Missouri River Recovery Management Plan and Environmental Impact Statement

Fish and Wildlife Environmental Consequences Analysis

Technical Report

August 2018

Intentionally Left Blank

Table of Contents

List of Figures

List of Tables

Acronyms and Abbreviations

BiOp	Biological Opinion
cfs	cubic feet per second
DSS	data storage system
EQ	Environmental Quality
ER	Engineering Regulations
ESA	Endangered Species Act
ESH	emergent sandbar habitat
ft	foot (feet)
HC	human considerations
HEC-EFM	Hydrologic Engineering Center – Ecosystems Functions Model
HEC-RAS	Hydrologic Engineering Center – River Analysis System
MRRMP-EIS	Missouri River Recovery Management Plan – Environmental Impact Study
MRRP	Missouri River Recovery Program
NED	National Economic Development
NEPA	National Environmental Policy Act
OSE	Other Social Effects
P&G	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
POR	Period of Record
RED	Regional Economic Development
USACE	U.S. Army Core of Engineers
USFWS	U.S. Fish and Wildlife System

1.0 Introduction

The Kansas City and Omaha Districts of the U.S. Army Corps of Engineers (USACE), in cooperation with the U.S. Fish and Wildlife Service (USFWS), have developed the Missouri River Recovery Management Plan and Environmental Impact Statement (MRRMP-EIS). The purpose of the MRRMP-EIS is to develop a suite of actions that meets Endangered Species Act (ESA) responsibilities for the piping plover, the interior least tern, and the pallid sturgeon. The purpose of the Fish and Wildlife Impact Analysis Technical Report is to provide supplemental information on the Fish and Wildlife analysis and results in addition to the information presented in the MRRMP-EIS. Additional details on the Environmental Quality (EQ) methodology and results are provided in this technical report. No National Economic Development (NED), Regional Economic Development (RED), or Other Social Effects (OSE) analyses was undertaken for Fish and Wildlife.

1.1 Summary of Alternatives

The MRRMP-EIS evaluates the following alternatives. A detailed description of the alternatives is provided in Chapter 2 of the MRRMP-EIS.

- **Alternative 1 – No Action.** This is the No Action alternative, in which the Missouri River Recovery Program (MRRP) would continue to be implemented as it is currently, including a number of management actions associated with the MRRP and 2003 Amended Biological Opinion (BiOp) compliance. Management actions under Alternative 1 include creation of early life stage habitat for the pallid sturgeon and emergent sandbar habitat (ESH), as well as a spring pulse for pallid sturgeon. The construction of habitat would be focused in the Garrison and Gavins reaches for ESH (an average rate of 164 acres per year) and between Ponca to the mouth near St. Louis for pallid sturgeon early life stage habitat (3,999 additional acres constructed).
- **Alternative 2 – USFWS 2003 Biological Opinion Projected Actions**. This alternative represents the USFWS interpretation of the management actions that would be implemented as part of the 2003 Amended BiOp Reasonable and Prudent Alternative (USFWS 2003). Whereas Alternative 1 only includes the continuation of management actions USACE has implemented to date for BiOp compliance, Alternative 2 includes additional iterative actions and expected actions that the USFWS anticipates would ultimately be implemented through adaptive management and as impediments to implementation were removed. Considerably more early life stage habitat (10,758 additional acres constructed) and ESH (an average rate of 1,331 acres per year) would be constructed under Alternative 2 than under Alternative 1. In addition, a spring pallid sturgeon flow release would be implemented every year if specific conditions were met. Alternative 2 would also modify System operations to allow for summer flows that are sufficiently low to provide for early life stage habitat as rearing, refugia, and foraging areas for larval, juvenile, and adult pallid sturgeon.
- **Alternative 3 – Mechanical Construction**. The USACE would mechanically construct ESH at an average rate of 332 acres per year distributed between the Garrison, Fort Randall, and Gavins Point Reaches. This amount represents the acreage necessary to meet the bird habitat targets after accounting for available ESH resulting from system operations. The average annual construction amount includes replacing ESH lost to erosion and vegetative growth, as well as constructing new ESH. An estimated 3,380 acres of early life stage habitat for the pallid sturgeon would be constructed under

Alternative 3. There would not be any reoccurring flow releases or pulses implemented under this alternative; however, should new information be learned through Level 1 and 2 studies over the next 9 years suggesting that spring discharges result in stronger aggregation of adult pallid sturgeon at spawning locations or increased reproductive success, a one-time spawning cue test could be implemented to provide additional information to support or refute this hypothesis. At the present time, it is assumed the test release would be similar to the timing, magnitude, duration, and pattern of the spawning cue included as a recurring release under Alternative 6.

- **Alternative 4 – Spring ESH Creating Release**. The USACE would mechanically construct ESH annually at an average rate of 195 acres per year distributed between the Garrison, Fort Randall, and Gavins Point Reaches. This amount represents the acreage necessary to meet the bird habitat targets after accounting for available ESH resulting from implementation of an ESH-creating reservoir release in the spring. Alternative 4 would be similar to Alternative 1 (the No Action alternative), with the addition of a spring release designed to create ESH for the least tern and piping plover. An estimated 3,380 acres of early life stage habitat for the pallid sturgeon would be constructed under Alternative 4.
- **Alternative 5 – Fall ESH Creating Release**. The USACE would mechanically construct ESH annually at an average rate of 253 acres per year distributed between the Garrison, Fort Randall, and Gavins Point Reaches. This amount represents the acreage necessary to meet the bird habitat targets after accounting for available ESH resulting from implementation of an ESH-creating reservoir release in the fall. Alternative 5 is similar to Alternative 1 (the No Action alternative), with the addition of a release in the fall designed to create sandbar habitat for the least tern and piping plover. An estimated 3,380 acres of early life stage habitat for the pallid sturgeon would be constructed under Alternative 5.
- **Alternative 6 – Pallid Sturgeon Spawning Cue**. The USACE would mechanically construct ESH annually at an average rate of 245 acres per year distributed between the Garrison, Fort Randall, and Gavins Point Reaches. In addition, the USACE would attempt a spawning cue pulse every three years in March and May. These spawning cue pulses would not be started and/or would be terminated whenever flood targets are exceeded. An estimated 3,380 acres of early life stage habitat for the pallid sturgeon would be constructed under Alternative 6.

1.2 USACE Planning Accounts

Alternative means of achieving species objectives will be evaluated including consideration for the effects of each action or alternative on a wide range of human considerations (HC). HC to be evaluated in the MRRMP-EIS alternatives are rooted in the economic, social, and cultural values associated with the natural resources of the Missouri River. The HC effects evaluated in the MRRMP-EIS are required under the National Environmental Policy Act (NEPA) and its implementing regulations (40 CFR Parts 1500-1508). The 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) also served as the central guiding regulation for the economic and environmental analysis included within the MRRMP-EIS. Further guidance that is specific to USACE is described in Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, which provides the overall direction by which USACE Civil Works projects are formulated, evaluated, and selected for implementation. These guidance documents describe four accounts that were established to facilitate evaluation and display the effects of alternative plans:

- The NED account displays changes in the economic value of the national output of goods and services expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the Nation.
- The RED account registers changes in the distribution of regional economic activity (i.e., jobs and income).
- The EQ account displays non-monetary effects of significant natural and cultural resources.
- The OSE account registers plan effects from perspectives that are relevant to the planning process but are not reflected in the other three accounts. In a general sense, OSE refers to how the constituents of life that influence personal and group definitions of satisfaction, well-being, and happiness are affected by some condition or proposed intervention.

The accounts framework enables consideration of a range of both monetary and non-monetary values and interests that are expressed as important to stakeholders, while ensuring impacts are not double counted. The USACE planning accounts evaluated for fish and wildlife include EQ.

1.3 Approach for Evaluating Environmental Consequences of the MRRMP-EIS

Evaluation of the environmental consequences of the MRRMP-EIS to fish and wildlife requires an understanding of how the physical conditions of the river would change under each of the MRRMP-EIS alternatives. The Missouri River and its floodplain provide important fish and wildlife habitat for a wide variety of flora and fauna. Prior to 20th century modifications to the Missouri River system, aquatic and floodplain habitats covered vast areas of the river valley, providing diverse and appropriate spawning, rearing, escape, migratory, and foraging habitats for fish; mating, rearing, foraging, hibernating, and dormancy habitats for mammals, reptiles, and amphibians; nesting, fledging, rearing, and foraging habitats for birds; and life cycle habitats for aquatic invertebrates. The net effect of alterations to the system during the past 100 years was extensive loss of the amount, quality, distribution, and variety of habitats available to native fauna and flora.

The Fish and Wildlife evaluation considers the effects of management actions on terrestrial and aquatic habitats and how changes in terrestrial and aquatic habitats could affect fish and wildlife. Physical components that are particularly important to ecosystems, native species, and floodplain habitats include river flows, flooding, drought, aquatic and terrestrial vegetation, channel dimensions, and many other ecosystem components. Ecosystems are comprised of structural and physical components (e.g., trees, wetland plants, soil, shallow water habitat, etc.) and dynamic processes (water flows, nutrient cycling, animal lifecycles, velocities, turbidity, variability in depth and streambed characteristics, etc.) that create habitat and ecosystem functions (water catchment, soil accumulation, habitat creation, invertebrate colonization sites, grassy bank overhangs giving bank stabilization, fish protection, filtration, etc.). Reconnectivity of the river with the floodplain is an important element for river species diversity and abundance (e.g., cottonwoods, willows, fish, and aquatic species). The quantity and quality of habitat and its ability to sustain itself has a value to the region and nation.

The environmental consequences evaluation quantifies the change in acres of terrestrial and aquatic habitat between the No Action and action alternatives along the mainstem Missouri River. Habitat, broadly defined, can be broken down into “classes” (i.e., fish and wildlife habitat

classes, wetland classes, and depth classes) with distinct characteristics and associated ecological relevance. Acres of terrestrial and aquatic habitats were quantified by reach and then compared to Alternative 1 to provide a comparison of effects across action alternatives. Importantly, the fish and wildlife habitat analysis does not provide absolute change in habitat classes. Because of modeling constraints, specific day inundation regimes were used to facilitate comparison of alternatives. For example, in the Garrison to Oahe Reach, modeling assumed upland grassland is represented by areas with no more than one day of inundation, forest is represented by areas with no more than 16 days of inundation, riparian woodland/forested wetland is represented by no more than 36 days of inundation, scrub shrub wetland is represented by no more than 52 days of inundation, emergent wetland is represented by no more than 159 days of inundation, and open water is represented by no more than 365 days of inundation. The number of days is the maximum number of days a class can be inundated for it to be defined as that class. The next “drier” habitat class is then defined by a range from that number of days during the growing season to its maximum inundation days. The modeling produces the change in the acreage of upland grassland inundated no more than one day, for instance, rather than the change in acreage of the upland grassland category as a whole. Each alternative has unique hydrology, and in most cases unique geometry, therefore, the upland grassland upper boundary varies slightly from alternative to alternative. To allow for a better comparison of “losses and gains” across alternatives all alternatives were normalized to the same upper boundary that represents the reasonable upper limit of upland grassland habitat. The analysis is useful for comparing trends between alternatives (e.g., trending toward wetter or drier habitats), but should not be used as an indicator of absolute changes or shifts in habitat classes. The impacts analysis assumes that changes in specific day inundation regimes are representative of the trends that would occur under each alternative. In addition to trends in habitat classes, the average frequency of flows occurring that are below 9,000 cfs for the period of record (POR) (82 years) and per a 24-hour period were quantified for the Fort Randall reach along the mainstem which will also allow for comparison of effects between action alternatives.

The conceptual flow chart shown in Figure 1 demonstrates, in a stepwise manner, how changes to the physical conditions of the Missouri River and its floodplain can impact fish and wildlife. This figure also shows the intermediate factors and criteria that were applied in assessing the EQ consequences to fish and wildlife.

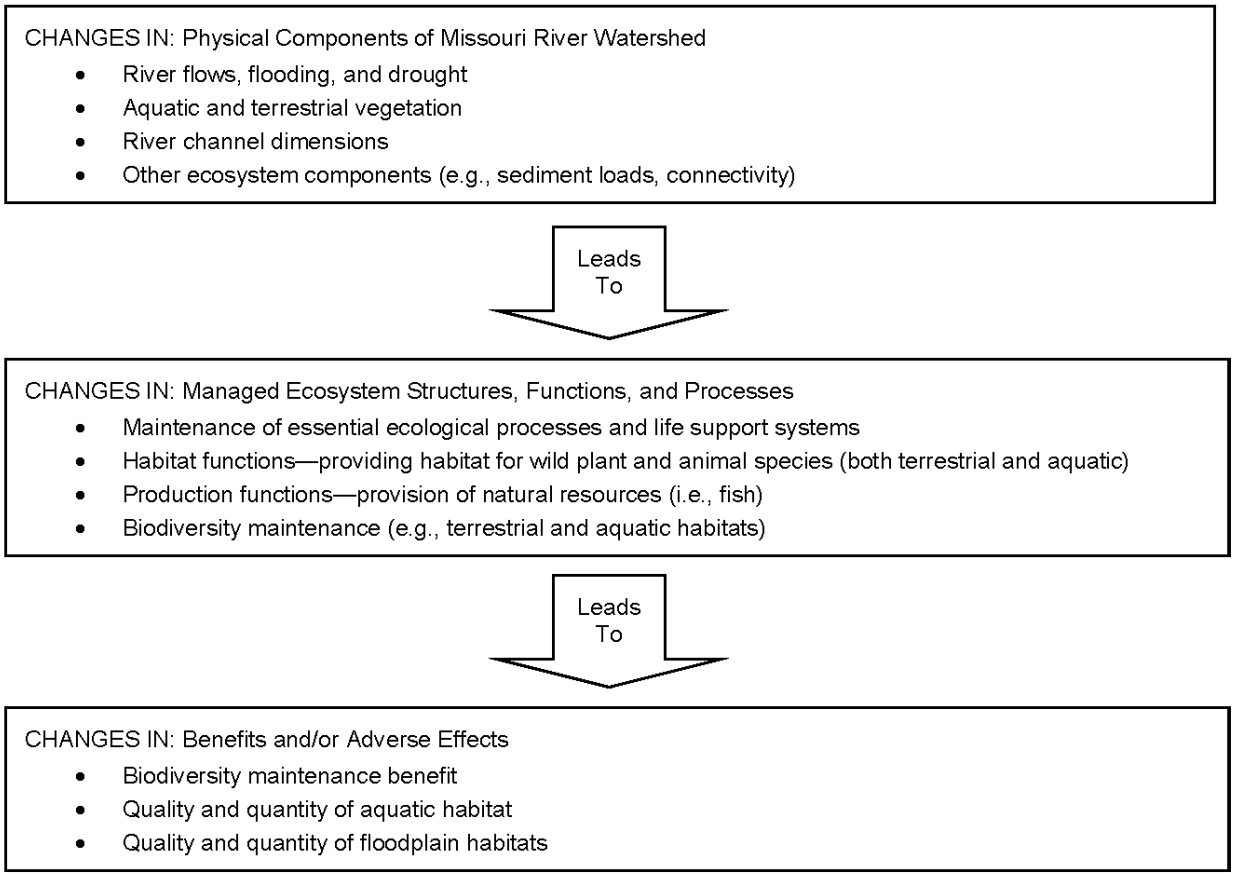


Figure 1. Flow Chart of Inputs Considered in Fish and Wildlife Evaluation

2.0 Methodology and Assumptions

2.1 Environmental Quality Methodology and Assumptions

The fish and wildlife modeling process is best described as a work flow (Figure 2) starting with two concurrent steps; (1) the alternatives simulations run in the Hydrologic Engineering Center – River Analysis System (HEC-RAS); and, (2) the definition of the habitat class/inundation period relationships. The completion of these two steps provided the input and structure for the following portion of the modeling process in the Ecosystems Functions Model (HEC-EFM). The HEC-EFM output (i.e., habitat class associated flows) was then placed into a steady flow HEC-RAS model which provided the spatial data needed to complete the modeling process. The resulting product was the tabulated area in acres per reach and habitat class. This process is described in detail below.

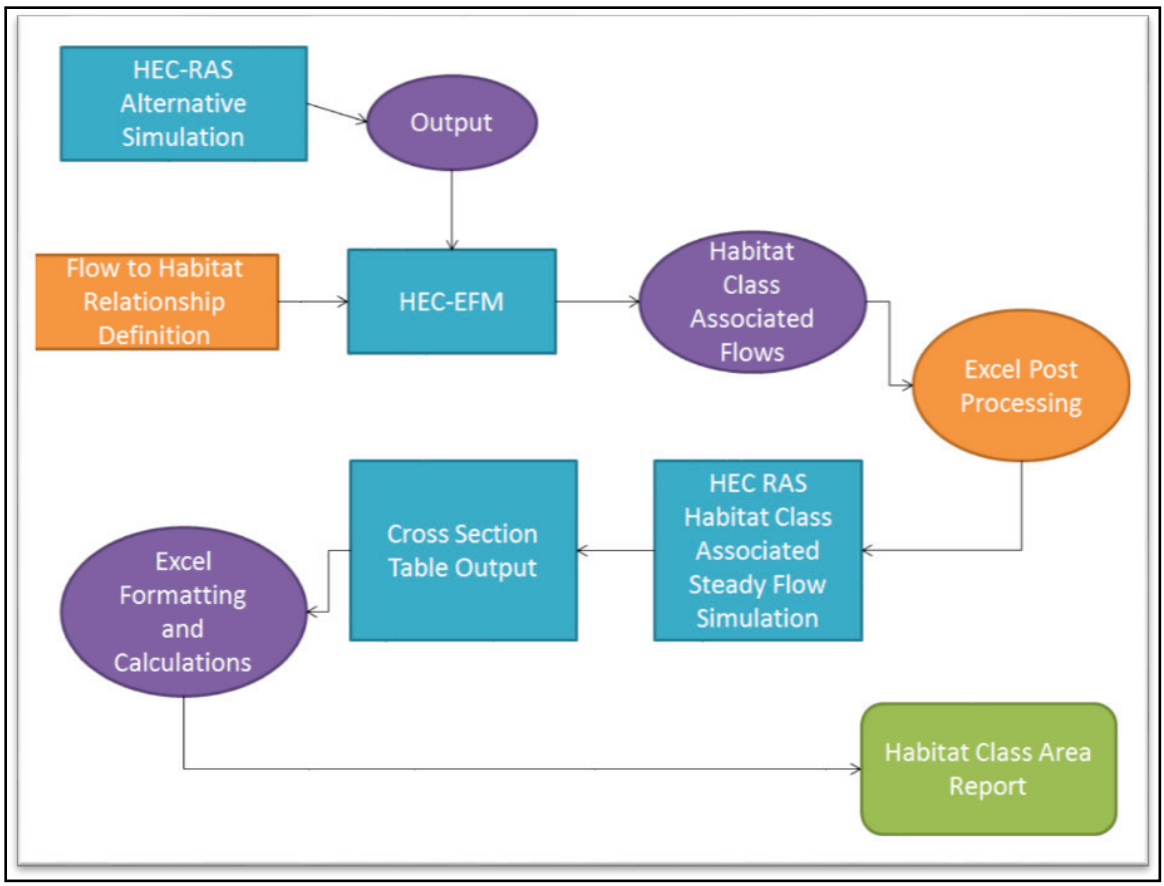


Figure 2. Modeling Process Work Flow Chart

The study area consists of the Missouri River and adjacent area from Fort Peck, Montana to the confluence with the Mississippi River near St. Louis, Missouri. For the purposes of this modeling effort, eight reaches (Table 1 and Figure 3) were delineated based on logical divisions in the context of the existing system (e.g., inter-reservoir reaches) or broad ecological similarities.

Table 1. Missouri River Study Reaches

Location	Reach
Upstream of Gavins Point Dam	Fort Peck Dam to Garrison Dam
	Garrison Dam to Oahe Dam
	Fort Randall Dam to Gavins Point Dam
Downstream of Gavins Point Dam	Gavins Point Dam to Rulo, Nebraska
	Rulo, Nebraska to Kansas River
	Kansas River to Grand River
	Grand River to Osage River
	Osage River to Mouth of the Missouri River

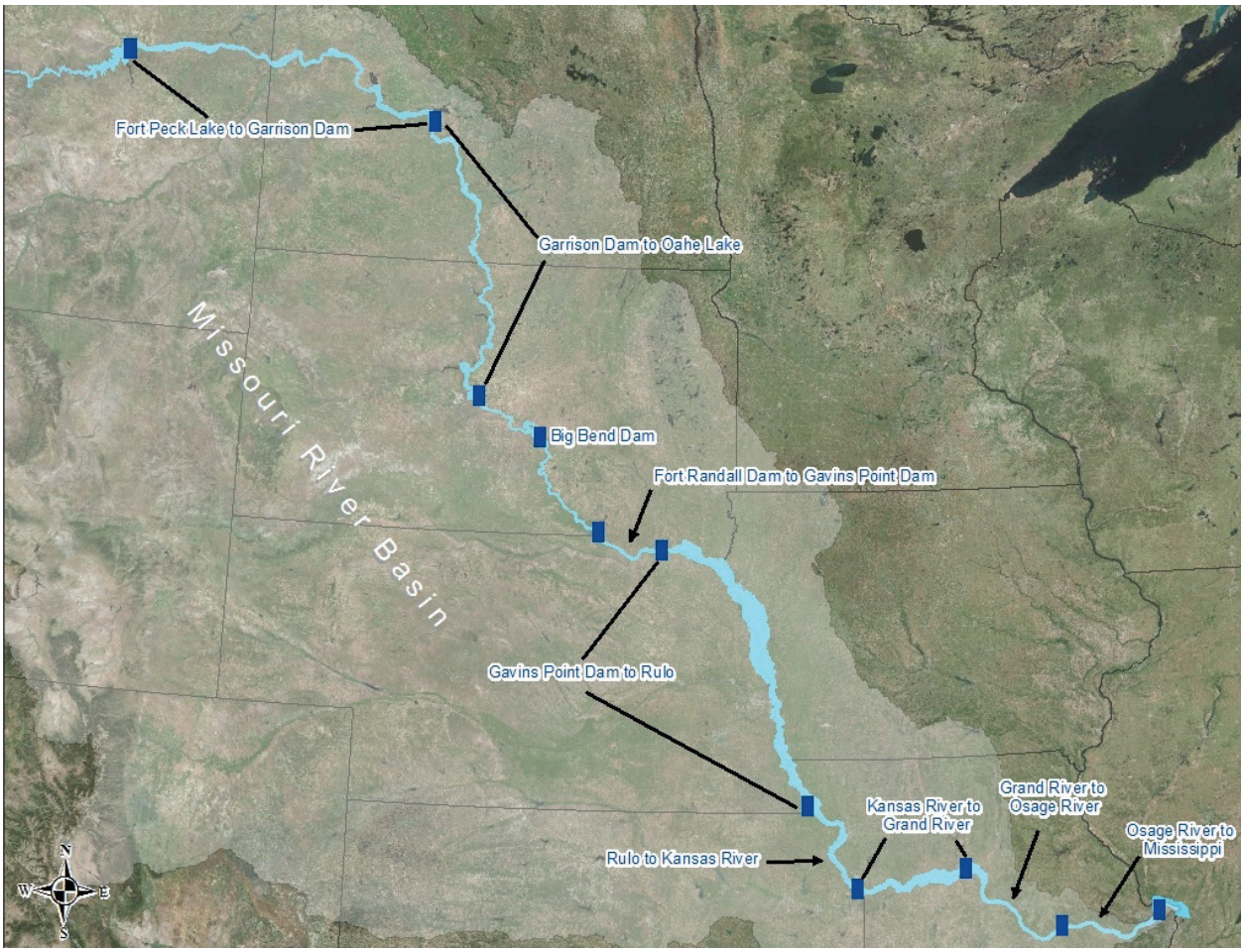


Figure 3. Missouri River Study Reaches

2.1.1 Flow to Habitat Relationship Definition

After the study area and each of the reaches were defined, the next step in modeling habitat under varying alternative flow scenarios was to identify and define the flow to habitat relationship. Habitat classes were based on the ecological systems and alliances from the U.S. National Vegetation Classification (NatureServe 2009). The habitat classes modeled include open water, emergent wetland, scrub shrub wetland, riparian woodland/ forested wetland, forest, and upland grassland. For each reach, habitat classes were defined by the frequency or duration of inundation over the year or during the growing season that would characterize that habitat class (Table 2). The number of days a habitat class is considered to be inundated was developed through a review of the depth, duration, and timing of inundation typical for each habitat class and/or the dominant species within these habitat classes described in the Missouri River baseline assessment and peer reviewed literature (Hansen et al. 1995; NatureServe 2009; Johnson et al. 1976; Nelson 2005; Nigh and Shroeder 2002; Steinauer and Rolfsmeier 2003; USACE 2013). Each of these individual classes is comprised of plant species included in Table 3 that are assumed for this modeling effort to occur under the same inundation regime. While a range of inundation periods could occur within each of the representative vegetation communities within individual habitat classes, maximum days of inundation were assumed for modeling purposes. As previously discussed, the number of days inundated is the maximum number of days a habitat class can be inundated for it to be defined as that class and

represents a range of days between the next “drier” class. Experts from the USFWS, USACE, and representatives from the fish and wildlife agencies of the mainstem states were requested to review and comment on the proposed approach and habitat class definitions.

Table 2. Habitat Season and Inundation Definitions

HEC-EFM Relationships				
Geographic Region	**Habitat Class**	**Season (Dates)**		**Duration (Maximum # of Days Inundated)[1]**
Fort Peck to Garrison	Open Water	1-Jan	31-Dec	365
	Emergent Wetland	2-May	30-Sep	151
	Scrub Shrub Wetland	2-May	30-Sep	50
	Riparian Woodland/Forested Wetland	2-May	30-Sep	32
	Forest	2-May	30-Sep	15
	Upland Grassland	2-May	30-Sep	1
Garrison to Oahe	Open Water	1-Jan	31-Dec	365
	Emergent Wetland	30-Apr	5-Oct	159
	Scrub Shrub Wetland	30-Apr	5-Oct	52
	Riparian Woodland/Forested Wetland	30-Apr	5-Oct	36
	Forest	30-Apr	5-Oct	16
	Upland Grassland	30-Apr	5-Oct	1
Fort Randall to Gavins	Open Water	1-Jan	31-Dec	365
	Emergent Wetland	24-Apr	8-Oct	168
	Scrub Shrub Wetland	24-Apr	8-Oct	59
	Riparian Woodland/Forested Wetland	24-Apr	8-Oct	39
	Forest	24-Apr	8-Oct	17
	Upland Grassland	24-Apr	8-Oct	1
Gavins to Rulo, NE	Open Water	1-Jan	31-Dec	365
	Emergent Wetland	18-Apr	11-Oct	177
	Scrub Shrub Wetland	18-Apr	11-Oct	65
	Riparian Woodland/Forested Wetland	18-Apr	11-Oct	41
	Forest	18-Apr	11-Oct	18
	Upland Grassland	18-Apr	11-Oct	1
Rulo to Kansas River, MO	Open Water	1-Jan	31-Dec	365
	Emergent Wetland	6-Apr	23-Oct	201
	Scrub Shrub Wetland	6-Apr	23-Oct	77
	Riparian Woodland/Forested Wetland	6-Apr	23-Oct	50
	Forest	6-Apr	23-Oct	20

HEC-EFM Relationships				
Geographic Region	**Habitat Class**	**Season (Dates)**		**Duration (Maximum # of Days Inundated)[1]**
	Upland Grassland	6-Apr	23-Oct	1
Kansas River, MO to Grand River, MO	Open Water	1-Jan	31-Dec	365
	Emergent Wetland	7-Apr	26-Oct	202
	Scrub Shrub Wetland	7-Apr	26-Oct	76
	Riparian Woodland/Forested Wetland	7-Apr	26-Oct	51
	Forest	7-Apr	26-Oct	20
	Upland Grassland	7-Apr	26-Oct	1
Grand River to Mississippi River	Open Water	1-Jan	31-Dec	365
	Emergent Wetland	2-Apr	31-Oct	212
	Scrub Shrub Wetland	2-Apr	31-Oct	81
	Riparian Woodland/Forested Wetland	2-Apr	31-Oct	53
	Forest	2-Apr	31-Oct	21
	Upland Grassland	2-Apr	31-Oct	1

[1] Represents a range from the next "drier" class (e.g., the forest habitat class in the Fort Peck to Garrison geographic region is found in areas with a range of days of inundation between 2 and 15 days).

The next step in the process requires use of the HEC-EFM, created and provided by the USACE Hydrologic Engineering Center, which is used to query flow values from the POR based on the habitat relationship definitions. HEC-EFM is a planning tool that was created to help study teams determine ecosystem responses to changes in the flow regime of a river or connected wetlands. HEC-EFM has specific needs in order to properly provide the desired output. HEC-EFM is software that queries flow data (input) and provides the user with both flows and elevations from the data based on the parameters specified. The season, number of days inundated, percent of time not inundated, and percent exceedance are defined for each of the habitat classes before using the HEC-EFM software (Table 3). These particular values and attributes are imperative pieces of information that are used to inform the HEC-EFM models and receive the desired output.

Table 3. Missouri River Habitat Classes and Vegetation Community Composition

Reaches	Habitat Class	Habitat Composition Description
Fort Peck to Garrison Dam Garrison to Oahe Dam Fort Randall Dam to Gavins	Open Water	Main Channel, Chutes/Secondary Channels, Open Water Sloughs, Oxbows, Pools, and Backwaters
	Emergent Wetland	Cattail Semipermanently Flooded Wetland, Cattail Seasonally Flooded Wetlands, Nebraska Sedge Seasonally Flooded Wetland, and Cordgrass Temporarily Flooded Wetlands
	Scrub Shrub Wetland	Temporarily Flooded Shrubland (Silver Sagebrush/Western Snowberry), Sandbar Willow Temporarily Flooded Shrubland, and Sandbar Willow Seasonally Flooded Shrubland
	Riparian Woodland/Forested Wetland	Cottonwood Riparian Woodland
	Forest	Green Ash, Elm, and Boxelder Forest
	Upland Grassland	Western Wheatgrass Prairie
Gavins Dam to Rulo Rulo to Kansas Kansas to Grand Grand to Osage Osage to confluence at Mississippi	Open Water	Main Channel, Chutes/Secondary Channels, Open Water Sloughs, Oxbows, Pools, Backwaters, Pondweed Aquatic Wetland, Waterlily Aquatic Wetland, Waterlily/Lotus Deep Marsh, and American Lotus Aquatic Wetlands
	Emergent Wetland	Buttonbush Shrub Swamp, Bulrush Deep Marsh, Reed Marsh, Bulrush/Cattail/Bur Reed Emergent Marsh, Smartweed/Bur Marigold Ephemeral Wetland, Smartweed/Bur Marigold Ephemeral Wetland, Wet Bottomland Prairie, Eastern Sedge Wet Meadow, Eastern Cordgrass Wet Meadow, and Wet-Mesic Bottomland Prairie
	Scrub Shrub Wetland	Sandbar Willow Temporarily Flooded Shrubland, and Sandbar Willow Seasonally Flooded Shrubland
	Riparian Woodland/Forested Wetland	Pin Oak/Mixed Hardwood Bottomland Forest, Floodplain Forest (Pecan, Bur Oak, Swamp White Oak, and Silver Maple), Cottonwood/Dogwood Riparian Woodland, Cottonwood/Willow Riparian Forest, Silver Maple-Elm Forest, and Sycamore/Plains Cottonwood/Black Willow Riverfront Forest
	Forest	Green Ash, American Elm, Hackberry, and Riverfront Forest
	Upland Grassland	Tallgrass Prairie

The season is considered to be the growing season for the reaches being modeled. The rest of the year is considered the dormant season, a time when extended periods of flooding may have little influence on the development of plant communities. Each of the reaches modeled has a unique growing season based on county averages. The season defined for the Open Water habitat class is defined as the entire year, from January 1 to December 31, as it assumed that water exists within the river channel at all times throughout the year, not only during the growing season. The number of days inundated is the total maximum amount of days during the defined season the plants are experiencing some level of flow. The inundation period for the habitat classes was defined using best available data including scientific literature, plant guides, and expert knowledge. The habitat classes used were largely based on the habitat classes assessed by the Missouri River baseline assessment (USACE 2013). The descriptions and functional models of the aquatic and terrestrial systems discussed in the Missouri River baseline assessment include information on inundation periods for each of the habitat classes. The hydroperiod or hydrologic regime of a habitat class and/or wetland defines the seasonal pattern of water levels or inundation period. Habitat class inundation periods or hydroperiod range from permanently flooded, intermittently flooded, seasonally flooded, saturated, and temporarily flooded. Permanently flooded areas are flooded throughout the year in all years. Intermittently flooded areas are flooded throughout the year except during periods of extreme drought. Seasonally flooded areas are flooded in the growing season on most years. The substrate of saturated areas is saturated for extended periods in the growing season but rarely have standing water. Temporarily flooded areas are flooded for brief periods in the growing season. The percent of time the habitat class is not inundated, or the percent of time the plants are dry during the defined season, is calculated by subtracting the number of days the plants are inundated from the number of days in the season to get the number of dry days. Then the number of dry days was divided by the number of days in the season. The percent exceedance for every habitat class was set to .5 or 50 percent. This tells HEC-EFM to select the 50th percentile from the POR or can also be stated as the median value from the dataset. This median value is representative of a typical day of flows from the POR in the Missouri River.

2.1.2 Ecological Functions Model (EFM)

Before the habitat class relationships were built in HEC-EFM, a new HEC-EFM model file was created. Each reach was evaluated in a separate HEC-EFM model resulting in the development of eight separate HEC-EFM models. HEC-EFM takes user defined river miles to evaluate specific locations. These locations were entered as Flow Regimes in the HEC-EFM *Properties window* (Figure 4). For this modeling effort, the flow regime was the output from a USACE HEC-RAS model. The model simulates flows for the Missouri River under varying management scenarios. For the purposes of this modeling effort, the POR (1930-2012) was simulated under the varying management alternatives. This HEC-RAS output was the flow regime input queried in HEC-EFM and consisted of the geographic locations or river cross sections selected for analysis. Each cross section was entered separately as a unique Flow Regime. The same .dss file was used for each Flow Regime, but the separate cross sections were manually selected from the *DSS Catalog* (Figure 4). The cross sections modeled were selected due to their geographic location downstream of a major tributary under the assumption that significant changes in flow occur at these confluence points. Each major tributary was identified within each of the individual reaches, and then the cross section directly down river was added as a flow regime. It is important to note that HEC-EFM requires the .dss file to be organized into a one-day format in order for the model to run (Figure 4).

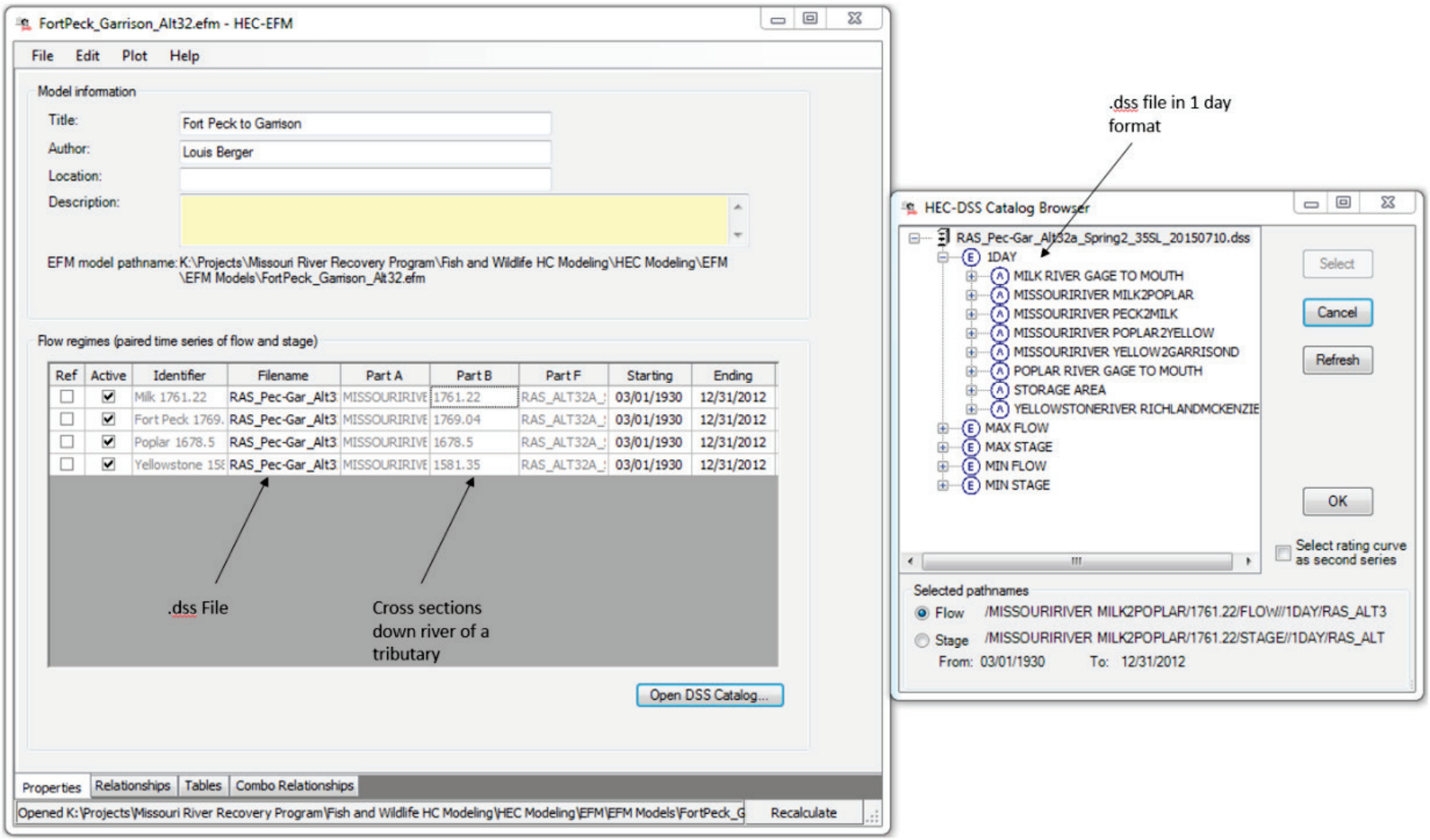


Figure 4. Example of DSS Catalog Window

After the flow regimes were entered into the HEC-EFM model, the relationships were created in the *Relationships window* of the specific HEC-EFM model being built (Figure 5). The relationships were named by the habitat classes they represent. For example, the emergent wetland habitat class and all the associated inundation information defined (i.e., season, number of days inundated, number of dry days, and percent exceedance) is one relationship. Each reach has six habitat classes associated with it and thus, has six relationships built into the HEC-EFM model. As were previously defined, for each relationship, under the *statistical queries section* on the left side of the *Relationships window* (Figure 5), the season and Duration of Days information was populated. Also previously defined, under the *Time series specifications section* on the bottom left portion of the *Relationships window* (Figure 5), the percent exceedance (n-yr) information was entered. The Season information was entered as a date range and, as previously discussed, the season represents the growing season for each of the reaches. Only the days within the date range specified were evaluated for every year in the POR. Next, the Duration of days entered into the blank box is always 1. This directs the model to process the data in whole day increments throughout the entire POR, looking at every single day within the date range specified. Under the *Duration of days option* (Figure 5), there are two drop down menus that drive the statistical outcomes reported by the model. For the purposes of this modeling effort (for each duration) the mean was computed. In the open water and emergent wetland relationships, the minimum was selected from the computed values and in all other relationships; a user defined % was entered. The user defined % is the percent of dry days from each habitat class that was previously calculated. Finally, 50 was entered into the *percent exceedance box* telling HEC-EFM to select the 50th percentile of the data representing a typical day of flows (Figure 5). It gave the median value for flows out of every individual day over the entire POR.

After each flow regime and relationship was built in HEC-EFM, the model was run by selecting the *Recalculate button* in the lower right corner of the HEC-EFM window. The results of the model then populated in the Tables window (Figure 5). The output is represented by the relationships on the y axis and flow regimes on the x axis. The flows reported in the output are the median value of an average of every day over the POR from the dates and percent defined in the model.

2.1.3 HEC-RAS Steady State Flow

The flows provided in the HEC-EFM output are representative of associated habitat classes. In order to evaluate the habitat associated flows under the varying management alternatives, the HEC-EFM flows were run through the baseline geometry in a steady flow simulation in HEC-RAS (Figure 6). Before the HEC-EFM output was entered into HEC-RAS, it was more efficient to prepare the data in excel before entering it into HEC-RAS. When the data was entered into HEC-RAS, the habitat classes were column headers with flow data to corresponding flow regime cross sections (y axis) listed below the habitat classes. The HEC-EFM output was copied and pasted into an excel worksheet and then formatted to match the HEC-RAS layout. Once the data was in a format that matched HEC-RAS, it was copied and pasted into the *Steady Flow Data window* (Figure 6). HEC-RAS does not only account for the flow regimes defined in HEC-EFM, but for the major tributaries flowing into the river being modeled. Those tributaries are represented as a separate cross section and require flow data as well. In this particular aspect, HEC-RAS is not cumulative, meaning it does not directly add the flow up river with the flow out of the tributary to equal the flow down river. Thus, for the purposes of this modeling effort, minor arbitrary flow values were used for the tributaries. The provided tributary flows were added into the *steady flow data table* in the column corresponding to the correct tributary and habitat class.

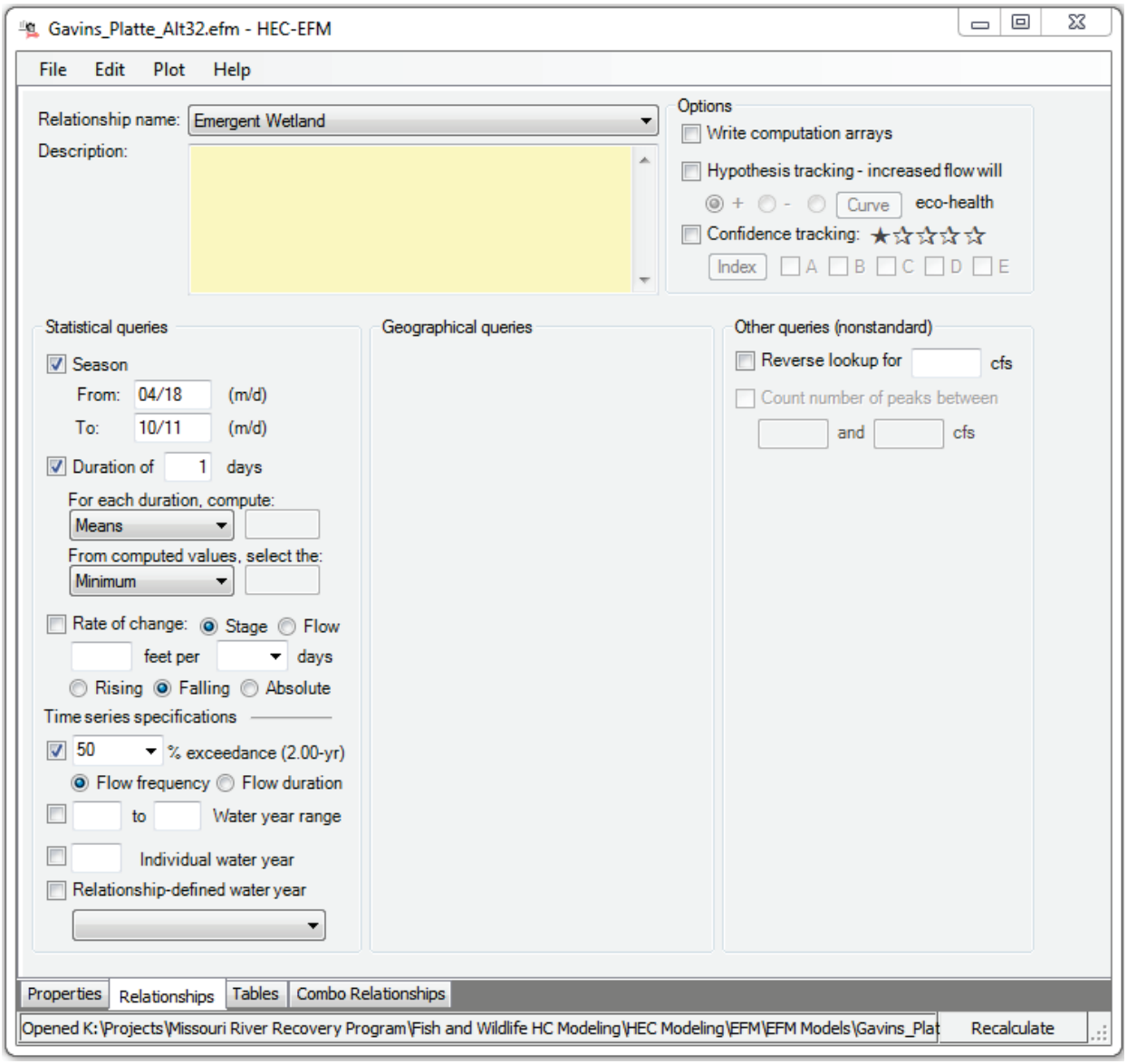
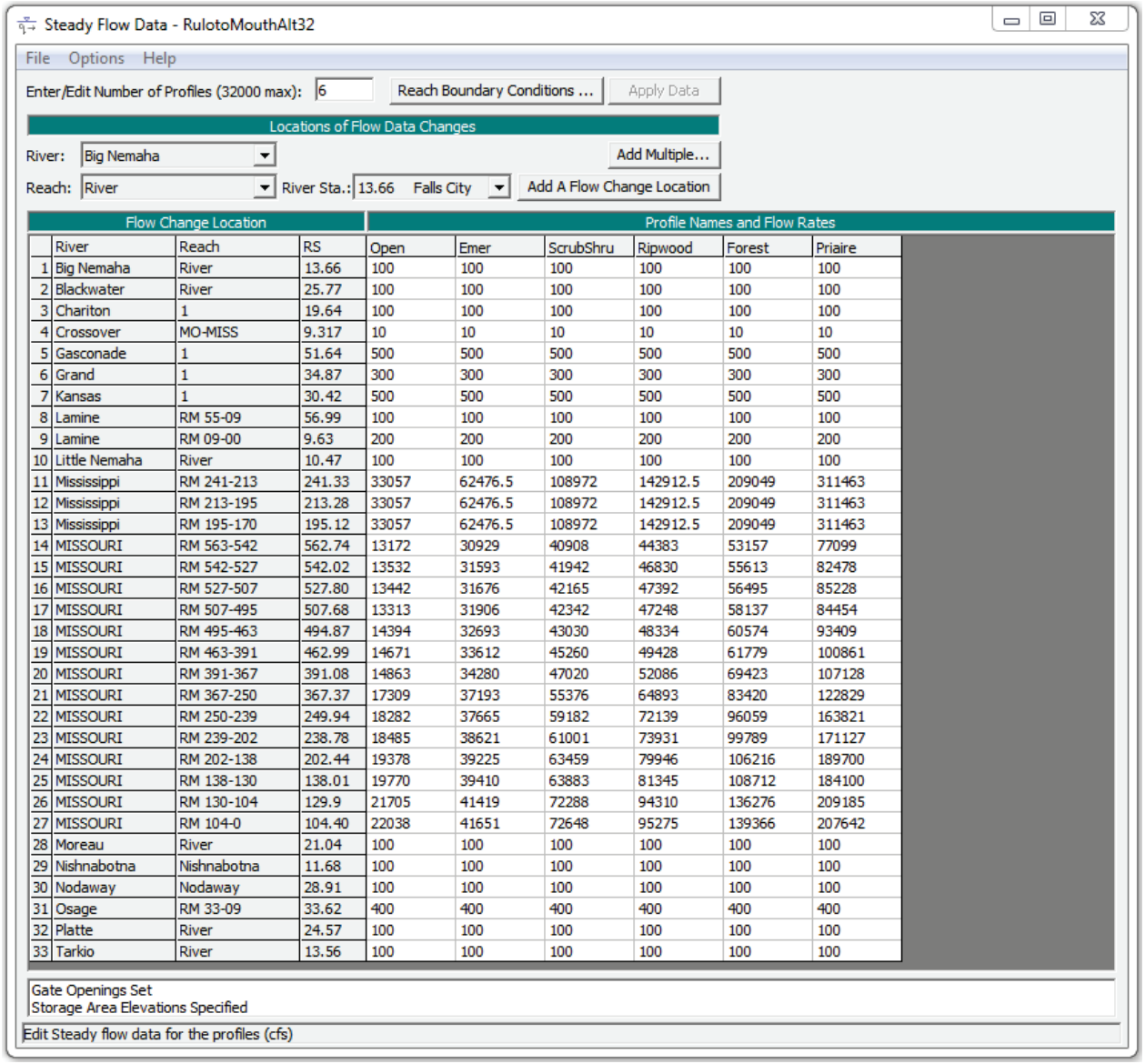


Figure 5. Example of HEC-EFM Relationships Window



	River	Reach	RS	Open	Emer	ScrubShru	Ripwood	Forest	Priaire
1	Big Nemaha	River	13.66	100	100	100	100	100	100
2	Blackwater	River	25.77	100	100	100	100	100	100
3	Chariton	1	19.64	100	100	100	100	100	100
4	Crossover	MO-MISS	9.317	10	10	10	10	10	10
5	Gasconade	1	51.64	500	500	500	500	500	500
6	Grand	1	34.87	300	300	300	300	300	300
7	Kansas	1	30.42	500	500	500	500	500	500
8	Lamine	RM 55-09	56.99	100	100	100	100	100	100
9	Lamine	RM 09-00	9.63	200	200	200	200	200	200
10	Little Nemaha	River	10.47	100	100	100	100	100	100
11	Mississippi	RM 241-213	241.33	33057	62476.5	108972	142912.5	209049	311463
12	Mississippi	RM 213-195	213.28	33057	62476.5	108972	142912.5	209049	311463
13	Mississippi	RM 195-170	195.12	33057	62476.5	108972	142912.5	209049	311463
14	MISSOURI	RM 563-542	562.74	13172	30929	40908	44383	53157	77099
15	MISSOURI	RM 542-527	542.02	13532	31593	41942	46830	55613	82478
16	MISSOURI	RM 527-507	527.80	13442	31676	42165	47392	56495	85228
17	MISSOURI	RM 507-495	507.68	13313	31906	42342	47248	58137	84454
18	MISSOURI	RM 495-463	494.87	14394	32693	43030	48334	60574	93409
19	MISSOURI	RM 463-391	462.99	14671	33612	45260	49428	61779	100861
20	MISSOURI	RM 391-367	391.08	14863	34280	47020	52086	69423	107128
21	MISSOURI	RM 367-250	367.37	17309	37193	55376	64893	83420	122829
22	MISSOURI	RM 250-239	249.94	18282	37665	59182	72139	96059	163821
23	MISSOURI	RM 239-202	238.78	18485	38621	61001	73931	99789	171127
24	MISSOURI	RM 202-138	202.44	19378	39225	63459	79946	106216	189700
25	MISSOURI	RM 138-130	138.01	19770	39410	63883	81345	108712	184100
26	MISSOURI	RM 130-104	129.9	21705	41419	72288	94310	136276	209185
27	MISSOURI	RM 104-0	104.40	22038	41651	72648	95275	139366	207642
28	Moreau	River	21.04	100	100	100	100	100	100
29	Nishnabotna	Nishnabotna	11.68	100	100	100	100	100	100
30	Nodaway	Nodaway	28.91	100	100	100	100	100	100
31	Osage	RM 33-09	33.62	400	400	400	400	400	400
32	Platte	River	24.57	100	100	100	100	100	100
33	Tarkio	River	13.56	100	100	100	100	100	100

Figure 6. Example of HEC-RAS Steady Flow Data Window

HEC-RAS has several data requirements that must be met to complete the next stage of the modeling process. A geometry file that contains the river cross sections and all river geometry for the area of interest was used. The geometry file was imported into the HEC-RAS project through the *Edit/Enter geometric data menu*. Once the data is entered, it can be viewed and the input of flow regimes from HEC-EFM can be verified. Steady flow data is a required input as well. The steady flow data is the previously formatted HEC-EFM output and is entered in the *Steady Flow Data window*. There are several steps that need to be completed before the flow data can be entered and the model parameters set correctly. First, each habitat class was added as a profile and renamed to the habitat class name. Next, the flows were added by copying and pasting from the preformatted table in Excel to the table in the *HEC-RAS steady flow data window*. Gate openings and storage area elevations can now be set. Both of these parameters are found in the *options drop down menu* from the *Steady Flow Data window*. After selecting the *Gate Openings option*, the *Spillway Gate Openings window* will open. Under each

 # Open column header, 1 was entered as the value; under each *Open Ht column header*, 67 was entered. These values must be entered for each of the habitat classes listed at the top of the window and for every *# Open and Open Ht column*. The *Storage Area Elevations menu* can be opened from the same *Options menu* as the *Gate Openings menu*. *Once the Storage Area Elevations window* is open, click on the *Set Blank Elevations to Empty button* in the lower left corner, this populates the storage area elevations automatically. The final step to complete the Steady Flow Data portion of the HEC-RAS project was set the boundary conditions. This was completed in the *Steady Flow Boundary Conditions window*, which is opened by selecting the *Reach Boundary Conditions… button* at the top of the *Steady Flow Data window*. In the *Steady Flow Boundary conditions window*, the furthest downstream cross section of the Mississippi River was located by scrolling through the table. This line in the table has a blank cell in the Downstream column. In this cell, the *Normal Depth S* needs to be set to .0001. This informed the HEC-RAS model that this cross section is the lower bounds of the area being evaluated. After the HEC-RAS model setup is complete, the *Perform a steady flow simulation button* at the top of the *HEC-RAS main window* was selected to open the *Steady Flow Analysis window*. The simulation runs after clicking the *Compute button* at the bottom of the window.

Once the steady flow simulation was completed, the results were exported from HEC-RAS and copied into an excel sheet so that acres of habitat could be summed and reported. This was done by selecting the *View summary output tables by profile button* from the *HEC-RAS main window*. Once in the *Profile Output Table window*, the locations and parameters to be displayed in the table were defined. To define the locations that will be reported in the output table, the *Define Location List…* from the *Location drop down menu* was selected. First, in the *Select Nodes for PF Table*, he *Node Types button* was selected and all node types except for *Cross Sections* were deselected. Once Cross Sections was the only node type with a check in the box to its left, selecting outside of the drop-down menu was done to close it. From the *River drop down list*, the river for which you are interested in viewing profiles from was selected; in this case it was the Missouri River. Once the river was selected, the reaches were selected by double clicking on them from the *Reach drop down menu*, and then moving either all or individual cross sections over to the *Selected Locations window* through selecting them and then clicking on the arrow. Once the locations were defined and all desired cross sections were in the *Selected Locations menu* on the right side of the *Select Nodes for PF Table*, OK was selected. To define the profile information that was reported in the table at each of the locations, *Define Table… from the Options drop down menu* was selected. Once these was in the *Create a Table Heading window*, the variables included into the output table were selected by double clicking them from the *Available Variables list*. Upon double clicking on the desired variables, these automatically populate in the *Table Column Headings* above. In the case of this analysis, *Top Width, W.S. Elev, Q Total, and Length Chnl* are the variables reported in the output table. Once all variables were selected and displayed in the *Table column Headings window*, OK was selected. Now the output table could be copied and pasted into Excel by selecting *Copy to Clipboard (Data and Headings)* from the *File drop down menu*. Then once in Excel, right click in any cell and select the paste option. Once all data was in Excel, reach length was multiplied by the habitat class top width to report acres of habitat.

In order to evaluate aquatic habitats in more detail, the open water habitat class was further defined as various depth classes. These depth class habitat classes were defined by the frequency or duration of inundation during time periods that are important for aquatic species life stages, as advised by USFWS. The specific time periods modeled include; overwintering late (January 1-February 28/29), early spawning (March 1-May 14), late spawning (May 15-June 30), summer rearing and growth (July 1-September 30), and overwintering early (October 1-December 31). Depth ranges modeled as classes include; 0-3 ft, 3-6 ft, 6-9 ft, 9-12 ft, 12-18 ft,

and >18 ft. The Cross Section Viewer software (Shelley and Bailey 2018) evaluated various depth classes over the alternative geometry to report acres of depth class habitat under each of the alternatives. Survey and Construction Reference Planes were uploaded into the software for each of the reach databases, and then the depth distribution was tabulated and output as a histogram displaying acres of habitat over the depth classes. Simpson's index was used to measure depth class habitat diversity and takes into account the number of depth class habitats present as well as the relative abundance of each depth class habitat. An equal distribution of depth classes would equal 1 with lower index values indicating less diversity and higher index values indicating higher diversity. The Simpson's index was calculated for diversity across depths for each seasonal period.

The frequency of the occurrence of flows below 9,000 cfs in the Fort Randall reach was calculated by counting how many times a flow below 9,000 cfs occurs from hourly flow data over the POR. An average number of occurrences within a 24-hour period is reported.

2.2 Risk and Uncertainty

Risk and uncertainty are inherent with any model that is developed and used for water resource planning. Much of the risk and uncertainty with the overall MRRMP-EIS is associated with the operation of the Missouri River system and the extent to which flows and reservoir levels will mimic conditions that have occurred over the 82-year POR. Unforeseen events such as climate change and weather patterns may cause river and reservoir conditions to change in the future and would not be captured by the HEC-RAS models or carried through to the fish and wildlife model described is this document. The project team has attempted to address risk and uncertainty in the MRRMP-EIS by defining and evaluating a reasonable range of plan alternatives that include an array of management actions within an adaptive management framework for the Missouri River. All of the alternatives were modeled to estimate impacts to fish and wildlife.

3.0 Environmental Quality Results

The EQ account results are presented in Table 4 through Table 8 for overall change modeled across the entire mainstem Missouri River for the POR for each alternative for the four fish and wildlife metrics. EQ account results are presented as the change in the amount of acres and the percent change of aquatic and floodplain habitat classes, wetland classes, and depth classes compared to Alternative 1 as modeled in all study reaches for the POR. EQ account results specific to each alternative in each of the river reaches are presented as well. The wetland habitat classes are not shown separately by alternative but are included in results for the fish and wildlife habitat classes.

3.1 Alternative 1 – No Action (Current System Operation and Current MRRP Implementation)

3.1.1 Fish and Wildlife Habitat Classes and Wetland Habitat Classes

The acres within each fish and wildlife habitat class and wetland habitat class for Alternative 1 are used as a comparison of the change in acres and percent change for Alternatives 2 through 6. The acres of fish and wildlife habitat classes and wetland classes are presented in Table 9 for upper river reaches and Table 10 for lower river reaches.

Table 4. Overall Change in Aquatic/Floodplain Habitat Classes

Habitat Types	Alternative 1	Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6	
	Acres of Habitat	Change in Area (acres) and % Change									
Open Water	218,891	2,085	1%	51	0%	-1,046	0%	358	0%	-422	0%
Emergent Wetland	42,377	360	1%	-1,702	-4%	-2,645	-6%	-1,651	-4%	-397	-1%
Scrub Shrub Wetland	96,027	732	1%	925	1%	3,183	3%	4	0%	376	0%
Riparian Woodland/Forested Wetland	25,267	-1,243	-5%	-112	0%	1,051	4%	-858	-3%	1,264	5%
Forest	24,759	1,968	8%	637	3%	-398	-2%	767	3%	-882	-4%
Upland Grassland	53,988	-3,903	-7%	201	0%	-145	0%	1,380	3%	60	0%

Table 5. Overall Change in Wetland Habitat Classes

Habitat Types	Alternative 1	Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6	
	Acres of Habitat	Change in Area (acres) and % Change									
Emergent Wetland	42,377	360	1%	-1,702	-4%	-2,645	-6%	-1,651	-4%	-397	-1%
Scrub Shrub Wetland	96,027	732	1%	925	1%	3,183	3%	4	0%	376	0%
Riparian Woodland/Forested	25,267	-1,243	-5%	-112	0%	1,051	4%	-858	-3%	1,264	5%

Table 6. Overall Change in Depth Classes for Each Seasonal Period

Depth Class	Alternative 1	Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6	
	Acres of Habitat	Change in Area (acres) and % Change									
Overwintering Late											
0-3	231,208	4,899	2.1%	-132	-0.1%	1,326	0.6%	1,673	0.7%	1,035	0.4%
3-6	154,273	1,225	0.8%	-207	-0.1%	383	0.2%	-189	-0.1%	709	0.5%
6-9	102,488	35,996	35.1%	-307	-0.3%	36,082	35.2%	35,616	34.8%	35,796	34.9%
9-12	74,560	1,148	1.5%	-974	-1.3%	-522	-0.7%	8,693	11.7%	60	0.1%
12-18	126,418	11,749	9.3%	1,176	0.9%	7,419	5.9%	7,637	6.0%	-35,887	-28.4%
>18	62,691	22,592	36.0%	3,774	6.0%	27,787	44.3%	24,130	38.5%	3,829	6.1%
Early Spawning											
0-3	248,511	3,080	1.2%	-680	-0.3%	190	0.1%	-1,629	-0.7%	-801	-0.3%
3-6	156,420	1,911	1.2%	-1,354	-0.9%	-1,551	-1.0%	-3,436	-2.2%	-1,529	-1.0%
6-9	106,654	3,851	3.6%	86	0.1%	309	0.3%	1,116	1.0%	1,082	1.0%
9−12	91,834	-31,975	-34.8%	82	0.1%	-7,181	-7.8%	148	0.2%	-195	-0.2%
12-18	207,123	43,049	20.8%	179,336	86.6%	-26,948	-13.0%	-45,112	-21.8%	153,533	74.1%
>18	246,227	-10,514	-4.3%	27,658	11.2%	5,642	2.3%	-44,571	-18.1%	61,394	24.9%
Late Spawning											
0-3	285,540	2,021	0.7%	853	0.3%	39	0.0%	122	0.0%	4,898	1.7%
3-6	200,508	1,746	0.9%	-95	0.0%	-1,157	-0.6%	-1,325	-0.7%	-128	-0.1%
6-9	116,569	616	0.5%	-217	-0.2%	-908	-0.8%	51	0.0%	837	0.7%
9-12	61,404	1,320	2.1%	49,089	79.9%	34,438	56.1%	15,021	24.5%	26,852	43.7%
12-18	364,507	-124,424	-34.1%	-62,733	-17.2%	-235,288	-64.5%	-221,635	-60.8%	-30,774	-8.4%
>18	210,482	32,188	15.3%	261,279	124.1%	1,584	0.8%	-16,450	-7.8%	311,811	148.1%

Depth Class	Alternative 1	Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6	
Summer Rearing and Growth											
0-3	263,952	1,044	0.4%	-673	-0.3%	-1,132	-0.4%	-662	-0.3%	-1,236	-0.5%
3-6	163,532	1,065	0.7%	-1,830	-1.1%	-3,095	-1.9%	-2,241	-1.4%	-1,800	-1.1%
6-9	91,248	2,397	2.6%	-68	-0.1%	13,424	14.7%	47	0.1%	1,155	1.3%
9-12	71,272	4,403	6.2%	-19,838	-27.8%	5,727	8.0%	2,034	2.9%	300	0.4%
12-18	346,750	-174,536	-50.3%	-42,688	-12.3%	-9,228	-2.7%	-1,677	-0.5%	-33,546	-9.7%
>18	293,604	83,515	28.4%	-17,430	-5.9%	42,832	14.6%	39,017	13.3%	68,945	23.5%
Overwintering Early											
0-3	243,655	2,399	1.0%	-776	-0.3%	-2,765	-1.1%	-397	-0.2%	-3,050	-1.3%
3-6	148,708	4,201	2.8%	-907	-0.6%	-2,368	-1.6%	-815	-0.5%	-1,972	-1.3%
6-9	75,861	-2,637	-3.5%	-54	-0.1%	66	0.1%	109	0.1%	258	0.3%
9-12	93,778	1,307	3.9%	-9,384	-10.0%	-4,409	-4.7%	-9,399	-10.0%	-2,087	-2.2%
12-18	207,221	156,736	75.6%	-986	-0.5%	144,293	69.6%	148,943	71.9%	21,950	10.6%
>18	293,298	-42,563	-14.5%	130,538	44.5%	-73,243	-25.0%	-40,686	-13.9%	80,872	27.6%

Table 7. Depth Class Diversity (Simpson's Index)

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Diversity Across Depths Within Each Seasonal Period	0.81	0.81	0.77	0.81	0.81	0.76

Table 8. Flow Occurrences below 9,000 cfs

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Total Number of Flow Occurrences <9,000 cfs	153,138	150,431	152,625	156,252	154,270	155,460
Average Number of Flow Occurrences <9,000 cfs per day	5.06	4.97	5.04	5.16	5.10	5.14

Table 9. All Habitat Classes – Upper River (Alternative 1)

Habitat Types	Acres of Habitat
Fort Peck to Garrison	
Open Water	65,156
Emergent Wetland	7,588
Scrub Shrub Wetland	55,964
Riparian Woodland/Forested Wetland	19,719
Forest	16,019
Upland Grassland	14,026
Garrison to Oahe	
Open Water	65,446
Emergent Wetland	7,365
Scrub Shrub Wetland	14,985
Riparian Woodland/Forested Wetland	1,336
Forest	3,096
Upland Grassland	4,509
Fort Randall to Gavins	
Open Water	9,354
Emergent Wetland	6,342
Scrub Shrub Wetland	13,077
Riparian Woodland/Forested Wetland	1,551
Forest	1,354
Upland Grassland	2,691

Table 10. All Habitat Classes – Lower River (Alternative 1)

Habitat Types	Acres of Habitat
Gavins to Rulo	
Open Water	26,462
Emergent Wetland	8,103
Scrub Shrub Wetland	3,847
Riparian Woodland/Forested Wetland	536
Forest	330
Upland Grassland	1,424
Rulo to Kansas River	
Open Water	10,665
Emergent Wetland	2,771
Scrub Shrub Wetland	894
Riparian Woodland/Forested Wetland	166
Forest	287
Upland Grassland	7,445
Kansas River to Grand River	
Open Water	12,062
Emergent Wetland	3,046
Scrub Shrub Wetland	1,208
Riparian Woodland/Forested Wetland	339
Forest	707
Upland Grassland	5,019
Grand River to Osage River	
Open Water	12,917
Emergent Wetland	3,917
Scrub Shrub Wetland	2,162
Riparian Woodland/Forested Wetland	414
Forest	1,187
Upland Grassland	9,354
Osage River to Mississippi River	
Open Water	16,827
Emergent Wetland	3,246
Scrub Shrub Wetland	3,888
Riparian Woodland/Forested Wetland	1,206
Forest	1,779
Upland Grassland	9,519

3.1.2 Depth Classes

The acres within each depth class for each period for Alternative 1 are used as a comparison of the change in acres and percent change for Alternatives 2 through 6. The acres of each depth class are presented in Table 11 for upper river reaches and Table 12 for lower river reaches.

Table 11. Acres of Depth Classes – Upper River (Alternative 1)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	112,795	119,716	152,183	120,503	113,277
3-6	50,841	52,219	93,051	52,901	50,887
6-9	2,114	39,789	49,941	23,038	6,222
9-12	11,189	6,758	637	636	10,142
12-18	16,376	1,707	1,077	2,969	2,170
>18	30,755	39,013	45,926	54,345	31,479
Garrison to Oahe					
0-3	73,392	73,833	74,133	73,927	70,972
3-6	56,206	58,518	62,537	60,932	51,547
6-9	29,153	28,856	28,860	29,339	28,669
9-12	26,068	27,187	16,938	22,642	27,843
12-18	26,318	47,477	31,866	47,506	4,446
>18	15,070	23,171	28,893	22,161	6,224
Fort Randall to Gavins					
0-3	13,633	19,356	23,560	29,907	20,406
3-6	12,342	12,582	13,162	13,585	13,099
6-9	9,097	7,458	8,453	7,976	7,762
9-12	5,538	7,737	7,675	9,125	7,643
12-18	12,704	9,562	20,522	8,492	19,572
>18	2,934	12,169	16,851	16,874	15,979

Table 12. Acres of Depth Classes – Lower River (Alternative 1)

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	15,219	20,869	22,630	24,042	22,236
3-6	16,805	17,046	18,909	19,509	17,005
6-9	39,642	14,441	14,092	14,418	15,216
9-12	1,391	31,895	19,166	19,023	26,378
12-18	68,690	95,209	268,801	230,036	121,211
>18	9,265	86,805	26,362	142,418	203,614
Rulo to Mississippi River					
0-3	16,169	14,736	13,035	15,574	16,763
3-6	18,080	16,056	12,849	16,606	16,170
6-9	22,483	16,110	15,223	16,477	17,991
9-12	30,373	18,258	16,989	19,845	21,772
12-18	2,330	53,168	42,241	57,747	59,822
>18	4,667	85,069	92,450	57,806	36,002

3.1.3 Flow Occurrences Below 9,000 cfs

The total number of flow occurrences below 9,000 cfs in the Fort Randall reach would be 153,138 for the POR and the average number of flow occurrences below 9,000 cfs per day would be 5.06, as modeled for the POR (Table 8) for Alternative 1.

3.2 Alternative 2 – USFWS 2003 Biological Opinion Projected Actions

3.2.1 Fish and Wildlife Habitat Classes and Wetland Habitat Classes

The acres of fish and wildlife habitat classes and wetland classes, the change in acres, and percent change for Alternative 2 are presented in Table 13 for upper river reaches and Table 14 for lower river reaches.

Table 13. All Habitat Classes – Upper River (Alternative 2)

Habitat Types	Acres of Habitat	Change in Acres	% Change
Fort Peck to Garrison			
Open Water	65,779	623	1%
Emergent Wetland	6,838	-750	-10%
Scrub Shrub Wetland	56,101	137	0%
Riparian Woodland/Forested Wetland	18,443	-1,276	-6%
Forest	16,235	216	1%
Upland Grassland	15,076	1,050	7%
Garrison to Oahe			
Open Water	66,780	1,333	2%
Emergent Wetland	6,418	-948	-13%
Scrub Shrub Wetland	14,863	-123	-1%
Riparian Woodland/Forested Wetland	1,076	-260	-19%
Forest	2,797	-299	-10%
Upland Grassland	4,805	296	7%
Fort Randall to Gavins			
Open Water	9,416	62	1%
Emergent Wetland	7,153	812	13%
Scrub Shrub Wetland	11,558	-1,519	-12%
Riparian Woodland/Forested Wetland	1,263	-288	-19%
Forest	2,517	1,162	86%
Upland Grassland	2,463	-228	-8%

Table 14. All Habitat Classes – Lower River (Alternative 2)

Habitat Types	Acres of Habitat	Change in Acres	% Change
Gavins to Rulo			
Open Water	26,486	24	0%
Emergent Wetland	8,775	672	8%
Scrub Shrub Wetland	3,829	-18	0%
Riparian Woodland/Forested Wetland	492	-44	-8%
Forest	796	467	142%
Upland Grassland	323	-1,101	-77%
Rulo to Kansas River			
Open Water	10,662	-3	0%
Emergent Wetland	2,922	151	5%
Scrub Shrub Wetland	1,290	396	44%
Riparian Woodland/Forested Wetland	387	220	132%
Forest	631	344	120%
Upland Grassland	6,336	-1,109	-15%
Kansas River to Grand River			
Open Water	12,074	12	0%
Emergent Wetland	3,391	346	11%
Scrub Shrub Wetland	1,999	791	65%
Riparian Woodland/Forested Wetland	691	352	104%
Forest	917	210	30%
Upland Grassland	3,308	-1710	-34%
Grand River to Osage River			
Open Water	12,930	13	0%
Emergent Wetland	3,968	51	1%
Scrub Shrub Wetland	2,665	503	23%
Riparian Woodland/Forested Wetland	675	260	63%
Forest	1,125	-61	-5%
Upland Grassland	8,589	-765	-8%
Osage River to Mississippi River			
Open Water	16,849	21	0%
Emergent Wetland	3,272	26	1%
Scrub Shrub Wetland	4,455	566	15%
Riparian Woodland/Forested Wetland	998	-208	-17%
Forest	1,709	-70	-4%
Upland Grassland	9,184	-335	-4%

3.2.2 Depth Classes

The acres of depth classes for each period, the change in acres, and percent change for Alternative 2 are presented in Table 15 through Table 17 for upper river reaches and Table 18 through Table 20 for lower river reaches.

Table 15. Acres in Depth Classes – Upper River Alternative 2)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	114,719	119,430	151,624	120,414	114,598
3-6	51,397	52,072	91,485	52,780	51,279
6-9	38,106	40,900	48,862	22,992	2,099
9-12	11,178	253	637	4,975	10,597
12-18	16,849	1,703	1,077	17,869	20,222
>18	50,161	39,069	45,275	38,731	50,278
Garrison to Oahe					
0-3	73,739	73,894	74,026	73,868	71,228
3-6	56,718	58,317	62,591	61,102	52,011
6-9	28,816	28,869	28,842	29,417	28,759
9-12	27,120	7,327	16,940	22,650	27,886
12-18	6,447	47,519	22,396	34,776	6,563
>18	15,569	23,204	28,781	22,798	6,288
Fort Randall to Gavins					
0-3	13,632	20,266	23,434	29,096	21,370
3-6	12,342	13,071	13,191	13,373	13,017
6-9	9,097	7,791	8,413	8,026	8,307
9-12	5,538	7,978	7,711	9,055	8,305
12-18	12,704	19,626	1,2653	2,947	18,779
>18	2,935	8,144	10,962	13,200	16,027

Table 16. Change in Acres in Depth Classes – Upper River (Alternative 2)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	1,924	-287	-559	-89	1,321
3-6	556	-147	-1,565	-121	391
6-9	35,992	1,111	-1,079	-46	-4,123
9-12	-11	-6,504	0	4,338	454
12-18	473	-4	0	14,900	18,052
>18	19,406	56	-651	-15,614	18,799
Garrison to Oahe					
0-3	346	61	-107	-58	256
3-6	512	-201	54	170	463
6-9	-337	14	-17	78	89
9-12	1,052	-19,861	2	8	42
12-18	-19,871	42	-9,470	-12,730	2,117
>18	499	33	-112	637	64
Fort Randall to Gavins					
0-3	0	910	-126	-811	964
3-6	0	490	28	-212	-82
6-9	0	333	-41	51	545
9-12	0	242	36	-70	662
12-18	0	10,064	-7,869	-5,545	-793
>18	1	-4,025	-5,889	-3,674	48

Table 17. Percent Change in Depth Classes – Upper River (Alternative 2)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	1.7%	-0.2%	-0.4%	-0.1%	1.2%
3-6	1.1%	-0.3%	-1.7%	-0.2%	0.8%
6-9	1702.5%	2.8%	-2.2%	-0.2%	-66.3%
9-12	-0.1%	-96.2%	0.0%	681.9%	4.5%
12-18	2.9%	-0.2%	0.0%	501.9%	831.9%
>18	63.1%	0.1%	-1.4%	-28.7%	59.7%
Garrison to Oahe					
0-3	0.5%	0.1%	-0.1%	-0.1%	0.4%
3-6	0.9%	-0.3%	0.1%	0.3%	0.9%
6-9	-1.2%	0.0%	-0.1%	0.3%	0.3%
9-12	4.0%	-73.1%	0.0%	0.0%	0.2%
12-18	-75.5%	0.1%	-29.7%	-26.8%	47.6%
>18	3.3%	0.1%	-0.4%	2.9%	1.0%
Fort Randall to Gavins					
0-3	0.0%	4.7%	-0.5%	-2.7%	4.7%
3-6	0.0%	3.9%	0.2%	-1.6%	-0.6%
6-9	0.0%	4.5%	-0.5%	0.6%	7.0%
9-12	0.0%	3.1%	0.5%	-0.8%	8.7%
12-18	0.0%	105.2%	-38.3%	-65.3%	-4.1%
>18	0.0%	-33.1%	-34.9%	-21.8%	0.3%

Table 18. Acres in Depth Classes – Lower River (Alternative 2)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	16,100	20,348	22,358	24,348	21,981
3-6	16,890	18,775	19,878	20,040	19,026
6-9	39,734	15,055	14,939	15,606	15,595
9-12	1,391	26,080	19,398	18,859	26,483
12-18	96,334	128,158	161,911	59,213	258,795
>18	9,397	104,700	74,949	262,215	138,262
Rulo to Mississippi River					
0-3	17,917	17,653	16,119	17,270	16,877
3-6	18,152	16,097	15,109	17,303	17,576
6-9	22,730	17,889	16,129	17,603	18,464
9-12	30,481	18,220	18,039	20,137	21,815
12-18	5,833	53,166	42,046	57,409	59,598
>18	7,221	60,596	82,703	40,175	39,880

Table 19. Change in Acres in Depth Classes – Lower River (Alternative 2)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	881	-522	-272	307	-256
3-6	85	1,729	969	531	2,021
6-9	93	614	847	1,189	379
9-12	0	-5,815	232	-164	106
12-18	27,644	32,949	-10,6890	-170,823	137,584
>18	132	17,895	48,587	119,797	-65,352
Rulo to Mississippi River					
0-3	1,748	2,918	3,084	1,696	114
3-6	73	41	2,260	697	1,406
6-9	248	1,779	906	1,126	473
9-12	107	-37	1,050	292	43
12-18	3,503	-2	-195	-338	-224
>18	2,554	-24,473	-9,747	-17,631	3,878

Table 20. Percent Change in Depth Classes – Lower River (Alternative 2)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	5.8%	-2.5%	-1.2%	1.3%	-1.1%
3-6	0.5%	10.1%	5.1%	2.7%	11.9%
6-9	0.2%	4.3%	6.0%	8.2%	2.5%
9-12	0.0%	-18.2%	1.2%	-0.9%	0.4%
12-18	40.2%	34.6%	-39.8%	-74.3%	113.5%
>18	1.4%	20.6%	184.3%	84.1%	-32.1%
Rulo to Mississippi River					
0-3	10.8%	19.8%	23.7%	10.9%	0.7%
3-6	0.4%	0.3%	17.6%	4.2%	8.7%
6-9	1.1%	11.0%	6.0%	6.8%	2.6%
9-12	0.4%	-0.2%	6.2%	1.5%	0.2%
12-18	150.3%	0.0%	-0.5%	-0.6%	-0.4%
>18	54.7%	-28.8%	-10.5%	-30.5%	10.8%

3.2.3 Flow Occurrences Below 9,000 cfs

The total number of flow occurrences and the average number per day below 9,000 cfs in the Fort Randall reach would be less under Alternative 2 than Alternative 1 as modeled for the POR (Table 8).

3.3 Alternative 3 – Mechanical Construction Only

3.3.1 Fish and Wildlife Habitat Classes and Wetland Habitat Classes

The acres of fish and wildlife habitat classes and wetland classes, the change in acres, and percent change for Alternative 3 are presented in Table 21 for upper river reaches and Table 22 for lower river reaches.

Table 21. All Habitat Classes – Upper River (Alternative 3)

Habitat Types	Acres of Habitat	Change in Acres	% Change
Fort Peck to Garrison			
Open Water	65,307	151	0%
Emergent Wetland	7,416	-171	-2%
Scrub Shrub Wetland	56,043	78	0%
Riparian Woodland/Forested Wetland	19,450	-269	-1%
Forest	16,156	137	1%
Upland Grassland	14,101	75	1%
Garrison to Oahe			
Open Water	65,342	-105	0%
Emergent Wetland	7,278	-88	-1%
Scrub Shrub Wetland	15,066	81	1%
Riparian Woodland/Forested Wetland	1,205	-130	-10%
Forest	3,325	229	7%
Upland Grassland	4,522	13	0%
Fort Randall to Gavins			
Open Water	9,305	-50	-1%
Emergent Wetland	5,917	-425	-7%
Scrub Shrub Wetland	13,657	580	4%
Riparian Woodland/Forested Wetland	1,313	-238	-15%
Forest	1,552	198	15%
Upland Grassland	2,626	-65	-2%

Table 22. All Habitat Classes – Lower River (Alternative 3)

Habitat Types	Acres of Habitat	Change in Acres	% Change
Gavins to Rulo			
Open Water	26,464	2	0%
Emergent Wetland	7,693	-409	-5%
Scrub Shrub Wetland	3,477	-371	-10%
Riparian Woodland/Forested Wetland	466	-70	-13%
Forest	439	110	33%
Upland Grassland	2,163	738	52%
Rulo to Kansas River			
Open Water	10,678	13	0%
Emergent Wetland	2,309	-462	-17%
Scrub Shrub Wetland	765	-129	-14%
Riparian Woodland/Forested Wetland	290	123	74%
Forest	299	12	4%
Upland Grassland	7,887	442	6%
Kansas River to Grand River			
Open Water	12,062	0	0%
Emergent Wetland	3,099	54	2%
Scrub Shrub Wetland	1,472	264	22%
Riparian Woodland/Forested Wetland	646	307	91%
Forest	688	-19	-3%
Upland Grassland	4,413	-605	-12%
Grand River to Osage River			
Open Water	12,918	1	0%
Emergent Wetland	3,759	-157	-4%
Scrub Shrub Wetland	2,199	37	2%
Riparian Woodland/Forested Wetland	474	60	15%
Forest	1,197	10	1%
Upland Grassland	9,403	49	1%
Osage River to Mississippi River			
Open Water	16,866	39	0%
Emergent Wetland	3,204	-42	-1%
Scrub Shrub Wetland	4,273	385	10%
Riparian Woodland/Forested Wetland	1,311	105	9%
Forest	1,739	-40	-2%
Upland Grassland	9,074	-446	-5%

3.3.2 Depth Classes

The acres of depth classes for each period, the change in acres, and percent change for Alternative 3 are presented in Table 23 through Table 25 for upper river reaches and Table 26 through Table 28 for lower river reaches.

Table 23. Acres in Depth Classes – Upper River (Alternative 3)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	112,800	119,725	152,252	120,469	113,417
3-6	50,833	52,219	93,267	52,870	50,821
6-9	2,118	39,790	50,158	23,034	6,185
9-12	9,877	6,758	43,108	636	468
12-18	16,597	1,707	1,077	2,969	140
>18	30,749	39,011	45,544	54,376	31,442
Garrison to Oahe					
0-3	73,294	73,835	73,848	73,787	70,855
3-6	56,025	58,531	62,373	61,086	51,383
6-9	28,844	28,848	28,817	29,272	28,666
9-12	26,405	27,200	23,855	2,819	28,335
12-18	27,408	47,475	22,388	4,062	4,445
>18	15,096	23,166	29,041	22,265	4,216
Fort Randall to Gavins					
0-3	13,649	19,145	23,647	29,844	21,145
3-6	12,327	12,475	13,171	13,556	13,097
6-9	9,103	7,472	8,435	7,980	7,764
9-12	5,537	7,712	7,691	9,143	7,916
12-18	12,573	10,878	20,501	8,515	19,079
>18	6,686	16,223	16,824	16,826	15,927

Table 24. Change in Acres in Depth Classes – Upper River (Alternative 3)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	5	9	69	-34	140
3-6	-8	0	216	-31	-66
6-9	4	1	217	-4	-37
9-12	-1,312	0	42,471	0	-9,674
12-18	221	0	0	0	-2,030
>18	-6	-2	-382	31	-37
Garrison to Oahe					
0-3	-99	1	-286	-139	-117
3-6	-181	13	-164	154	-165
6-9	-308	-7	-43	-67	-4
9-12	337	13	6,917	-19,823	491
12-18	1,090	-2	-9,478	-43,444	-1
>18	26	-5	148	104	-2,008
Fort Randall to Gavins					
0-3	17	-211	88	-62	739
3-6	-15	-107	9	-29	-3
6-9	6	14	-18	4	2
9-12	-1	-25	16	18	273
12-18	-131	1,316	-21	23	-493
>18	3,752	4,054	-27	-48	-52

Table 25. Percent Change in Depth Classes – Upper River (Alternative 3)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	0.0%	0.0%	0.0%	0.0%	0.1%
3-6	0.0%	0.0%	0.2%	-0.1%	-0.1%
6-9	0.2%	0.0%	0.4%	0.0%	-0.6%
9-12	-11.7%	0.0%	6671.3%	0.0%	-95.4%
12-18	1.3%	0.0%	0.0%	0.0%	-93.5%
>18	0.0%	0.0%	-0.8%	0.1%	-0.1%
Garrison to Oahe					
0-3	-0.1%	0.0%	-0.4%	-0.2%	-0.2%
3-6	-0.3%	0.0%	-0.3%	0.3%	-0.3%
6-9	-1.1%	0.0%	-0.1%	-0.2%	0.0%
9-12	1.3%	0.0%	40.8%	-87.5%	1.8%
12-18	4.1%	0.0%	-29.7%	-91.4%	0.0%
>18	0.2%	0.0%	0.5%	0.5%	-32.3%
Fort Randall to Gavins					
0-3	0.1%	-1.1%	0.4%	-0.2%	3.6%
3-6	-0.1%	-0.8%	0.1%	-0.2%	0.0%
6-9	0.1%	0.2%	-0.2%	0.1%	0.0%
9-12	0.0%	-0.3%	0.2%	0.2%	3.6%
12-18	-1.0%	13.8%	-0.1%	0.3%	-2.5%
>18	127.9%	33.3%	-0.2%	-0.3%	-0.3%

Table 26. Acres in Depth Classes – Lower River (Alternative 3)

	Seasonal Period				
Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	15,217	19,961	22,284	23,395	21,325
3-6	16,801	16,709	18,452	18,707	16,896
6-9	3,9637	14,431	14,127	14,440	15,257
9-12	1,391	31,955	18,913	18,989	25,959
12-18	68,688	273,054	205,607	230,816	125,809
>18	9,265	127,380	289,757	135,001	326,380
Rulo to Mississippi River					
0-3	16,115	15,164	14,362	15,784	16,137
3-6	18,080	15,132	13,150	15,483	15,605
6-9	22,478	16,199	14,815	16,453	17,935
9-12	30,375	18,291	16,927	19,846	21,716
12-18	2,328	53,345	52,201	57,700	56,762
>18	4,669	68,105	90,595	47,706	45,871

Table 27. Change in Acres in Depth Classes – Lower River (Alternative 3)

	Seasonal Period				
Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	-2	-909	-346	-647	-911
3-6	-4	-336	-457	-802	-109
6-9	-4	-10	35	23	41
9-12	0	60	-253	-34	-418
12-18	-2	177,845	-63,194	780	4,598
>18	0	40,575	263,395	-7,417	122,766
Rulo to Mississippi River					
0-3	-53	429	1,328	210	-627
3-6	0	-924	302	-1,123	-565
6-9	-5	89	-408	-24	-56
9-12	2	33	-62	1	-57
12-18	-2	177	9,960	-47	-3,060
>18	2	-16,964	-1,855	-10,100	9,869

Table 28. Percent Change in Depth Classes – Lower River (Alternative 3)

	Seasonal Period				
Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	0.0%	-4.4%	-1.5%	-2.7%	-4.1%
3-6	0.0%	-2.0%	-2.4%	-4.1%	-0.6%
6-9	0.0%	-0.1%	0.2%	0.2%	0.3%
9-12	0.0%	0.2%	-1.3%	-0.2%	-1.6%
12-18	0.0%	186.8%	-23.5%	0.3%	3.8%
>18	0.0%	46.7%	999.1%	-5.2%	60.3%
Rulo to Mississippi River					
0-3	-0.3%	2.9%	10.2%	1.3%	-3.7%
3-6	0.0%	-5.8%	2.3%	-6.8%	-3.5%
6-9	0.0%	0.6%	-2.7%	-0.1%	-0.3%
9-12	0.0%	0.2%	-0.4%	0.0%	-0.3%
12-18	-0.1%	0.3%	23.6%	-0.1%	-5.1%
>18	0.0%	-19.9%	-2.0%	-17.5%	27.4%

3.3.3 Flow Occurrences Below 9,000 cfs

The total number of flow occurrences and the average number per day below 9,000 cfs in the Fort Randall reach would be less under Alternative 3 than Alternative 1 as modeled for the POR (Table 8).

3.4 Alternative 4 – Spring ESH Creating Release

3.4.1 Fish and Wildlife Habitat Classes and Wetland Habitat Classes

The acres of fish and wildlife habitat classes and wetland classes, the change in acres, and percent change for Alternative 4 are presented in Table 29 for upper river reaches and Table 30 for lower river reaches.

Table 29. All Habitat Classes – Upper River (Alternative 4)

Habitat Types	Acres of Habitat	Change in Acres	% Change
Fort Peck to Garrison			
Open Water	65,673	517	1%
Emergent Wetland	7,112	-476	-6%
Scrub Shrub Wetland	56,043	79	0%
Riparian Woodland/Forested Wetland	21,507	1,788	9%
Forest	14,165	-1,854	-12%
Upland Grassland	13,972	-54	0%
Garrison to Oahe			
Open Water	64,231	-1,215	-2%
Emergent Wetland	7,713	347	5%
Scrub Shrub Wetland	15,638	652	4%
Riparian Woodland/Forested Wetland	649	-686	-51%
Forest	4,250	1,154	37%
Upland Grassland	4,257	-252	-6%
Fort Randall to Gavins			
Open Water	9,292	-63	-1%
Emergent Wetland	5,069	-1,273	-20%
Scrub Shrub Wetland	14,386	1,309	10%
Riparian Woodland/Forested Wetland	1,183	-367	-24%
Forest	1,254	-101	-7%
Upland Grassland	3,186	495	18%

Table 30. All Habitat Classes – Lower River (Alternative 4)

Habitat Types	Acres of Habitat	Change in Acres	% Change
Gavins to Rulo			
Open Water	26,442	-20	0%
Emergent Wetland	7,481	-622	-8%
Scrub Shrub Wetland	3,659	-188	-5%
Riparian Woodland/Forested Wetland	396	-140	-26%
Forest	718	389	118%
Upland Grassland	2,005	581	41%
Rulo to Kansas River			
Open Water	10,621	-44	0%
Emergent Wetland	2,274	-497	-18%
Scrub Shrub Wetland	901	7	1%
Riparian Woodland/Forested Wetland	309	142	86%
Forest	419	132	46%
Upland Grassland	7,705	260	3%
Kansas River to Grand River			
Open Water	12,029	-33	0%
Emergent Wetland	3,060	15	0%
Scrub Shrub Wetland	1,705	497	41%
Riparian Woodland/Forested Wetland	577	238	70%
Forest	698	-9	-1%
Upland Grassland	4,311	-708	-14%
Grand River to Osage River			
Open Water	12,896	-21	0%
Emergent Wetland	3,669	-247	-6%
Scrub Shrub Wetland	2,318	156	7%
Riparian Woodland/Forested Wetland	583	169	41%
Forest	1,142	-44	-4%
Upland Grassland	9,342	-12	0%
Osage River to Mississippi River			
Open Water	16,659	-168	-1%
Emergent Wetland	3,354	109	3%
Scrub Shrub Wetland	4,560	671	17%
Riparian Woodland/Forested Wetland	1,114	-92	-8%
Forest	1,715	-64	-4%
Upland Grassland	9,064	-455	-5%

3.4.2 Depth Classes

The acres of depth classes for each period, the change in acres, and percent change for Alternative 4 are presented in Table 31 through Table 33 for upper river reaches and Table 34 through Table 36 for lower river reaches.

Table 31. Acres in Depth Classes – Upper River (Alternative 4)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	114,172	118,699	152,218	121,041	113,632
3-6	51,378	51,126	92,557	53,070	50,943
6-9	38,076	40,779	49,652	36,404	6,233
9-12	10,660	6,758	28,329	4,365	475
12-18	4,148	1,707	28	3,597	3,393
>18	50,460	39,109	45,176	53,985	31,399
Garrison to Oahe					
0-3	73,347	73,691	73,802	73,707	70,869
3-6	56,026	59,122	62,071	59,905	51,105
6-9	29,151	28,947	28,748	29,107	28,757
9-12	26,026	27,242	23,715	24,757	26,480
12-18	44,796	7,378	4,718	33,648	3,958
>18	15,347	1,749	23,117	13,677	6,009
Fort Randall to Gavins					
0-3	13,636	19,145	23,245	29,523	18,997
3-6	12,341	12,475	13,160	13,454	12,312
6-9	9,099	7,472	8,467	8,033	7,498
9-12	5,540	7,712	7,714	9,051	7,695
12-18	12,570	10,878	20,461	2,947	11,195
>18	6,685	16,223	16,486	11,492	15,900

Table 32. Change in Acres in Depth Classes – Upper River (Alternative 4)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	1,377	-1,017	36	538	356
3-6	537	-1,093	-494	169	56
6-9	35,962	990	-289	13,365	11
9-12	-529	0	27,692	3,729	-9,668
12-18	-12,228	0	-1,049	628	1,223
>18	19,705	96	-750	-360	-80
Garrison to Oahe					
0-3	-45	-142	-332	-220	-103
3-6	-180	603	-467	-1,027	-442
6-9	-2	91	-112	-232	88
9-12	-42	54	6,777	2,115	-1,363
12-18	18,478	-40,099	-27,148	-13,858	-488
>18	277	-21,422	-5,776	-8,484	-215
Fort Randall to Gavins					
0-3	3	-211	-315	-384	-1,409
3-6	-1	-107	-2	-131	-788
6-9	2	14	14	57	-264
9-12	1	-25	39	-74	52
12-18	-134	1,316	-61	-5,545	-8,377
>18	3,751	4,054	-365	-5,382	-79

Table 33. Percent Change in Depth Classes – Upper River (Alternative 4)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	1.2%	-0.8%	0.0%	0.4%	0.3%
3-6	1.1%	-2.1%	-0.5%	0.3%	0.1%
6-9	1701.1%	2.5%	-0.6%	58.0%	0.2%
9-12	-4.7%	0.0%	4349.8%	586.0%	-95.3%
12-18	-74.7%	0.0%	-97.4%	21.2%	56.4%
>18	64.1%	0.2%	-1.6%	-0.7%	-0.3%
Garrison to Oahe					
0-3	-0.1%	-0.2%	-0.4%	-0.3%	-0.1%
3-6	-0.3%	1.0%	-0.7%	-1.7%	-0.9%
6-9	0.0%	0.3%	-0.4%	-0.8%	0.3%
9-12	-0.2%	0.2%	40.0%	9.3%	-4.9%
12-18	70.2%	-84.5%	-85.2%	-29.2%	-11.0%
>18	1.8%	-92.5%	-20.0%	-38.3%	-3.5%
Fort Randall to Gavins					
0-3	0.0%	-1.1%	-1.3%	-1.3%	-6.9%
3-6	0.0%	-0.8%	0.0%	-1.0%	-6.0%
6-9	0.0%	0.2%	0.2%	0.7%	-3.4%
9-12	0.0%	-0.3%	0.5%	-0.8%	0.7%
12-18	-1.1%	13.8%	-0.3%	-65.3%	-42.8%
>18	127.8%	33.3%	-2.2%	-31.9%	-0.5%

Table 34. Acres in Depth Classes – Lower River (Alternative 4)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	15,225	20,639	22,288	22,698	21,408
3-6	16,806	17,154	18,345	18,584	16,405
6-9	39,648	14,324	14,032	14,527	15,216
9-12	1,391	25,657	19,123	18,758	32,742
12-18	68,683	110,170	61,777	239,855	280,533
>18	9,265	139,437	26,371	208,579	120,706
Rulo to Mississippi River					
0-3	16,154	16,526	14,027	15,852	15,984
3-6	18,105	14,993	13,219	15,424	15,576
6-9	22,596	15,442	14,762	16,601	18,222
9-12	30,420	17,285	16,961	20,069	21,977
12-18	3,640	50,042	42,235	57,475	52,435
>18	8,721	55,351	100,916	48,703	46,041

Table 35. Change in Acres in Depth Classes – Lower River (Alternative 4)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	6	-231	-342	-1,344	-829
3-6	1	108	-564	-925	-600
6-9	6	-117	-61	110	0
9-12	0	-6,238	-43	-266	6,365
12-18	-7	14,961	-207,024	9,819	159,322
>18	0	52,632	9	66,161	-82,908
Rulo to Mississippi River					
0-3	-14	1,791	993	278	-780
3-6	26	-1,063	370	-1,182	-594
6-9	114	-668	-460	123	231
9-12	47	-973	-28	224	205
12-18	1,310	-3,126	-6	-272	-7,387
>18	4,054	-29,718	8,466	-9,103	10,039

Table 36. Percent Change in Depth Classes – Lower River (Alternative 4)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	0.0%	-1.1%	-1.5%	-5.6%	-3.7%
3-6	0.0%	0.6%	-3.0%	-4.7%	-3.5%
6-9	0.0%	-0.8%	-0.4%	0.8%	0.0%
9-12	0.0%	-19.6%	-0.2%	-1.4%	24.1%
12-18	0.0%	15.7%	-77.0%	4.3%	131.4%
>18	0.0%	60.6%	0.0%	46.5%	-40.7%
Rulo to Mississippi River					
0-3	-0.1%	12.2%	7.6%	1.8%	-4.7%
3-6	0.1%	-6.6%	2.9%	-7.1%	-3.7%
6-9	0.5%	-4.1%	-3.0%	0.7%	1.3%
9-12	0.2%	-5.3%	-0.2%	1.1%	0.9%
12-18	56.2%	-5.9%	0.0%	-0.5%	-12.3%
>18	86.9%	-34.9%	9.2%	-15.7%	27.9%

3.4.3 Flow Occurrences Below 9,000 cfs

The total number of flow occurrences and the average number per day below 9,000 cfs in the Fort Randall reach would be greater under Alternative 4 than Alternative 1 as modeled for the POR (Table 8).

3.5 Alternative 5 – Fall ESH Creating Release

3.5.1 Fish and Wildlife Habitat Classes and Wetland Habitat Classes

The acres of fish and wildlife habitat classes and wetland classes, the change in acres, and percent change for Alternative 5 are presented in Table 37 for upper river reaches and Table 38 for lower river reaches.

Table 37. All Habitat Classes – Upper River (Alternative 5)

Habitat Types	Acres of Habitat	Change in Acres	% Change
Fort Peck to Garrison			
Open Water	65,843	687	1%
Emergent Wetland	7,258	-330	-4%
Scrub Shrub Wetland	55,605	-359	-1%
Riparian Woodland/Forested Wetland	19,493	-226	-1%
Forest	16,139	120	1%
Upland Grassland	14,134	108	1%
Garrison to Oahe			
Open Water	65,135	-312	0%
Emergent Wetland	7,714	349	5%
Scrub Shrub Wetland	14,609	-376	-3%
Riparian Woodland/Forested Wetland	399	-937	-70%
Forest	3,287	191	6%
Upland Grassland	5,594	1,085	24%
Fort Randall to Gavins			
Open Water	9,321	-33	0%
Emergent Wetland	5,901	-441	-7%
Scrub Shrub Wetland	13,465	388	3%
Riparian Woodland/Forested Wetland	1,424	-127	-8%
Forest	1,633	278	21%
Upland Grassland	2,626	-65	-2%

Table 38. All Habitat Classes – Lower River (Alternative 5)

Habitat Types	Acres of Habitat	Change in Acres	% Change
Gavins to Rulo			
Open Water	26,469	7	0%
Emergent Wetland	7,459	-644	-8%
Scrub Shrub Wetland	3,679	-169	-4%
Riparian Woodland/Forested Wetland	383	-153	-29%
Forest	543	214	65%
Upland Grassland	2,170	745	52%
Rulo to Kansas River			
Open Water	10,657	-8	0%
Emergent Wetland	2,330	-441	-16%
Scrub Shrub Wetland	760	-134	-15%
Riparian Woodland/Forested Wetland	298	132	79%
Forest	290	3	1%
Upland Grassland	7,894	449	6%
Kansas River to Grand River			
Open Water	12,062	0	0%
Emergent Wetland	3,099	53	2%
Scrub Shrub Wetland	1,469	261	22%
Riparian Woodland/Forested Wetland	643	304	90%
Forest	690	-17	-2%
Upland Grassland	4,417	-601	-12%
Grand River to Osage River			
Open Water	12,918	1	0%
Emergent Wetland	3,758	-158	-4%
Scrub Shrub Wetland	2,152	-11	0%
Riparian Woodland/Forested Wetland	536	122	29%
Forest	1,147	-39	-3%
Upland Grassland	9,440	85	1%
Osage River to Mississippi River			
Open Water	16,844	16	0%
Emergent Wetland	3,207	-39	-1%
Scrub Shrub Wetland	4,291	403	10%
Riparian Woodland/Forested Wetland	1,233	27	2%
Forest	1,797	18	1%
Upland Grassland	9,093	-426	-4%

3.5.2 Depth Classes

The acres of depth classes for each period, the change in acres, and percent change for Alternative 5 are presented in Table 39 through Table 41 for upper river reaches and Table 42 through Table 44 for lower river reaches.

Table 39. Acres in Depth Classes – Upper River (Alternative 5)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	114,501	118,961	152,319	120,526	113,824
3-6	51,362	51,155	92,543	52,852	50,989
6-9	38,040	40,806	49,574	23,006	6,232
9-12	9,886	6,724	10,837	634	473
12-18	2,974	1,707	12,210	2,915	3,394
>18	50,329	22,118	34,244	54,375	50,717
Garrison to Oahe					
0-3	73,395	73,852	73,731	74,001	70,949
3-6	55,505	57,770	61,894	60,794	51,344
6-9	29,172	28,848	29,466	29,296	28,770
9-12	4,501	27,151	21,799	24,751	28,401
12-18	47,420	6,452	4,717	33,951	20,563
>18	19,341	15,230	23,785	22,226	6,297
Fort Randall to Gavins					
0-3	13,633	19,028	23,432	29,762	21,124
3-6	12,342	12,320	13,160	13,528	13,095
6-9	9,097	7,482	8,461	7,993	7,764
9-12	5,538	7,697	7,688	9,149	7,916
12-18	12,704	10,940	20,868	20,328	19,097
>18	2,935	15,916	16,442	15,589	15,931

Table 40. Change in Acres in Depth Classes – Upper River (Alternative 5)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	1,706	-756	136	22	547
3-6	521	-1,064	-508	-49	102
6-9	35,926	1,017	-367	-33	10
9-12	-1,303	-33	10,201	-2	-9,669
12-18	-13,402	0	11,133	-54	1,224
>18	19,574	-16,895	-11,682	30	19,238
Garrison to Oahe					
0-3	3	19	-403	74	-23
3-6	-701	-748	-643	-138	-204
6-9	19	-8	607	-43	101
9-12	-21,567	-36	4,861	2,109	558
12-18	21,102	-41,025	-27,149	-13,555	16,117
>18	4,271	-7,941	-5,108	65	73
Fort Randall to Gavins					
0-3	0	-328	-128	-145	718
3-6	0	-261	-3	-57	-4
6-9	0	24	8	17	2
9-12	0	-40	13	24	273
12-18	0	1,378	346	11,836	-475
>18	1	3,747	-409	-1,285	-48

Table 41. Percent Change in Depth Classes – Upper River (Alternative 5)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	1.5%	-0.6%	0.1%	0.0%	0.5%
3-6	1.0%	-2.0%	-0.5%	-0.1%	0.2%
6-9	1699.4%	2.6%	-0.7%	-0.1%	0.2%
9-12	-11.6%	-0.5%	1602.3%	-0.3%	-95.3%
12-18	-81.8%	0.0%	1033.7%	-1.8%	56.4%
>18	63.6%	-43.3%	-25.4%	0.1%	61.1%
Garrison to Oahe					
0-3	0.0%	0.0%	-0.5%	0.1%	0.0%
3-6	-1.2%	-1.3%	-1.0%	-0.2%	-0.4%
6-9	0.1%	0.0%	2.1%	-0.1%	0.4%
9-12	-82.7%	-0.1%	28.7%	9.3%	2.0%
12-18	80.2%	-86.4%	-85.2%	-28.5%	362.5%
>18	28.3%	-34.3%	-17.7%	0.3%	1.2%
Fort Randall to Gavins					
0-3	0.0%	-1.7%	-0.5%	-0.5%	3.5%
3-6	0.0%	-2.1%	0.0%	-0.4%	0.0%
6-9	0.0%	0.3%	0.1%	0.2%	0.0%
9-12	0.0%	-0.5%	0.2%	0.3%	3.6%
12-18	0.0%	14.4%	1.7%	139.4%	-2.4%
>18	0.0%	30.8%	-2.4%	-7.6%	-0.3%

Table 42. Acres in Depth Classes – Lower River (Alternative 5)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	15,226	19,926	21,485	23,271	21,301
3-6	16,802	16,626	18,146	18,663	16,904
6-9	39,276	14,398	14,214	14,425	15,265
9-12	32,945	32,077	19,303	18,730	25,971
12-18	68,627	114,395	62,103	230,539	256,329
>18	9,265	91,870	27,436	193,630	132,654
Rulo to Mississippi River					
0-3	16,126	15,115	14,696	15,731	16,060
3-6	18,072	15,113	13,440	15,455	15,561
6-9	22,519	16,235	14,905	16,576	17,938
9-12	30,384	18,333	16,798	20,042	21,618
12-18	2,330	28,517	42,974	57,340	56,781
>18	4,951	56,522	92,125	46,801	47,013

Table 43. Change in Acres in Depth Classes – Lower River (Alternative 5)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	7	-943	-1,145	-771	-935
3-6	-3	-420	-763	-846	-101
6-9	-366	-43	121	8	49
9-12	31,553	182	137	-294	-406
12-18	-63	19,186	-206,698	503	135,118
>18	0	5,065	1,074	51,212	-70,960
Rulo to Mississippi River					
0-3	-42	379	1,661	157	-703
3-6	-7	-943	591	-1,151	-609
6-9	36	125	-318	98	-53
9-12	11	75	-191	197	-154
12-18	0	-24,651	733	-407	-3,041
>18	284	-28,547	-325	-11,005	11,011

Table 44. Percent Change in Depth Classes – Lower River (Alternative 5)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	0.0%	-4.5%	-5.1%	-3.2%	-4.2%
3-6	0.0%	-2.5%	-4.0%	-4.3%	-0.6%
6-9	-0.9%	-0.3%	0.9%	0.1%	0.3%
9-12	2267.8%	0.6%	0.7%	-1.5%	-1.5%
12-18	-0.1%	20.2%	-76.9%	0.2%	111.5%
>18	0.0%	5.8%	4.1%	36.0%	-34.9%
Rulo to Mississippi River					
0-3	-0.3%	2.6%	12.7%	1.0%	-4.2%
3-6	0.0%	-5.9%	4.6%	-6.9%	-3.8%
6-9	0.2%	0.8%	-2.1%	0.6%	-0.3%
9-12	0.0%	0.4%	-1.1%	1.0%	-0.7%
12-18	0.0%	-46.4%	1.7%	-0.7%	-5.1%
>18	6.1%	-33.6%	-0.4%	-19.0%	30.6%

3.5.3 Flow Occurrences Below 9,000 cfs

The total number of flow occurrences and the average number per day below 9,000 cfs in the Fort Randall reach would be greater under Alternative 5 than Alternative 1 as modeled for the POR (Table 8).

3.6 Alternative 6 – Pallid Sturgeon Spawning Cue

3.6.1 Fish and Wildlife Habitat Classes and Wetland Habitat Classes

The acres of fish and wildlife habitat classes and wetland classes, the change in acres, and percent change for Alternative 6 are presented in Table 45 for upper river reaches and Table 46 for lower river reaches.

Table 45. All Habitat Classes – Upper River (Alternative 6)

Habitat Types	Acres of Habitat	Change in Acres	% Change
Fort Peck to Garrison			
Open Water	65,485	329	1%
Emergent Wetland	7,633	45	1%
Scrub Shrub Wetland	55,668	-296	-1%
Riparian Woodland/Forested Wetland	20,345	626	3%
Forest	15,278	-741	-5%
Upland Grassland	14,062	36	0%
Garrison to Oahe			
Open Water	64,871	-575	-1%
Emergent Wetland	9,040	1,675	23%
Scrub Shrub Wetland	13,630	-1,355	-9%
Riparian Woodland/Forested Wetland	1,996	660	49%
Forest	2,802	-294	-9%
Upland Grassland	4,398	-112	-2%
Fort Randall to Gavins			
Open Water	9,321	-33	0%
Emergent Wetland	5,842	-500	-8%
Scrub Shrub Wetland	13,870	793	6%
Riparian Woodland/Forested Wetland	1,295	-256	-16%
Forest	1,416	61	5%
Upland Grassland	2,626	-65	-2%

Table 46. All Habitat Classes – Lower River (Alternative 6)

Habitat Types	Acres of Habitat	Change in Acres	% Change
Gavins to Rulo			
Open Water	26,555	93	0%
Emergent Wetland	7,166	-937	-12%
Scrub Shrub Wetland	3,700	-147	-4%
Riparian Woodland/Forested Wetland	392	-144	-27%
Forest	552	223	68%
Upland Grassland	2,337	912	64%
Rulo to Kansas River			
Open Water	10,607	-58	-1%
Emergent Wetland	2,295	-476	-17%
Scrub Shrub Wetland	876	-18	-2%
Riparian Woodland/Forested Wetland	316	149	90%
Forest	383	96	34%
Upland Grassland	7,751	306	4%
Kansas River to Grand River			
Open Water	12,013	-49	0%
Emergent Wetland	3,059	13	0%
Scrub Shrub Wetland	1,729	521	43%
Riparian Woodland/Forested Wetland	538	199	59%
Forest	634	-73	-10%
Upland Grassland	4,408	-611	-12%
Grand River to Osage River			
Open Water	12,895	-22	0%
Emergent Wetland	3,695	-222	-6%
Scrub Shrub Wetland	2,326	164	8%
Riparian Woodland/Forested Wetland	537	123	30%
Forest	1,101	-85	-7%
Upland Grassland	9,396	42	0%
Osage River to Mississippi River			
Open Water	16,721	-107	-1%
Emergent Wetland	3,251	5	0%
Scrub Shrub Wetland	4,602	714	18%
Riparian Woodland/Forested Wetland	1,112	-94	-8%
Forest	1,711	-68	-4%
Upland Grassland	9,069	-450	-5%

3.6.2 Depth Classes

The acres of depth classes for each period, the change in acres, and percent change for Alternative 6 are presented in Table 47 through Table 49 for upper river reaches and Table 50 through Table 52 for lower river reaches.

Table 47. Acres in Depth Classes – Upper River (Alternative 6)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	113,658	119,393	152,272	120,959	113,782
3-6	51,150	52,062	92,552	53,017	50,958
6-9	38,031	40,791	49,676	23,996	6,211
9-12	10,675	6,721	28,259	636	473
12-18	3,139	1,707	1,077	3,009	3,395
>18	30,211	39,093	45,140	54,056	50,761
Garrison to Oahe					
0-3	73,676	73,826	74,165	73,770	70,951
3-6	56,608	58,253	62,577	61,172	51,423
6-9	29,131	28,886	28,866	29,137	28,770
9-12	26,662	27,249	16,928	22,954	28,505
12-18	3,669	41,112	30,614	4,712	24,613
>18	15,309	18,012	28,864	22,927	6,267
Fort Randall to Gavins					
0-3	13,599	19,144	24,781	29,724	18,835
3-6	12,350	12,481	12,910	13,491	12,353
6-9	9,114	7,473	10,024	7,997	7,476
9-12	5,539	7,714	7,813	9,062	7,607
12-18	12,706	10,877	20,189	8,557	18,472
>18	6,553	16,218	17,787	16,870	14,815

Table 48. Change in Acres in Depth Classes – Upper River (Alternative 6)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	863	-324	89	456	505
3-6	309	-157	-498	116	71
6-9	35,917	1,001	-265	958	-10
9-12	-514	-37	27,623	0	-9,669
12-18	-13,237	0	0	40	1,225
>18	-544	80	-786	-289	19,282
Garrison to Oahe					
0-3	283	-8	32	-157	-22
3-6	402	-265	40	240	-124
6-9	-21	30	7	-202	101
9-12	594	62	-10	312	662
12-18	-22,649	-6,365	-1,252	-42,794	20,167
>18	239	-5,159	-29	766	43
Fort Randall to Gavins					
0-3	-33	-212	1,221	-182	-1,571
3-6	8	-100	-252	-94	-746
6-9	17	15	1,570	21	-287
9-12	1	-22	138	-63	-36
12-18	2	1,315	-333	65	-1,100
>18	3,619	4,049	936	-4	-1,164

Table 49. Percent Change in Depth Classes – Upper River (Alternative 6)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	0.8%	-0.3%	0.1%	0.4%	0.4%
3-6	0.6%	-0.3%	-0.5%	0.2%	0.1%
6-9	1699.0%	2.5%	-0.5%	4.2%	-0.2%
9-12	-4.6%	-0.5%	4338.9%	0.0%	-95.3%
12-18	-80.8%	0.0%	0.0%	1.3%	56.5%
>18	-1.8%	0.2%	-1.7%	-0.5%	61.3%
Garrison to Oahe					
0-3	0.4%	0.0%	0.0%	-0.2%	0.0%
3-6	0.7%	-0.5%	0.1%	0.4%	-0.2%
6-9	-0.1%	0.1%	0.0%	-0.7%	0.4%
9-12	2.3%	0.2%	-0.1%	1.4%	2.4%
12-18	-86.1%	-13.4%	-3.9%	-90.1%	453.6%
>18	1.6%	-22.3%	-0.1%	3.5%	0.7%
Fort Randall to Gavins					
0-3	-0.2%	-1.1%	5.2%	-0.6%	-7.7%
3-6	0.1%	-0.8%	-1.9%	-0.7%	-5.7%
6-9	0.2%	0.2%	18.6%	0.3%	-3.7%
9-12	0.0%	-0.3%	1.8%	-0.7%	-0.5%
12-18	0.0%	13.8%	-1.6%	0.8%	-5.6%
>18	123.3%	33.3%	5.6%	0.0%	-7.3%

Table 50. Acres in Depth Classes – Lower River (Alternative 6)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	15,217	20,295	24,796	22,733	21,358
3-6	16,802	16,910	18,928	18,569	16,384
6-9	39,638	14,297	13,967	14,466	15,229
9-12	1,391	31,662	18,587	18,778	32,850
12-18	68,687	253,507	240,257	238,812	125,714
>18	9,265	183,195	331,611	218,445	264,437
Rulo to Mississippi River					
0-3	16,093	15,051	14,423	15,530	15,679
3-6	18,072	15,185	13,412	15,484	15,618
6-9	22,370	16,289	14,873	16,809	18,433
9-12	30,352	18,293	16,668	20,140	22,256
12-18	2,330	53,453	41,596	58,114	56,977
>18	5,182	51,103	98,891	50,251	37,890

Table 51. Change in Acres in Depth Classes – Lower River (Alternative 6)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	-2	-574	2,167	-1,309	-878
3-6	-3	-135	19	-940	-621
6-9	-4	-144	-126	48	13
9-12	0	-232	-579	-245	6,472
12-18	-3	158,298	-28,544	8,776	4,503
>18	0	96,390	305,249	76,027	60,823
Rulo to Mississippi River					
0-3	-75	316	1,389	-44	-1,085
3-6	-7	-871	563	-1,121	-552
6-9	-113	179	-350	331	442
9-12	-21	35	-321	295	484
12-18	0	285	-645	367	-2,845
>18	515	-33,966	6,441	-7,555	1,888

Table 52. Percent Change in Depth Classes – Lower River (Alternative 6)

Depth Class	Seasonal Period				
	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	0.0%	-2.8%	9.6%	-5.4%	-3.9%
3-6	0.0%	-0.8%	0.1%	-4.8%	-3.7%
6-9	0.0%	-1.0%	-0.9%	0.3%	0.1%
9-12	0.0%	-0.7%	-3.0%	-1.3%	24.5%
12-18	0.0%	166.3%	-10.6%	3.8%	3.7%
>18	0.0%	111.0%	1157.9%	53.4%	29.9%
Rulo to Mississippi River					
0-3	-0.5%	2.1%	10.7%	-0.3%	-6.5%
3-6	0.0%	-5.4%	4.4%	-6.8%	-3.4%
6-9	-0.5%	1.1%	-2.3%	2.0%	2.5%
9-12	-0.1%	0.2%	-1.9%	1.5%	2.2%
12-18	0.0%	0.5%	-1.5%	0.6%	-4.8%
>18	11.0%	-39.9%	7.0%	-13.1%	5.2%

3.6.3 Flow Occurrences Below 9,000 cfs

The total number of flow occurrences and the average number per day below 9,000 cfs in the Fort Randall reach would be greater under Alternative 6 than Alternative 1 as modeled for the POR (Table 7).

4.0 Literature Cited

Hansen, P. L., R. D. Pfister, K. Boggs, B. J. Cook, J. Joy, and D.K. Hinckley. 1995. Classification and Management of Montana's Riparian and Wetland Sites. Montana Forest and Conservation Experiment Station School of Forestry, The University of Montana. Misc. Pub. No. 54.

Johnson, W.C., R.L. Burgess, and W.R. Keammerer. 1976. Forest overstory and environment along the Missouri River in North Dakota. Ecological Monographs 46:59–84.

NatureServe. 2009. Possible Vegetation Alliances and Associations in the Missouri River Valley. Arlington, VA.

Nelson, P. W. 2005. The Terrestrial Natural Communities of Missouri. Missouri Natural Areas Commission, Missouri Department of Natural Resources.

Nigh, T.A., and W.A. Schroeder. 2002. Atlas of Missouri Ecoregions. Missouri Department of Conservation, Jefferson City, Missouri.

Shelley, John, and Philip Bailey. 2018. The Cross Section Viewer: A Tool for Automating Geomorphic Analysis Using Cross Section Data. ERDC/TN RSM- 18-3. Vicksburg, MS: U.S. Army Engineer Research and Development Center. http://dx.doi.org/10.21079/11681/26284

Steinauer, G., and S. Rolfsmeier. 2003. *Terrestrial Natural Communities of Nebraska*, Nebraska Natural Heritage Program, Nebraska Game and Parks Commission.

USACE 2013. Missouri River Baseline Assessment.

USFWS 2003. Amendment to the 2000 Biological Opinion on the Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System.