, head and snout length, mouth width, interorbital width and dorsal scute count, left lateral scute count, right ventral scute count). Significant differences were found between fish from Androscoggin and Kennebec rivers for interorbital width and lateral scute counts which suggests that even though the Androscoggin and Kennebec rivers drain into a common estuary, these rivers support largely discrete populations of shortnose sturgeon. The study also found significant genetic differences among all three populations indicating substantial reproductive isolation among them and that the observed morphological differences may be partly or wholly genetic.

Grunwald et al. (2002) examined mitochondrial DNA (mtDNA) from shortnose sturgeon in eleven river populations. The analysis demonstrated that all shortnose sturgeon populations examined showed moderate to high levels of genetic diversity as measured by haplotypic diversity indices. The limited sharing of haplotypes and the high number of private haplotypes are indicative of high homing fidelity and low gene flow. The researchers determined that glaciation in the Pleistocene Era was likely the most significant factor in shaping the phylogeographic pattern of mtDNA diversity and population structure of shortnose sturgeon. The Northern glaciated region extended south to the Hudson River while the southern non-glaciated region begins with the Delaware River. There is a high prevalence of haplotypes restricted to either of these two regions and relatively few are shared; this represents a historical subdivision that is tied to an important geological phenomenon that reflects historical isolation. Analyses of haplotype frequencies at the level of individual rivers showed significant differences among all systems in which reproduction is known to occur. This implies that although higher level genetic stock relationships exist (i.e., southern vs. northern and other regional subdivisions), shortnose sturgeon should be managed at the level of discrete stocks and that low gene flow exists between the majority of populations.

Waldman et al. (2002) also conducted mtDNA analysis on shortnose sturgeon from 11 river systems and identified 29 haplotypes. Of these haplotypes, 11 were unique to northern, glaciated

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segment must meet two criteria under NOAA Fisheries policy. First, it must be discrete, or separated, from other populations of its species or subspecies. Second, it must be significant, or essential, to the long-term conservation status of its species or subspecies. This formal legal procedure to designate DPSs for shortnose sturgeon has not been undertaken.

systems and 13 were unique to the southern non-glaciated systems. Only 5 were shared between them. This analysis suggests that shortnose sturgeon show high structuring and discreteness and that low gene flow rates indicated strong homing fidelity.

Wirgin et al. (in press), also conducted mtDNA analysis on shortnose sturgeon from 12 rivers (St. John, Kennebec, Androscoggin, Upper Connecticut, Lower Connecticut, Hudson, Delaware, Chesapeake Bay, Cooper, Peedee, Savannah, Ogeechee and Altamaha). This analysis suggested that most population segments are independent and that genetic variation among groups was high.

The best available information demonstrates differences in life history and habitat preferences between northern and southern river systems and given the species' anadromous breeding habits, the rare occurrence of migration between river systems, and the documented genetic differences between river populations, it is unlikely that populations in adjacent river systems interbreed with any regularity. This likely accounts for the failure of shortnose sturgeon to repopulate river systems from which they have been extirpated, despite the geographic closeness of persisting populations. This characteristic of shortnose sturgeon also complicates recovery and persistence of this species in the future as if a river population is extirpated in the future, it is unlikely that this river will be recolonized. Consequently, this BO will treat the nineteen separate populations of shortnose sturgeon as subpopulations (one of which occurs in the action area) for the purposes of this analysis.

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. The range extended from the St John River in New Brunswick, Canada to the Indian River in Florida. Today, only 19 populations remain ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. Shortnose sturgeon are large, long lived fish species. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. The species is anadromous in the southern portion of its range (i.e., south of Chesapeake Bay), while northern populations are amphidromous (NOAA Fisheries 1998). Population sizes vary across the species' range. From available estimates, the smallest populations occur in the Cape Fear (~8 adults; Moser and Ross 1995) and Merrimack Rivers (~100 adults; M. Kieffer, United States Geological Survey, personal communication), while the largest populations are found in the Saint John (~100,000; Dadswell 1979) and Hudson Rivers (~61,000; Bain et al. 1998). As indicated in Kynard 1996, adult abundance is less than the minimum estimated viable population abundance of 1000 adults for 5 of 11 surveyed northern populations and all natural southern populations. Kynard 1996 indicates that all aspects of the species' life history indicate that shortnose sturgeon should be abundant in most rivers. As such, the expected abundance of adults in northern and north-central populations should be thousands to tens of thousands of adults. Expected abundance in southern rivers is uncertain, but large rivers should likely have thousands of adults. The only river systems likely supporting populations of these sizes are the St John, Hudson and possibly the Delaware, making the continued success of shortnose sturgeon in these rivers critical to the species as a whole. While no reliable estimate of the size of either the total species or the

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shortnose sturgeon population in the Northeastern United States exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed.

Threats to shortnose sturgeon recovery

The Shortnose Sturgeon Recovery Plan (NOAA Fisheries 1998) identifies habitat degradation or loss (resulting, for example, from dams, bridge construction, channel dredging, and pollutant discharges) and mortality (resulting, for example, from impingement on cooling water intake screens, dredging and incidental capture in other fisheries) as principal threats to the species' survival.

Several natural and anthropogenic factors continue to threaten the recovery of shortnose sturgeon. Shortnose sturgeon continue to be taken incidentally in fisheries along the east coast and are probably targeted by poachers throughout their range (Dadswell 1979; Dovel et al. 1992; Collins et al. 1996). Bridge construction and demolition projects may interfere with normal shortnose sturgeon migratory movements and disturb sturgeon concentration areas. Unless appropriate precautions are made, internal damage and/or death may result from blasting projects with powerful explosives. Hydroelectric dams may affect shortnose sturgeon by restricting habitat, altering river flows or temperatures necessary for successful spawning and/or migration and causing mortalities to fish that become entrained in turbines. Maintenance dredging of Federal navigation channels and other areas can adversely affect or jeopardize shortnose sturgeon populations. Hydraulic dredges can lethally take sturgeon by entraining sturgeon in dredge dragarms and impeller pumps. Mechanical dredges have also been documented to lethally take shortnose sturgeon. In addition to direct effects, dredging operations may also impact shortnose sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with resuspended fine sediments. Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely detrimental impacts to water quality which can affect shortnose sturgeon. For example, the St. Stephen Power Plant near Lake Moultrie, South Carolina was shut down for several days in June 1991 when large mats of aquatic plants entered the plant's intake canal and clogged the cooling water intake gates. Decomposing plant material in the tailrace canal coupled with the turbine shut down (allowing no flow of water) triggered a low dissolved oxygen water condition downstream and a subsequent fish kill. The South Carolina Wildlife and Marine Resources Department reported that twenty shortnose sturgeon were killed during this low dissolved oxygen event.

Contaminants, including toxic metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs) can have substantial deleterious effects on aquatic life including production of acute lesions, growth retardation, and reproductive impairment (Cooper 1989; Sinderman 1994). Ultimately, toxins introduced to the water column become associated with the benthos and can be particularly harmful to benthic organisms (Varanasi 1992) like sturgeon. Heavy metals and organochlorine compounds are known to accumulate in fat tissues of sturgeon, but their long term effects are not yet known (Ruelle and Henry 1992; Ruelle and Kennlyne 1993). Available data suggests that early life stages of fish

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are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976).

Although there is scant information available on the levels of contaminants in shortnose sturgeon tissues, some research on other related species indicates that concern about the effects of contaminants on the health of sturgeon populations is warranted. Detectible levels of chlordane, DDE (1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene), DDT (dichlorodiphenyl-trichloroethane), and dieldrin, and elevated levels of PCBs, cadmium, mercury, and selenium were found in pallid sturgeon tissue from the Missouri River (Ruelle and Henry 1994). These compounds were found in high enough levels to suggest they may be causing reproductive failure and/or increased physiological stress (Ruelle and Henry 1994). In addition to compiling data on contaminant levels, Ruelle and Henry also determined that heavy metals and organochlorine compounds (i.e. PCBs) accumulate in fat tissues. Although the long term effects of the accumulation of contaminants in fat tissues is not yet known, some speculate that lipophilic toxins could be transferred to eggs and potentially inhibit egg viability. In other fish species, reproductive impairment, reduced egg viability, and reduced survival of larval fish are associated with elevated levels of environmental contaminants including chlorinated hydrocarbons. A strong correlation that has been made between fish weight, fish fork length, and DDE concentration in pallid sturgeon livers indicates that DDE increases proportionally with fish size (NOAA Fisheries 1998).

Contaminant analysis was conducted on two shortnose sturgeon from the Delaware River in the fall of 2002. Muscle, liver, and gonad tissue were analyzed for contaminants (ERC 2002). Sixteen metals, two semivolatile compounds, three organochlorine pesticides, one PCB Aroclor, as well as polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) were detected in one or more of the tissue samples. Levels of aluminum, cadmium, PCDDs, PCDFs, PCBs, DDE (an organochlorine pesticide) were detected in the "adverse affect" range. It is of particular concern that of the above chemicals, PCDDs, DDE, PCBs and cadmium, were detected as these have been identified as endocrine disrupting chemicals. While no directed studies of chemical contamination in shortnose sturgeon in the Delaware River have been undertaken, it is evident that the heavy industrialization of the Delaware River is likely adversely affecting this population. As much of the Connecticut River is also industrialized, it is likely that shortnose sturgeon in the Connecticut River experience similar contaminant loads.

During summer months, especially in southern areas, shortnose sturgeon must cope with the physiological stress of water temperatures that may exceed 28°C. Flourney *et al.*(1992) suspected that, during these periods, shortnose sturgeon congregate in river regions which support conditions that relieve physiological stress (i.e., in cool deep thermal refuges). In southern rivers where sturgeon movements have been tracked, sturgeon refrain from moving during warm water conditions and are often captured at release locations during these periods (Flourney *et al.*1992; Rogers and Weber 1994; Weber 1996). The loss and/or manipulation of these discrete refuge habitats may limit or be limiting population survival, especially in southern river systems.

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Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which contain elevated temperatures or high biological demand, can reduce dissolved oxygen levels. According to the Recovery Plan for shortnose sturgeon (NOAA Fisheries 1998) low oxygen levels (below 5 mg/L) are known to be stressful to aquatic life, and presumably, sturgeon would be adversely affected by levels below this limit. Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28°C (Flourney et al. 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal.

Status of Shortnose Sturgeon in the Connecticut River

NOAA Fisheries' goal for shortnose sturgeon is to recover the species to a level that would support reclassifying this sturgeon from endangered to threatened and eventually removing them from the federal list of threatened and endangered species. The primary methods for achieving that goal in the Connecticut River are to (a) protect shortnose sturgeon from anthropogenic activities that threaten the survival of individual members of the population and (b) re-establish unimpeded movement of shortnose sturgeon throughout their historic range in the Connecticut River.

Natural mortality is a factor that should be considered when estimating the impacts to species recovery. Taubert (1980) estimated the total instantaneous mortality rate to be 0.12 for adult shortnose sturgeon in the Holyoke Pool portion of the Connecticut River. It is likely that the fishing mortality rate is very low in this population, so the natural mortality rate is probably very close to the instantaneous mortality rate (NOAA Fisheries 1998). Using catch curves and Hoenig's technique, total instantaneous natural mortality for shortnose sturgeon in the Connecticut River estuary was estimated to be 0.13 (T. Savoy personal communication, in NOAA Fisheries 1998).

The best available scientific data indicates that historically, shortnose sturgeon ranged above Hadley Falls to Turners Falls. Spring high water events afforded upstream migrating shortnose sturgeon the opportunity to navigate the Hadley Falls area. The Holyoke Dam and associated lock and pool were built in 1849, for the most part blocking downriver fish from the 58 km reach of river between Holyoke and Turners Falls. It is also possible that shortnose sturgeon were able to use the Hadley Boat Lock to gain access to upriver habitat. The first successful fishway, an elevator, was installed at the tailrace in 1955 to pass fish attracted to the hydroelectric turbine discharge. Consequently from 1849 to 1955, shortnose sturgeon above the dam were isolated from shortnose sturgeon below the dam, with the possible exception of some members of the upriver population passing downriver over the crest of the dam or through the lock, canal system or turbines. Another fishway, the spillway lift, was built in 1976 at the base of the dam to pass fish attracted to spillage water.

The Holyoke Dam separates shortnose sturgeon in the Connecticut River into an upriver group (above Holyoke Dam) and a lower river group that occurs below Holyoke Dam to Long Island Sound. The abundance of the upriver group has been estimated by mark-recapture techniques using Carlin tagging (Taubert 1980) and PIT tagging (Kynard unpublished data). No information exists on the historical numbers of shortnose sturgeon in the Connecticut River prior

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to the late 1970s. Estimates of total adult abundance calculated in the early 1980s range from 297 to 516 in the upriver population to 800 in the lower river population. Population estimates conducted in the 1990's indicated populations in the same range. The total upriver population estimates ranged from 297 to 714 adult shortnose sturgeon, and the size of the spawning population was estimated at 47 and 98 for the years 1992 and 1993 respectively. The lower Connecticut River population estimate for sturgeon >50 cm TL was based on a Carlin and PIT tag study from 1991 to 1993. A mean value of 875 adult shortnose sturgeon was estimated by these studies. Savoy (in press) estimates that the lower river population may be as high as 1000 individuals, based on tagging studies from 1988-2002. It has been cautioned that these numbers may overestimate the abundance of the lower river group because the sampled area is not completely closed to downstream migration of upriver fish (Kynard 1997). Other estimates of the total adult population in the Connecticut River have reached 1200 (Kynard 1998) and based on Savoy's recent numbers the total population may be as high as 1400 fish. Regardless of the actual number of fish present in the river, the effective breeding population, consisting of the upriver population as no lower river fish are currently passed upstream, totals only approximately 400 fish.

Talbert (1980b) reported that Connecticut River shortnose sturgeon exhibited relatively good growth until 8 to 10 years after which it declined rapidly. The average length of shortnose sturgeon at age 10 was 70.1cm, but shortnose sturgeon at age 25 were only 90cm in length. The largest shortnose sturgeon recorded by Talbert was 111cm in length. While the majority of shortnose sturgeon captured in this study were between 8 and 18 years of age, shortnose sturgeon in excess of 25 years were not uncommon.

Shortnose sturgeon in the Connecticut River reach sexual maturity at approximately age 8. In the Connecticut River, Buckley and Kynard (1985) found that spawning lasted 2-5 days in 1980-1992, and Kynard (1997) noted that spawning lasted 7-13 days in 1989-1993. A more recent study (Kieffer and Kynard in press), notes a spawning period of 5-17 days during the same 26 day period each year (April 27 – May 22). Shortnose sturgeon spawn in the Connecticut River from the last week of April to mid-May; after peak spring flows and in moderate, decreasing river discharge (Taubert 1980; Buckley and Kynard 1985; Kynard 1997). In the lower Connecticut River, most of the ripening shortnose sturgeon migrate to their spawning grounds in August-October and remain near the spawning areas (i.e., overwinter) until spring (Dadswell 1979; Buckley and Kynard 1985).

Several areas of the river have been identified as concentration areas. In the downriver segment, a concentration area is located in Agawam, MA which is thought to provide summer feeding and over wintering habitat. Other concentration areas for foraging and over wintering is located in Hartford, Connecticut, at the Head of Tide (Buckley and Kynard 1985) and in the vicinity of Portland, Connecticut (CTDEP 1992). Shortnose sturgeon also make seasonal movements into the estuary, presumably to forage (Buckley and Kynard 1985; Savoy in press). Above the dam, there are also several concentration areas. During summer, shortnose sturgeon congregate near Deerfield. Many overwinter at Whitmore. Successful spawning has been documented at two sites in Montague and this is thought to be the primary spawning site for shortnose sturgeon in the Connecticut River (see below).

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In the Connecticut River, foraging occurs in the summer in both freshwater and saline reaches of the river (Buckley and Kynard 1985; Savoy and Shake 1992). One foraging area is located above Holyoke Dam and four others are located below Holyoke Dam. There is also an overwintering area located approximately 25 km downstream of the upriver (Montague) spawning area. These upriver sites are probably preferred by pre-spawning shortnose sturgeon that will reproduce the following spring (Kieffer and Kynard, in press). Shortnose sturgeon in the lower river appear to migrate upstream to the area of the Holyoke Dam throughout the summer foraging season. It is possible that these fish seek to reach the upstream foraging and overwintering areas to await the spring spawning season. The migration of juvenile and adult shortnose sturgeon to points downstream of the Holyoke Dam appears to be a natural event coincidental with increased river discharges (Seibel 1991; Kynard 1997).

Adult shortnose sturgeon remain in freshwater all year in the Connecticut River, but some adults briefly enter low salinity river reaches in May to June and then return upriver (Buckley and Kynard 1985; Savoy in press). The concentration area used by adult fish in the Connecticut River is in reaches where natural or artificial features cause a decrease in river flow, possibly creating suitable substrate conditions for freshwater mussels (Kieffer and Kynard 1993), a major prey item for adult sturgeon (Dadswell et al. 1984). Both adults and juveniles have been found to use the same river reaches in the Connecticut River and have summer home ranges of about 10 km (Savoy 1991; Seibel 1991). The wintering range is usually less than 2 km, with fish congregating in deep areas, usually within or near the summer range (Seibel 1991). Foraging adults prefer curved or island reaches in the summer, not straight runs, and appear to prefer gravel and rubble substrate in the summer, but sand in the winter. Fish foraging activity is almost equal during day and night, but most adult sturgeon occur in slightly deeper water during the day than at night.

In 1983, Buckley and Kynard identified a shortnose sturgeon spawning site below Holyoke Dam. This area was initially determined to be a spawning area based on the relatively high numbers of telemetered sturgeon concentrating in the region during the spring spawning season. Investigation of this site, however, has provided evidence of successful spawning in very few years. In 1985, 4 eggs and 4 embryos were recovered (Buckley and Kynard 1985). In 1998, one egg was collected at Holyoke and during 1999 seven eggs were collected at Holyoke (4 of the eggs were dead and the remaining 3 were in an early stage of development). This suggests that a limited amount of spawning may occur below the Holyoke Dam, but given the numbers of eggs and larvae captured at the upstream versus the downstream spawning sites it is clear that spawning at Montague (the upriver site) is significantly more successful.

Two areas above Holyoke Dam, near Montague, have more consistently been found to provide spawning habitat for shortnose sturgeon. This spawning habitat is located at river km 190-192 and is the most upstream area of use. It is located just downstream of the species' historical limit in the Connecticut River at Turners Falls (river km 198). Across the latitudinal range of the species, spawning adults typically travel to approximately river km 200 or further upstream where spawning generally occurs at the uppermost point of migration within a river (Kynard 1997; NOAA Fisheries 1998). The Montague sites have been verified as spawning areas based

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on successful capture of sturgeon eggs and larvae in 1993, 1994, and 1995, that were 190 times the number of fertilized eggs and 10 times the number of embryos found in the Holyoke site (Vinogradov 1997). In seven years of study (1993-1999), limited successful spawning, as indicated by capture of embryos or late stage eggs, occurred only once (1995) at Holyoke Dam (Vinogradov 1997; Kynard et al. 1999c). Using this same measure, successful spawning occurred at Montague during 4 of 7 years. Both Montague and Holyoke sites have been altered by hydroelectric dam activities, but all information suggests that females spawn successfully at Montague, not at Holyoke Dam. Thus, it appears that most, if not all, recruitment to the population comes from spawning in the upriver segment.

The Montague area is the 1.4-km reach from the Rock Dam to 200m downstream of Cabot Station. In this area, river depths are less than 10m and all common types of river habitat are present. Much of the river bottom in the natural river bed and in the tailrace of Cabot Station is rock and rubble. The 0.5-km long tailrace downstream of Cabot Station contains rubble/boulder shoals that can be exposed briefly in spring during low river discharge and low Cabot Station generation.

Kieffer and Kynard (in press), conducted a multiyear study (1993-2003) on the pre-spawning migration and spawning of Connecticut River shortnose sturgeon. Seventy-two adults were tracked from the four wintering sites, with 54 adults tracked during two or more spring periods. During this ten year period, only eighteen (25%) of the adults initiated a pre-spawning migration. The study observed 27 (26 males, 1 female) pre-spawning migrations from wintering areas. Twenty-four of the pre-spawning adults wintered at Whitmore and initiated a pre-spawning migration from there. Three males wintered and initiated migration from other winter sites (Second Island, Hatfield, and Elwell Island). While river discharge, day length and moon phase differed when migration began, males left Whitmore each year during similar temperatures (7.0-9.2°C). Fifty-one non-spawning adults were also tracked as they left Whitmore. Adults left Whitmore on similar dates to the spawning adults. Most non-spawning adults left Whitmore at the same time or within a week of pre-spawning migrants (i.e., by the first week in May). However, during all years, some adults remained at the winter site through early June, suggesting that they were foraging at the winter site.

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Tracking also occurred at the Deerfield Confluence Area, many of the fish radio-tagged at Deerfield migrated to Montague, with several of the males moving back and forth between Deerfield and Montague at least once. A group of nonspawners was also located at Deerfield. Some of these fish stayed at Deerfield until at least November, suggesting that the Deerfield area is used by adults in all reproductive stages during spring and summer.

A total of 450 males and 55 females were captured and measured at Montague during 1993-2003. While both sexes showed a significant and similar length/weight relationship, females were significantly greater in total length and weight than males. Abundance estimates at the Montague site during spawning ranged from 14 to 360 adults. Spawning was documented to have succeeded in 1993, 1994, 1995, 1998-2000 and 2003 and spawning failed in 1996, 1997, 2001 and 2002. The mean abundance of adults for the years when spawning succeeded was significantly higher (198) than in years when spawning failed (50). Spawning succeeded more

often at Cabot Station (7 years) than at Rock Dam. For the 11 years of the study, successful spawning only occurred for 7 years. In all years, spawning occurred from April 27-May 22, lasting from 5-17 days (mean 8.3 days). Even during years when spawning occurred, tracking indicated that some females did not spawn. While females spawned at either Cabot Station or Rock Dam, some males likely spawned at both locations. In 2002, spawning failed because the pre-spawning migration failed (no females and only two males were captured at Montague).

During spawning, the daily mean temperatures at Cabot Station were 6.5-14.7°C and the mean temperatures when spawning occurred at Rock Dam were 9.1-14.5°C. Females spawned in water depths of 1-5m with a peak at 1.5-1.9m. Bottom water velocity at spawning site was a mean of 70cm/s with the greatest usage of 75-125 cm/s. The only substrate type females used was cobble/rubble (101-300 mm diameter).

Suitable spawning windows were determined to be based on day length, water temperature and water discharge. Endogenous physiological factors controlled by day length set the duration of the potential spawning window. For the Connecticut River, this period is from April 27 – May 22. Within this window, temperature and discharge must overlap for spawning to occur. Kieffer and Kynard estimated that during the period of 1904 and 1991, 33 years had unsuitable discharge and 7 years likely had failed pre-spawning migrations. Thus, of these years, spawning likely failed for 40 years and was unknown for 2 years (due to unusual discharge patterns). The longest period of suitable discharge at Cabot Station was 5 consecutive years (1948-1952 and 1964-1968) and the longest period of unsuitable discharge was 4 consecutive years (1969-1972). The results of this analysis clearly indicate that shortnose sturgeon spawning in the Connecticut River does not occur every year. The cause of these failures has not yet been identified.

Pre-spawning males moved at a mean ground speed of 4 km/day and females moved 3-10 km/day. This is significantly slower than ground speeds recorded during summer and fall (16-20 km/day; Buckley and Kynard 1985). This suggests that pre-spawning adults, who have not foraged since November, may be conserving energy for spawning. The migration route for all adults leaving the winter site was the channel.

Two wintering and migration strategies appear to be used by Connecticut River pre-spawning females. Most females downstream of the Holyoke Dam that could spawn the next spring, attempt to migrate upstream to Deerfield during the summer or early fall preceding spawning (Kynard et al. in press). When displaced over the dam, most were disoriented and returned downstream before spawning, but two remained upstream, summered at Deerfield, wintered at Whitmore and migrated to spawn at Montague. The migration and behavior of these two fish likely shows the natural movement pattern of downstream segment females if upstream passage was available over Holyoke Dam. The choice by pre-spawning females to winter at Whitmore, closest to Montague, strongly suggests that this choice is adaptive and likely has energetic benefits from a shorter spring spawning migration.

Many males spawned during several conservative years, but no male spawned every year. Trusov (1991) found difference in the maturation rates of testes of male stellate sturgeons (*Acipenser stellatus*) and suggested feeding success likely influenced stage of maturity. The

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interval of spawning for females was 6 years or more and highly variable. It should be noted that these males and females were from the upstream population segment and that unlike the downstream population segment, these fish do not have access to the mineral and forage resources in the estuary. Kieffer and Kynard (in press) suggest that female spawning periodicity in a reunited Connecticut River population would likely show a shorter time interval between spawning of females.

Vinogradov (1997) conducted a detailed comparison study of the Holyoke and Montague spawning sites, but did not detect significant differences in habitat parameters (substrate quality, bottom velocity, water temperature). The researchers hypothesized that sturgeon are spawning site specific and that there is a strong behavioral drive to move upriver. The investigators argued that Holyoke Dam may have less of an effect on the potential population size (by limiting the number of spawners) than on the compromise to gene flow, which is extremely significant in a population where high levels of demographic stochasticity may determine the population's long-term viability.

Monitoring of spawner abundance in the Connecticut River indicated that abundance varies greatly from year to year: in 1992 there were 47 spawners, while in 1993, 98 spawners were detected (Kieffer and Kynard unpublished data). Sampling in 1998 revealed that spawning at both locations was mainly unsuccessful, except for a rare female at Montague and Holyoke. In fact, all evidence indicates that, until 1999, there had been limited or no significant reproduction since 1995 (Kynard et al. 1999c). Further, it appears that not every mature female spawns successfully. In the Connecticut River, one of four female shortnose sturgeon removed for egg culture in 1988 could not spawn due to a tumor (Kynard personal observation), suggested to be due to exposure to coal tar leachate in the river.

In 1997, an ecological risk analysis was conducted for shortnose sturgeon in the Connecticut River by Applied Biomathematics (Root and Akcakaya 1997). The analysis concluded that the stability observed in upriver and downriver populations of shortnose sturgeon in the Connecticut River would be possible under two conditions: reproduction in both upper and lower populations and small to moderate rates of dispersal between them; or no fecundity in the lower population, very high fecundity in the upper population and a high rate of net downstream dispersal.

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ENVIRONMENTAL BASELINE

Environmental baselines for biological opinions include the past and present impacts of all State, Federal, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impacts of State or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this biological opinion includes the effects of several activities that may have affected the survival and recovery of threatened and endangered species in the Action Area. The activities that shape the environmental baseline of this consultation include the effects of the past operation of the Holyoke Project, additional dams, up- and downstream hydropower and other electric generating facilities, coal tar deposits, fisheries, research projects, and water quality.

Impacts of Federal Actions that have Undergone Formal or Early Section 7 Consultation
On June 26, 1992, NOAA Fisheries issued a BO to the New England District Army Corps of Engineers (ACOE) for maintenance dredging of the Connecticut River Federal Navigation Project. The BO concluded that the proposed long-term maintenance dredging project was likely to jeopardize the continued existence of shortnose sturgeon in the Connecticut River due to the high number of shortnose sturgeon expected to be killed or otherwise affected by hopper dredging operations. In cooperation with the ACOE, NOAA Fisheries developed a reasonable and prudent alternative which would avoid jeopardy to shortnose sturgeon in the Connecticut River. The RPA included a time of year restriction and a change in disposal location. The accompanying Incidental Take Statement indicated that NOAA Fisheries believed up to 10 shortnose sturgeon were likely to be taken from dredging operations on an annual basis but due to difficulty in monitoring take, the ITS exempted the take of five observed mortalities in the hopper dredge annually. This action has been ongoing since the 1960s and continues today. Dredging occurs nearly every year.

Impacts of the Historical Operation and Maintenance of Holyoke Dam
Construction and operation of hydroelectric projects in the Connecticut River have significantly altered the natural characteristics of the river by altering the river flows and temperatures necessary for successful shortnose sturgeon spawning and/or migration. Hydroelectric projects also elevate the turbidity levels as a result of erosion generated by abnormal flow fluctuations and reduce the water velocity within the impoundment, making it difficult for sturgeon to find or effectively use the fishways. The most significant hindrance to shortnose sturgeon migration is the existence of the Holyoke Dam, a 150 year old barrier to normal upstream and downstream movement patterns of the Connecticut River shortnose sturgeon population. If the average shortnose sturgeon life span is 20 years, this represents almost 8 generations that have been affected by impaired migration. This long-term separation of the upriver and downriver shortnose sturgeon groups by Holyoke Dam likely has had significant effects on the Connecticut River population's likelihood of surviving and recovering in the wild.

The effects of the Holyoke Project on the shortnose sturgeon's ability to migrate in the Connecticut River have likely adversely affected the shortnose sturgeon's likelihood of surviving in the river. An extensive evaluation of shortnose sturgeon rangewide revealed that shortnose sturgeon above Holyoke Dam have the slowest growth rate of any surveyed (Taubert 1980 in Kynard 1997) while shortnose sturgeon in the lower Connecticut River have a high condition factor and general robustness (Savoy, in press). This suggests that there are growth advantages associated with foraging in the lower river or at the fresh- and salt-water interface. There are four documented foraging sites downstream of the Holyoke Dam, while only one exists upstream. The presence of the Holyoke Dam has likely resulted in depressed juvenile and adult growth due to inability to take advantage of the increased productivity of the fresh/salt water interface. This likely has negatively impacted the survival of the Connecticut River population of shortnose sturgeon and impeded recovery. As noted above, this has also likely made the spawning periodicity of females greater.

Managers have had to decide whether to pass shortnose sturgeon found in the fish lift upstream and whether to actively facilitate the passage of additional shortnose sturgeon located below

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Holyoke Dam. Factors complicating their decision have been (1) the difficulty shortnose sturgeon have in successfully entering fishways at Holyoke Dam, (2) the question of whether there was a successful spawning location below Holyoke Dam, and (3) the lack of safe downstream passage for shortnose sturgeon past the Holyoke Project. Initially, managers were concerned that relocating shortnose sturgeon upstream could unnaturally mix two populations that were separate and/or could result in the mortality of these individuals and/or their offspring as they subsequently attempted to move downstream. On the other hand, managers recognized that if there was really one population of shortnose sturgeon in the Connecticut River and the only successful spawning site was upstream of the Holyoke Project, then failure to provide access would deny the individual fish the opportunity to contribute to future generations. This could be limiting the gene pool, perhaps threatening the continued existence and recovery of the shortnose sturgeon population in the Connecticut River.

Upstream migrations are essential for shortnose sturgeon population growth, and fish moving upstream are currently aided by the existing fish lifts at the Holyoke Dam. Between 1981 and 1998, 104 shortnose sturgeon were captured and/or lifted over Holyoke Dam. Between 1981 and 1995, 60 adult shortnose sturgeon were found in the fish lifts at the Holyoke Dam. Thirty-nine of these fish were lifted above the dam and released in the Holyoke Pool. Typically the fish lift was operated from late April to mid-July and again during September and October. During the spring, the lift was operated 7 days a week, attraction water was provided approximately 12 hours a day and many lifts were made each day. During the fall, the lift was operated 5 days a week, attraction water was provided approximately 8 hours a day and the lift was operated three to four times a day (Kynard 1998).

With the existing fish lift operations, it appears that only a small percentage of the shortnose sturgeon present at the dam are passed upstream. From 1980-2001, only 112 sturgeon have been lifted at the Holyoke Dam. Compared to the number of adults documented below the dam and the number that would likely migrate above the dam to overwinter and/or spawn, this number suggests that upstream passage has been largely unsuccessful. For example, during the spring of 1982, 67 adults were identified at the dam and 4 were passed; during the fall of 1982, 45 adults were identified at the dam and none were passed; from 1993 to 1995, hundreds of shortnose sturgeon were identified below the dam and between 1 and 6 were passed in any one year (Kynard 1998). In 1996 the most sturgeon were passed above the dam, with 16 being passed that year. In the fall, low passage is likely due to the decreased passing effort and the inability of fish to pass through the shallow rapids downstream of the lift entrance (Kynard 1998). It appears that the presence of the dam with insufficient passage has severely and negatively impeded upstream passage of shortnose sturgeon. This has likely decreased the effective population size of the Connecticut River population of shortnose sturgeon, as such a small percentage of the females potentially seeking access to the spawning site are successfully passed upstream.

Shortnose sturgeon migrating upstream can be injured, or killed, by attempting to swim through or falling back from, the project bypass reach which has minimal water depth as well as fractured bedrock substrate with moderate to high water velocities. Additionally, fish can become stranded in pools below the dam or entrapped in water collection systems subsequent to their release from the fish elevator, upstream of the dam. For example, in 1998, 28 shortnose sturgeon

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were observed to move upstream to Holyoke Dam between July 27 and August 3. Thirty-nine percent of those entered the fish lift (n=11); 54% were captured in apron pools (n=15); and 7% (n=2) were stranded in the west spillway pool (Kynard et al. 1999c). Only 2 of the 28 fish were released directly into the fish lift flume and the remainder that were passed upstream were driven 7 km upstream to Brunnelle's Marina to alleviate potential mortality in the flume. The majority of the fish reaching the dam were found to have sustained injuries to their snout, ventral fins and ventral scute. These injuries were likely sustained during the upstream migration through the shallow rocky approach to the dam (Kynard et al. 1999a).

Fish that have been lifted or displaced above Holyoke Dam have been documented to either return downstream, move to overwintering sites upstream, or move to spawning sites at Montague. An analysis of fish displaced over Holyoke Dam from 1993 to 1995 revealed that 25% continued to move upstream to spawning grounds and 33% moved back downstream. Managers have been concerned with shortnose sturgeon migrations, given the difficulties with upstream passage and the level of documented mortality associated with downstream passage.

Studies have documented the number of shortnose sturgeon that die below Holyoke Dam since evaluations began in 1992. A 1999 study by Kynard, Kieffer and Burlingame supported previous observations that (1) most movement of shortnose sturgeon downstream of Holyoke Dam occurs during high water periods, (2) some upstream adults move downstream of the dam, (3) some lifted adults remain above the dam for years, others return downstream within a year without spawning, and (4) a high percentage of the adults passing downstream of Holyoke Dam are killed. Confirmed or suspected mortalities during downstream passage include 1 fish in 1988; 1 fish in 1990; 1 in 1992; 2 in 1994; 1 in 1995; 2 in 1996; 1 in 1997; 7 in 1998; and 4 in 1999. This probably significantly underestimates the number of shortnose sturgeon killed in association with the dam because it is only based on sturgeon that had been tagged and tracked.

Specifically, in 1998 and 1999, 21 radio tagged shortnose sturgeon were tracked to points downstream of Holyoke Dam (via Hadley Falls Station or the Canal System). Fifty-two percent of these fish died, and many of the fish that survived sustained external injuries ranging from broken fins to cleft snouts to damaged scutes (Kynard et al. 1999c). Eight of the 11 fish that died in 1998 and 1999 passed through Hadley Falls Station (Kynard et al. 1999a).

The best available scientific data indicate that the existing Holyoke Project has artificially divided the Connecticut River population of shortnose sturgeon. Safe, effective, and efficient upstream and downstream passage has not been provided at the Holyoke Project for its 150 years of existence and the absence of such passage has prevented the recovery and reduced the genetic integrity of shortnose sturgeon in the Connecticut River.

Other past impacts of the Holyoke Dam include stranding shortnose sturgeon in pools below the dam. Ledges at the base of the spillway make it difficult for fish to pass upstream, especially in low flow conditions. In the past few years, attempts have been made to find and remove sturgeon stranded in pools when the fish lift ceased operating for the season. In 1990, 3 sturgeon were rescued from the pools, 4 sturgeon were rescued in 1996, 17 in 1998, and 37 in 1999. Without active efforts to remove these sturgeon and relocate them, they likely would have died

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due to increased temperatures and decreased dissolved oxygen. Many of the sturgeon rescued possessed heavy abrasions. Two shortnose sturgeon were stranded in the apron pool below the dam in 2002. These fish were removed and released into the mainstem river unharmed.

In addition to its effects on migration, the operation of the Holyoke Dam has other impacts. Shortnose sturgeon can be impacted by typical flow fluctuations as a result of past peaking and pulsing operations, elevated turbidity levels as a result of erosion generated by abnormal flow fluctuations, reduction of water velocity within the impoundment, and the degradation of riverine aquatic habitat both above and below the dam. These factors can also restrict effective migration by making the water conditions less suitable for shortnose sturgeon passage.

Impacts of Non-Federally Regulated Actions

Non-Federally Regulated Fishery Operations

Shortnose sturgeon are taken incidentally in anadromous fisheries along the East coast and may be targeted by poachers (NOAA Fisheries 1998). It has been estimated that approximately 20 shortnose sturgeon are killed each year in the commercial shad fishery and an additional number are also likely taken in recreational fisheries (T. Savoy pers. comm. in NOAA Fisheries 1998). Shortnose sturgeon have also been incidentally caught by recreational or commercial fishers, as seen in the Connecticut River shad fishery, and could be subject to poaching. Due to a lack of reporting, no information on the number of shortnose sturgeon caught and released or killed in commercial or recreational fisheries on the Connecticut River is available.

Impacts of Other Potential Sources of Impacts in the Action Area

Scientific Studies

Previous research projects conducted in the Connecticut River since 1976 may have influenced shortnose sturgeon survival, reproduction and/or migration. Research projects conducted in the action area included, but were not limited to, capturing, measuring, weighing, tagging (internal and external) and obtaining eggs from shortnose sturgeon. Currently, two ongoing research projects are permitted by NOAA Fisheries. Both Dr. Boyd Kynard (USGS) and Mr. Tom Savoy (Connecticut Department of Environmental Protection) possess ESA Section 10(a)(1)(A) Permits to conduct scientific research on shortnose sturgeon in the Connecticut River. Both researchers have been conducting research in the Connecticut River for several years.

Dr. Kynard's current permit (No. 1239) authorizes him to take annually, for a period of five years, from the Connecticut River: 200 eggs, embryos and larvae (lethal take); 275 adult and large juveniles (capture, PIT tag and release); 25 adult and large juvenile (capture, PIT tag, internal radio tag and release); 1000 pre-spawned eggs (lethal take); 10 prespawning adults (capture, maintain in lab, release after experiments); and 20 pre-spawned adults (capture, radio tag, release). All of Dr. Kynard's work is to be conducted above the Holyoke Dam with the exception of the take of the 10 prespawning adults which are to be taken from below the Holyoke Dam. Dr. Kynard's permit specifies that indirect mortalities associated with research activities must not exceed five shortnose sturgeon within the five year period of the permit; and no more than two shortnose sturgeon in any one year. Dr. Kynard reported two mortalities in 2002.

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Mr. Savoy's current permit (No. 1247) authorizes him to take annually, for a period of five years, from the Connecticut River: 100 juveniles (capture, tag, release); 400 adults (capture, tag, release, stomach sampling); 25 adult and large juveniles (capture, sonic/radio tag, release); 150 larvae (lethal take); 150 eggs (lethal take). Dr. Savoy's permit specifies that indirect mortalities associated with research activities must not exceed five shortnose sturgeon within the five year period of the permit; and no more than two shortnose sturgeon in any one year. Dr. Savoy's permit is only for activities below the Holyoke Dam. Under previous research permits, Dr. Savoy has had 13 mortalities, all due to mortality in gill nets.

Impacts of Contaminants and Water Quality

Heavy usage of the Connecticut River and development along the waterfront has likely affected shortnose sturgeon throughout the action area. Coastal development and/or construction sites often result in excessive water turbidity, which could influence sturgeon spawning and/or foraging ability. Industries along the Connecticut River include or have included in the past, hydroelectric and other energy generating facilities, an armory, firearms factory, industrial mills and various other industrial pursuits. A 2004 cleanup of the river organized by the Connecticut River Watershed Council (CRWC) provides evidence of the highly polluted state of the Connecticut River. This cleanup collected approximately 42 tons of trash from the river including: propane tanks, car and boat parts, containers of motor oil and antifreeze as well as various other large and small items. The cleanup also observed but could not remove two heating oil tanks, three cars and three boats. Many of these items likely leak chemical waste into the river. The effect of trash and general pollution on shortnose sturgeon in the Connecticut River is unknown. While water quality has improved in the Connecticut River, previous pollution levels have led to historic dissolved oxygen levels as low as 2-4mg/L and the designation of the river by some environmental groups as "the best landscaped sewer in America" (Savoy, in press).

Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which contain elevated temperatures or high biological demand, can reduce dissolved oxygen levels. Shortnose sturgeon are known to be adversely affected by low oxygen levels (below 5 mg/L). Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28°C (Flourney *et al.*1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal. Point source discharge (i.e., municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality and may also impact the health of sturgeon populations. The compounds associated with discharges can alter the pH of receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival.

The New England Interstate Water Pollution Control Commission issued a report in early 1998 on water quality threats. This report indicated that the Connecticut River had several major water quality issues. These included: toxins, such as PCBs; combined sewer overflows (CSOs) which can cause poor water quality conditions in urban areas after storm events; and non-point

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source pollution. All four of the states with Connecticut River waters have public health advisories regarding the consumption of fish caught in the river (MA: PCBs, CT: mercury and PCBs). The Connecticut River Watershed Council (CRWC) has also identified acid rain and atmospheric deposition of mercury and other contaminants as a problem throughout the watershed.

Coal tar deposits released in the Connecticut River have likely affected spawning success, egg survival and/or larval development. Coal tar contains toxic Polycyclic Aromatic Hydrocarbons (PAHs) that are known to be carcinogenic. Other pollutants in the Connecticut River, such as polychlorinated biphenyls (PCBs), could affect shortnose sturgeon reproduction as well. In the Connecticut River, coal tar leachate was suspected of impairing sturgeon reproductive success. Kocan (1993) conducted a laboratory study to investigate the survival of sturgeon eggs and larvae exposed to PAHs, a by-product of coal distillation. Only approximately 5% of sturgeon embryos and larvae survived after 18 days of exposure to Connecticut River coal-tar (i.e., PAH) demonstrating that contaminated sediment is toxic to shortnose sturgeon embryos and larvae under laboratory exposure conditions (NOAA Fisheries 1998). There are several known coal tar contaminated sites below the Holyoke Dam that have only recently begun to be cleaned up. It is likely that these sites as well as any others have had adverse effects on any shortnose sturgeon present in the action area over the years.

Impacts of Invasive Species

A number of invasive species are known to exist in the watershed. These species have been inadvertently and purposefully introduced to the Connecticut River watershed by humans. These include common reed, purple loosestrife, Eurasian milfoil, water chestnut, mute swans, Asiatic clams, and wooly adelgids. The potential for these species to affect shortnose sturgeon is currently unknown.

Impacts of Dams, Hydroelectric and Other Power Plants

The presence of other dams on the Connecticut River could effect shortnose sturgeon migration. There are 16 dams upstream of the Holyoke Dam on the river's mainstem, and one breached structure downstream of Holyoke. The Enfield Dam was constructed in 1902 and is located at rkm 110, downstream from the Holyoke Dam. It is a 1.7 meter canal wing dam which may impede the movement of upstream migrating shortnose sturgeon during periods of extreme low water (Buckley 1982; Buckley and Kynard 1983). The dam was breached in 1977 and is currently passable to fish in at least four locations. Historical information documents the migration of adult shortnose sturgeon upstream past the Enfield Rapids and the dam as far back as 1912, well before the breaches occurred (Eastman 1912). Historical information also suggests that the Enfield Dam never functioned as a permanent barrier, but rather as a seasonal impediment to the upstream movement of shortnose sturgeon. The Holyoke Dam is the first barrier to migratory fish on the mainstem Connecticut River.

The presence of a dam, alone, alters the natural flow fluctuations of a river. Changes in the natural flows and natural flow fluctuations are a result of how a dam is operated. The upstream

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Turners Falls and Deerfield River Projects are peaking projects[4] and control flows to the Holyoke impoundment to some extent. Turners Falls is located approximately 35 miles upstream of the Holyoke Dam on the mainstem Connecticut River and has a hydraulic capacity of up to 15,000 cfs. The present Turners Falls Dam, canal and a small power station were licensed in 1889. The dam diverts the mainstem into a 3.5-km long power canal that supplies water to Cabot Station, a hydroelectric generating facility built in 1920. Cabot Station has six Francis turbines with a generation capacity of 51 MW at 368 m^3/s flow, a 50-m wide spillway, a modified Ice Harbor fish ladder, and a bypass flume. During periods of high discharge that exceed Cabot Station's generating capacity (about 400m^3/s), water spills over Turners Falls Dam into the natural river bed that leads to the Rock Dam. In spring, as discharge decreases, most river flow is diverted into the power canal and spillage ceases at Turners Falls Dam. When the dam controls all river flow, Cabot Station generates in peaking mode with low generation during hours of low demand and high generation and discharge during peak demand. Flows passing through Turners Falls from the pump storage operations at Northfield Mountain are responsible for most of the flows to the Holyoke Project. Located 30 miles upstream of the Holyoke Dam on the Deerfield River, the Deerfield River Project also contributes to the variations in daily and hourly inflows to the Holyoke Project, although to a lesser extent than the other projects.

As a result of fluctuating downstream flows, the Holyoke, Turner Falls, and Deerfield River Projects likely have influenced shortnose sturgeon spawning patterns, degraded reproductive habitat or elevated turbidity levels, impairing shortnose sturgeon movement in the Connecticut River. High river flows during the normal shortnose sturgeon spawning period can cause unacceptably fast bottom water velocities and prevent females from spawning. This situation was observed in the Connecticut River in early May of 1983 and 1992 when flows were higher than normal and temperatures were lower than normal, but still adequate for spawning (Buckley and Kynard 1985, Kynard 1997). Buckley and Kynard (1985) and Kieffer and Kynard (in press) speculated that the reproductive rhythm of females may be under endogenous control and suitable river conditions must be available or endogenous factors prevent females from spawning. Thus, reproductive success depends on suitable river conditions during the spawning season, and human interactions causing habitat flow modifications could alter these natural river conditions, thus affecting spawning success. Dewatering events while females are spawning at Rock Dam have been documented to terminate spawning (Kieffer and Kynard in press) and flow regulation at Rock Dam makes spawning of shortnose sturgeon at this site impossible in most years. Regular operation of Turners Falls Dam and Cabot Station introduce shifts in discharge and velocity that have deleterious effects on shortnose sturgeon spawning success. Operations at Cabot Station during years of low discharge may significantly reduce survival of eggs and embryos. When there is a no-flow period, spawning substrate can be de-watered, probably killing eggs and embryos.

Regulation of the Connecticut River creates unnatural discharge regimes that affect the spawning of females and survival of early life stages. There are a series of Army Corps of Engineer's (ACOE) dams on tributaries located upstream of Montague. These dams are used to control floods and as spring river discharge decrease, the ponded waters in the dams is released. This

4 A peaking facility is a power-generating plant that only operates during the maximum load periods (i.e., the times when energy demand is at its peak). This results in greater fluctuations in daily and seasonal dam operation and flow rates.

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extends the cool, high-discharge period beyond natural conditions. The extension of this discharge for even a week is likely sufficient to close the discharge window and cause spawning failure (Kieffer and Kynard in press).

Impingement of shortnose sturgeon on power plant cooling water intake screens may also have contributed to sturgeon mortality in the Connecticut River. This is likely to be a problem at facilities with screens with larger mesh sizes and high water velocities. Mortalities were thought to be high at the Connecticut Yankee nuclear power plant; however, this plant has not been operational since 1996 and decommissioning was completed in 2003.

Summary and Synthesis of the Status of the Species and Environmental Baseline

In summary, the potential for activities described above that may have previously impacted listed species to affect shortnose sturgeon remains throughout the action area of this consultation. As described in the subsection "Status of Shortnose Sturgeon in the Connecticut River," which is incorporated by reference here, and the Environmental Baseline, shortnose sturgeon and their habitat in the Connecticut River have been affected by several different factors including: impaired water quality from both point and non-point sources; incidental take in scientific studies and commercial and recreational fisheries; construction and demolition of bridges; dredging activities; and, the operation of hydroelectric and other dams and electric generating facilities. While over 1000 shortnose sturgeon likely inhabit the Connecticut River, this number is far below the expected carrying capacity of this river without anthropogenic impacts on this river system (1000s to 10,000). While the most recent population estimates suggest that the population is stable, and perhaps slowly increasing (Savoy in press), this population still faces numerous threats in this river system (see pp. 24-29 "status of shortnose sturgeon in the Connecticut River").

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EFFECTS OF THE PROPOSED ACTION

This section of a biological opinion assesses the direct and indirect effects of the proposed action on threatened or endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. This biological opinion examines the likely effects (direct and indirect) of the proposed action on the shortnose sturgeon in the Connecticut River and their habitat within the context of the species' current status, the environmental baseline, and cumulative effects.

The biology of shortnose sturgeon complicates the assessment of shortnose sturgeon movement and impacts to the species, as these fish have a long life span, delayed sexual maturity and non-annual spawning behavior (Buckley and Kynard 1985). Migration patterns that are observed during one year are not always seen in consecutive years because mature adults will not return to the spawning site each year. Radio-tagging studies give an excellent overview of shortnose sturgeon patterns, but these studies only provide data on a small percentage of animals and are not representative of all age-classes or both sexes of the shortnose sturgeon population.

Regardless, recent data have provided a better assessment of shortnose sturgeon in the Connecticut River than ever before.

The 1998 Shortnose Sturgeon Recovery Plan outlines the current status of the species as well as the major threats to the species' survival. As noted above and in the Recovery Plan, hydroelectric dams may affect shortnose sturgeon by restricting and degrading habitat, altering river flows or temperatures necessary for successful spawning and/or migration, reducing water velocity within the impoundment, and causing mortality to fish that become entrained in turbines. An inability to safely move below dams and use potentially beneficial habitats may restrict population growth. Evidence from the Connecticut River (Kynard 1997) and the Cape Fear River (Moser and Ross 1995) suggests that pre-spawning adults may move to the dam at a time when fish lifts or locks are not operating, making it impossible for these adults to migrate to upstream spawning areas. Since sturgeon require adequate river flows and water temperatures for spawning, any alterations that dam operations pose on a river's natural flow pattern, including increased or reduced discharges, can be detrimental to sturgeon reproductive success. Additionally, dam maintenance activities, such as minor excavations along the shore, release silt and other fine river sediments that could be deposited in nearby spawning sites and degrade important habitat. The impacts of this physical barrier on shortnose sturgeon populations must be considered when determining the best method to protect and recover this species.

The Shortnose Sturgeon Recovery Plan outlines several task priorities for each population of shortnose sturgeon. The highest recovery priorities for the Connecticut River population include the following: insure that proposed structures provide passage; identify movement patterns and eliminate barriers to movement; and restore flows and spawning substrate. These recovery priorities are directly linked to the existence of the Holyoke Project and effectiveness of the fishways.

Downstream Passage

Based on known information, there are three potential means for shortnose sturgeon to achieve downstream passage: through the Kaplan turbines, over the dam or through the Bascule Gate, and through the canal bypass facility. Like other diadromous fish species, the migration of shortnose sturgeon can be characterized by directed and sustained movement over large distances. Consequently, this category of fishes has adapted behavioral mechanisms which allow it to make the most efficient use of energy. One such adaptation is the use of the dominant flow pattern in a riverine environment (the area of maximum water flow and depth). As such, it is likely that downstream migrating shortnose sturgeon will follow one of two routes to bypass the hydroelectric project under normal project operating conditions: use of generation flows into project turbines when the river stage is low or moderate, and utilization of spillage over the dam or Bascule Gate (if open) when the river stage is above average or high. The survivability of these passage routes is likely low. The other likely passage route is in the channel that runs near the bank of the river closest to the Hadley Falls station. Preliminary computational fluid dynamics (CFD) modeling has demonstrated that a large volume and velocity of water runs through the channel and enters the canal bypass. Shortnose sturgeon traveling in the channel should be diverted into the canal bypass facility. The full depth louvers are designed to guide these fish into the bypass pipe where they are transported below the dam. The Settlement

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contains provisions that HG&E shall "install, operate and maintain downstream fish passage facilities for diadromous...fish...that safely and successfully pass the fish without injury or significant impairment to behavioral patterns." Radio tracking studies completed in 1998 and 1999 highlight the severity of the impact of the lack of safe downstream passage on shortnose sturgeon. These studies estimated that approximately 52% of shortnose sturgeon adults attempting to pass downstream of the dam are killed. This study also attempted to estimate the number of shortnose sturgeon that are expected to migrate downstream each year. The researchers indicated that the number of adults passing downstream varies annually from 0 to 90, with a mean of 31 (Kynard et al. 1999c). While no studies have examined the success of downstream migrating juvenile shortnose sturgeon, the effects are likely to be similar; with perhaps slightly fewer being killed by passing through the turbines as smaller fish may be better able to pass through that system.

Passage through the turbines

Mortality rates of juvenile fish passing through Kaplan units, such as the units at the Holyoke Power Project, are usually lower than that of Francis turbine units. Additionally, the mortality rates for fish which pass through Kaplan units are not positively correlated to the operating head or peripheral runner velocity, as they are with Francis turbine units (Eicher 1987). However, if one has knowledge of the flow pattern where the water enters the top of the runner, the probability of a turbine strike can be estimated. This is possible because most migratory fish will align their body's axis with the absolute velocity component (a constant parameter). Under this scenario, the probability of a strike will vary with the radius of the runner, increasing as the fish moves away from the center hub. This is particularly important when considering the possibility of turbine injury or mortality to a benthic fish such as sturgeon, because a fish which passes through the lower parts of the wicket gates, as a primarily benthic oriented fish might do, will migrate further from the hub and have a higher probability of mechanical injury or mortality. Consequently, how a fish species is distributed vertically as they pass through the wicket gates and into the runner blade, may ultimately determine the survivability of the entrained fish.

The current trashracks likely do not act as a behavioral barrier to minimize entrainment. As indicated above, during the 1998 and 1999 evaluation of shortnose sturgeon movement, researchers recorded the fate of 21 radio-tagged shortnose sturgeon adults that migrated downstream past the Holyoke Project. Over half of these individuals were either remotely or manually tracked just upstream and in the forebay of the station. Of the 8 internally tagged (in the abdomen) fish tracked into the generating station, 7 exited via the tailrace and were characterized as "immobile." For these internally tagged fish to be characterized as such, both the fish and the tag would have to have been damaged during the passage event. The last fish's signal was terminated (stopped transmitting) during its passage. All 8 fish that were tracked through Hadley Falls Station into the tailrace were killed (representing 38% of the 21 downstream migrating fish). The physical characteristics of 6 of these tagged fish were documented prior to passage through the facility. They were all grown adults ranging from 82 to 125 cm in length and 6.3 to 11.8 kg in weight, and they were all able to enter the station despite the full depth 5 inch trashrack overlays at the project intakes. Based on this information, all shortnose sturgeon that attempt to move downstream by passing through the turbines are likely to be killed. Based on the estimate that on average 31 shortnose sturgeon currently attempt to pass

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downstream of the dam each year, NOAA Fisheries anticipates that 12 shortnose sturgeon (i.e., 38% of 31) will be killed through entrainment in the turbines each year until modifications are made to prevent entrainment.

The March 2004 Settlement Agreement and proposed license articles contain several requirements to prevent entrainment in the turbines. HG&E will conduct CFD modeling in 2004 of the Hadley Falls intakes to evaluate the potential of modifying the existing Hadley Falls intake racks to be an effective interim, and potentially long-term, device to prevent entrainment and impingement of fish at the Hadley Falls intakes. Also in 2004, HG&E will complete a flume study at the USGS facility to evaluate the swimming depth and behavior of yearling, juvenile and adult shortnose sturgeon at a bar rack structure, to determine the threshold velocity for avoidance of impingement/entrainment of yearling, juvenile and adult shortnose sturgeon at conditions present at the proposed modified intake racks with 2-inch spacing and to determine if shortnose sturgeon can avoid impingement/entrainment at conditions present at a potential alternative bar rack with 2-inch spacing and velocities of 2 feet-per-second (fps). These studies will allow HG&E to determine if the existing intake racks can be modified in such a way to prevent entrainment of sturgeon in the turbines (i.e., prevent sturgeon from entering the turbines) while also preventing impingement on the racks. If these studies indicate that the existing racks can be modified and other conditions have been met relating to the Bascule Gate and the spillway (see below), HG&E shall install and construct a device by the end of 2006 that prevents entrainment and impingement at the Hadley Falls intakes. If this device proves not to be effective, HG&E shall design, engineer and permit an alternative exclusion device in 2008 with construction completed in 2009. If the CFD modeling and flume studies indicate that modifications to the existing racks will not be sufficient to prevent entrainment and impingement of shortnose sturgeon at the intakes, in 2007 HG&E will design, engineer and permit an alternative device that will not only exclude fish from the Hadley Falls intakes without impingement, but will also provide for safe and successful downstream passage. This device is expected to be a means to more efficiently divert fish to the canal bypass facility or provide an equivalent (i.e., at least 90%) level of guidance. This device would be constructed in 2008 and be operational prior to April 1, 2009. The installation of a device that is successful at preventing entrainment in the turbines is expected to reduce downstream passage mortality rates by 73% (representing the percentage of shortnose sturgeon that die going downstream as a result of passage through the turbines) as this device will not be determined to be successful if any shortnose sturgeon are entrained in the turbines. By eliminating the potential for entrainment in the turbines, this source of mortality will be eliminated. However, this source of mortality will continue through at least 2006 and possibly through 2009, depending on the success of the interim modifications to the existing racks.

Passage through the canal bypass facility

The third downstream passage option available for shortnose sturgeon is diversion into the canal bypass facility. Shortnose sturgeon entering this facility are guided into the bypass pipe by a full depth louver array and a wedge-wire ramp. Clear spacing between the louver slats is two inches, presenting a physical barrier to larger fish and a behavioral barrier to smaller fish. A trash rake is operational to remove debris from the louver structure. Flume studies conducted in 2000 at Alden Laboratory (Amaral et. al 2001), determined that shortnose sturgeon can be effectively

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guided by a 15-degree full-depth louver array, such as the one operational in the canal bypass. This study indicated that guidance efficiencies for shortnose sturgeon were over 90%. Based on this information it is expected that at least 90% of the shortnose sturgeon that enter the canal bypass area will ultimately enter the bypass pipe. The louver array will prevent shortnose sturgeon from entering the canal system and the exclusion device installed (in 2002) at the attraction water entrance gate will prevent shortnose sturgeon from being passed into the attraction water system, where mortality rates were high (estimated at an average of 2 shortnose sturgeon per year). Additional studies required by the Settlement (see below) require HG&E to assess the effectiveness of the louver facility to guide shortnose sturgeon in the field and confirm that guidance efficiency is at least 90%. This information will provide a more accurate estimation of the percentage of shortnose sturgeon expected to be guided safely downstream by this facility. Based on the currently available information, it is expected that 90% of shortnose sturgeon entering the bypass canal will be passed safely downstream, leaving 10% to either seek an alternative means of passage (i.e., over the dam or through the Bascule Gate) or abandon the passage attempt.

Before all modifications are made, 17 shortnose sturgeon (55% of the 31 expected to pass downstream) per year are likely to pass below the dam through the canal bypass facility[5]. After all modifications are made and shortnose sturgeon are passing upstream of the dam, this number is expected to increase to at least 315 shortnose sturgeon (90% of an expected 350 downstream migrants) annually.

The bypass pipe has a three-foot diameter and carries water from upstream of the dam to the downstream sampling station and then into the tailrace. Conditions inside the bypass pipe are sufficient to protect shortnose sturgeon from mortality and injury; however during lower flow conditions it is possible that shortnose sturgeon may experience abrasions from rubbing against the pipe.

During certain times of year (typically April 1 – July 15 and September 15 – November 15), the downstream fish sampling facility is operational and shortnose sturgeon and any shortnose sturgeon using the bypass facility will enter this facility. As currently configured, shortnose sturgeon are sluiced along the wedge wire screen into the existing 1-ft 6-inch trough and then onto the sampling table. In its present state, the trough is not wide enough for larger adult shortnose sturgeon to maneuver the trough safely, and it is likely that these larger fish will be injured if they hit the backside of the steel trough. To minimize the potential for injury to large shortnose sturgeon, HG&E shall increase the width of the steel trough at the end of the wedge wire screen ramp of the downstream sampling facility by approximately one foot. In addition, a rubber lining will be placed on the facing of the end wall of the trough to cushion any impact that the fish may experience when entering the trough. The potential for injury or mortality to shortnose sturgeon also exists if shortnose sturgeon are left on the sampling table for any length of time as the water is very shallow and is likely to quickly warm and have low dissolved oxygen levels. In order to prevent this source of injury and/or mortality, HG&E must not operate the sampling station when personnel are not present to handle fish. Any shortnose sturgeon caught

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5 This number is calculated by subtracting the number of fish likely to pass through the turbines (38% or 12 fish) and the number of fish likely to pass over the dam or through the bascule gate (7% or 2 fish).

at the sampling station will be immediately transferred to permanent concrete holding tanks located at the fish sampler to hold fish until they can be checked for tags or injuries. Since the holding tank has flow through water, sturgeon can be safely held up to 12 hours. A net will be placed in the bottom of the tank and act as a false bottom so fish can be easily and safely removed from the tank. This protocol (see Appendix B and Appendix C) is expected to eliminate the potential for mortality of shortnose sturgeon at the sampling station. The number of shortnose sturgeon that will be affected by handling at the sampling station is dependent on the number that pass while the sampling station is open. Before modifications to upstream and downstream passage are completed (i.e., before 2010), depending on the time of year when shortnose sturgeon pass downstream of the dam, up to 17 shortnose sturgeon (55% of downstream migrants) may be affected by the operation of the sampling station. After modifications to upstream and downstream passage are completed (i.e., 2010 and beyond), depending on the time of year when shortnose sturgeon pass downstream of the dam, up to 315 shortnose sturgeon (90% of downstream migrants) may be affected by the operation of the sampling station.

Pursuant to proposed Article 410, HG&E will evaluate the modifications to the Downstream Sampling Facility. The modifications will be evaluated through observation and records of the condition of any shortnose sturgeon found at the Downstream Sampling Facility. For each occurrence, the condition and other physical and biological parameters will be recorded on observation sheets (see Appendix C). While this will require the handling of shortnose sturgeon, the handling time is expected to be minimal and no injury or mortality is expected as a result of this requirement.

When the sampling station is not operational, the bypass pipe releases fish directly into the tailrace. During levels of high water this drop likely occurs with minimal potential for injury to shortnose sturgeon as sturgeon are dropped perpendicular to water flow which will minimize the impact of the drop. However, during lower water levels, the height of the drop can be quite high increasing the likelihood of injury and/or mortality from the impact of hitting the water from a considerable distance. The rate of injury from this aspect of the project is unknown. To assess this impact, HG&E is required to conduct field studies (see below) to determine the impacts of the drop on downstream migrating shortnose sturgeon. If it is determined that it is necessary to reduce the height of the drop from the discharge pipe to the tailrace to enhance the survival or reduce injury to shortnose sturgeon, HG&E will make such modifications by 2006. Thus, by 2006 this source of injury is expected to be eliminated or greatly reduced. As there has been no evidence of other fish species being killed as a result of this drop, no shortnose sturgeon are expected to die as a result of the drop, however the potential for injury may exist.
Compared to the other two options for downstream passage, the best available information suggests that passage through the canal bypass system is the safest means of passage for downstream migrating shortnose sturgeon. As indicated above, downstream migrating shortnose sturgeon are expected to migrate with the flow. In order to increase the number of downstream migrating shortnose sturgeon entering the bypass facility in the fall months, HG&E will change flow prioritization from the Hadley Falls units to the Canal during nighttime periods from October 1 through the time when the river temperature reaches 5°C or November 30, when any downstream movements are expected to be completed. This operational change is expected to

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reduce the number of shortnose sturgeon becoming entrained in the Hadley Falls intakes and to increase the number of shortnose sturgeon safely passing downstream of the dam in October and November through the bypass pipe.

In addition, the alternative exclusion and guidance devices contemplated in the plans for downstream passage as means to reduce entrainment and to reduce the number of sturgeon passing through the Bascule Gate or over the dam, are likely to result in an increased number of fish entering the bypass facility. While this may increase the number of fish experiencing injury as a result of passage in the pipe or upon exiting into the tailrace, the severity of these injuries is expected to be significantly less than those experienced by fish entrained in the turbines or going over the spillway. As the mortality rate of shortnose sturgeon entrained in the turbines is 100% and the mortality rate of sturgeon passing in the spillway is also high, the diversion of sturgeon into the bypass pipe facility is expected to greatly reduce the mortality rate of downstream migrating shortnose sturgeon. However, the best available information suggests that in a lab setting, guidance with the louver facility is expected to be 90%. If guidance in the field is at least this high, there will still be some percentage (10%) of shortnose sturgeon that are not guided into the canal bypass. These fish will either abandon the downstream passage attempt or seek an alternate passage route (i.e., pass over the dam or through the Bascule Gate). Based on the best available information, before modifications to upstream and downstream passage are completed (i.e., before 2010), up to 17 shortnose sturgeon may utilize the bypass canal. After modifications to upstream and downstream passage are completed (i.e., 2010 and beyond), up to 315 shortnose sturgeon may utilize the bypass canal.

Passage over the Dam or through the Bascule Gate

Shortnose sturgeon that pass over the dam or through the Bascule Gate are likely to experience injury and/or mortality as the impact of the drop can be significant. Sturgeon are vulnerable to hitting the concrete apron of the dam and suffering injury or mortality as a result from this. Based on the 1998 and 1999 tracking studies, it has been estimated that of the sturgeon that die when migrating downstream, 27% of mortality (7% of downstream migrating fish) occurs from either going over the dam/through the Bascule Gate or through the canal system. The most effective solution to this problem is to divert fish away from the spillway and Bascule Gate and through the canal (see below). However, it is likely that any diversion system will not eliminate the potential for sturgeon to pass over the dam or through the Bascule Gate, especially during high flow events. In order to determine what solutions exist to mitigate this problem, in 2005 HG&E will conduct an analysis to evaluate the feasibility of using/modifying the Bascule Gate and/or modifying the spillway in the vicinity of Rubber Dam Section No. 5 (adjacent to the Bascule Gate) to pass shortnose sturgeon and to investigate modifications of these facilities to safely and successfully pass fish down the spillway and over the apron without injury or significant impairment to essential behavioral patterns. If this analysis indicates that there is a feasible method for modifying the Bascule Gate to safely and successfully pass fish down the spillway and over the apron and other conditions have been met regarding modifications to the existing intake rack (see above), HG&E shall prepare a functional design drawing of the selected option to modify the Bascule Gate for safely and successfully passing fish without injury or significant impairment to essential behavioral patterns and will build a prototype and conduct field testing in 2006, with engineering/permitting in 2007 and construction in 2008. Also in

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2008 HG&E will design, engineer and permit an alternative passage device in the vicinity of Rubber Dam Section No. 5, with construction completed in 2009 and operation commenced prior to April 1, 2010. If it is determined in 2005 that the required conditions have not been met, then in 2006 HG&E shall perform a full feasibility study of the options for an alternative passage device in the vicinity of Rubber Dam Section No. 5 to safely and successfully pass fish without injury or significant impairment to essential behavioral patterns and build a prototype and field test, if necessary. In 2007, HG&E shall bid, build and complete construction and the alternative passage device with construction in 2008 and operation commencing prior to April 1, 2009.

This source of mortality (i.e., 7% of downstream migrating fish) will continue to occur through at least 2008 and possibly through 2010, depending on the success of the interim modifications to the existing racks. Based on the estimate that on average 31 shortnose sturgeon currently attempt to pass downstream of the dam each year, NOAA Fisheries anticipates that 2 shortnose sturgeon (7% downstream migrants) will be killed by passing over the dam or through the bascule gate until this source of mortality is minimized.

The installation of a device that is successful at either preventing shortnose sturgeon from passing through the Bascule Gate or over the dam or that ensures safe and successful passage through this route or diverts fish to the canal bypass facility, is expected to reduce downstream passage mortality rates. It is unlikely, however, that this source of mortality will be eliminated completely as during high flow events, shortnose sturgeon are likely to still pass in the spill despite the existence of an alternative passage or diversion system. As noted above, based on the currently available information, it is expected that 90% of shortnose sturgeon entering the bypass canal will be passed safely downstream, leaving 10% to either seek an alternative means of passage or abandon the passage attempt. It is estimated that half of these fish will attempt to pass over the dam or through the bascule gate and that they will be killed during this passage attempt. As such, even after all modifications are complete (in 2010), up to 5% of the annual downstream migrants are likely to be killed by passing over the dam or through the Bascule Gate. Based on the assumption that all spawning fish (estimated at 25% of the total population or 350 fish) will seek to migrate downstream past the dam each year, up to 17 shortnose sturgeon are likely to be killed attempting to pass downstream of the dam each year.

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Denial of Access to Summer Foraging Habitat/Abandonment of Downstream Migration
In addition to the mortality and injury attributable to attempts at downstream passage, a lack of safe and successful downstream passage has negatively impacted the shortnose sturgeon in the Connecticut River by preventing many shortnose sturgeon from migrating past the dam from upstream overwintering or spawning sites to the more productive downstream foraging sites. The growth of individual shortnose sturgeon in the Connecticut River has been thought to be connected to the availability of downstream habitat and effective foraging. Dadswell et al. (1984) reviewed growth throughout the shortnose sturgeon's latitudinal range and found that fish grow faster in the south, but do not attain the larger size of northern fish. Adults upstream of the Holyoke Dam in the Connecticut River had the slowest growth of any group examined, perhaps because they are unable to use downstream estuarine foraging areas (NOAA Fisheries 1998). The estuarine foraging grounds of the lower Connecticut River provide nutrient and mineral resources that are not available in the upstream foraging area. In addition, there are multiple

foraging sites below the dam while there is only one suitable site above the dam. This likely makes competition for forage greater in the upriver segment further exacerbating the lack of suitable nutrient and mineral resources. Fish likely need to migrate downstream to lower river forage areas for optimum growth and development. Without effective passage around the Holyoke Project, this freedom of movement cannot be safely attained. It is expected that the improvements to downstream passage afforded by the Settlement Agreement will improve the ability of shortnose sturgeon to access the downstream foraging areas. This should have the effect of improving the size of shortnose sturgeon in the Connecticut River as more fish will have access to the mineral and nutrient resources of the downstream foraging sites. This may also improve spawning success as well nourished, healthier, larger fish may be more successful spawners. In addition, it has been hypothesized (Kieffer and Kynard, in press) that access to the downstream forage sites will decrease the spawning interval for females.

Based on the number of adult shortnose sturgeon known to exist above the dam (approximately 400), approximately 100 shortnose sturgeon should currently be attempting to pass downstream of the dam each year (all post-spawned adults). However, it has been estimated that on average, only 31 shortnose sturgeon pass downstream of the dam each year. This indicates that approximately 69 shortnose sturgeon per year either fail to attempt to pass downstream of the dam or abandon the downstream migration. While the exact cause of this is unknown, given the instinctual drive to go downstream and the lack of adequate forage resources above the dam, it is reasonable to assume that the failure to pass downstream is associated with the existence of the dam and the lack of safe and successful passage below the dam. Once the modifications are all made and safe and successful passage is available, approximately 350 shortnose sturgeon are expected to spawn above the dam and subsequently make a downstream migration to the estuarine foraging grounds. Based on a guidance efficiency of 90%, it is estimated that 315 of these shortnose sturgeon will be able to pass downstream of the dam safely and successfully. As indicated in sections above, 5% of the fish attempting to migrate downstream are expected to find an alternate route of passage (over the dam or through the Bascule Gate) and likely be killed in the passage attempt, and another 5% are likely to abandon the downstream passage attempt. Thus, the modifications are expected to reduce the number of shortnose sturgeon that fail to make the post-spawning downstream migration from 69% to 5%.

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Summary of Effects of the Dam on Downstream Passage

The Settlement Agreement requires the new or modified facilities and structures to be in place and operating by April 1, 2010. Depending on the implementation plan (i.e., Phase 2A or 2B) taken, current downstream passage methods may not change until that time. As such, over the next 6 years, based on previous estimates of mortality, 45% of downstream migrants are expected to be killed. Based on an average of 31 migrants per year, it is likely that 84 shortnose sturgeon will be killed while attempting to migrate downstream of the dam over the next six years (2005-2009 downstream passage seasons). Effectiveness studies following the installation of the new downstream facilities will document future passage efficiency.

The most current available information and preliminary laboratory observations suggest that shortnose sturgeon have the ability to use a fishway device such as the ones described in the Settlement, if the device is specifically designed to accommodate the size, behavior and

swimming ability of the target species. Consequently, it is of significant importance that all research studies contemplated in the Settlement are carried out and the results incorporated into the ultimate design of any new devices or operational changes proposed at the dam. The best available information suggests that in a lab setting, guidance with the louver facility is expected to be 90%. If guidance in the field is at least this high, there will still be some percentage (10%) of shortnose sturgeon that are not guided into the canal bypass. These fish will either abandon the downstream passage attempt or seek an alternate passage route, likely to be passage over the dam or through the Bascule Gate.

Before modifications are made to ensure safe downstream passage, it is expected that 45% of downstream migrating shortnose sturgeon will be killed (estimated at 14 shortnose sturgeon a year out of an average of 31 downstream migrants). Once modifications are complete, this percentage will be reduced to 5%. However, once modifications to upstream passage are made, it is expected that the number of shortnose sturgeon attempting to migrate downstream past the dam will greatly increase. It is estimated that once modifications to the upstream passage facilities are complete, at least 350 shortnose sturgeon will attempt to pass downstream of the dam. As such, at that time, as many as 17 shortnose sturgeon may be killed each year during attempts at downstream passage.

Upstream Passage

While it was previously thought that the occurrence of shortnose sturgeon in the Holyoke fish lift was a rare random event, it is now believed that shortnose sturgeon migrate to the Holyoke Dam in the late spring to early fall, likely seeking passage to the upstream feeding and overwintering area (Kynard 1998). Individual fish have also been documented to return repeatedly to the base of the Holyoke Dam. It is believed that river discharge will trigger when fish choose to migrate upstream, enter the lift, or both. A 1998 study found that approximately 85% of the time, fish movement into the bypass reach ensued following a river discharge which exceeded 600 m^3/s (Kynard 1998). Further, no shortnose sturgeon entered the Holyoke fish lifts during the major migration period for anadromous fish in the spring of 1998 until a period of high river discharge occurred in mid-June (Kynard et al. 1999a).

Kynard et al. (1999c) and Vinogradov (1997) hypothesize that mature shortnose sturgeon do not stop at Holyoke Dam to overwinter before spawning at Holyoke in the spring, but that mature and immature fish stop because the dam blocks their migration to upriver foraging, wintering, and spawning areas. This research is consistent with more recent data collected by Kieffer and Kynard. The river reach at Holyoke consists of a rapids and is a route between concentration areas, not a summer foraging or wintering site like those used by shortnose sturgeon in other reaches of the Connecticut River (Kynard 1997 in Kynard et al. 1999c). Additionally, during years of high flow, sturgeon that overwinter at the Holyoke site need to expend a great amount of energy to maintain their position and may not have the necessary reserve to make the spawning migration in the spring. Since shortnose sturgeon do not spawn every year, a delay could result in not just one missed opportunity, but multiple years of missed opportunities. Therefore, it is imperative that fish are able to easily migrate upstream to suitable spawning habitat to complete their life cycle by spawning.

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Fish passage upstream of the Holyoke Project has been provided by two fish lifts: one in the spillway and one in the tailrace. The entrance to the spillway fish lift is located in 2 meters of water and is directly below the trash spill gate. Fish that are lifted at the tailrace or spillway enter a common flume at the level of the head pond and are guided to an exit route upstream of the dam. During this exit, fish swim by the flume window and are identified visually. It is felt that identification of shortnose sturgeon is fairly accurate due to their unique body shape. The fish lifts are currently operated from April 15-July 14 and September 16-November 15. The Settlement includes provisions to require that the fish lifts be operational between July 15 and September 15 if deemed necessary for the upstream passage of shortnose sturgeon. Due to the lack of safe downstream passage facilities and the expected high mortality of downstream migrating shortnose sturgeon, any sturgeon captured in the fish lift are currently returned downstream of the dam.

Unusually high river flows in August of 1996 triggered a request to operate the spillway fish lift for Atlantic salmon. During the operation of the lift, 18 shortnose sturgeon were intercepted and tagged at the Holyoke Project. It was initially believed that this was an atypical event. However, the capture of shortnose sturgeon in the apron pools during 1996, 1998 (n=28), and 1999 (n=37), supports the conclusion that many migrants that reach the dam are not lifted (Kynard et al. 1999c) either because the fishway is not operating, or the fish cannot successfully navigate the fishway entrances. This provides evidence that the fish lift will need to be operational during the July 15 – September 15 time period in order to provide passage for shortnose sturgeon.

The lack of successful upstream passage of shortnose sturgeon is highlighted by the low numbers of shortnose sturgeon that have been captured in the fish lift since it became operational in 1975. Information is only available through 2002; however a total of only 112 shortnose sturgeon have entered the fish lift in that time period. The number in the fish lift ranged from 0 in some years to up to 16 in 1996, with an average of 5 fish lifted per year. Based on the population estimate of shortnose sturgeon downstream of the dam, this is a small percentage of the number of shortnose sturgeon that likely attempt to pass upstream of the dam. In the spring and autumn lifting periods of 1982, 67 adults were estimated to be at the base of the dam in the spring with 4 passed and in the fall 45 adults were estimated to be present at the base of the dam and none were passed. In spring 1994, 112 were estimated at the base of the dam and only one was lifted. In spring 1995, 164 adults were present and only 1 was lifted. This information indicates that the current fish lift facilities are inefficient at attracting and lifting shortnose sturgeon over the dam.

Available information indicates that far more sturgeon use the spillway lift than the tailrace lift. The entrance to the tailrace lift is located in the upstream corner of the tailrace in approximately 13 meters of water. The turbulence in this area can be expected to affect the swimming efficiency and behavior of shortnose sturgeon. Shad have a hard time locating the entrance to the tailrace lift in the boil of the turbine discharge (Barry and Kynard 1986). The tailrace fish lift, when compared to the spillway fish lift, has a larger hopper and a higher constant discharge of water, but appears to be inefficient at attracting and lifting shortnose sturgeon (Kynard 1998). Tracking studies have indicated that sturgeon only enter the tailrace when the bypass reach is dewatered.

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Habitat-based flow requirements for the bypass reach have been incorporated into the Settlement agreement. The "zone of passage" (ZOP) flow sets forth the water surface elevations, velocities and depths for the upstream migration season. The release of permanent ZOP flows (1300cfs) during the upstream migration season will improve the potential for shortnose sturgeon to safely and successfully reach the fish lifts without injury or significant impairment to essential behavioral patterns.

Modifications have been made in an attempt to enhance the physical conditions for upstream migrating sturgeon. Shortnose sturgeon appear to have difficulty reaching the spillway lift entrance as they are not able to negotiate the shallow rocky environment. Because of their body and fin form, sturgeons cannot turn sharply and most have difficulty negotiating rapids, an activity that leaves fish with damaged ventral scutes. Laboratory observations at Conte Anadromous Fish Research Center strongly suggest that the bottom stop-log board located inside the entrance to the spillway fish lift is a barrier to many shortnose sturgeon that attempt to enter (Kynard et al. 1999a). This stop-log board was removed before the 1999 migratory period, but only 1 fish of 37 captured at the base of the dam (dam apron or spillway) entered the lift before it ceased to operate at the end of July. In the fall of 2001, approximately 350 cubic yards of bedrock were removed from the west side of the tailrace in the area adjacent to the tailrace lift entrance gallery. The lack of any observed improvement in fish lift efficiency since these improvements have been made indicates that the modifications made to date have not been sufficient to ensure that sturgeon appearing at the base of the dam are able to pass safely and successfully above the dam.

In the combined spring and fall lifting periods of 1982, only 3.6% of the fish were lifted as determined from the number of fish passed and abundance estimates of adults at the dam (4 out of 112). In the spring of 1994, only 0.89% of the fish below the dam were lifted (1 out of 112) while in the spring of 1995, 0.61% of the shortnose sturgeon were lifted upstream (1 out of 164). Further, from late June to early August of 1998, approximately 39% of the shortnose sturgeon at the base of the dam entered the fish lift (11 out of 28). These percentages, which represent the best available data, were averaged to determine passage efficiency of the existing unimproved fishlifts and their timing of operation for upstream migrating shortnose sturgeon (equaling 11%). If the estimated potential spawning population of downstream sturgeon is 250 animals (i.e., 25% of a total downstream population of 1000 (Savoy in press)) and only 11% of these fish are able to move upstream and attain access to the existing fishways, the expected number of fish that are released into the fish trap above the dam moving upstream can be estimated at 28. Thus, up to 28 shortnose sturgeon per year are expected to be collected in the fish lifts before modifications are made. Vinogradov (1997) estimated as many as 200 migrants are present at the Holyoke Dam in a given year, including prespawning adults. Using this estimate, the number of fish that the proposed action is expected to incidentally harass, trap, capture or collect (due to tagging and handling) during routine upstream passage operations is estimated at 22 fish per year; this number is very similar to the 28 shortnose sturgeon estimated based on the size of the downstream sturgeon population.

According to studies undertaken in 1998 and 1999, a large number of upstream migrating fish are subject to injury while migrating through the bypassed river reach (Kynard et al. 1999c).

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Studies in 1998 and 1999 found that only 11% of the fish at the base of the dam had no visible damage (Kynard et al. 1999c). As indicated above, before modifications are made, up to 28 shortnose sturgeon may enter the fish lifts each year. Based on an injury rate of 89%, up to 25 shortnose sturgeon are likely to be injured in their upstream passage attempt.

Effect of Proposed Modifications to Fishlifts

The Settlement contains several requirements to facilitate upstream fish passage by modifying the existing fish lifts. Both fish lifts will be modified for 40,000 cfs operation. This modification will increase the amount of time that the lifts can be operated which will allow the facility to be available more often to pass shortnose sturgeon upstream, particularly during and after high flow events. This modification is likely to improve the ability of shortnose sturgeon to pass upstream as upstream passage is most likely to occur after a high flow event. HG&E will also modify the fish lift attraction water system. Augmentation of the attraction water system to supply more water to the lifts will ensure that enough water will be available to attract shortnose sturgeon to the entrances. Modifications will also be made to the tailrace fish lift and the tower will be replaced. Shortnose sturgeon are expected to be better accommodated in the larger size fish lift hopper and the increased size of the lift will likely reduce the crowding that occurs during the peak of the American shad migration. These modifications should reduce the stress of upstream passage in the fish lift. Modifications are also required for the spillway fish lift and this tower will also be replaced. The new hopper will have twice the capacity of the old hopper providing the benefits of reduced crowding and reduced stress from lifting operations. Concern has been expressed in the past regarding the potential for shortnose sturgeon concentrated at the base of the spillway fish lift to be injured. The expansion of the transport/crowding channels will give the sturgeon an area to enter and rest away from any flow over the dam. Reorienting the hopper from discharging perpendicular to the length of the flume to discharging along the length of the flume should also minimize any injury potential.

Modifications to the exit channel are also required. The exit flume will be widened and hydraulic gates and a flow inducer will be installed in the flume to maintain velocities in the range of 0.5-1.0fps and to define a directional flow. The installation of a backlit panel to aid in fish enumeration and identification will allow the fish lifts to remain open during periods of high flow and increased turbidity when in the past during these conditions the lifts were closed. Widening of the exit flume should reduce the potential for sturgeon to contact the walls of the flume which is likely to cause abrasions. The increased area should also reduce the potential for stress due to overcrowding, particularly during the American shad migration period.

The enhancements required by the Settlement will likely improve upstream fish migration to some extent, but as shortnose sturgeon have difficulty migrating through any type of fish lift, the flow becomes increasingly important to ensure efficient and safe passage. Based on available information and preliminary observations in the laboratory, it appears that increases in flow and improvements to the fishway entrances should allow shortnose sturgeon to find and safely reach the entrance to the fishways, particularly the spillway lift. Until such time that safe and successful downstream passage is in place, sturgeon caught in the lift need to be transported back downstream. The provisions of the shortnose sturgeon handling plan (Appendix C) will ensure that this transport occurs safely and without causing injury or mortality to sturgeon.

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All improvements are required to be completed by the spring 2005 Upstream Passage Season. As such, increased numbers of shortnose sturgeon should be observed in the fish lifts beginning in the 2005 upstream passage season. As noted above, based on the number of shortnose sturgeon adults below the dam (approximately 1000 (Savoy in press)), approximately 250 shortnose sturgeon should attempt to pass upstream of the dam each year. The Settlement Agreement indicates that HG&E will provide upstream passage for all shortnose sturgeon appearing at the base of the dam. As such, it is expected that 100% of shortnose sturgeon attempting to pass upstream of the dam will be able to safely and successfully complete this migration. As such, approximately 250 shortnose sturgeon should enter the fish lift annually, beginning in 2005. Modifications are expected to greatly reduce the sources of injury to upstream migrating fish and these fish are not expected to be negatively affected by the upstream passage attempt.

By the end of 2006, HG&E is required to submit a report of monitoring and study results to the Parties of the Settlement, including NOAA Fisheries. If the effectiveness study concludes that the upstream passage facilities and measures are not providing safe and successful passage of shortnose sturgeon without injury or significant impairment to essential behavioral patterns, additional modifications will be required. Once modifications to the upstream and downstream passage facilities are complete, and shortnose sturgeon are no longer removed from the fish lift, approximately 350 shortnose sturgeon are expected to enter the fish lift each year (i.e, 25% of the total river population).

Stranding of Shortnose Sturgeon in Pools Below the Dam

When spill over the dam crest or through the Bascule Gate ceases under certain conditions, shortnose sturgeon become stranded in pools below the spillway. In addition, after dam spillage ceases in the summer or fall, shortnose sturgeon may be present in the west apron pool but will remain unnoticed unless they are removed by netting. Shortnose sturgeon that have been rescued from these pools have been observed to have significant hemorrhaging along the ventral scutes and damage to their fins. If not rescued, these fish would likely have died from these wounds, stress from increased temperature and decreased dissolved oxygen, or a combination of these factors. In 1990, three shortnose sturgeon were found stranded below the dam. On August 13, 1996, two shortnose sturgeon were found stranded in the apron pool and placed upstream of the dam, while on August 19, 1996, two additional fish were discovered in the apron pool and released downstream in the tailrace. No fish were found stranded in 1997, probably due to the lack of high flows that attract fish to the dam. On July 21, 1998, 14 sturgeon were found stranded; the majority of these were in the west apron pool. On August 3, 1998, three sturgeon were found stranded on the west side of the spillway and in the west apron pool, and in 1999, 37 sturgeon were rescued from pools when the fish lift ceased operation. No shortnose sturgeon were found stranded in 2000.

The installation of the rubber dam across the crest of the dam in 2001 was anticipated to help minimize stranding as HG&E is now better able to control flows into the bypass reach. It is unlikely, however, that this potential source of injury has been completely eliminated and following high flow periods it is likely that some shortnose sturgeon will be stranded in pools

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each year. For example, two shortnose sturgeon were stranded in the apron pool in 2002. The provisions of the shortnose sturgeon handling plan that are incorporated into the Settlement, should ensure that injury is minimized and no sturgeon die as a result of being stranded in the pools below the dam. A similar plan was put into practice in 1996 and no mortality of stranded shortnose sturgeon has been reported since that time. Prior to the installation of the rubber dam, an average of 10 shortnose sturgeon were stranded below the dam each year. Since the rubber dam was installed, an average of 0.5 shortnose sturgeon have been stranded each year. Based on an analysis of past strandings, it is unlikely that strandings will occur every year. However, it is likely that some stranding will continue to occur. Based on an analysis of the stranding data since 2001, NOAA Fisheries anticipates that three shortnose sturgeon will strand below the dam in any five year period. As noted above, it is anticipated that these fish will be returned to the mainstem river unharmed.

Denial of Access to Overwintering and Spawning Habitat/Abandonment of Upstream Migration
In addition to the mortality and injury attributable to attempts at upstream passage, a lack of safe and successful upstream passage has negatively impacted the shortnose sturgeon in the Connecticut River by preventing shortnose sturgeon from migrating past the dam from downstream foraging areas to the upstream overwintering and spawning sites. This creates a situation where even sturgeon that successfully pass downstream of the dam are essentially trapped below the dam with no means of getting back upstream to spawn. While studies have collected a few eggs and embryos below the dam, there is no evidence to support the hypothesis that there is a successful spawning site below the dam. This makes it critical that prespawning adults are able to pass above the dam and reach the upstream spawning grounds. As indicated above, the preferred ecological strategy appears to be to move to the upstream overwintering areas in the fall before the spawning season so that energy is not expended in the spring on a long and difficult migration to the spawning grounds. Evidence also suggests that shortnose sturgeon will abandon spawning runs if ecological conditions are not adequate and females are capable of reabsorbing eggs. This suggests that prespawners caught below the dam likely do not spawn below the dam but rather abandon the spawning attempt. The only successful spawning that occurs in the Connecticut River is by shortnose sturgeon that remain above the dam without the advantage of the nutrient and mineral resources of the downstream foraging sites. It is expected that the improvements to upstream passage afforded by the Settlement Agreement will improve the ability of shortnose sturgeon to access the upstream overwintering and spawning areas. This should have the effect of improving the effective size of the shortnose sturgeon population in the Connecticut River as more fish will have access to the spawning sites. This should improve the likelihood of recovery of this population of shortnose sturgeon.

Based on the number of adult shortnose sturgeon known to exist below the dam (approximately 1000), approximately 250 shortnose sturgeon should currently be attempting to pass upstream of the dam each year (all pre-spawned adults). However, it has been estimated that on average, only 28 shortnose sturgeon are likely to enter the fishlifts each year (before all modifications are complete). This indicates that approximately 222 shortnose sturgeon per year either fail to attempt to pass upstream of the dam or abandon the upstream migration. While the exact cause of this is unknown, it is reasonable to assume that it is associated with the existence of the dam and the lack of safe and successful passage above the dam. Due to the decision to not pass

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shortnose sturgeon that appear in the fishlift above the dam, the current operations deny all shortnose sturgeon attempting to migrate upstream of the dam. As such, approximately 250 shortnose sturgeon are prevented from making the upstream migration each year.

In addition to spawners, it is also likely that nonspawners will migrate above the dam to overwintering areas as evidence suggests that not all adults at the upstream overwintering areas spawn. Also, sturgeon may reasonably be expected to pass above the dam during the summer months during movements not attributable to migration to overwintering or spawning areas. As such, the expected number of shortnose sturgeon attempting to pass over the dam could in fact be higher than 350 sturgeon per year, however, there is currently no information available to assess the number of additional sturgeon that may attempt to pass above the dam.

Once the modifications are all made and safe and successful passage is available, at least 350 shortnose sturgeon are expected to spawn above the dam and make an upstream migration to the overwintering and/or spawning grounds above the dam. The Settlement Agreement indicates that HG&E will provide upstream passage for all shortnose sturgeon appearing at the base of the dam. As such, it is expected that 100% of shortnose sturgeon attempting to pass upstream of the dam will be able to safely and successfully complete this migration. Thus, the modifications are expected to reduce the number of shortnose sturgeon that fail to make the pre-spawning upstream migration from 100% to 0%.

Summary of Effects of the Dam on Upstream Passage
The Settlement Agreement requires the new or modified facilities and structures to be in place and operating by April 1, 2005. Depending on the effectiveness of these changes, additional changes may be necessary. It is anticipated that these would be completed by 2010 at the very latest. However, while shortnose sturgeon may be able to be passed safely upstream as early as 2005, without safe downstream passage, which will not be completed until 2009, it is not prudent to pass shortnose sturgeon above the dam because as many as 45% are likely to die on their subsequent downstream migration. As such, over the next 6 years, it is not anticipated that shortnose sturgeon will be passed upstream. At this time it is unknown what the efficiency of the modified fish lifts will prove to be, however it is expected that an increased number of shortnose sturgeon should be observed at the base of the fish lifts and in the fish lifts themselves. Effectiveness studies following the installation of the new upstream facilities will document future passage efficiency.

Other Effects of Dam Operations
Migratory patterns and strandings below the dam can also be influenced by flow conditions. The Settlement requires that the Holyoke Project continue to be operated in a modified run-of-river mode where the project inflow will approximately equal the outflow into the tailrace. This should have a positive influence on flow and water fluctuation patterns in the Connecticut River when compared to the previous peaking/pulsing operations at the Holyoke Project. The Deerfield River and Turner Falls Projects largely control flows to the Holyoke Project (with run-of-river operations), so the flow conditions at the Holyoke Dam that could result in impeded migration will likely be influenced by conditions at the upstream hydropower facilities. modified run-of-river operations at the proposed project will reduce, to the extent possible within

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this licensing action, flow fluctuations and elevated turbidity that could impact shortnose sturgeon migration and survival.

Habitat-based flow requirements for the bypass reach have been incorporated into the Settlement agreement. The "habitat flow" sets forth the water surface elevations, velocities and depths for the period of time outside of the upstream migration season (when zone of passage flows are required). The release of permanent habitat flows (840cfs) will improve the potential for shortnose sturgeon to safely and successfully maneuver in the bypass reach without injury or significant impairment to essential behavioral patterns. In addition, if shortnose sturgeon attempt to reach the spillway lift outside of the time period when zone of passage flows are in place, the habitat flows should facilitate passage of shortnose sturgeon through the bypass reach and improve their ability to traverse the reach to the spillway lift entrance.

Summary of Direct and Indirect Effects of Dam Maintenance and Operations

While the upriver and downriver populations in the Connecticut River seem relatively unchanged since the 1970s (Kynard 1997), it is reasonable to expect that the presence of the Holyoke Dam without the required enhancements will have chronic, adverse effects on the long term survival and recovery of the Connecticut River population of shortnose sturgeon. Even though this population has remained relatively stable for the past 30 years, it has shown no sign of recovery. In fact, researchers have indicated that the Connecticut River, although capable of supporting a much larger population of shortnose sturgeon (1000s-10,000), continues to accommodate a very small population for the amount of habitat currently available, as compared to shortnose sturgeon populations in other river systems. While shortnose sturgeon remain endangered, the modifications proposed as part of the Settlement should greatly improve the ability of shortnose sturgeon to safely and successfully migrate upstream and downstream past the dam. While diminished future spawning and foraging will likely continue, particularly before 2010 when all proposed modifications are expected to be completed, the implementation of the changes required by the Settlement will likely increase the likelihood of this population of shortnose sturgeon surviving and recovering, by increasing access to overwintering grounds, spawning habitat, and prime foraging habitat, and reducing causes of direct injury and mortality.

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INTERDEPENDENT AND INTERRELATED EFFECTS

In addition to the direct and indirect effects outlined above, there are several research projects identified in the Settlement Agreement and proposed license articles that will affect shortnose sturgeon. As these research projects will result in the directed take of shortnose sturgeon, this BO and accompanying Incidental Take Statement can not authorize this take, however, it is still appropriate to assess the effects of these projects on shortnose sturgeon in the context of the action in its entirety. The licensee, HG&E, is in the process of applying for an ESA Section 10(a)(1)(A) Permit for Scientific Research on Endangered Species that will authorize this take. An ESA Section 7 consultation and an analysis under the National Environmental Policy Act (NEPA) will also be conducted on the issuance of the ESA permit by NOAA Fisheries Office of Protected Resources. All of the studies discussed below, with the exception of the USGS flume study which will be conducted under the provisions of Dr. Kynards' current Section 10 permit, are included in the Section 10 permit application submitted by HG&E. This permit application is currently under review by NOAA Fisheries Office of Protected Resources.

Pursuant to proposed Article 410, HG&E must evaluate the effect of the height of the drop from the Louver Bypass Discharge Pipe to the tailrace on shortnose sturgeon. To do this, HG&E will capture ten wild adult shortnose sturgeon from below the dam and release these fish one at a time into the Canal upstream of the louver array at the gatehouse during a period of flow which represents the maximum potential drop (likely to be during the Fall when river flows are at their minimum). These tagged fish will be allowed to pass through the entire length of the louver facility and return to the river. An antenna will be installed at the downstream end of the tailrace and a second antenna will be installed 200 feet further downstream to monitor the progress of the released fish. In addition, after 24-hours and again after one week, HG&E shall survey the river downstream of the Bypass by boat with tracking equipment to confirm that the released fish are alive and displaying normal movements and behavior. If the released fish are alive and behaving normally, it will be assumed that they have successfully passed through the Louver Bypass Discharge Pipe and survived the drop to the tailrace without significant injury. While it will not be possible to determine if these fish suffered minor injuries, it will be possible to determine if the fish died or suffered massive damage. The capture and tagging of adult shortnose sturgeon from below the dam is not likely to have any long-term effect on these fish. As these fish are not contributing to the spawning population, there is no concern on any effects if these were prespawning adults (i.e., if they would have spawned in the following spring if allowed to pass over the dam). In addition, as these fish will return to the river after the study, the capture and use of these fish for the study is not likely to have any impact on the Connecticut River population of shortnose sturgeon. In addition, it is not expected that these sturgeon will be killed by the drop and is far more likely that they will suffer minor injuries if any at all.

Also pursuant to proposed Article 410, HG&E is required to test the effectiveness of the full depth louver facilities as a guidance device. HG&E will mark approximately 50 cultured shortnose sturgeon[6] and 10 wild adult sturgeon. These fish will be released in the Canal below the gatehouse, approximately 300 feet upstream of the louvers. All fish will be recaptured in the Downstream Sampling Facility. The ten wild adult sturgeon will then be used in the study evaluating the effect of the drop from the louver bypass pipe (see above). This study will be conducted during the day and at night and will occur at multiple flows and all results will be reported to NOAA Fisheries. It is anticipated that all of the sturgeon will be guided by the louver array and be recaptured in the sampling facility. However, the potential exists for some of the sturgeon to exit the canal and attempt to migrate downstream of the dam by entering the turbines or by going through the Bascule Gate or over the dam. If this occurs, these sturgeon are likely to die. However, as the researchers will test these fish to ensure that they are predisposed to migrating downstream, it is unlikely that the sturgeon will swim upstream to find an alternative route downstream. It is also possible that some of the smaller fish will go through the louver array into the canal system. If this occurs, these fish should be able to be recaptured as they will all be radio-tagged. No adults should enter the canal system as the 2 inch spacing on the louvers is small enough to act as a physical barrier. Even if some sturgeon did escape from the researchers, no adverse effects to those fish or the Connecticut River shortnose sturgeon

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6 These shortnose sturgeon were spawned from adults captured from the Connecticut River under the authority of Dr. Kynard's ESA Section 10 permit following appropriate protocols to ensure genetic diversity (i.e., one female spawned with multiple males). These fish are F1 fish and have been kept at the Conte lab for less than one year.

population will occur as these fish are either wild fish or the product of wild fish. It is unlikely that there will be any mortality associated with this study; however, it is possible that some of the larger fish will be injured if they rub against the pipe or the sampling facility. These injuries are not expected to be severe or life threatening and will likely be minor. A separate consultation will be performed on the issuance of this permit when project details are fully formed.

Several studies have been proposed at the USGS flume facility. These studies will be conducted under the authority of the Section 10 permit held by Dr. Kynard. No effects to the Connecticut River shortnose sturgeon population are expected as a result of this study as no shortnose sturgeon will be caught from the wild above the number currently authorized by Dr. Kynard's permit.

In 2005, HG&E plans to undertake a study to identify potential spawning sites downstream of Holyoke Dam. It should be noted that this is not a study recommended by NOAA Fisheries and that it was independently proposed by HG&E. As there have been studies completed in the past of the potential for a spawning site to exist below the dam and this activity is currently authorized in the permits issued to Dr. Savoy and Dr. Kynard, NOAA Fisheries does not believe that this activity is necessary as all available information suggests that if any level of spawning does occur below the dam it is likely unsuccessful and only occurs because the fish have failed to access the upstream spawning sites. HG&E plans on investigating the potential for a spawning site to exist in the vicinity of the Enfield Dam. Sampling will be conducted by deploying plankton nets in targets areas to attempt to capture sturgeon eggs and larvae. As no other project details have been developed, it is not possible to determine the likely effects of this proposed project on the Connecticut River population of shortnose sturgeon. A separate consultation will be performed on the issuance of this permit when project details are fully formed.

In order to collect data and evaluate how downstream migrating shortnose sturgeon approach the Project, HG&E must complete a five-year radio tracking study. This is scheduled to occur from 2006-2009. HG&E will install an array of antennas along the face of the louver bypass, the Bascule Gate, the Hadley Falls intakes, the louver entrance and the upstream and downstream end of the tailrace. HG&E intends to radio tag at least 20 shortnose sturgeon per year upstream of the dam, while avoiding tagging Stage 4 (prespawning) female shortnose sturgeon. The tagging of shortnose sturgeon is not known to cause long lasting effects to shortnose sturgeon and this activity is not likely to negatively impact the individuals or the survival or recovery of the Connecticut River shortnose sturgeon population. A separate consultation will be performed on the issuance of this permit when project details are fully formed.

HG&E is also required to re-estimate the size of the Connecticut River shortnose sturgeon population. As no sampling regime has been proposed to date, it is not possible to determine the effects of this study on the Connecticut River shortnose sturgeon population. This study is slated to occur in 2008. NOAA Fisheries encourages HG&E to follow the procedures and methods published in NOAA Fisheries "Protocol for Use of Atlantic and Shortnose Sturgeons" (2000). A separate consultation will occur on the issuance of this project when project details are fully developed.

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In addition to the research activities that will require an ESA Section 10 permit, many of the construction projects required to install the modifications for the Project, will likely require a Rivers and Harbors Act Section 10 permit or Clean Water Act Section 404 permit issued by the US Army Corps of Engineers (ACOE). These permits may be required for in-water work associated with modifications to fishway facilities and/or other modifications or installations of structures required by the Settlement. As there are currently no engineering or construction plans and the exact nature of these modifications are unknown, it is not possible to assess the impacts of these activities on shortnose sturgeon at this time. These actions must undergo separate Section 7 consultation between NOAA Fisheries and the ACOE to assess the effects of any in-water construction activities on shortnose sturgeon.

CUMULATIVE EFFECTS

Cumulative effects as defined in 50 CFR §402.02 includes the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they required separate consultation pursuant to section 7 of the ESA.

Several features of the shortnose sturgeon's natural history, including delayed maturation, non-annual spawning (Dadswell et al. 1984; Boreman 1997), and long life-span, affect the rate at which recovery can proceed. The cumulative activities in the Connecticut River that will likely continue to impact shortnose sturgeon recovery are recreational and commercial fisheries, coal-tar contaminants and other pollutants, additional Connecticut River dams, upstream hydropower development, and development and/or construction activities resulting in excessive water turbidity and habitat degradation.

Besides the impacts of the Holyoke Project, shortnose sturgeon are currently and will continue to be negatively impacted by other anthropogenic activities in the Connecticut River. Shortnose sturgeon are protected from directed fisheries, but they are captured as bycatch in commercial and recreational fisheries, mainly the American shad gill net fishery. In the Connecticut River, Savoy and Shake (1992) estimated 2-25 adults were taken annually by the American shad fishery, and some fish are also caught by sport fishers angling for catfish. Poaching in the Connecticut River may also contribute to excessive shortnose sturgeon mortality.

Shortnose sturgeon continue to be negatively impacted by the presence of coal tar deposits in the Connecticut River. Coal tar contains toxic PAH's that are known to be carcinogenic, so the proximity to these toxics could affect spawning success of the adult population, egg survival and larval development. Kocan et al. (1993) found that approximately 5% of sturgeon embryos and larvae survived after 18 days of exposure to Connecticut River coal tar contaminated sand in a flow-through laboratory system. In addition, although no longer permitted, PCBs remain present in the Connecticut River sediments (FERC 1999b). The MA DEP has issued an advisory for consumption of channel catfish caught in the river. A paper company on the Millers River upstream of the project area is most likely the source of the PCB contamination in the Holyoke Project area. This toxic chemical likely negative impacts to shortnose sturgeon. For example,

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PCB contamination in the Hudson River has been linked to increased incidences of fin rot in shortnose sturgeon.

The presence of other existing dams on the Connecticut River likely compounds the problems associated with shortnose sturgeon migration. Enfield Dam, located at rkm 110, is the only potential obstruction downstream of the Holyoke Dam. While fish generally move freely over this dam, it can prevent upriver movement during periods of extreme low water (Buckley 1982; Buckley and Kynard 1983). However, as identified earlier in this document, the Enfield Dam is not considered an impediment to the upstream migration of shortnose sturgeon.

Other electrical generating facilities on the Connecticut River also have an impact on shortnose sturgeon. The Turners Falls Project, located approximately 35 miles upstream of the Holyoke Dam, and the Deerfield River Project, located 30 miles upstream of the Holyoke Dam on the Deerfield River, operate in alternating peaking and pulsing modes. This practice results in an abnormal increase or decrease in the amount of water delivered to the lower river below the dam. Consequently, these peaking projects at times adversely affect downstream habitat, making it less suitable for shortnose sturgeon spawning and migration. For example, higher water flows may result in faster water velocity, requiring shortnose sturgeon to expend a greater amount of energy to maintain their position within the water column and trigger endogenous factors which may prevent females from successfully spawning. Additionally, impingement of shortnose sturgeon on power plant cooling water intake screens is also believed to contribute to sturgeon mortality in the lower Connecticut River.

Excessive turbidity due to coastal development and/or construction sites (e.g., bridge construction or demolition) may also sturgeon spawning. Shortnose sturgeon require a clean rock or cobble substrate to deposit their eggs and unfavorable substrates would make it impossible for eggs to adhere to critical interstitial areas. Additionally, excessive turbidity impairs sturgeon foraging by making it difficult to locate prey.

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INTEGRATION AND SYNTHESIS OF EFFECTS

Shortnose sturgeon are endangered throughout their entire range. This species exists as nineteen separate populations that show no evidence of interbreeding. The shortnose sturgeon residing in the Connecticut River form one of these nineteen populations.

The Holyoke Dam has impeded or permanently obstructed natural upstream and downstream migration of the Connecticut River population of shortnose sturgeon for approximately 150 years. Shortnose sturgeon above the dam have access to spawning habitat but to date have not been able to safely access productive downstream foraging habitat. Sturgeon that safely migrate downriver from above the dam would have to successfully find the fishways and pass upstream to return to productive spawning habitat above the dam. As evidenced above, currently only 45% of downstream migrating sturgeon are likely to survive. Sturgeon below Holyoke Dam have access to foraging habitat, but have great difficulty finding the entrance to the fishway and passing safely upstream to access spawning habitat. By separating the sturgeon's foraging habitat from its primary spawning habitat and making the connection between the two habitat

types unreliable, Holyoke Dam prevents shortnose sturgeon in the Connecticut River from completing their life cycle.

Root and Akcakaya (1997) conducted an ecological risk analysis for shortnose sturgeon populations in the Connecticut River using a conservative assumption of density independent growth (with a growth rate of 1.0). To overcome the absence of empirical data, the modelers had to make a number of assumptions that could decrease the reliability of the model predictions, but the assumptions about the annual survival rates, maturation age, and spawning periodicity appear to have made little difference in the outcome of the modeling results as shown by the similar results produced under two different fecundity options. Despite the number of assumptions, the model predicted that the observed stability of the two populations is possible either with reproduction in both upper and lower populations (at fecundity rates of 75% or higher) and small to moderate rates of dispersal between them, or with no fecundity in the lower population, very high fecundity in the upper population and high rate of net downstream dispersal.

Additionally, the model predicted that, with no reproduction below Holyoke Dam as current evidence supports, the lower river population could survive *only* if the upper population had a fecundity rate of 3 to 19 times greater than assumed in the model and there was a net downstream migration rate greater than 1% (Root and Akcakaya 1997). There is no evidence to suggest that the fecundity of the upper river sturgeon population could be 3 to 19 times greater than was simulated. Furthermore, several studies have concluded that reducing populations to small sizes dramatically increases their probability of extinction (MacArthur and Wilson 1967; Shaffer 1981; Gilpin and Soule 1986; Goodman 1987). This modeling effort highlights that without a high rate of net downstream dispersal and continued high fecundity in the upper river, it is unlikely that the Connecticut River population of shortnose sturgeon will survive and recover in the future.

If the license is issued as proposed by the Settlement Agreement and the accompanying proposed license articles, the proposed action should enhance the likelihood of safe and successful downstream and upstream migration by shortnose sturgeon. Splitting a population of this endangered species, by itself, can be expected to increase the risk of extinction for each subgroup because the effective size of each population fragment is now much smaller (Gilpin and Soule 1986). The proposed action with the mandated enhancements would mitigate the problem by enhancing passage and enhancing the ability of sturgeon to migrate between suitable spawning habitat and suitable foraging habitat. Specifically, sturgeon below the dam have access to reliable foraging habitat but have marginal spawning habitat, while sturgeon above the dam have access to reliable spawning habitat but have marginal foraging habitat. It is reasonable to expect shortnose sturgeon above the dam to have lowered growth rate because the dam limits their access to suitable foraging habitat. At the same time, it is reasonable to expect shortnose sturgeon below the dam to have lowered reproductive success because the dam limits their access to suitable spawning habitat. The installation of facilities that ensure safe and successful upstream and downstream passage is expected to greatly reduce these problems and increase the chance of survival and recovery of this population of shortnose sturgeon. As no passage device is likely to pass 100% of the upstream and downstream migrating sturgeon, mortality and injury is likely to continue to occur, albeit at reduced rates. The most significant improvements are

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likely to be seen when entrainment in the turbines is eliminated and access to the fish lifts is improved.

By restricting migration, the Holyoke Dam probably compromises gene flow more than it affects the potential sturgeon population size (by limiting the number of spawners). While the population has been described as stable for years, it has shown no signs of recovery. It is likely that shortnose sturgeon have continued to persist in the Connecticut River partially because of their long life-span, assisted upstream passage and limited downstream passage. Given the available information, an occasional female may spawn downstream but there is no verifiable documentation that a productive spawning site exists downstream of Holyoke Dam. In all shortnose sturgeon populations that have been investigated, the spawning site is always the most upriver reach used by the population (Kynard 1997).

The proposed action, issuing a new License Order for the Holyoke Project with the conditions specified in the Settlement Agreement, largely mitigates the effects of the dam's operation by improving passage of shortnose sturgeon and ensuring the ability of spawning adults to safely and quickly access spawning grounds, and allowing fish to safely access productive feeding habitat at the fresh/salt water interface. The continued existence and operation of the dam under the terms of a new License Order is not likely to reduce the reproduction, numbers or distribution of shortnose sturgeon in the Connecticut River in a way that appreciably reduces the likelihood of the survival and recovery of the population or the species as a whole. It is not likely to reduce reproduction because more shortnose sturgeon are likely to migrate successfully upstream past the dam to the upstream spawning grounds and more shortnose sturgeon are likely to be able to access the better downstream foraging grounds which is likely to increase the success of reproduction and decrease the time between spawnings. It is not likely to reduce distribution because it is likely to result in a larger and more stable Connecticut River shortnose sturgeon population. While the existence and operation of the dam under the terms of the new license will continue to kill and injure some shortnose sturgeon, therefore reducing numbers in one sense, the death of these fish will be offset by the increase in reproduction. The operation of the dam under the new license will reduce the percentage of downstream migrating shortnose sturgeon that are killed in the passage attempt from 45% to 5%. This reduction is largely due to the elimination of the potential for entrainment in the turbines. The likelihood of shortnose sturgeon to be injured in attempts to pass upstream of the dam is also eliminated (reduced from current estimates of 89% injury). The proposed action is also expected to increase the percentage of shortnose sturgeon that are able to migrate successfully past the dam from 11% to near 100%. The terms of the new License Order will also eliminate the potential for mortality during stranding events by requiring that the licensee follow the terms of the shortnose sturgeon handling plan. While the operation of the Holyoke Project under the terms of a new License Order will continue to kill and injure some number of shortnose sturgeon in the Connecticut River, the population will be reconnected by safe passage up and downstream of the dam. The ability to pass the dam largely unimpeded will benefit the Connecticut River population of shortnose sturgeon by allowing access to prime foraging and spawning grounds resulting in an increase in annual spawning success and a decrease in the interval between successful spawnings. This is likely to result in an increase in population growth and an increasingly stable population size and structure. Given the current state of the data and model availability, it is impossible at this time to predict the actual

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rate and magnitude of population growth resulting from the operation of the dam under the terms of the new license.

It is important to note that despite the decrease in the percentage of shortnose sturgeon dying in attempts to pass downstream of the dam, NOAA Fisheries has estimated that, in fact, more shortnose sturgeon are likely to die in downstream passage attempts after all modifications to upstream and downstream passage are complete. This is due to the increased number of fish expected to be able to make successful upstream and downstream migrations. While the number of downstream migrating fish that die each year will increase (from 14 to 17), the deaths represent a significantly smaller portion of the downstream migrating fish (5% rather than 45%). In addition, the fish that die are likely to be post-spawners and have made a contribution to the population through increased genetic diversity and numbers of juveniles. As such, the significance that the death of these fish has on the shortnose sturgeon population in the Connecticut River is reduced. The loss of three more fish annually that will occur with all modifications complete is mitigated by the following: the increase in the percentage of fish that are able to safely and successfully pass up- and down-stream of the dam; the decrease in the number of fish injured in upstream passage attempts; the expected decrease in the spawning interval due to improved access to downstream foraging sites; and, the expected increase in the number of successfully spawning adults and a resultant increase in the number of larvae and juveniles.

If FERC issued a license that did not authorize the continued operation and maintenance of the Holyoke Project and the dam was not subsequently removed, the effects of the Holyoke Project on shortnose sturgeon would not be alleviated. The physical structures associated with the Project (i.e., the dam) impede both upstream and downstream passage of shortnose sturgeon. While no shortnose sturgeon would likely be killed passing through the powerhouse if the turbines were shut down, shortnose sturgeon would die and/or be injured by passing over the dam. In addition, there would be no means for shortnose sturgeon to pass upstream over the dam. The result would be detrimental to the shortnose sturgeon population as the population would effectively be split in two, with the upstream population having no access to the downstream foraging areas and the downstream population having no access to the upstream overwintering and spawning grounds. This scenario would likely result in a decrease in the numbers of shortnose sturgeon in this population due to the death of fish attempting to pass over the dam and a decrease in reproduction. Even if fish were able to successfully pass downstream over the dam, once downstream there would be no means of passing back upstream. This would likely decrease the number of adults present at the spawning grounds in the spring. While spawning may continue to occur above the dam, the interval between spawnings would be affected by the lack of access to the downstream foraging areas. For these reasons, the reproduction and numbers of shortnose sturgeon in the Connecticut River would likely be decreased. As there is no evidence of successful spawning below the dam, it is also likely that the population of shortnose sturgeon below the dam would eventually die out, as it would only be supplemented by the fish that successfully passed over the dam. Thus, the distribution of shortnose sturgeon in the Connecticut River would also be affected as the population would be divided and it is likely that the downstream population would not be self-sustaining. These assumptions are supported by the modeling completed by Root and Akcakaya (1997) which

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concluded that without a high rate of net downstream dispersal and continued high fecundity in the upper river, it is unlikely that the Connecticut River population of shortnose sturgeon would survive and recover in the future. For these reasons, if a license were issued that did not authorize the continued operation and maintenance of the Holyoke Project and the dam was not removed, it would likely result in an appreciable reduction in the likelihood of this population, and the species as a whole, to survive and recover as compared to the operation and maintenance of the Holyoke Project under the terms of the new License.

If FERC were to issue a license that did not authorize the continued operation and maintenance of the Holyoke Project and the dam was subsequently removed, the Connecticut River shortnose sturgeon population would have no impediments to up- and down- stream migration. This would likely result in unrestricted access to upstream overwintering spawning and overwintering grounds, as well as to downstream foraging and overwintering areas. It is likely that the population would increase as the number of spawning adults increased and the interval between spawnings decreased. However, the same effect on population growth and distribution is expected to occur from the issuance of the new License. As the new License requires safe and successful upstream and downstream migration, it is likely to result in similar improvements to access to spawning, foraging, and overwintering grounds which will lead to the same improvements in numbers and distribution. While the 5% of downstream migrants that are likely to die as a result of passing downstream of the dam operating under the new License would not die if the dam were removed, the death of this number of fish is not likely to appreciably reduce the likelihood of the survival and recovery of this population of shortnose sturgeon or the species as a whole. As noted above, the loss of this number of fish is mitigated by the following: a reconnected population due to the safe and successful passage up- and down- stream of the dam and the expected increase in the number of successfully spawning adults and a resultant increase in the number of larvae and juveniles. In addition, the fish that die are likely to be post-spawners and have made a contribution to the population through increased genetic diversity and numbers of juveniles. For these reasons, if the Holyoke Dam were removed, it is not likely that it would result in an appreciable difference in the likelihood of this population, and the species as a whole, to survive and recover as compared to the operation and maintenance of the Holyoke Project under the terms of the new License.

For these reasons, NOAA Fisheries believes that the issuance of a new License Order, as conditioned by the Settlement and the proposed License Articles, would not reduce the reproduction, numbers, and distribution of the Connecticut River shortnose sturgeon population or the species as a whole in a way that appreciably reduces their likelihood of survival and recovery in the wild. The ability to pass the dam largely unimpeded will allow access to prime foraging and spawning grounds resulting in an increase in annual spawning success and a decrease in the interval between successful spawnings. This is likely to result in an increase in population growth and an increasingly stable population size and structure which will increase the likelihood of survival and recovery for this population of shortnose sturgeon.

CONCLUSION

After reviewing the current status of the Connecticut River population of shortnose sturgeon, the environmental baseline for the action area, the effects of the proposed action, including

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interdependent and interrelated actions and the cumulative effects, it is NOAA Fisheries' biological opinion that as the action, is not likely to reduce the reproduction, numbers, and distribution of the Connecticut River shortnose sturgeon population, it is not likely to jeopardize the continued existence of the Connecticut River population of shortnose sturgeon or the species as a whole. No critical habitat has been designated for this species; therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations prohibit the take of endangered and threatened species without special exemption. "Take" is defined in Section 3 of the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by NOAA Fisheries to include "any act, which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering" (50 CFR 222.102). The term "harass" has not been defined by NOAA Fisheries; however, it is commonly understood to mean to annoy or bother. "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity (50 CFR 402.02). Under the terms of section 7(b)(4) and section 7(o)(2) of the ESA, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement (ITS).

The measures described below are non-discretionary, and must be undertaken by FERC so that they become binding conditions of the license issued to Holyoke Gas and Electric for the exemption in section 7(o)(2) to apply. If FERC (1) fails to assume and implement the terms and conditions or (2) fails to require HG&E to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the license, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of the incidental take, FERC must report the progress of the action and its impact on the species to NOAA Fisheries as specified in the Incidental Take Statement [50 CFR §402.14(i)(3)].

The levels of incidental take are limited to the amount of take anticipated from the action (i.e., the existence and operation of the Holyoke Project per the 2004 Settlement Agreement). The goal of this consultation is to increase the number of shortnose sturgeon passing around the Holyoke Dam and to decrease the percentage of migrating shortnose sturgeon taken by mortality and injury. The incidental take levels were separated into upstream and downstream assessments to best quantify the anticipated allowable levels. Appendix D contains a table outlining the expected take. In the accompanying biological opinion, NOAA Fisheries determined that this level of anticipated take is not likely to result in jeopardy to the species.

This ITS and accompanying reasonable and prudent measures should be treated as an adaptive management process. If the identified measures are implemented and shortnose sturgeon still do not seem to be utilizing the fishways, additional alternatives may need to be considered. Unexpected conditions will most likely arise in any project, especially taking into account a

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fluctuating river system, a hydroelectric project known to cause fish mortality, and a migratory endangered species that has been essentially separated from optimal foraging and/or spawning habitat for 150 years. This ITS does not incorporate natural or cumulative anthropogenic mortality, as NOAA Fisheries assessed the level of take associated with *only* the Holyoke Project. This ITS is also based on the assumption that FERC will incorporate all of the terms of the Settlement Agreement and the proposed License Articles.

It should be noted that neither this BO nor the accompanying ITS provide authorization or exemption for directed incidental take for research projects on shortnose sturgeon required by the Settlement and identified as "interrelated actions" in the BO. Authorization for these actions must come from NOAA Fisheries Office of Protected Resources through an ESA Section 10(a)(1)(a) Permit for Scientific Research on Endangered Species. It is the understanding of NOAA Fisheries that HG&E has initiated this process. In addition, neither this BO nor the accompanying ITS provide authorization or exemption for incidental take from any construction projects that will require a Rivers and Harbors Act Section 10 permit or Clean Water Act Section 404 permit issued by the US Army Corps of Engineers (ACOE). These permits may be required for in-water work associated with modifications to fishway facilities and/or other modifications or installations of structures required by the Settlement. These actions must undergo separate Section 7 consultation between NOAA Fisheries and the ACOE to assess the effects of any in-water construction activities on shortnose sturgeon.

Amount or Extent of Incidental Take

Incidental take of shortnose sturgeon from upstream migrations

The Holyoke Project directly and indirectly affects upstream migrating shortnose sturgeon. The project physically affects sturgeon while they move through the rapids on the way to the dam and while the fish are moving through the fishways. In the past, severely damaged ventral scutes were documented while shortnose sturgeon migrated upstream through the bypass reach. In addition, the Holyoke Dam has prevented migrating fish from reaching productive upstream spawning habitat for 150 years. While impossible to quantify, this hindrance most likely has delayed recovery and has had long term genetic effects on the population. Fortunately, with the recommended modifications to the Holyoke Project, the significance of this hindrance to the shortnose sturgeon population is expected to decrease over the term of the new License Order.

From 1975 to 2002, 112 shortnose sturgeon passed through the upstream fish lifts (Kynard 1998). The estimated downstream population of adult shortnose sturgeon is approximately 1000 individuals but not all of these adults would be expected to spawn every year. Based on limited data, females spawn approximately every 6 years and males spawn every 2 years. Furthermore, only about 25% of the successful upriver breeding portion of the Connecticut River population is estimated to spawn annually (Kynard 1997). Using the proportion of fish spawning in the upriver group, only 25% of the total adult downstream population of 1000 sturgeon can be expected to attempt to migrate to upstream areas to spawn in any given year (equaling 250 fish). In addition, some number of nonspawning adults and/or juveniles may attempt to migrate upstream in a given year, possibly to overwintering areas. However, not all of the shortnose sturgeon that reach the dam will enter the existing fish lifts with their current structural

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specifications and during the current operating schedule (April 1 through July 15 and September 15 through November 15).

Using the best available information (see p. 48) it is expected that approximately 28 shortnose sturgeon will enter the fish lift per year until modifications to the upstream passage facilities are complete. Verification of this level of take will be evaluated when the fish pass through the fishlift and are observed by the observation personnel.

It is important to note that improving fish passage and increasing the number of sturgeon moving above the dam will increase the non-lethal take of fish by means of harassing, trapping, capturing, or collecting. For example, the reasonable and prudent measures of this Incidental Take Statement call for the continuation of tagging and monitoring efforts of shortnose sturgeon at the Holyoke Project. The requirement to continue monitoring shortnose sturgeon affected by the Holyoke Project will increase the handling time of this endangered species. While this non-lethal take will likely create stress on the animals, it is not likely to be detrimental to the survival of the individuals or the population, instead contributing to better scientific understanding and more effective management for the recovery of the species.

However, this allowable non-lethal incidental take of shortnose sturgeon via harassing, trapping, capturing, or collecting must be quantified. The estimate of incidental take is based on the implementation of the information collection and tagging program identified in the Shortnose Sturgeon Handling Plan (see Appendix C) included in the Settlement Agreement. Although NOAA Fisheries is requiring the collection of such information, it is the licensee's responsibility for the handling and tagging of the fish intercepted in the trapping facility. When an intentional take is described as part of the proposal in order to minimize anticipated future incidental take and facilitate the collection of species-specific information for management and recovery of the population, the biological opinion and its Incidental Take Statement may serve as the authority for that take.

The number of fish moving upstream (and therefore non-lethal take) will most likely increase once the fish lifts are fully operational and the entrance/approach is improved (in 2005). The new fishways and associated improvements are expected to increase passage efficiency significantly. Any fish that passes through the fishway will be subject to take in the form of trapping, capturing, harassment, and/or handling. However, this take is not detrimental to the survival and recovery of the population, as increased upstream passage will likely increase reproduction and stimulate recovery.

After modifications to the upstream passage facilities are made, yet before downstream passage improvements are complete (i.e., 2005-2009), increased numbers of shortnose sturgeon should be observed in the fish lifts. As noted above, based on the number of shortnose sturgeon adults below the dam (approximately 1000 (Savoy in press)), approximately 250 shortnose sturgeon should attempt to pass upstream of the dam each year. As such, approximately 250 shortnose sturgeon should enter the fish lift annually, beginning in 2005.

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Once the fish lifts are fully operational and shortnose sturgeon can essentially undertake free migration, the entire population of shortnose sturgeon, estimated at 1400 animals, could be expected to move either upstream, downstream, or both. Of this total population, 25% of these animals can be expected to spawn in any given year (equaling 350 fish). Thus, once the improvements are in effect consistent with the Settlement Agreement, and the fish are capable of moving freely around the Holyoke Dam, the expected incidental take of shortnose sturgeon from harass, trap, capture, or collect for the relicensed Holyoke Project for upstream passage should be at least 350 animals/year. In addition to spawners, it is also likely that nonspawners will migrate above the dam to overwintering areas as evidence suggests that not all adults at the upstream overwintering areas spawn. Also, sturgeon may reasonably be expected to pass above the dam during the summer months during movements not attributable to migration to overwintering or spawning areas. As such, the expected incidental take could in fact be higher than 350 sturgeon per year, however, there is currently no information available to assess the number of additional sturgeon that may attempt to pass above the dam.

Based on the number of adult shortnose sturgeon known to exist below the dam (approximately 1000), approximately 250 shortnose sturgeon should currently be attempting to pass upstream of the dam each year (all pre-spawned adults). However, it has been estimated that on average, only 28 shortnose sturgeon are likely to enter the fishlifts each year (before all modifications are complete). This indicates that approximately 222 shortnose sturgeon per year either fail to attempt to pass upstream of the dam or abandon the upstream migration. While the exact cause of this is unknown, it is reasonable to assume that it is associated with the existence of the dam and the lack of safe and successful passage above the dam. Due to the decision to not pass shortnose sturgeon that appear in the fishlift above the dam, the current operations deny all shortnose sturgeon attempting to migrate upstream of the dam. As such, approximately 250 shortnose sturgeon are prevented from making the upstream migration each year. As there is no evidence of successful spawning below the dam, the denial of access to the upstream spawning grounds leads to the failure of these fish to spawn and contribute to the population in terms of genetic diversity and increased numbers of juveniles. Thus, the denial of access to the upstream spawning grounds represents a significant impairment that actually injures individual shortnose sturgeon and the population by significantly impairing essential behavioral patterns including breeding, spawning, rearing, and migrating (i.e., the NOAA Fisheries definition of "harm"). As such, approximately 250 shortnose sturgeon per year will be harmed by denying access to upstream overwintering and spawning grounds. This source of take will continue until all downstream modifications are complete (i.e., 2010).

Once the modifications are all made and safe and successful passage is available, approximately 350 shortnose sturgeon are expected to spawn above the dam and make an upstream migration to the overwintering and/or spawning grounds above the dam. The Settlement Agreement indicates that HG&E will provide upstream passage for all shortnose sturgeon appearing at the base of the dam. As such, it is expected that 100% of shortnose sturgeon attempting to pass upstream of the dam will be able to safely and successfully complete this migration. Thus, the modifications are expected to reduce the number of shortnose sturgeon that fail to make the pre-spawning upstream migration from 100% to 0%. As such, the number of shortnose sturgeon harmed by denying access to upstream overwintering and spawning grounds will decreased from 250 to 0.

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According to studies undertaken in 1998 and 1999, a large number of upstream migrating fish are subject to injury while migrating through the bypassed river reach (Kynard et al. 1999c). Studies in 1998 and 1999 found that only 11% of the fish at the base of the dam had no visible damage (Kynard et al. 1999c). As indicated above, before modifications are made, up to 28 shortnose sturgeon may enter the fish lifts each year. Based on an injury rate of 89%, up to 25 shortnose sturgeon are likely to be injured in their upstream passage attempt. Verification of this level of take will be evaluated when the fish pass through the fishlift and are observed by the observation personnel.

The level of incidental take by injury will decrease once the improved fish lifts and project enhancements are fully operational (in 2005 as currently anticipated in the Settlement). The improvements to the existing fishways (entrances, hopper capacity, etc.) will significantly improve the safety of fish movement and navigation through the rapids below the dam; consequently, after all the upstream passage improvements are completed, no shortnose sturgeon are expected to be injured in the attempt to pass upstream of the dam.

Summary of incidental take of shortnose sturgeon from upstream migrations

	Type of Take	Before Upstream Passage Modifications 2004	After Upstream Passage Modifications 2005-2009	After Downstream Passage Modifications 2010 – future
Upstream Passage	Harass, trap, capture, collect in fish lift and associated facilities	***28*** (11% upstream migrants)	***250*** (25% downstream population)	***350*** (25% total population)
	Injury associated with entering and transport in fish lifts	***25*** (89% of fish captured in fish lifts)	***0***	***0***
	Harm – abandon upstream passage attempt or do not attempt to pass upstream	***250*** (100% potential upstream migrants)	***250*** (100% potential upstream migrants)	***0***

Incidental take of shortnose sturgeon from downstream migrations

The Holyoke Project can impose direct, physical harm on the shortnose sturgeon population while they are attempting to migrate downstream of the Holyoke Project. Sturgeon are also subject to harm indirectly with the impeded downstream migration. This indirect harm is exemplified by the slow growth rates of adults above the Holyoke Dam, likely due to the inability to utilize the downstream estuarine foraging sites.

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In previous years, approximately 52% of the tagged adults passing downstream of Holyoke Dam entered Hadley Falls Station or the Canal System and were killed. Unfortunately, the specific number of fish killed per year is difficult to estimate because there is currently no counting system for fish moving downstream of the Holyoke Dam. The best method to verify downstream passage rates is to establish a radio tagging study as described in the Settlement. This long-term radio tracking study (5 years) will monitor the number of tagged fish moving downstream past the project, and will be used to validate the incidental take level associated with the migration, as well as the effectiveness of the newly constructed fish passage facilities. At the end of the initial 5 year radio tagging study, NOAA Fisheries will evaluate whether further tagging is necessary and the schedule for future studies. If an additional study is not immediately warranted (i.e., another study is scheduled to begin in 5 years), the licensee, FERC, and NOAA Fisheries will discuss an alternate method of monitoring downstream incidental take during the interim.

The downstream mortality rate of 52% has been reduced by the percentage of mortality (estimated at 7%) eliminated as a result of the installation of the full depth louvers which prevents shortnose sturgeon from entering the canal system as well as the installation of the shortnose sturgeon exclusion device at the attraction water entrance. Until the improved downstream fish passage facilities are installed and operating consistent with the Settlement Agreement (i.e., in 2010), the expected incidental take of shortnose sturgeon from mortality or injury for the relicensed Holyoke Project for downstream passage has been set at 45% of the animals migrating downstream per year, with 7% of the migrating animals being killed by going over the dam or through the bascule gate. Based on the estimate that on average 31 shortnose sturgeon currently attempt to pass downstream of the dam each year, NOAA Fisheries anticipates that 12 (38% of downstream migrants) shortnose sturgeon will be killed through entrainment in the turbines each year until modifications are made to prevent entrainment and two shortnose sturgeon will be killed by passing over the dam or through the Bascule Gate. This estimate is based on the downstream movement and entrainment rates of tagged shortnose sturgeon that migrated past the Holyoke Dam in the summer and fall of 1998 and 1999 (see p. 38-44).

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It would be expected that the level of lethal incidental take will increase once the fish lifts are fully operational (in 2005) as more shortnose sturgeon would be expected to be present above the dam. However, HG&E has agreed that no shortnose sturgeon will be released from the fish lifts upstream of the dam until NOAA Fisheries determines it is appropriate. Therefore, this increase in mortality will not occur and the levels of lethal take contemplated above will remain in effect until all downstream passage facility improvements are completed (by 2010).

Once the recommended downstream fish passage facilities are installed and operating effectively, the expected incidental take of shortnose sturgeon from mortality or injury associated with downstream movement past the relicensed Holyoke Project is anticipated to decrease from 52% to 5% of the annual downstream migrants. The basis for this recommendation is outlined below.

The Settlement requires a device to be installed that will eliminate the potential for shortnose sturgeon to be entrained in the turbines. The installation of this device will eliminate this source of mortality. It is estimated that entrainment in the turbines accounts for 73% of the mortality of downstream migrating sturgeon (i.e., 38% of downstream migrating fish); this source of mortality is expected to be eliminated by 2010. The remaining mortality associated with downstream passage has been attributable to passage in the spillway (i.e., over the dam or through the Bascule Gate) or through the canal system. The installation of the full depth louvers has eliminated the potential for mortality in the canal system. It is expected that the installation of an alternative passage device will divert fish to the canal bypass or be at least as effective as the canal bypass facility. Thus, it is expected that 90% of shortnose sturgeon will be passed safely downstream, leaving 10% to either seek an alternative means of passage or abandon the passage attempt. The Settlement requires that safe passage be provided through the Bascule Gate, however, it is anticipated that some level of mortality will be experienced by those fish that travel through the Bascule Gate and/or over the spillway. This level of mortality is expected to account for 5% of the annual downstream migrants and accounts for downstream passage at all available facilities, including the canal bypass facility. Based on the estimate that 350 post-spawned adults will attempt to migrate downstream past the dam, up to 17 shortnose sturgeon are likely to be killed in attempting to pass over the dam or through the Bascule Gate. As effectiveness studies are conducted, it may be necessary to revise this estimate.

The expected incidental take for shortnose sturgeon from harassment, trapping, capture, or collection is difficult to quantify due to an inability to count or monitor downstream outmigrating sturgeon in the field. The radio tagging study as well as information collected on sturgeon collected at the sampling station will assist with this assessment, but that information is not available for development of this Incidental Take Statement. While we believe that a large percentage of the total sturgeon population, if not the entire population, could be expected to use the downstream fishways at some point in their life cycle, assignment of a number is highly speculative. It is however, reasonable to estimate that all two year old shortnose sturgeon, following a residency period above the dam near the spawning site, will pass downstream of the dam and that all postspawned adults will pass below the dam on the way to the foraging grounds. If only postspawned adults attempted to pass downstream of the dam, it is expected that the incidental take will be as high as 25% of the total population (350 adults). It is also likely that any nonspawning adults that overwintered above the dam will travel to the downstream foraging grounds. It is also reasonable to expect that some shortnose sturgeon may move up and down stream of the dam independent of movements to overwintering, foraging or spawning sites. Based on these assumptions, it is possible that the nearly the entire upstream population of shortnose sturgeon may pass downstream of the dam in a given year. As such, the expected incidental take could in fact be higher than 315 sturgeon per year (25% of the population minus the 5% of downstream migrants likely to be killed and 5% likely to abandon the downstream passage attempt), however, there is currently no information available to assess the number of additional sturgeon that may attempt to pass below the dam.

Based on the number of adult shortnose sturgeon known to exist above the dam (approximately 400), approximately 100 shortnose sturgeon should currently be attempting to pass downstream of the dam each year (all post-spawned adults). However, it has been estimated that on average,

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only 31 shortnose sturgeon pass downstream of the dam each year. This indicates that approximately 69 shortnose sturgeon per year either fail to attempt to pass downstream of the dam or abandon the downstream migration. While the exact cause of this is unknown, it is reasonable to assume that it is associated with the existence of the dam and the lack of safe and successful passage below the dam. As there is evidence that shortnose sturgeon above the dam are significantly smaller than those below the dam, the denial of access to the downstream foraging grounds leads to decreased growth rates and decreased fecundity, demonstrated in part by the increased spawning interval of shortnose sturgeon above the dam. Thus, the denial of access to the downstream foraging grounds represents a significant impairment that actually injures individual shortnose sturgeon and the population by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, and feeding (i.e., the NOAA Fisheries definition of "harm"). As such, approximately 69 shortnose sturgeon per year will be harmed by denying access to downstream foraging grounds.

Once the modifications are all made and safe and successful passage is available, approximately 350 shortnose sturgeon are expected to spawn above the dam and subsequently make a downstream migration to the estuarine foraging grounds. Based on a guidance efficiency of 90%, it is estimated that 315 of these shortnose sturgeon will be able to pass downstream of the dam safely and successfully. As indicated in sections above, 5% of the fish attempting to migrate downstream are expected to find an alternate route of passage (over the dam or through the Bascule Gate) and likely be killed in the passage attempt, and another 5% are likely to abandon the downstream passage attempt. Thus, the modifications are expected to reduce the number of shortnose sturgeon that fail to make the post-spawning downstream migration from 69% to 5%. This will decrease the number of shortnose sturgeon harmed by denial of access to the downstream foraging grounds from 69 to 17 fish per year.

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Summary of incidental take of shortnose sturgeon from downstream migrations

	Type of Take	Before Modifications 2004-2009	After Modifications 2010 – future
Downstream Passage	Killed by entrainment in turbines	***12*** (38% downstream migrants)	***0***
	Killed by going over dam or through Bascule gate	***2*** (7% downstream migrants)	***17*** (5% downstream migrants)
	Harass, trap, capture, collect fish traveling through bypass pipe and/or downstream sampling station	***17*** (55% downstream migrants)	***315*** (90% downstream migrants)
	Harm – abandon downstream passage attempt	***69*** (17% upstream population/69% potential downstream migrants)	***17*** (5% downstream migrants)

Incidental take of shortnose sturgeon from strandings in pools below the Holyoke Dam
The Holyoke Project can impose direct, physical harm on the shortnose sturgeon population by altering attraction water flows or shutting down the fish lifts, leading to shortnose sturgeon being stranded in the pools below the Holyoke Dam. These stranded sturgeon would most likely die if not rescued, but even after rescuing, the sturgeon from these pools are exposed to significant hemorrhaging along the ventral scutes and damage to the fins. While it is difficult to determine when and where these injuries occurred, it is noteworthy that a large portion of the stranded fish have been injured. Since rescue procedures were developed in 1996, no additional fish mortality has occurred. The rescue actions described in the Shortnose Sturgeon Handling Plan incorporated into the Settlement, will help to alleviate any mortality and extensive injury associated with these pools, but until rescued, sturgeon trapped in these pools are subject to injury and stresses related to increased temperature and decreased dissolved oxygen. Shortnose sturgeon stranded in the pools are subject to injury, harassment, capture (as a result of the rescue protocol), trapping, and, potentially, mortality. Consequently, the following incidental take level is designed to account for all shortnose sturgeon trapped in and rescued from the pools below the Holyoke Dam.

Three shortnose sturgeon were found stranded in pools and were rescued in 1990, 4 were rescued in 1996, 17 in 1998, and 37 in 1999. From 1991 to 1995, the dam's apron pools were not monitored so stranded fish could have been missed, but in 1997, no fish were found stranded. No shortnose sturgeon were found stranded in 2000 or 2001, when the rubber dam was installed. Two shortnose sturgeon were stranded in 2002 and none were stranded in 2003 or 2004. Averaging the number of stranded fish for the years since the rubber dam was installed, (e.g., 2001-2004) results in an average of 0.5 shortnose sturgeon stranded per year. Based on an

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analysis of past strandings, it is unlikely that strandings will occur every year. However, it is likely that some stranding will continue to occur. Based on an analysis of the stranding data since 2001, NOAA Fisheries anticipates that three shortnose sturgeon will strand below the dam in any five year period. As noted above, it is anticipated that these fish will be returned to the mainstem river unharmed. Therefore, the expected incidental take of shortnose sturgeon for the relicensed Holyoke Project for fish stranding below the dam will be evaluated as a 5 year running average of three animals. Thus, up to 3 shortnose sturgeon are expected to be taken over any consecutive five year period, beginning in 2005. The incorporation of a 5 year running average will account for yearly fluctuations in flow patterns and stranding anomalies.

Summary of incidental take of shortnose sturgeon stranding in pools below dam

	Type of Take	Before Modifications 2005-2009	After Modifications 2010 – future
Stranding in pools below dam	Harass, trap, capture, collect in removal attempts	***3 per 5 years*** (5 year running average)	***3 per 5 years*** (5 year running average)

Reasonable and prudent measures

NOAA Fisheries believes the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize impacts of incidental take of shortnose sturgeon in the Connecticut River resulting from the existence and operation of the Holyoke Dam under the terms of the new license:

1. Shortnose sturgeon must be collected and handled appropriately at the downstream sampling station and in the event of a stranding. In addition, such interactions must be reported to NOAA Fisheries.

2. Water quality in the holding tanks at the downstream sampling station must be adequate for holding shortnose sturgeon.

Terms and conditions

In order to be exempt from prohibitions of section 9 of the ESA, FERC must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. To implement RPM #1, the licensee must follow the shortnose sturgeon handling plan (Appendix C).

2. To implement RPM #1, by January 1 of each year, the licensee must discuss with NOAA Fisheries whether any updates to the shortnose sturgeon handling plan are necessary. If required, all updates must be made by April 1 of each year.

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3. To implement RPM #1, by January 1 of each year, the licensee must submit a report to NOAA Fisheries on the status of shortnose sturgeon at the Holyoke Project, including the numbers of identified sturgeon passing upstream (and downstream, if detected), the number of sturgeon rescued from the apron pools, the relative effectiveness of fishways, and mortality from the previous year.

4. To implement RPM #1, the licensee must notify NOAA Fisheries when the Holyoke Project reaches 75% of the incidental take levels for shortnose sturgeon, including upstream migrating, downstream migrating, and fish stranding below the dam levels.

5. To implement RPM #2, the licensee must monitor the water quality of the holding tanks used at the Downstream Sampling facility. Personnel must ensure that no shortnose sturgeon are held for longer than 12 hours, that water depth is sufficient, that water temperature does not exceed 27°C and that dissolved oxygen levels are at least 5mg/L at all times.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, the level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. FERC must immediately provide an explanation of the causes of the taking and review with NOAA Fisheries the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NOAA Fisheries has determined that the operation and maintenance of the Holyoke Project per the terms of the Settlement Agreement is not likely to jeopardize the continued existence of shortnose sturgeon in the Connecticut River or the species as a whole. To further reduce the adverse effects of the Holyoke Project on endangered shortnose sturgeon, NOAA Fisheries recommends that FERC implement the following conservation measures.

1. FERC and/or the licensee should support future research (beyond the 5 year study required by the Settlement) to identify migration patterns of shortnose sturgeon in the Connecticut River. A radio telemetry study should be designed to track fish, evaluate the effectiveness of downstream fish passage, and ascertain the use of upstream, downstream, and Holyoke Dam impoundment habitat. Based on the results of these migration studies, future research should also focus on eliminating barriers to this movement. The fishways as proposed in the Settlement were based on the best available information to pass shortnose sturgeon and are expected to safely pass other migrating fish. While proposed effectiveness studies will document the passage

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efficiency, new technologies should be explored to allow for easier passage and to further reduce upstream and downstream mortality.

2. FERC and/or the licensee should support future research to determine abundance, age structure, sex ratio, and recruitment of the Connecticut River shortnose sturgeon population. Knowledge of juvenile and male/female distribution could assist FERC and/or the licensee in assessing the effectiveness of the fish passageways on the long term viability of the shortnose sturgeon population. Information on the fitness and abundance of the upstream and downstream groups is essential to document to determine if the existing fishways are allowing downstream fish to spawn and upstream fish to effectively forage.

3. FERC and/or the licensee should support future research that evaluates the relationship between flow and the upstream migration of shortnose sturgeon. It has been found that increased river discharge may trigger fish movement to the dam (Kynard 1998). A study of this relationship would provide a better estimate of the flow needed for successful upstream migration by shortnose sturgeon. FERC could use this information to determine future adequate flow rates in the reach below the spillway.

4. FERC and/or the licensee should strive to minimize turbulence at the entrance of the tailrace fish lift to enhance the attraction of fish. Turbulence creates multi-directional cues that confuse fish, and unfortunately the tailrace fish lift entrance is located at the surface in the turbulent boil of the turbine outflow. This turbulence makes the tailrace lift highly ineffective, therefore the tailrace lift system could become more efficient at passing shortnose sturgeon upstream, if the turbulence could be minimized.

5. FERC should assist the licensee in developing a means to better monitor the downstream passage of shortnose sturgeon. This could involve establishing permanent antenna detection arrays at the canal bypass facility to detect downstream movement of shortnose sturgeon. This information would help HG&E and NOAA Fisheries better understand the natural migration patterns of shortnose sturgeon in the Connecticut River.

6. If any lethal take occurs, FERC and/or the licensee should arrange for contaminant analysis of the specimen. If this recommendation is to be implemented, the fish should be frozen and NOAA Fisheries should be contacted immediately to provide instructions on shipping and preparation.

7. If any lethal take occurs, the licensee should take fin clips for genetic analysis of the specimen. Fin clips should be returned to NOAA Fisheries to facilitate the ongoing analysis of the genetic composition of shortnose sturgeon populations. See Appendix E for proper procedures.

REINITIATION OF CONSULTATION

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This concludes formal consultation on the actions outlined in the Settlement for the Holyoke Hydroelectric Project. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in the Incidental Take Statement is met or exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. If the amount or extent of incidental take is exceeded, FERC must reinitiate consultation on the Holyoke Project immediately.

The conclusion of this biological opinion was based on the information available at the time of consultation. The conclusions of this consultation are based on the assumption that FERC will adopt the final Settlement Agreement as is and that the revised License for the Holyoke Project will include the license articles as proposed in the Settlement Agreement. Should the License that is ultimately issued by FERC differ from the intent of the Settlement Agreement or the license articles as currently proposed in the Settlement Agreement, this would constitute a modification of the identified action and FERC would need to reinitiate consultation promptly.

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APPENDIX A

Full Text of Selected License Articles Proposed in Settlement Agreement

Article 401. The licensee shall operate and maintain the inflatable rubber dam installed in November 2001 at the Project.

Article 405.

(a) *Run-of-River Operations.* The licensee shall operate the Project in a run-of-river mode and maintain a minimum impoundment elevation of 100.4 feet National Geodetic Vertical Datum (NGVD) with an allowable fluctuation of ±0.2 foot for the protection of water quality, aquatic and fisheries, and recreational resources of the Holyoke Project and Connecticut River. However, the licensee shall conduct an evaluation of potential modifications to run-of-river operations to address the goals stated in (b)(1) below. Until such time as the Commission authorizes the licensee to modify the run-of-river mode of operations through the process described in (b) and (c) below, the licensee shall at all times act to minimize the fluctuation of the impoundment surface elevation by maintaining a discharge from the Project so that, at any point in time, flows, as measured immediately downstream of the Project tailrace, approximate the sum of the inflows to the Project impoundment.

(b) *Testing of potential modifications to Run-of-River Operations.* As approved as part of the Comprehensive Operations Flow Plan (COFP) by FERC on June 24, 2003 (103 FERC ¶ 62,178), the licensee shall implement a plan for testing potential modifications to run-of-river operations that provides for the following:

(1) Consultation by the licensee as described in (e) below to identify management objectives related to the following resource goals: (A) to more effectively limit water level fluctuations at Rainbow Beach and other habitat areas for the federally threatened and state endangered Puritan tiger beetle upstream of the Project Dam; (B) to prevent injury or significant impairment of essential behavioral patterns to the federally and state endangered shortnose sturgeon; and (C) to balance the magnitude of the fluctuations in the lower and upper sections of the Impoundment; (D) to balance the impact on wetland areas adjacent to the lower and upper sections of the Impoundment; (E) to maintain the seasonally adjusted minimum flows into the bypass reach and the canal system as stated in License Article 406; and (F) to the extent possible, reduce fluctuations in river flows downstream of the Project;

(2) A provision pursuant to which the licensee would perform hydraulic model studies to evaluate effects of various operating regimes relative to the stated resource goals identified in (1) above;

(3) Consultation by the licensee as described in (e) below to develop a preferred operating regime and compliance measures that balance the licensee's operation

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constraints and the resource goals identified in (1) above;

(4) Implementation and monitoring by the licensee of the preferred operating regime determined under (3) above for a trial period of 12 months from the date of implementation, with a provision for continuation of the testing for up to an additional 12 months, if the U.S. Fish and Wildlife Service (FWS), U.S. NOAA National Marine Fisheries Service (NOAA Fisheries), Massachusetts Division of Fisheries and Wildlife (MADFW), Massachusetts Department of Environmental Protection (MADEP) and the licensee agree that river conditions in the impoundment during the test period were not representative of typical river flow conditions;

(5) Notification and response if, during the testing of the modified run-of-river operations, the licensee is unable to meet the Bypass Habitat Flows or the Bypass Zone-of-Passage Flows described in License Article 406; such notice to be provided to FWS, NOAA Fisheries, MADFW, MADEP, Trout Unlimited (TU), and C Connecticut River Watershed Council (CRWC) within 24 hours; with the licensee reverting immediately to the existing minimum flow; and with consultation as described in (e) below to modify or terminate the test of the modified run-of-river operations;

(6) Preparation by the licensee of the following evaluations using the data collected during the trial period: (A) an evaluation of the effects of the modifications to the run-of-river operations on the federally and state threatened and endangered species; (B) a determination of any appropriate revision to the Threatened and Endangered Species Protection Plan (including any necessary changes to reflect state species); (C) a determination of measures as appropriate to avoid adverse impacts to the federally and state endangered shortnose sturgeon, including stranding; (D) an evaluation of how the modifications to the run-of-river operations affected the licensee's ability to achieve flow elevations in the bypass reach (*i.e.*, Bypass Habitat Flows and Bypass Zone-of-Passage Flows pursuant to License Article 406); (E) a recommendation, if necessary, to modify the Texon Gage as a compliance measure for Bypass Habitat Flows and Bypass Zone-of-Passage Flows; (F) an evaluation of how the modifications to the run-of-river operations affect wetland areas adjacent to the lower and upper sections of the impoundment; (G) an evaluation of impacts of modified run-of-river operation on downstream flow fluctuations; and (H) to the extent possible, proposed measures to reduce fluctuations in river flows downstream of the Project;

(7) Circulation by the licensee of the results of the test of modified run-of-river operations and evaluations performed under the plan to FWS, NOAA Fisheries, MADFW, MADEP, TU, and CRWC, and consultation thereafter as described in (e) below on a proposed long-term resolution of the issue.

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(c) *Proposed modification of run-of-river operations.* In the event that there is consensus among the consulted parties as identified in (b)(4) above that a modification of the run-of-river operation requirement is needed to meet the goals stated in (b)(1) above, the licensee shall file the following with the Commission and the MADEP on or before November 30, 2004 [or within 3 months after any extension of the test period by written agreement of the licensee and FWS, NOAA Fisheries, MADFW, and MADEP, pursuant to (4) above]: (A) a report containing the results of the test of modified run-of-river operations, the evaluations performed under the plan, and any comments from the consulted parties; and (B) a proposed amendment to the COFP for a modified operating protocol. Copies of the report and proposed amendment shall also be provided to FWS, NOAA Fisheries, MADFW, MADEP, TU, and CRWC. The licensee shall implement the modified run-of-river operating protocol as approved by the Commission.

(d) *Emergencies and short period modifications.* The run-of-river mode operation and minimum impoundment surface elevation requirements may be temporarily modified if required by operating emergencies, so long as the emergency is beyond the control of the licensee, is not reasonably foreseeable, and could not have been avoided by the exercise of due care by the licensee. Further, releases may be temporarily modified because of an emergency for short periods upon mutual agreement between the licensee, the FWS, NOAA Fisheries, MADEP, and MADFW. If Project operations are so modified, the licensee shall notify the Commission and FWS, NOAA Fisheries, the MADEP and MADFW in advance if knowable or as soon as possible otherwise, but no later than 24 hours after each such incident, and shall provide the reason for the modified flow. The licensee shall also comply with the additional requirements in Condition 9(b) of the Water Quality Certification issued by the MADEP on February 14, 2001 (as incorporated in Article 421).

(e) *Consultation with resource agencies and other parties.* The licensee shall follow the consultation process described in License Article 420 and will distribute all reports to the resource agencies and other parties listed in that Article.

Article 406. The licensee shall release seasonally-adjusted minimum flows into the bypass reach and into the canal system for the protection and enhancement of water quality and aquatic and fisheries resources as described in this License Article. The flows released into the bypass reach when the fish lifts are not operational shall be of an amount that is determined to ensure an adequate water level in all bypass channels for fish habitat and that protects the federally and state endangered shortnose sturgeon from injury or significant impairment to essential behavioral patterns (Bypass Habitat Flows). Additionally, the flows released into the bypass reach when the fish lifts are operational shall be of an amount that is determined to ensure safe and successful passage of fish without injury or significant impairment to essential behavioral patterns (Bypass Zone-of-Passage Flows).

(a) *Bypass Zone-of-Passage Flows.* Within 60 days after the date of the order approving the Settlement and modifying the License Articles, and after consultation [as described in (i) below], the licensee shall file with the Commission, for approval, an amendment to the Comprehensive Operations and Flow Plan [as approved by the Commission on June 24, 2001 (103 FERC ¶ 62,178) (COFP)] to provide for the release of flows into the bypass reach, when the

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fish lifts are operational [as described in (a)(2) below], of an amount that ensures the safe and successful passage of diadromous fish (including the federally and state endangered shortnose sturgeon, when such passage is determined to be appropriate, as described below) and resident fish (when such passage is determined to be necessary, as described below), without injury or significant impairment to their essential behavioral patterns. All flows into the bypass reach shall be correlated to the Texon Gage. The following provisions shall achieve that goal:

(1) A provision for the release of flows to the bypass reach sufficient to achieve the water surface elevations in the bypass reach which correspond to the 1997 Barnes & Williams IFIM Study of 1300 cfs flow as measured in the bypass reach. It is agreed that flows achieving a water surface elevation of 62.85 +/- 0.1 feet National Geodetic Vertical Datum (NGVD) at the Texon Gage (as defined in (a)(3) below) satisfy this requirement;

(2) A provision describing that the fish lifts at the Project will be operational for the period April 1 through November 15 of each year, as refined by U.S. Fish and Wildlife Service (FWS), U.S. NOAA National Marine Fisheries Service (NOAA Fisheries), Massachusetts Division of Fisheries and Wildlife (MADFW), Massachusetts Department of Environmental Protection (MADEP) on an annual basis; provided, however, that the fish lifts will not be operational during the period July 15 through September 15 until such time as: (A) NOAA Fisheries determines that upstream passage of the federally and state endangered shortnose sturgeon over the dam is appropriate; or (B) MADFW and FWS determine that resident fish passage is necessary; and

(3) A provision describing the Texon Gage as the benchmark to measure water surface elevations NGVD for the purposes of determining the Bypass Habitat Flows and the Bypass Zone-of-Passage Flows through: (A) the correlation of NGVD elevations to the readings on the existing Texon Staff Gage (located on the Texon Building); (B) the use of NGVD elevations as confirmed on an electronic gage to be located adjacent to the Texon Building; or (C) the use of an equivalent mechanism for determining NGVD elevations in the future as agreed to by the licensee and the resource agencies in consultation pursuant to paragraph (i) below.

(b) *Bypass Habitat Flows*. Within 60 days after the date of the order approving the Settlement and modifying the License Articles, and after consultation [as described in (i) below], the licensee shall file with the Commission, for approval, an amendment to the COFP to provide for the release of flows into the bypass reach, when the fish lifts are not operational [as described in (a)(2) above], of an amount that ensures an adequate water level in all bypass channels for fish habitat and that protects the federally and state endangered shortnose sturgeon from injury, stranding, or significant impairment to their essential behavioral patterns. All flows into the bypass reach shall be correlated to the Texon Gage. The following provisions shall achieve that goal:

(1) A provision for Interim Bypass Habitat Flows for the release of flows to the bypass reach sufficient to achieve the water surface elevations in the bypass reach which correspond to the 1997 Barnes & Williams IFIM Study of 840 cfs flow as measured in the bypass reach. It is

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agreed that flows achieving a water surface elevation of 62.3 +/- 0.1 feet NGVD at the Texon Gage [as defined in (a)(3) above] satisfy this requirement; and

(2) A plan to establish Permanent Bypass Habitat Flows for normal operations and maintenance conditions at the Project based on the Interim Bypass Habitat Flows adjusted and modified based on flow demonstrations performed for normal operating conditions (*i.e.*, with releases through the Bascule Gate) and for maintenance conditions (*i.e.*, with releases through Rubber Dam Section No. 1 (section at South Hadley end of dam), when the Bascule Gate is out of service): (A) the evaluation of water surface elevations and the distribution of flows in the bypass after the Spring 2004 fish passage season, and (B) determination if any channel modifications for flow distributions or changes to the Interim Bypass Habitat Flows are necessary to achieve the water surface target elevations from the 1997 Barnes and Williams study for each of the three bypass channels in the bypass reach to provide an adequate water level for fish habitat and to prevent any adverse impacts to the federally and state endangered shortnose sturgeon, including injury, stranding, or significant impairment to essential behavioral patterns. If it is determined that there is a need for modifications to the Holyoke (West) Channel or a need for changes to the Interim Bypass Habitat Flows, after consultation [as described in (i) below], the licensee shall file an application to amend the license for the Project to the extent required by the Commission's regulations. Any changes proposed under such an application for license amendment shall be coordinated with changes based on the modified run-of-river operations set forth under License Article 405.

(c) *Canal Minimum Flows.* Within 60 days after the date of the order approving the Settlement and modifying the License Articles, and after consultation [as described in (i) below], the licensee shall file with the Commission for approval an amendment to the COFP, as necessary, to provide for the release of seasonally-adjusted minimum flows into the canal system that include all of the following provisions:

(1) A provision for interim canal system minimum flows into the canal system, downstream of the louver bypass facility, of 400 cfs consistent with the Comprehensive Canal Operations Plan [as approved by the Commission on June 5, 2003 (103 FERC ¶ 62,130) (CCOP)] and the COFP. The licensee shall use generation records (consistent with the form and content of the filings made at the Commission for the period in question) and unit rating curves as an interim compliance measure; and

(2) The plan to establish permanent canal system minimum flow compliance measures to ensure a 400 cfs continuous minimum flow into the canal system downstream of the louver facility, as filed with the MADEP in December 2003. The plan includes –

(A) The use of head gate openings and pond elevations to determine the quantity of flow (calculated from gate opening/discharge relationships) and flow measurements in the first level canal (using new flow measurement equipment installed in the first level canal) to ensure adequate flow distribution;

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(B) The filing with the Commission and the MADEP on or before June 30 2004, of permanent compliance measures as a revision to the CCOP as necessary; and

(C) A provision that if significant modifications are made by the licensee or any other entity on the canal, after establishment of the permanent canal system minimum flows, that could change leakage or the distribution of flow in the canal system, the licensee will evaluate the magnitude and distribution of flows in the canal system. Then, in consultation [as described in (i) below], the licensee shall file a proposed revision to the permanent canal system minimum flow compliance measures contained in the CGOP as necessary to achieve the resource management objectives and the minimum flow requirements set forth in this License Article and agreed to by the resource agencies and other parties [pursuant to consultation as described in (i) below].

(d) *Canal System Outage Procedures.* Within 60 days after the date of the order approving the Settlement and modifying the License Articles, and after consultation [as described in (i) below], the licensee shall file with the Commission for approval an amendment to the COFP, as necessary, to provide canal system drawdown procedures and operation of weirs in the canal to protect and enhance mussel species including the federally and state listed endangered dwarf wedgemussel and the state listed endangered yellow lampmussel as follows:

(1) To provide interim canal system outage procedures that provide for:

(A) Maintenance of minimum flows through the headgates sufficient to ensure that the pool between Boatlock and Riverside remains at an elevation equal to the Riverside Station intake sill elevation and at ambient river temperature throughout the drawdown period;

(B) Maintenance of sufficient flows from the Project headgates to provide water in the first level canal (once maintenance is completed) to protect the state listed endangered yellow lampmussel at the lower end of the louvers;

(C) Keeping No. 3 Overflow closed until the end of the canal system outage period, at which time it may be opened for inspection and maintenance;

(D) Maintenance of measures for the protection of mussels if heavy machinery is used in the canal during the canal system outage period;

(E) A plan for evaluation of the experimental weir in the first level canal to

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determine if it retains water and develop and implement plans to modify as required; and

(F) A plan for evaluation of the need for additional weirs to keep mussel habitat areas watered.

(2) To provide permanent canal system outage procedures that provide:

(A) Based on the evaluations of the Spring and Fall 2004 canal system outages, the licensee shall consult pursuant to (i) below to modify the interim canal system outage procedures (including the drawdown procedures, experimental weir, and any additional weirs) to the extent necessary to protect and enhance mussel species including the federally and state listed endangered dwarf wedgemussel and the state listed endangered yellow lampmussel, and to generally ensure sufficient flows into the canal system during the outages for the protection and enhancement of water quality and aquatic and fisheries resources;

(B) On or before January 31, 2005, the licensee shall file with the Commission, for approval as an amendment to the CCOP, a permanent canal system outage plan for canal drawdowns that addresses the following: Provisions implemented in the Spring and Fall 2004 canal system outage [as stated in (d)(2)(A) above], the evaluation and potential installation of a permanent weir in 2005 and/or additional weirs as necessary, and an update of the matters addressed in the interim canal system outage procedures;

(C) The licensee shall notify all canal water users and FWS, NOAA Fisheries, MADEP, MADFW, Trout Unlimited, and Connecticut River Watershed Council prior to any canal system outage; and

(D) The licensee shall implement the plan as approved by the Commission.

(e) *Flow Prioritization*. The licensee shall operate the Holyoke Project according to the following flow prioritization plan:

Minimum Project Flow Prioritization During Fish Passage		
Priority	**Spring Passage**	**Fall Passage**
1	Canal to 400 cfs (plus 150 cfs for louvers)	Canal to 400 cfs (plus 150 cfs for louvers)
2	Bypass Reach Habitat Flows	Bypass Reach Habitat Flows
3	Fishway Attraction Water up to 440 cfs	Fishway Attraction Water up to 440 cfs

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4	Bypass Reach Zone-of-Passage Flows	Bypass Reach Zone-of-Passage Flows
5	Hadley Falls Unit 1	Hadley Falls to capacity, as long as canal has at least 3,000 cfs
6	Canal to 2,000 cfs	
7	Hadley Falls to capacity	

The licensee shall file any proposed modification to that flow prioritization plan as a proposed revision to the COFP after consultation [as described in (i) below].

(f) *Monitoring.* The licensee shall specify the methods for operating and releasing bypass reach and canal system minimum flows as required by License Article 407 of this license, and shall monitor compliance with the minimum flows as required by License Article 408.

(g) *Emergencies.* Releases from the Holyoke Project may be temporarily modified if required by operating emergencies, so long as the emergency is beyond the control of the licensee, is not reasonably foreseeable, and could not have been avoided by the exercise of due care by the licensee. Further, releases may be temporarily modified because of an emergency for short periods upon mutual agreement between the licensee, the FWS, NOAA Fisheries, the MADEP, and the MDFW. If the flows are so modified, the licensee shall notify the Commission and FWS, NOAA Fisheries, the MADEP and MADFW in advance if knowable or in advance or as soon as possible otherwise, but no later than 24 hours after each such incident, and shall provide the reason for the modified flow.

(h) *Changes.* If the information reported pursuant to this License Article indicates that a different flow regime is needed to protect and enhance water quality or aquatic and fisheries resources in the Project vicinity of the Connecticut River, the Commission may require such changes.

(i) *Consultation with resource agencies and other parties.* The licensee shall follow the consultation process described in License Article 420 and will distribute all reports to the resource agencies and other parties listed in that Article.

Article 407.

(a) The licensee shall implement the Comprehensive Operations and Flow Plan as approved by the Commission on June 24, 2003 (103 FERC ¶ 62,178) (COFP), including run-of-river operation, bypass flows, and fish passage operational flows.

(b) With respect to any proposed modifications to the COFP, the licensee shall follow the consultation process described in License Article 420.

(c) The Commission reserves the right to require changes to any proposed modifications to the COFP. Construction of any flow release mechanism(s) or structure(s) shall not begin until

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the Commission notifies the licensee that the proposed modified COFP is approved. The licensee shall implement the modified COFP as approved by the Commission, including any changes required by the Commission. Any flow release mechanism(s) or structure(s) constructed by the licensee shall be shown on the as-built drawings filed pursuant to License Article 303 of this license.

(d) If the information reported pursuant to License Articles 404, 408, and 410 indicates that a different flow regime or method of achieving the flow regime is necessary to provide adequate protection and enhancement of water quality or aquatic and fisheries resources in the Project vicinity of the Connecticut River, the Commission may require such changes.

Article 408. The licensee shall operate the Project to protect and enhance water quality and mussel populations in the canal system.

(a) *General canal operations.* The licensee shall implement the Comprehensive Canal Operations Plan, as approved by the Commission on June 5, 2003 (103 FERC ¶ 62,130) (CCOP) [with the amendments to the CCOP contained in the Comprehensive Operations and Flow Plan, as approved by the Commission on June 24, 2003 (103 FERC ¶ 62,178)] to protect and enhance water quality and mussel populations in the canal system. With respect to any proposed modifications to the CCOP, the licensee will consult with the resource agencies and the other parties as specified in paragraph (d) below.

(b) *Operation of the full depth louvers and exclusion racks.* The licensee shall continue to operate, clean and otherwise maintain the full depth louvers, installed in the first level of the canal system in Fall 2002 and the exclusion racks at the attraction water intake gates to ensure efficient and reliable operation of these facilities for the protection of aquatic resources. The licensee shall annually inspect the full depth louvers and exclusion racks, and repair them as necessary. In the event the full depth louver facility is out of service during the fish passage season as described in License Article 411(a)(2), the canal system will not be operated and the headgates will be closed to seal flows into the canal. If necessary, at the end of the fish passage season a slow drain of the canal will be performed to return any fish to the Connecticut River. In the event of a failure of the canal louver bypass system, the licensee shall shut the canal down. If there is a structural failure of the louver panels, the licensee shall notify Massachusetts Division of Fisheries and Wildlife (MADFW), U.S. Fish and Wildlife Service (FWS), and U.S. NOAA National Marine Fisheries Service (NOAA Fisheries) within 24 hours and shall implement a slow drain procedure to allow any fish in the canal downstream of the louver facility to return to the River.

(c) *Effectiveness studies of full depth louvers.* The licensee shall implement the effectiveness study plan for the full depth louvers as they affect surface migrants pursuant to the effectiveness study plan addressed in Section 4.3(g) of the Settlement. In consultation [as described in (d) below], the licensee will prepare and file an effectiveness study plan for the full depth louvers as they affect bottom migrants (as addressed in Section 4.7(c)(1)(B) of the Settlement) with the Commission and Massachusetts Department of Environmental Protection (MADEP) on or before July 1, 2004. The effectiveness of the full depth louvers will be

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evaluated based on the overall downstream fish passage goal of safely and successfully passing the fish without injury or significant impairment to essential behavioral patterns. The study results regarding facility effectiveness shall be circulated to FWS, NOAA Fisheries, MADFW, MADEP, Trout Unlimited, and Connecticut River Watershed Council, and filed with the Commission and MADEP no later than December 31 of the year of completion of the study. If based on the louver effectiveness studies, and any other relevant information in the record of this proceeding, the licensee, the resource agencies and the other parties [in consultation as described in (d) below] determine that the full depth louvers are effective, the licensee may close the Boatlock Station Bypass.

(d) *Consultation with resource agencies and other parties.* The licensee shall follow the consultation process described in License Article 420 and will distribute all reports to the resource agencies and other parties listed in that Article.

(e) The Commission reserves the right to require changes to any proposed modification to the CCOP. The licensee shall implement the modified CCOP as approved, including any changes required by the Commission. If the results of monitoring indicate that changes in Project structures or operations are necessary to protect and enhance water quality and mussel populations in the canal system (*e.g.*, canal operations and/or structures), the Commission may direct the licensee to modify Project structures or operations.

Article 409.

(a) The licensee shall implement the Fish and Aquatic Habitat Plan, as approved by the Commission on June 24, 2003 (103 FERC ¶ 62,175), to monitor fish and aquatic habitat and fish populations within the bypass reach and the Holyoke canals. The licensee will propose to modify the plan, if necessary, based on the 2003 and 2004 canal system outages and to track the 12-year plan in the Fish and Aquatic Habitat Plan (as addressed in Section 4.11(e) of the Settlement). In addition, the licensee shall implement the provision of the Comprehensive Canal Operations Plan, as approved by the Commission on June 5, 2003 (103 FERC ¶ 62,130) with respect to monitoring of canal mussel populations.

(b) The licensee shall follow the consultation process described in License Article 420 with respect to any proposed modifications to, or reporting, under the Fish and Aquatic Habitat Plan.

(c) The Commission reserves the right to require changes to any proposed modifications to the Fish and Aquatic Habitat Plan. Implementation of the modified plan shall not commence until the Commission notifies the licensee that the filing is approved. The licensee shall implement the modified plan as approved by the Commission, including any changes required by the Commission.

(d) If the results of the monitoring plan indicate that changes in Project structures or operations [including any measures identified by the licensee, the resource agencies and the other parties in consultation as described in (b) above] are necessary to protect aquatic and fisheries

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resources, the Commission may direct the licensee to modify Project structures or operations accordingly.

Article 410. The licensee shall install, operate, and maintain downstream fish passage facilities at the Holyoke Project that safely and successfully pass diadromous and resident fish without injury or significant impairment to essential behavioral patterns. The licensee shall further implement and enhance downstream fish passage in several phases as described below. The downstream fish passage facilities are to be designed, constructed and operated to: (i) prevent entrainment or impingement in the Project intake system, (ii) prevent injury to fish if passed over or through the dam onto the spillway, and (iii) ensure that all downstream migrating diadromous and resident fish that appear on the upstream side of the dam shall be passed downstream without injury or significant impairment to essential behavioral patterns.

Operational deadlines for new downstream fish passage facilities shall depend on whether Phase 2A or Phase 2B is implemented, as determined by the licensee in consultation with the resource agencies [U.S. Fish and Wildlife Service (FWS), U.S. NOAA National Marine Fisheries Service (NOAA Fisheries), Massachusetts Division of Fisheries and Wildlife (MADFW), and Massachusetts Department of Environmental Protection (MADEP)] and other parties [Trout Unlimited (TU) and Connecticut River Watershed Council (CRWC)] pursuant to (c) below. If in consultation with the resource agencies the licensee implements Phase 2A, then the complete downstream passage facilities are to be operational by no later than April 1, 2010, although the licensee shall provide interim (and potentially long-term) facilities to prevent entrainment and impingement in the intake system by April 1, 2006. If in consultation with the resource agencies the licensee implements Phase 2B, then the complete downstream passage facilities are to be operational by no later than April 1, 2009. Regardless of the Phase implemented, the licensee shall monitor effectiveness of the facilities and make additional improvements as provided for below.

(a) *Downstream fish passage.* The licensee shall implement the Downstream Fish Passage Plan [as approved by the Commission on June 19, 2003 (103 FERC ¶ 62,165)] to cover the operation, maintenance, and evaluation of the existing downstream fish passage facilities at the Holyoke Project until modification of that plan is authorized by the Commission under paragraph (b) below. With respect to any proposed modifications to the Downstream Fish Passage Plan, the licensee will consult with the resource agencies and the other parties as specified in paragraph (c) below.

(b) *Downstream fish passage enhancements* – Within 60 days after the date of the order approving the Settlement and modifying the License Articles (as described in License Article 420), and after consultation [as described in (c) below], the licensee shall file with the Commission and MADEP, for approval, a plan to enhance the existing downstream fish passage facilities at the Holyoke Project that includes:

(1) *Phase 1 – 2004-2005.* During the period 2004 through 2005, in consultation with the parties pursuant to paragraph (c) below, the licensee shall implement modifications to the Downstream Sampling Facility; shall potentially implement modifications to the Louver

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Bypass Discharge Pipe (as set forth below); shall implement operational changes to prioritize flows from the Hadley units to the canal during Fall evening hours; and shall conduct research and studies (as set forth below). Based on such research, on or before December 31, 2005, the licensee [in consultation pursuant to paragraph (c) below], shall determine whether to implement Phase 2A or Phase 2B (as described below in paragraphs (c) and (d) below). The Phase 1 work will include:

(A) To minimize the potential for injury to federally and state endangered shortnose sturgeon if they enter the Downstream Sampling Facility, after initial consultation pursuant to paragraph (c) below, the licensee will develop a plan to modify the Downstream Sampling Facility with such modifications to be completed by April 15, 2004, and to test the effectiveness of such modifications thereafter in 2004. The plan shall be filed with the Commission and the MADEP on or before March 1, 2004. The licensee will implement the plan as approved in writing by the Commission. If, after such modifications, evidence of injury to shortnose sturgeon is found, the licensee will consult with the resource agencies and other parties pursuant to paragraph (c) below to determine if any additional modifications are appropriate. The licensee will operate the Downstream Sampling Facility in accordance with the Downstream Sampling Facility Operating Protocol, attached as Appendix G to the Settlement.

(B) The licensee will evaluate the effect of the height from the drop of the Louver Bypass Discharge Pipe to the tailrace on shortnose sturgeon through a radio tracking study. If, in consultation pursuant to paragraph (c) below, the licensee determines it is necessary to reduce the height of the drop from the Louver Bypass Discharge Pipe to the tailrace to enhance the survival of shortnose sturgeon, the licensee shall propose how best to modify the Louver Bypass Discharge Pipe in a plan to be filed [after consultation pursuant to paragraph (c) below] that provides for such modifications to be implemented in 2005, to be operational for the Spring 2006 Upstream Passage Season, and effectiveness testing of the modifications in 2006 after the modifications are implemented. The licensee shall file the plan with the Commission and the MADEP on or before April 1, 2005 and shall implement the plan as approved in writing by the Commission.

(C) To reduce entrainment, the licensee will develop a plan [in consultation pursuant to paragraph (c) below] to change flow prioritization from the Hadley Falls units to the Canal during nighttime periods from October 1 through the later of: (i) the time when the River temperature reaches 5° C., or (ii) November 30 [unless the resource agencies and other parties, in consultation pursuant to paragraph (c) below, agree to an earlier time], with prioritizing the Canal first and then regulating the Hadley Falls Station. The licensee shall file the plan with the Commission and the MADEP on or before December 31, 2004, and shall implement the plan as approved in writing by the Commission. The licensee will also consult with the resource agencies and other parties [pursuant to paragraph (c) below] to determine if additional or alternative operational changes will enhance downstream passage.

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(D) In consultation pursuant to paragraph (c) below, the licensee shall conduct a Louver Field Study in 2004: (i) to evaluate effectiveness of the full depth louvers to guide shortnose sturgeon and American eels; and (ii) to evaluate the behavior of shortnose sturgeon and American eels at the ramp and the entrance to the bypass pipe.

(E) In consultation pursuant to paragraph (c) below, the licensee shall conduct CFD Modeling in 2004: (i) of the Hadley Falls intakes to evaluate the potential of modifying the existing Hadley Falls intake racks to be an effective interim (and potentially long-term) device to prevent entrainment and impingement of fish at the Hadley Falls; and (ii) of a potential bottom weir to evaluate if such a weir would produce flow patterns conducive to guide bottom migrants into the Canal.

(F) In consultation pursuant to paragraph (c) below, the licensee shall conduct a USGS Flume Study in 2004: (i) to determine the swimming depth and behavior of yearling, juvenile and adult shortnose sturgeon at a bar rack structure; (ii) to determine the threshold velocity for avoidance of impingement/entrainment of yearling, juvenile, and adult shortnose sturgeon at conditions present at the proposed modified Hadley Falls intake racks with 2-inch spacing; and (iii) to determine if yearling, juvenile, and adult shortnose sturgeon can avoid impingement/entrainment at conditions present at a potential alternative bar rack facility (2-inch spacing and velocities of 2 fps).

(G) In consultation pursuant to paragraph (c) below, the licensee shall conduct a USGS Flume Study in 2005: (i) to determine how shortnose sturgeon would respond to a bottom weir for guidance; and (ii) to determine how shortnose sturgeon would respond to a bypass entrance, integral with a rack structure.

(H) In consultation pursuant to paragraph (c) below, the licensee shall conduct a Bascule Gate and Rubber Dam Section No. 5 Analysis (comprised of a desk-top study) in 2005: (i) to identify potential solutions to the interference of the Bascule Gate discharge on the entrance to the spillway fishway; (ii) to evaluate the feasibility of using/modifying the Bascule Gate and/or modifying the spillway in the vicinity of Rubber Dam Section No. 5 (adjacent to the Bascule Gate) to pass shortnose sturgeon, American eels and other migratory fish; and (iii) to investigate modifications to the Bascule Gate and/or the spillway in the vicinity of Rubber Dam Section No. 5 to safely and successfully pass the fish without injury or significant impairment to essential behavioral patterns down the spillway and over the apron into the Bypass Reach.

(I) In consultation pursuant to paragraph (c) below, the licensee shall conduct an Eel Study in 2004 to determine the timing of migration of silver-phase American eels at the Project.

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(J) In consultation pursuant to paragraph (c) below, the licensee shall conduct a Spawning Study in 2005 to identify potential spawning sites for shortnose sturgeon downstream of the Dam.

(2) *Decision Point – 2005.* Based on the results of the Phase 1 research, on or before September 30, 2005, the licensee will distribute to the resource agencies and other parties [as provided in paragraph (c) below] a recommendation on whether to implement Phase 2A or Phase 2B, as described below. It is the intent that the licensee will implement Phase 2A as set forth in paragraph (b)(3) below if: (i) if the results of the Phase 1 studies (described above) demonstrate that the licensee can modify the existing Hadley Falls intake racks to be an effective interim (and potentially long-term) exclusion device while achieving the threshold velocity for avoidance of entrainment and impingement of fish; and (ii) there is a potential solution to the Bascule Gate discharge interference on the spillway fishway and a means of providing safe passage down the spillway and over the apron have been identified. If the two elements (i) and (ii) above are not confirmed by the FWS, NOAA Fisheries, MADEP and MADFW pursuant to the process described below, then the licensee shall implement Phase 2B.

The process for determining whether the licensee will implement Phase 2A or Phase 2B shall be as follows: After circulation by the licensee of the study results and the licensee's recommendation for Phase 2A or Phase 2B, the licensee shall consult pursuant to paragraph (c) below. On or before December 31, 2005, FWS, NOAA Fisheries, MADEP and MADFW shall notify the licensee if they all agree with the licensee's recommendation; in which case, the licensee shall implement that recommendation. If FWS, NOAA Fisheries, MADEP and MADFW do not all agree with the licensee's recommendation, they will so notify the licensee by December 31, 2005, and the licensee will then implement Phase 2B.

(3) *Phase 2A – 2006-2010.* Based on the Phase 1 research, consistent with the decision made pursuant to paragraph (b)(2) above, and in consultation pursuant to paragraph (c) below, the licensee shall implement the work and research as outlined below for further enhancements of the downstream fish passage facilities. Under Phase 2A the licensee shall: (i) continue to implement operational changes commenced in 2005 to enhance downstream passage of shortnose sturgeon; (ii) construct and install an interim (and potentially long-term) device by the end of 2006 that prevents entrainment and impingement at the Project based on modifications of the Hadley Falls intake racks and installation of a new trash rake structure connected with the intake racks; (iii) prepare a functional design drawing of the selected option to modify the Bascule Gate to safely and successfully pass fish without injury or significant impairment to essential behavioral patterns and to solve interference of Bascule Gate discharge on the spillway fishway, then build a prototype and field test (if necessary) in 2006, with engineering/permitting in 2007 and construction in 2008; (iv) undertake additional research during the period 2006 to 2010 to ensure that the downstream passage facilities are effective for exclusion and safe and successful passage of fish over the dam; (v) design, engineer, and permit in 2008: (A) an alternative exclusion and (B) an alternative passage device in the vicinity

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of Rubber Dam Section No. 5 (if the modifications to the Hadley Falls intake racks are determined not to be successful as a long-term exclusion device), to safely and successfully pass fish without injury or significant impairment to essential behavioral patterns, with construction of these facilities completed in 2009, and with the start of effectiveness testing of these facilities in 2010; and (vi) implement a long-term monitoring program for shortnose sturgeon from 2011 to the end of the Project License. The specific schedule is as follows:

2006

- The licensee shall design, engineer, permit, build and complete the modifications to existing Hadley Falls intake racks and installation of a new trash rake structure, as agreed to at the Decision Point 2005 above, as an exclusion device for downstream migrating fish including shortnose sturgeon to prevent entrainment and impingement at the Hadley Falls intakes. The modifications to the Hadley Falls intake racks and the installation of the new trash rake will be completed by the end of 2006 (or earlier if possible depending on River conditions and obtaining necessary permits).

- The licensee shall continue to implement operational changes commenced in 2005.

- The licensee shall prepare a functional design drawing of the selected option to modify the Bascule Gate for safe passage and to solve interference of Bascule Gate discharge on spillway fishway; build prototype and field test (if necessary).

- The licensee shall conduct effectiveness studies of the modifications to the Louver Bypass Discharge Pipe if implemented in 2005 and shall distribute the results to the resource agencies and other parties pursuant to paragraph (c) below.

- The licensee shall perform radio tracking studies of shortnose sturgeon and silver-phase American eels, and shall distribute the results to the resource agencies and other parties pursuant to paragraph (c) below.

2007

- The licensee shall engineer, design and permit modifications to the Bascule Gate to provide safe and successful passage for the fish without injury or significant impairment to essential behavioral patterns and to solve the interference of Bascule Gate discharge on the spillway fishway.

- The licensee shall continue to perform radio tracking studies of shortnose sturgeon and use such studies to evaluate the effectiveness of the modifications to the Hadley Falls intake racks completed in 2006; shall continue to perform radio tracking studies of silver-phase American eels, if necessary; and shall distribute the results to the resource agencies and other parties pursuant to paragraph (c) below.

2008

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- The licensee shall provide to the resource agencies and other parties (consulted pursuant to paragraph (c) below) the results of the effectiveness testing of the modifications to the Hadley Falls intake racks and other measures in 2006-2007, and the licensee's conclusion whether those modifications and other measures achieve the goals for Phase 2A as stated above. Based on that information the licensee, the resource agencies and other parties (through the decisional process described in Appendix F, Part III, Decision Point – 2005, of the Settlement) shall determine if it is necessary to build an alternative exclusion device

    - If (through the decisional process described in Appendix F, Part III, Decision Point – 2005, of the Settlement) the resource agencies (FWS, NOAA Fisheries, MADEP and MADFW) determine that it is not necessary for the licensee to build an alternative exclusion device, then the licensee shall design, engineer, permit and construct the modifications to the Bascule Gate, for fish passage.

    - If (through the decisional process described in Appendix F to the Settlement) the resource agencies (FWS, NOAA Fisheries, MADEP and MADFW) determine that it is necessary for the licensee to build an alternative exclusion and passage device(s), then the licensee shall design, engineer and permit: (i) an alternative exclusion device, and (ii) an alternative passage device (in the vicinity of Rubber Dam Section No. 5), as determined by the resource agencies and other parties (in consultation pursuant to paragraph (c) below) that will not only exclude fish from the Hadley Falls intakes without impingement, but will also provide for safe and successful downstream passage of fish without injury or significant impairment to essential behavioral patterns.

- The licensee shall continue to perform radio tracking studies of shortnose sturgeon and distribute results to the resource agencies and other parties pursuant to paragraph (c) below.

- The licensee shall conduct a Population Survey for shortnose sturgeon in the Connecticut River, from Long Island Sound to Turners Falls (as described more fully in Appendix F to the Settlement Agreement) and distribute the results to the resource agencies and other parties pursuant to paragraph (c) below.

2009

- As determined to be necessary in 2008, the licensee shall bid, build and complete construction of device(s) designed and permitted in 2008 (in consultation with the resource agencies and other parties pursuant to paragraph (c) below).

- The licensee shall continue radio tracking studies of shortnose sturgeon and distribute the results to the resource agencies and other parties pursuant to paragraph (c) below.

2010

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- The licensee shall commence operation of the device(s) constructed in 2009 prior to April 1, 2010.

- The licensee shall, in consultation pursuant to paragraph (c) below, develop a plan to study the effectiveness of the exclusion and passage device(s) completed in 2008-2009; shall implement that plan; and shall distribute the results to the resource agencies and other parties by January 31, 2011, pursuant to paragraph (c) below.

- The licensee shall consult [pursuant to paragraph (c) below] to develop long-term monitoring protocol for shortnose sturgeon during the term of the License for the Project, with distribution of the results annually to the resource agencies and other parties pursuant to paragraph (c) below. If after 2010 the licensee determines, in consultation pursuant to paragraph (c) below, that shortnose sturgeon are not passing safely downstream of the Project, the licensee will consult further with the resource agencies and other parties pursuant to paragraph (c) below to determine a plan for re-evaluating the downstream passage facilities.

Plans to implement each part of Phase 2A above shall be prepared and submitted to the resource agencies and other parties pursuant to paragraph (c) below. The licensee shall consult with the resource agencies and other parties, and/or obtain the concurrence and/or approval of that plan, pursuant to paragraph (c) below. Thereafter, the licensee shall file such plans with the Commission and the MADEP, and shall implement such plans as approved in writing by the Commission.

(4) *Phase 2B – 2006-2009.* Based on the Phase 1 research, consistent with the decision made pursuant to paragraph (b)(2) above, and in consultation pursuant to paragraph (c) below, the licensee shall implement the work and research as outlined below for further enhancements of the downstream fish passage facilities. Under Phase 2B the licensee shall: (i) to continue to implement operational changes commenced in 2005 to enhance downstream passage of shortnose sturgeon; (ii) to continue studies and research to determine the appropriate alternative exclusion and passage device(s), including an angled bar rack; (iii) to design/permit measures and modifications in 2007 for: (A) an alternative exclusion device, and (B) an alternative passage device (in the vicinity of Rubber Dam Section No. 5) to safely and successfully pass fish without injury or significant impairment to essential behavioral patterns and avoid any potential flow interference problems with the spillway fishway, construct these facilities in 2008, and start effectiveness testing of these facilities in 2009; (iv) to undertake additional research and additional measures from 2006 to 2009 to ensure that the downstream passage facilities are effective for exclusion and guidance as described below; and (v) to implement a long-term monitoring program for shortnose sturgeon from 2010 to the end of the Project License. The specific schedule is as follows:

2006

- The licensee shall perform a full feasibility study of options for an alternative passage device (in the vicinity of Rubber Dam Section No. 5) to: (i) safely and

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successfully pass the fish without injury or significant impairment to essential behavioral patterns down the spillway over the apron and into the Bypass Reach, and (ii) avoid any potential flow interference problems with the spillway fishway. Build prototype and field test (if necessary).

- The licensee shall continue to implement operational changes commenced in 2005.

- The licensee shall consult pursuant to paragraph (c) below to develop a research and study program to evaluate alternative exclusion and passage device(s).

- The licensee shall perform radio tracking studies of shortnose sturgeon and silver-phase American eel; and shall distribute the results to the resource agencies and other parties pursuant to paragraph (c) below.

- The licensee shall conduct effectiveness studies of the modifications to the Louver Bypass Discharge Pipe if performed in 2005 and shall distribute the results to the resource agencies and other parties pursuant to paragraph (c) below.

2007

- In consultation with the resource agencies and other parties pursuant to paragraph (c) below, the licensee shall design/engineer/permit: (i) an alternative exclusion device and (ii) an alternative passage device (in the vicinity of Rubber Dam Section No. 5), determined in 2006 by the licensee, the resource agencies and the other parties (in consultation pursuant to paragraph (c) below) to safely and successfully pass the fish without injury or significant impairment to essential behavioral patterns down the spillway over the apron and into the Bypass Reach, avoiding any potential flow interference problems with the spillway fishway, that will not only exclude fish from the Hadley Falls intakes without impingement, but also provide for safe and successful downstream passage of migratory and resident fish.

- The licensee shall continue to implement operational changes commenced in 2005.

- The licensee shall continue radio tracking studies of shortnose sturgeon and shall distribute the results to the resource agencies and other parties pursuant to paragraph (c) below.

2008

- As designed and permitted in 2007, in consultation with the resource agencies and other parties pursuant to paragraph (c) below, the licensee shall bid, build and complete construction of: (i) the alternative exclusion device, and (ii) the alternative passage device.

- The licensee shall continue to implement operational changes commenced in 2005.

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- The licensee shall continue radio tracking studies of shortnose sturgeon and shall distribute the results to the resource agencies and other parties pursuant to paragraph (c) below.

- The licensee shall conduct a Population Survey for shortnose sturgeon in the Connecticut River, from Long Island Sound to Turners Falls (as described more fully in Appendix F to the Settlement Agreement) and distribute the results to the resource agencies and other parties pursuant to paragraph (c) below.

2009

- The licensee shall commence operation of the device(s) constructed in 2008 prior to April 1, 2009.

- The licensee shall, in consultation pursuant to paragraph (c) below, develop a plan to study the alternative exclusion and passage devices completed in 2008; shall implement the plan; and shall distribute the study results to resource agencies and other parties by January 31, 2010, pursuant to paragraph (c) below.

- The licensee shall consult resource agencies and other parties pursuant to paragraph (c) below to develop long-term monitoring protocol for shortnose sturgeon during the term of the License for the Project, with distribution of the results annually to the resource agencies and other parties pursuant to paragraph (c) below. If after 2009 the licensee determines, in consultation pursuant to paragraph (c) below, that shortnose sturgeon are not passing safely downstream of the Project, the licensee will consult further with the resource agencies and other parties pursuant to paragraph (c) below to determine a plan for re-evaluating the downstream passage facilities.

Plans to implement each part of Phase 2B above shall be prepared and submitted to the resource agencies and other parties pursuant to paragraph (c) below. The licensee shall consult with the resource agencies and other parties, and/or obtain the concurrence and/or approval of that plan, pursuant to paragraph (c) below. Thereafter, the licensee shall file such plans with the Commission and the MADEP, and shall implement such plans as approved in writing by the Commission.

(c) *Consultation and the filing of plans*. The licensee shall follow the consultation process described in License Article 420.

(d) The Commission reserves the right to require changes to any plan filed. Implementation of any provision outlined in a plan shall not commence until the Commission notifies the licensee that the plan is approved. Upon Commission approval, the licensee shall implement the plan, including any changes required by the Commission. Any structure built in accordance with a plan shall be shown on the as-built drawings filed pursuant to License Article 303.

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Article 411. The licensee shall install, operate, and maintain upstream fish passage facilities at the Holyoke Project that ensure that all upstream migrating diadromous and resident fish are able to safely and successfully pass upstream of the Project without injury or significant impairment to essential behavioral patterns. Upstream passage shall include the federally and state endangered shortnose sturgeon and resident fish only when the resource agency(ies) determines it is necessary or appropriate as described more fully below. The licensee shall implement and enhance upstream fish passage as outlined in Phase 1 and Phase 2A/2B described below.

(a) *Upstream fish passage – Phase 1.* Within 60 days after the date of the order approving the Settlement and modifying the License Articles (as described in License Article 420), and after consultation [as described in (e) below], the licensee shall file with the Commission and Massachusetts Department of Environmental Protection (MADEP), for approval, an amendment to the Upstream Fish Passage Plan [as approved by the Commission on June 24, 2003 (103 FERC ¶ 62,177)] to cover the operation, maintenance, and evaluation of the existing upstream fish passage facilities (including the enhancements completed since issuance of the 1999 License Order) at the Holyoke Project that includes:

(1) The upstream passage facilities listed as including: (A) the attraction water system, (B) the tailrace entrance and lift tower, (C) the spillway entrance and lift tower, (D) the spillway transport channel, (E) the entrance flume with the fish trapping and viewing station, (F) the exit flume, (G) trapping and hauling system, and (H) the fish exit channel.

(2) The following enhancements already performed to the upstream passage facilities (completed after issuance of the 1999 License Order) listed as including: (A) modification of the gate insert in the west tailrace entrance to improve flows for fish passage, (B) modifications to the Holyoke (West) Channel in the bypass reach to reduce stranding of upstream migrants, (C) improvement to the "V Gate" in the tailrace entrance gallery to reduce shad milling, and (D) increased elevation of the area above the Hadley Falls Station draft tubes to provide for operation up to 40,000 cfs river flow.

(3) The continued operation of the tailrace and spillway fish lift facilities, as described herein during the Upstream Passage Season (to be defined as from April 1 through November 15 of each year), as refined by the U.S. Fish and Wildlife Service (FWS), the NOAA National Marine Fisheries Service (NOAA Fisheries), MADEP and Massachusetts Division of Fisheries & Wildlife (MADFW) on an annual basis; provided, however, that the fish lifts shall not be operational for the period from July 15 to September 15 of each year until such time as: (A) NOAA Fisheries determines that upstream passage of shortnose sturgeon over the Dam is appropriate; or (B) MADFW and FWS determine that resident fish passage is necessary. The specific dates and hours of operation of the fish lifts during these periods is to be determined by MADFW in consultation with the licensee in accordance with Condition 14(d) of the Water Quality Certification issued by the MADEP in February 2001, and in consultation with NOAA Fisheries once upstream passage of shortnose sturgeon is implemented;

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(4) A provision that except for Fall 2004, the licensee will not interrupt fish lift operations during the Upstream Passage Season; and a functioning trap for salmon and the ability to trap and truck shad will be available during the Upstream Passage Season before and after construction in 2004;

(5) A provision that when shortnose sturgeon appear at the fish lift facilities but are not to be lifted, the licensee shall follow the Shortnose Sturgeon Handling Plan (attached as Appendix E to the Settlement);

(6) A provision that the licensee will implement measures and procedures to operate the No. 2 Overflow in such a manner to avoid releasing water during Upstream Passage Season when the fish lifts are operational pursuant to the No. 2 Overflow Procedures (attached as Appendix D to the Settlement);

(7) Provisions for: (A) maintaining the fish passage facilities in proper order and keeping such facilities clear of trash, logs, and material that would hinder passage; (B) performing maintenance such that the fish passage facilities would operate effectively prior to and during the Upstream Passage Season; and (C) developing a fish passage maintenance plan describing the anticipated maintenance, a maintenance schedule, and contingencies; and

(8) A provision to allow agency personnel access to the project site and to pertinent project records, for the purpose of inspecting the fish passage facilities.

(b) *Upstream fish passage – Phase 2.* Within 90 days after the date of the order approving the Settlement and modifying the License Articles (as described in License Article 420), and after consultation [as described in (e) below], the licensee shall file with the Commission and MADEP, for approval, a plan to enhance the existing upstream fish passage facilities at the Holyoke Project that includes:

(1) Completion of the installation of the following improvements by the Spring 2005 Upstream Passage Season, with development of final detailed plans and schedule in consultation [as described in (e) below], and submittal of final detailed plans and schedule to the Commission for approval:

(A) Replacement of the tailrace lift tower, auxiliary equipment and hopper to accommodate 33 cubic feet per minute capacity;

(B) Replacement of the spillway tower, auxiliary equipment and hopper to accommodate 46 cubic feet per minute capacity;

(C) Increase of the width of the spillway transport channel to an average width of 6 feet;

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(D) Modifications to the exit flume to accommodate the new spillway lift location;

(E) Increase of the width of the fish exit channel up to a maximum of 14 feet between the lift towers and the fish counting station;

(F) Installation of a high capacity adjustable drain valve in the flume;

(G) Addition of a second fish trap and viewing window in the exit flume;

(H) Expansion of the fish counting station to include both fish traps;

(I) Modification of the fish trapping and hauling system to improve the work area and minimize hoisting and netting of fish; and

(J) Modification of the attraction water supply system to provide up to 200 cfs at the spillway entrance and 120 cfs at each of the tailrace entrances.

(2) A schedule that provides for construction to begin in 2004 and be completed prior to the start of the Spring 2005 Upstream Passage Season;

(3) Milestones to identify target completion dates for key components to ensure compliance with Spring 2005 Upstream Passage Season requirements; and

(4) Contingency plans for unexpected delays in construction. If, by November 1, 2004, it is determined that the licensee will not meet the start of the operation of the fish lifts pursuant to (a)(1) above, or the planned construction is substantially behind schedule, then the licensee shall promptly consult with the resource agencies and other parties (no later than November 30, 2004) to develop and agree on alternatives for fish lift operations for the Spring 2005 Upstream Passage Season.

(c) *Effectiveness testing of upstream fish passage facilities.* The licensee shall evaluate and monitor the effectiveness of the upstream fish passage facilities for diadromous and resident fish as follows:

(1) On or before September 30, 2004, the licensee shall circulate to the resource agencies and the other parties [as described in (e) below], a proposed plan for the evaluation and monitoring of the effectiveness of upstream fish passage facilities. Such plan shall include, but not be limited to, the following:

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(A) Evaluation of operation and attraction flows;

(B) Evaluation of the adequacy and effectiveness of the 7-foot-wide exit channel upstream of the counting station, the existing 4.5-foot-wide spillway entrance, and the existing 6-foot-wide spillway entrance channel to provide upstream fish passage;

(C) Evaluation of the ability to achieve the target design populations for upstream fish passage at the Project (1,000,000 each for American shad and blueback herring; 6,000 for Atlantic salmon; unquantified for American eels, and an estimated 500 shortnose sturgeon); and

(D) Annual reports to be distributed to the resource agencies and other parties [as described in (e) below] by December 31st of each year.

After consultation as described in (e) below, on or before November 30, 2004, the licensee shall file that plan with the Commission and the MADEP, and shall implement the plan as approved by the Commission.

(2) By December 31, 2006, the licensee shall distribute a cumulative report of the study results of the effectiveness testing to the resource agencies and other parties [as described in (e) below], which report shall include conclusions and recommendations as to whether the goal as stated at the beginning of this License Article has been achieved. Within three months after distribution of the report, the licensee shall consult [as described in (e) below] with respect to the study results.

(3) If, based on the study plan and the study results described in (c)(1) and (c)(2) above, the report concludes that the upstream passage facilities and measures are not accomplishing the objective stated above, or if the study does so conclude but the MADEP, MADFW, FWS and/or NOAA Fisheries do not concur with the conclusions in the report, in consultation with the licensee and the other parties [as described in (e) below], the licensee will develop plans to modify the upstream fish passage facilities including, if necessary:

(A) Increasing the width of the exit channel upstream of the counting station to 10 feet;

(B) Increasing the width of the spillway entrance to 8 feet; and/or

(C) Increasing the width of the spillway entrance channel to 8 feet.

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The licensee shall circulate such plans and a schedule for the implementation of the modifications to the resource agencies and the other parties [as described in (e) below] and shall propose any modifications as a result of comments. After consultation [as described in (e) below], the licensee shall file the final plans and schedule with the Commission (in the form of an application to amend the License for the Project) and with the MADEP (for approval consistent with Condition 14(c) of the Water Quality Certification issued by the MADEP on February 14, 2001, as incorporated in Article 421) that addresses the proposed changes to fishway operations or structures determined to be necessary to protect and enhance fish passage for diadromous and resident fish. The licensee will implement the plan as approved by the Commission.

(4) If, based on the effectiveness study results, the MADEP, MADFW, FWS and NOAA Fisheries, in consultation with the licensee and the parties [as described in (e) below], are unable to determine whether or not the new upstream fish passage facilities are effective or what modifications are necessary to the facilities in order to meet the goal of safe and successful upstream fish passage as described above, the licensee will extend the plan for evaluation and monitoring of the effectiveness of such facilities for diadromous and resident fish (as described in (c)(1) and (c)(2) above) for an additional year, with a report distributed to the resource agencies and other parties [as described in (e) below]. Based on the extension of the study, on or before December 31, 2007, the licensee will prepare a cumulative report and follow the procedures in (c)(2) above. If, after this one-year extension of the study, the licensee, the resource agencies and the other parties are unable to determine whether or not the new facilities are effective or what modifications are necessary to the facilities in order to meet the goal of safe and successful upstream fish passage as described above, then the licensee will extend or schedule additional evaluation and monitoring as determined to be needed pursuant to consultation described in (e) below.

(5) Following completion of construction under (c)(3) above, the licensee shall consult with the resource agencies and other parties [as described in (e) below] whenever necessary and as requested by the resource agencies to assess the effectiveness of the upstream fish passage facilities to pass shortnose sturgeon and other diadromous and resident, including an evaluation of the ability to achieve the target design populations for upstream fish passage as described in (c)(1)(C) above. If NOAA Fisheries, FWS, and/or MADFW determine, based on the study results under (c)(1) above, that modifying the spillway entrance to the upstream passage facilities and/or an adjustment to the attraction flows is necessary to meet the goal of safe and successful upstream passage of shortnose sturgeon and other diadromous and resident, the licensee shall implement the modifications as directed by NOAA Fisheries, FWS and MADFW, and as approved in writing, as necessary, by the Commission.

(d) *Annual report and monitoring of upstream fish passage facilities.* On or before January 31 of each year, the licensee shall submit to the resource agencies and other parties [as described in (e) below] and the Connecticut River Atlantic Salmon Commission a report of the previous year's activities relative to the operation of the upstream fish passage facilities

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[including the number of fish lifted, relative to the target design populations for upstream fish passage as described in (c)(1)(C) above and plans for the next year's activities]. The licensee shall monitor upstream passage for diadromous and resident fish including, but not limited to, counting, trapping, monitoring, and collection of biological data consistent with Condition 15 of the Water Quality Certification issued by the MADEP on February 14, 2001 (as incorporated in Article 421).

(e) *Consultation and the filing of plans*. The licensee shall follow the consultation process described in License Article 420.

(f) The Commission reserves the right to require changes to any plan filed. Implementation of any provision outlined in a plan shall not commence until the Commission notifies the licensee that the plan is approved. Upon Commission approval, the licensee shall implement the plan, including any changes required by the Commission. Any structure built in accordance with a plan shall be shown on the as-built drawings filed pursuant to License Article 303.

Article 413.

(a) Upon completing construction of new, or modifications to existing upstream and downstream fish passage facilities required by License Articles 410-412 the licensee shall monitor the use and effectiveness of those fish passage facilities, pursuant to the plans developed under those License Articles, to ensure effective fish and eel passage. In addition, the licensee shall monitor effectiveness of: (i) the channel modifications [as specified in the Comprehensive Operations and Flow Plan as approved by the Commission on June 24, 2003 (103 FERC ¶ 62,178)]; and (ii) the full depth louvers in the first level of the canal system pursuant to a plan to be filed with the Commission on or before July 1, 2004 [as specified in License Article 408(c) above].

The effectiveness monitoring plans shall include the specific provisions for monitoring the effectiveness of the specific facility, as well as a schedule for: (1) implementation of that plan; (2) consultation as described in (b) below concerning the results of the monitoring; and (3) filing the results, the resource agencies' and other parties' comments, and the licensee's response to the comments, with the Commission and the Massachusetts Department of Environmental Protection .

(b) The licensee shall follow the consultation process described in License Article 420, and shall also provide copies of all reports to the Connecticut River Atlantic Salmon Commission.

(c) The Commission reserves the right to require changes to the effectiveness monitoring plans. Implementation of any provision outlined in the plans shall not commence until the Commission notifies the licensee that the filing is approved. The licensee shall implement the plan(s) as approved by the Commission, including any changes required by the Commission.

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Article 414.

(a) Except as otherwise provided in License Articles 410-412 above, the licensee shall prepare an annual construction plan for fishway construction to be undertaken in that coming year, in consultation as described in (b) below. A draft of that construction plan will be provided to the resource agencies and other parties on or before January 31 of each year, containing the detailed plans and schedule for fishway construction to be undertaken during that calendar year; the construction plan shall be designed to avoid interruption of the operation of the fish lifts at the Project. The licensee shall file the construction plan with the Commission and Massachusetts Department of Environmental Protection on or before February 28 before the applicable construction period commences.

(b) The licensee shall follow the consultation process described in License Article 420.

(c) The Commission reserves the right to require changes to the proposed construction schedule. The licensee shall implement the construction plan as approved by the Commission, including any changes required by the Commission.

Article 415. Authority is reserved to the Commission to require the Licensee to construct, operate, and maintain, or to provide for the construction, operation, and maintenance of, such fishways as may be prescribed by the Secretary of the Interior or the Secretary of Commerce, as appropriate, pursuant to Section 18 of the Federal Power Act.

Article 416.

(a) The licensee shall implement the Threatened and Endangered Species Protection Plan (T&E Plan) as approved by the Commission on June 6, 2003 (103 FERC ¶ 62,131) covering the federally and state endangered shortnose sturgeon (*Acipenser brevirostrum*), federally threatened and state endangered bald eagle (*Haliaeetus leucocephalus*), federally threatened and state endangered Puritan tiger beetle (*Cicindela puritana*), federally endangered and state endangered dwarf wedge mussel (*Alismidonta heterodon*), and state endangered yellow lampmussel (*Lampsilis cariosa*).

(b) The licensee shall follow the consultation process described in License Article 420 with respect to any proposed modifications to the T&E Plan.

(c) The Commission reserves the right to require changes to any proposed modifications to the T&E Plan. The licensee shall implement the modified T&E Plan as approved by the Commission, including any changes required by the Commission.

Article 420. The licensee must comply with the conditions imposed upon it in Part IV of the Settlement (and the Appendices referenced therein) covering the Holyoke Project, as filed with the Commission on March __, 2004.

With respect to a plan, modification to a plan, or work to be undertaken pursuant to the Settlement, the licensee shall first provide a draft of such plan, modification to a plan, or description of work to the resource agencies [U.S. Fish and Wildlife Service (FWS), U.S. NOAA

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National Marine Fisheries Service (NOAA Fisheries), Massachusetts Division of Fisheries and Wildlife (MADFW), Massachusetts Department of Environmental Protection (MADEP)] and to the other parties (Trout Unlimited and Connecticut River Watershed Council), providing a minimum of 30 days for review, comment and recommendations prior to filing the plan with the FERC and the MADEP. Prior to filing the plan or description of work with the FERC and the MADEP, the licensee shall obtain the concurrence and/or approval of that plan/work from the resource agency or resource agencies as follows: (1) FWS and/or NOAA Fisheries for a plan/work which may impact a resource for which FWS and/or NOAA Fisheries have responsibilities under the Endangered Species Act (U.S.C. §1531, *et seq.*); (2) MADFW and/or MADEP for a plan/work which the MADFW and MADEP have responsibilities under the Massachusetts Endangered Species Act (M.G.L. c. 131A); (3) MADEP for a plan/work subject to Water Quality Certification issued by the MADEP on February 14, 2001 (as incorporated in Article 421); and/or (4) FWS and/or NOAA Fisheries for all decisions on measures needed for fish passage, fish passage design drawings, and fish passage implementation schedules for which the FWS and/or NOAA Fisheries have specific statutory responsibility under the Federal Power Act (with such concurrence and/or approval not unreasonably withheld, and with any refusal to concur/approve to be based on sound science).

The licensee shall include with the filing with the FERC and the MADEP documentation of consultation; copies of comments and recommendations on the proposed plan, modified plan and/or work after it has been prepared and provided to the resource agencies and the other parties consulted, and specific descriptions of how the comments are accommodated by the licensee's proposed plan and/or work. If the licensee does not adopt a recommendation by an agency or other party [other than a recommendation by an agency(ies) from which the licensee shall obtain prior concurrence and/or approval, as described in (i), (ii) and (iii) above], the filing shall include the licensee's reasons, based on project-specific information.

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APPENDIX B

Louver Bypass Pipe and Fish Sampling Facility Operating Procedures

This procedure needs to be used when opening and closing the louver bypass pipe and operating the louver bypass fish sampling facility. **The fish sampling facility must be staffed whenever it is operating in sampling mode.**

TO FILL THE PIPE WITH WATER

The following instructions assume that the bypass pipe is empty and: 1) the upstream slide gate is closed; 2) the downstream slide gate is open and the pipe is empty; 3) both two-inch ball valve air vents are open; and 4) the sluice gates at the fish sampling facility are closed.

Step 1. Close the downstream slide gate.

Step 2. Open the upstream gate two inches. At this opening the pipe should fill in about ten minutes.

Step 3. As the pipe fills, air should be coming out of both air vents. When water starts to come out of the downstream air vent at the access manhole, close the valve completely. When air stops coming out of the upstream air vent at the canal wall, the pipeline is full—close that air vent.

Step 4. Open the upstream gate completely.

TO PLACE THE FACILITY IN SAMPLING MODE

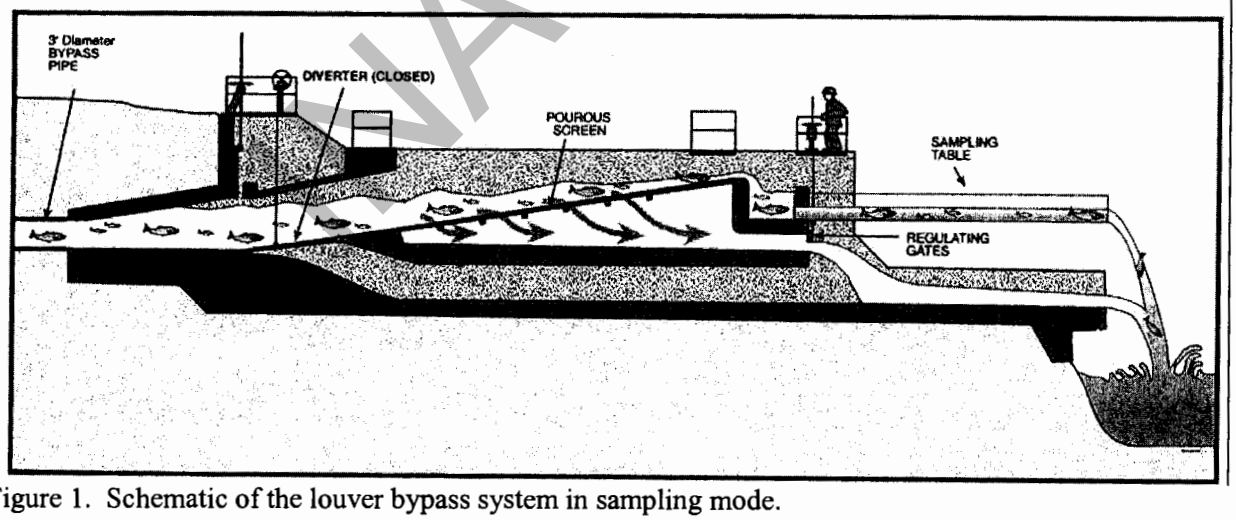

Figure 1. Schematic of the louver bypass system in sampling mode.

The following instructions assume that the pipe is full of water:

Step 1. Lower diversion vane.

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Step 2. Open both sluice gates on fish sampling facility.

Step 3. Check to see that there is no one in the fish sampling facility (all three levels) and open the downstream slide gate slowly at a rate of no more than two feet per minute.

Step 4. Allow 3-4 minutes for the flow to reach steady state.

Step 5. Adjust the sluice gates to achieve the desired amount of flow over the weir into the sampling trough. Gates should be moved in 0.1 foot increments. Wait 1-2 minutes between gate adjustments for flow to return to steady state.

TO PLACE THE FACILITY IN NON-SAMPLING (BYPASS) MODE

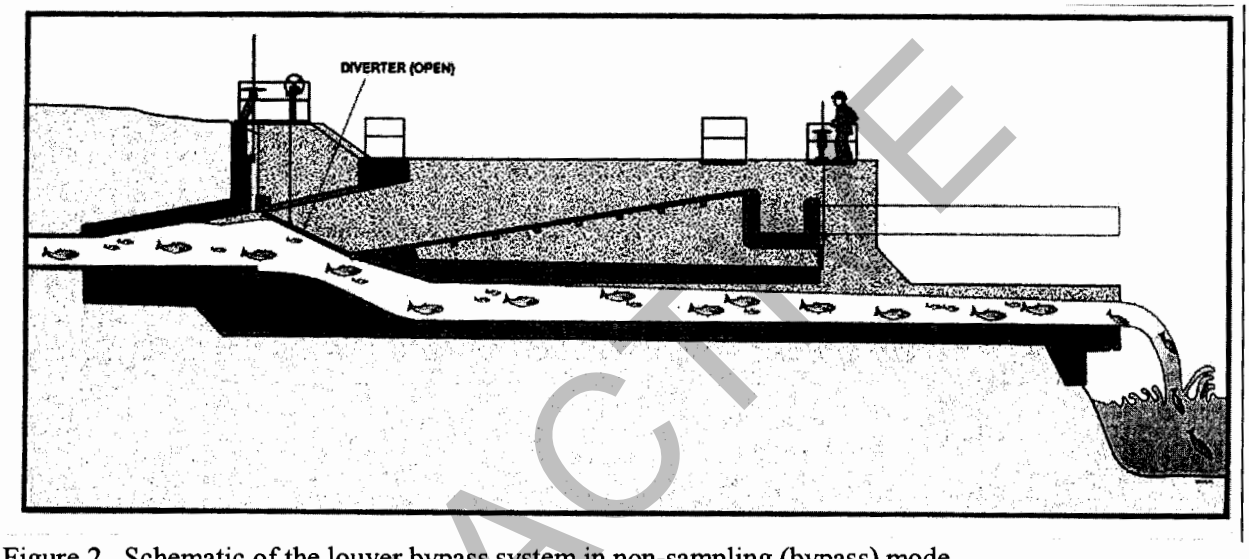

Figure 2. Schematic of the louver bypass system in non-sampling (bypass) mode.

The following instructions assume that the facility is in sampling mode:

Step 1. Raise the diversion vane completely.

Step 2. Check to see that there is no one in the fish sampling facility (all three levels) and open the downstream gate slowly, no more than two feet per minute.

TO SHUTDOWN AND DEWATER THE BYPASS PIPE

The following instructions assume that the sampling facility is in non-sampling (bypass) mode.

Step 1. Close the downstream slide gate slowly at a rate of no more than two feet per minute.

Step 2. Close the upstream slide gate completely.

Step 3. Raise the manhole cover over the upstream air vent at the canal wall and open the valve completely.

Step 4. Raise the diversion vane about a foot to allow flow and fish to pass under it.

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Step 5. Open the downstream slide gate 0.1 feet to drain the pipeline. Do not allow anything to block the flow of air to the vent. Do not open the gate more than 0.1 feet at this time.

Step 6. After five minutes, open the downstream air vent. Water may come out of the vent at this time.

Step 7. When water stops coming out of the downstream air vent, open the downstream slide gate to 1.0 foot.

NOTE: Except during emergency conditions, such as a pipe break, the upstream slide gate should not be used to shutdown flow in the pipeline. This could lead to excessive negative pressures in the pipeline, which would cause the pipeline to collapse. If you must close the upstream slide gate, also open the upstream air vent.

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APPENDIX C

Shortnose Sturgeon Handling Plan

Shortnose sturgeon (SNS) are listed as a federally and state endangered species. Historically, over one hundred SNS have been lifted upstream at Holyoke Dam. With the use of radio tags and PIT tags, it has been determined that many SNS also migrate downstream of the Holyoke Dam. In the past, SNS have been found at Holyoke in the spillway lift, the attraction water flume, the tailrace attraction water channel, the bypass reach pools and the dam apron pools. This plan addresses how SNS found at the Holyoke dam will be handled and how this handling will be documented during 2004. SNS may be encountered by personnel during fish lift operations, at the downstream sampling station and in the event of stranding. Procedures for handling fish and documenting these interactions are outlined below. All contact information and the appropriate reporting form follow these procedures. All personnel counting fish at the fish lift counting windows and louver bypass fish sampler will be trained to properly handle SNS by Micah Kieffer or Boyd Kynard from USGS, Conte Anadromous Fish Research Center.

Fish Lift Operations

Due to concerns regarding the safety of downstream passage for SNS, SNS are not currently being passed above the Holyoke dam. Should any SNS be found in the fish lift, the licensee shall implement the procedures and reporting requirements outlined below. A number of Connecticut River SNS carry inactive radio tags that were implanted during earlier studies of SNS migratory behavior. These SNS were also PIT tagged. A list of these PIT tag numbers will be provided to personnel counting fish. If any of these fish are captured, Micah Kieffer or Boyd Kynard from USGS, Conte Anadromous Fish Research Center will be contacted (see contact information below). They will remove the radio tags and record information on the internal condition of these SNS. If any SNS carrying an internal radio tag with an external antenna are observed, Micah Kieffer or Boyd Kynard from USGS, Conte Anadromous Fish Research Center, will be contacted and will respond and assess the condition of these fish.

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1. For each SNS detected, the licensee shall record the weight, length, and condition of the fish. Each SNS will be checked for PIT, Carlin, radio, or other tags (see above). Tag numbers will be recorded and, if not previously tagged, the fish may be tagged with a PIT tag. River flow, minimum flow in the bypassed reach, and water temperature will be recorded. All relevant information will be recorded on the reporting sheet, "*SHORTNOSE STURGEON REPORTING SHEET FOR THE HOLYOKE PROJECT*," a copy of which is attached hereto).

2. The licensee shall follow the contact procedure outlined below to obtain a contact with the appropriate ESA permit/approval for handling SNS.

3. If alive and uninjured, the SNS will be immediately returned downstream. A long handled net will be used to place the SNS in the tailrace from the deck behind the powerhouse.

4. If any injured SNS are found, the licensee shall report immediately to NOAA Fisheries (see contact information below). Injured fish must be photographed and measured, if possible, and the reporting sheet must be submitted to NOAA Fisheries within 24 hours. If badly injured, the licensee shall retain the injured fish, if possible, until transported to a NOAA Fisheries-recommended facility for potential rehabilitation.

5. If any dead SNS are found, the licensee must report immediately to NOAA Fisheries (see contact information below). Any dead specimens or body parts should be photographed, measured and preserved by the licensee until they can be obtained by NOAA Fisheries for analysis.

Downstream Sampling Station

SNS may be encountered by personnel operating the downstream sampling station. Due to the shallow depths and tight turns of the sampling station table, it may not be appropriate for SNS to stay on the table and return to the river through the table exit. To help monitor downstream passage of SNS and to minimize the likelihood of adverse affects, the licensee shall implement the following procedures and reporting requirements:

1. Any SNS observed in the sampling station will be immediately removed with a net and placed in an appropriate holding tank. SNS will not be allowed to stay on the sampling station table. For each fish detected, the licensee shall record the weight, length, and condition. Each SNS will be checked for PIT, Carlin, radio, or other tags. The licensee shall record tag numbers and, if not previously tagged, the fish may be tagged with a PIT tag. A number of Connecticut River SNS carry inactive radio tags that were implanted during earlier studies of SNS migratory behavior. These SNS were also PIT tagged. A list of these PIT tag numbers will be provided to personnel counting fish. If any of these fish are captured, Micah Kieffer or Boyd Kynard from USGS, Conte Anadromous Fish Research Center will be contacted. They will remove the radio tags and record information on the internal condition of these SNS. If any SNS carrying an internal radio tag with an external antenna are observed, Micah Kieffer or Boyd Kynard from USGS, Conte Anadromous Fish Research Center will be contacted and will respond and assess the condition of these fish. River flow and water temperature will be recorded. All relevant information will be recorded on the reporting sheet "*SHORTNOSE STURGEON REPORTING SHEET FOR THE HOLYOKE PROJECT*," (see attached form).

2. The licensee shall follow the contact procedure(s) outlined below to obtain the appropriate ESA permit/approval for handling SNS.

3. If alive and uninjured, the SNS will be immediately returned downstream. A long handled net will be used to place the SNS in the tailrace.

4. If any injured SNS are found, the licensee shall report immediately to NOAA Fisheries

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(see contact information below). Injured fish must be photographed and measured, if possible, and the reporting sheet must be submitted to NOAA Fisheries within 24 hours. If badly injured, the licensee should retain the injured fish, if possible, until transported to a NOAA Fisheries-recommended facility for potential rehabilitation.

5. If any dead SNS are found, the licensee must report immediately to NOAA Fisheries (see contact information below). Any dead specimens or body parts should be photographed, measured and preserved by the licensee until they can be obtained by NOAA Fisheries for analysis.

Shortnose Sturgeon Stranding

The potential exists for SNS to be stranded in pools below the Holyoke dam whenever there is a significant change in the bypass flows or in minimum flows in the bypassed reach. If this situation occurs, these pools need to be checked as soon as possible for the presence of SNS and the following protocol shall be followed:

1. Designated HG&E employees and fish lift operation staff must monitor the pools below the dam as soon as possible after such a change.

2. The licensee shall follow the contact procedure outlined below to obtain an appropriate ESA permit/approval for handling SNS.

3. For each fish removed from the pool, the licensee shall record the weight, length, and condition. Each SNS will be checked for PIT, Carlin, radio, or other tags. Tag numbers will be recorded and if not previously tagged, the fish may be tagged with a PIT tag. River flow, minimum flows in the bypassed reach, and water temperature will be recorded. All relevant information will be recorded on the reporting sheet "*SHORTNOSE STURGEON REPORTING SHEET FOR THE HOLYOKE PROJECT*" (see attached).

4. If stranded but alive and uninjured, the SNS will be moved to a pool in the bypassed reach that will provide egress out of the area.

5. If any injured SNS are found, the licensee shall report immediately to NOAA Fisheries (see contact information below). Injured fish must be photographed and measured, if possible, and the reporting sheet must be submitted to NOAA Fisheries within 24 hours. If badly injured, the licensee should retain the injured fish, if possible, until transported to a NOAA Fisheries-recommended facility for potential rehabilitation.

6. The licensee shall report any dead fish immediately to NOAA Fisheries (see contact information below). Any dead specimens or body parts should be photographed, measured and preserved by the licensee until they can be obtained by NOAA Fisheries for analysis.

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7. Contact Rich Murray (HG&E) at 413-536-9453; Chris Tomichek (Kleinschmidt Associates) at 860-526-2358; Bob Stira (NGS) at 860-810-1948.

Contact information:

- If any SNS are detected – contact Conte Anadromous Fish Lab: Micah Kieffer at (413) 863-3817; or Boyd Kynard at (413) 863-3807. If unavailable, contact Massachusetts Division of Fish and Wildlife: Caleb Slater at (508) 792-7270 (133); or Mark Tisa at (508) 792-7270 (129).

- Within 24 hours of any stranding event or contact with an injured or dead SNS, contact NOAA Fisheries Northeast Regional Office: Pat Scida at (978)-281-9208; or Julie Crocker at (978) 281-9328 x6530, and fax any reporting sheets to 978-281-9394.

Reports at end of passage seasons

- At the end of the upstream and downstream passage seasons, copies of all reporting sheets will be sent to:

Endangered Species Coordinator
Protected Resource Division
NOAA Fisheries
One Blackburn Drive
Gloucester, MA 01930-2298

Chris Tomichek
Kleinschmidt Associates
161 River Street
P.O. Box 1050
Deep River , CT 06417

Boyd Kynard
S.O. Conte Anadromous Fish Research Center
P.O. Box 796
Turners Falls, MA 01376

Caleb Slater
Massachusetts Div. of Fisheries and Wildlife
One Rabbit Hill Road
Westborough, MA 01581

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SHORTNOSE STURGEON REPORTING SHEET FOR THE HOLYOKE PROJECT

Date:_____ Time:_____

Physical conditions
Is spill being released over the dam? YES NO
What is the approximate gauged river flow?_____ (Ex. 45,000 cfs)
What is the approximate gauged minimum flow in the bypass reach?_____
What is the approximate gauged minimum flow in the canal reach?_____
Water temperature (°C): at surface_____ and/or at bottom_____

Are fishways operating (circle)? YES NO
If yes, circle one or both: TAILRACE SPILLWAY

Is project generating? YES NO
If yes, what units are currently being operating? UNIT1 UNIT2

Location from where species was recovered (circle): TAILRACE LIFT SPILLWAY LIFT DAM
APRON POOLS ATTRACTION WATER STRUCTURE CANAL BYPASS
OTHER _____
If fish lift, estimate condition of lift: EMPTY FEW FISH MODERATE FULL VERY FULL

Species information:
Total Length:_____ Fork length:_____ Weight:_____
Condition of fish: _____

Does the sturgeon have visible injuries or abrasions? YES NO
If Yes, circle and code area of abrasions on sturgeon diagram on back side of sheet.

Was sturgeon previously tagged? YES NO
If tagged, what type? CARLIN PIT RADIO OTHER_____
What is the tag number?_____

If not tagged, did you tag the fish? YES NO
If yes, what type of tag and ID number? TYPE_____ID#_____

Comments/other:_____
_____
_____
_____
_____

Name of watch observer:_____

Observer's Signature:_____

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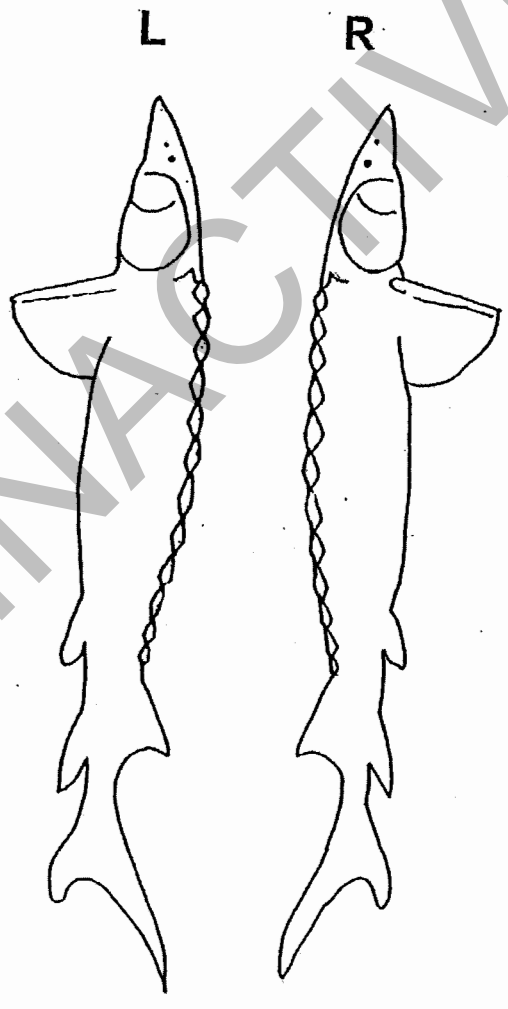
Abrasion Codes

None

Light Whitening or smoothed scutes; early sign of skin abrasion.

Moderate Early sign of redness on skin, scutes or fins; erosion of skin over bony structures; loss of skin pigment.

Heavy Large portion of skin red, scutes excessively worn, damaged, or missing; patches of skin missing; boney structures exposed; flaccid musculature.



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APPENDIX D

Take associated with the Holyoke Project as exempted by the Incidental Take Statement.

	Type of Take	Before Upstream Passage Modifications 2004	After Upstream Passage Modifications 2005-2009	After Downstream Passage Modifications 2010 – future
Upstream Passage	Harass, trap, capture, collect in fish lift and associated facilities	***28*** (11% upstream migrants)	***250*** (25% downstream population)	***350*** (25% total population)
	Injury associated with entering and transport in fish lifts	***25*** (89% of fish captured in fish lifts)	***0***	***0***
	Harm – abandon upstream passage attempt or do not attempt to pass upstream	***250*** (100% potential upstream migrants)	***250*** (100% potential upstream migrants)	***0***

	Type of Take	Before Modifications 2004-2009	After Modifications 2010 – future
Downstream Passage	Killed by entrainment in turbines	***12*** (38% downstream migrants)	***0***
	Killed by going over dam or through Bascule gate	***2*** (7% downstream migrants)	***17*** (5% downstream migrants)
	Harass, trap, capture, collect fish traveling through bypass pipe and/or downstream sampling station	***17*** (55% downstream migrants)	***315*** (90% downstream migrants)
	Harm – abandon downstream passage attempt	***69*** (17% upstream population/69% potential downstream migrants)	***17*** (5% downstream migrants)

	Type of Take	Before Modifications 2005-2009	After Modifications 2010 – future
Stranding in pools below dam	Harass, trap, capture, collect in removal attempts	***3 per 5 years*** (5 year running average)	***3 per 5 years*** (5 year running average)

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Storage of Sample

1. If it is not possible to immediately send the sample to NOAA Fisheries, the sample should be refrigerated or frozen.

Sending of Sample

1. All vials should be sealed with a lid and further secured with tape. Vials should be placed into Ziploc or similar resealable plastic bags. Vials should be then wrapped in bubble wrap or newspaper (to prevent breakage) and sent to:

   NOAA Fisheries
   Northeast Regional Office
   Protected Resources Division
   Attn: Endangered Species Coordinator
   One Blackburn Drive
   Gloucester, MA 01930

2. Upon sending a sample, contact Julie Crocker at (978) 281-9328 ext. 6530 or Pat Scida at (978) 281-9208 to inform NOAA Fisheries to expect a sample.

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