MISSOURI RIVER
RECOVERY PROGRAM

DRAFT

Missouri River Recovery Management Plan and Environmental Impact Statement

FISH AND WILDLIFE ENVIRONMENTAL CONSEQUENCES ANALYSIS TECHNICAL REPORT

December 2016

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Fish and Wildlife Environmental Consequences Analysis Technical Report

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Acronyms and Abbreviations

BiOp	Biological Opinion
EQ	Environmental Quality
ER	Engineering Regulations
HC	Human Considerations
HEC-EFM	Hydrologic Engineering Center – Ecosystems Functions Model
HEC-RAS	Hydrologic Engineering Center – River Analysis System
MRRIC	Missouri River Recovery Implementation Committee
MRRMP-EIS	Missouri River Recovery Management Plan – Environmental Impact Study
MRRP	Missouri River Recovery Plan
NED	National Economic Development
NEPA	National Environmental Protection Agency
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	United States Army Core of Engineers
USFWS	United States Fish and Wildlife System

1.0 Introduction

The USACE in cooperation with the USFWS are developing a Missouri River Recovery Management Plan and Environmental Impact Statement (MRRMP-EIS). The purpose of the MRRMP-EIS is to develop a management plan that includes a suite of actions that removes or precludes jeopardy status for the piping plover, the interior least tern, and the pallid sturgeon using USACE authorities.

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 Management Plan alternatives. Detailed descriptions of the alternatives is provided in the MRRMP-EIS, Chapter 2.

- **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 BiOp compliance. Management actions under No Action include construction of early life stage habitat for the pallid sturgeon and emergent sandbar habitat (ESH), as well as a spring plenary pulse. The construction of habitat will be focused in the Garrison and Gavins reaches for ESH (an average rate of 107 acres per year) and between Ponca to the mouth near St. Louis for 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 No Action 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 3,546 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 only create ESH through mechanical means at an average rate of 391 acres per year across the entire system. 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 additional 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.

- **Alternative 4 – Spring ESH Creating Release.** The USACE would mechanically construct ESH annually at an average rate of 240 acres per year across the entire system. 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 (current operations), with the addition of a spring release designed to create ESH for the least tern and piping plover. An additional 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 309 acres per year across the entire system. This alternative is based on Alternative 1 (current operations), with the addition of a release in the fall designed to create sandbar habitat for the least tern and piping plover. An additional 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 303 acres per year across the entire system. 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 or would be terminated whenever flood targets are exceeded. An additional 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 national economic development (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 regional economic development (RED) account registers changes in the distribution of regional economic activity (i.e., jobs and income).
- The environmental quality (EQ) displays non-monetary effects of significant natural and cultural resources.

- The other social effects (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 Missouri River Recovery Management Plan

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 native 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 native terrestrial and aquatic habitats and how changes in terrestrial and aquatic habitats could affect native fish and wildlife. Physical components that are particularly important to ecosystems, native species, and floodplain habitats include rivers 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 the no-action alternative 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 one day of inundation, forest is represented by areas with 16 days of inundation, riparian woodland/forested wetland is

represented by 36 days of inundation, scrub shrub wetland is represented by 52 days of inundation, emergent wetland is represented by 159 days of inundation, and open water is represented by 365 days of inundation. The modeling produces the change in the acreage of upland grassland inundated at one day, for instance, rather than the change in acreage of the upland grassland category as a whole. 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 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.

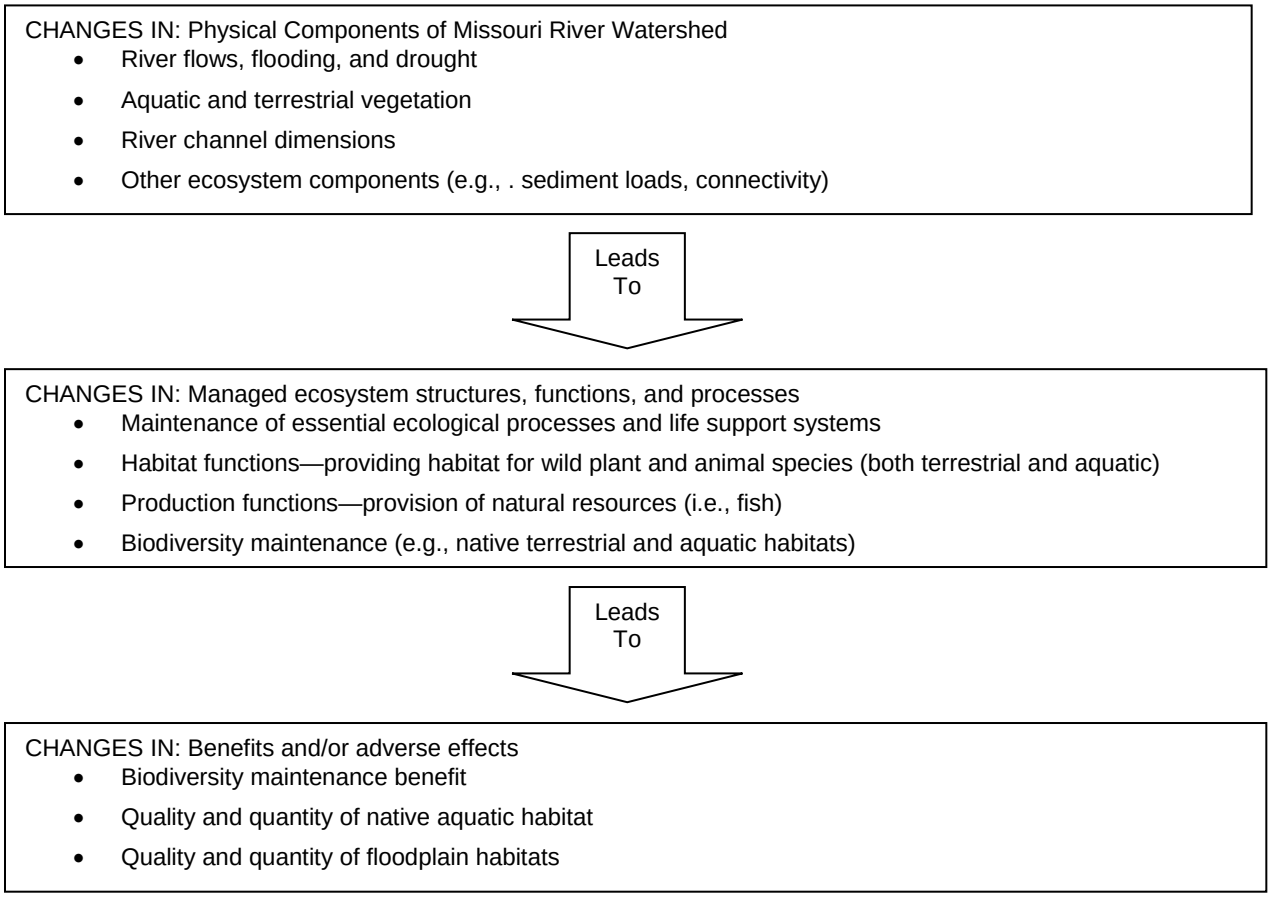

Figure 1. Flow Chart of Inputs Considered in Fish and Wildlife Evaluation

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 HEC-RAS; and, (2) the definition of the habitat class/inundation period relationships. The completion of these two steps provides the input and structure for the following portion of the modeling process in Ecosystem Functions Model (HEC-EFM). The HEC-EFM output (i.e., habitat class associated flows) is then placed into a steady flow HEC-RAS model which provides the spatial data needed to complete the modeling process. The resulting product is the tabulated area in acres per river reach and habitat class. This process is described in detail below.

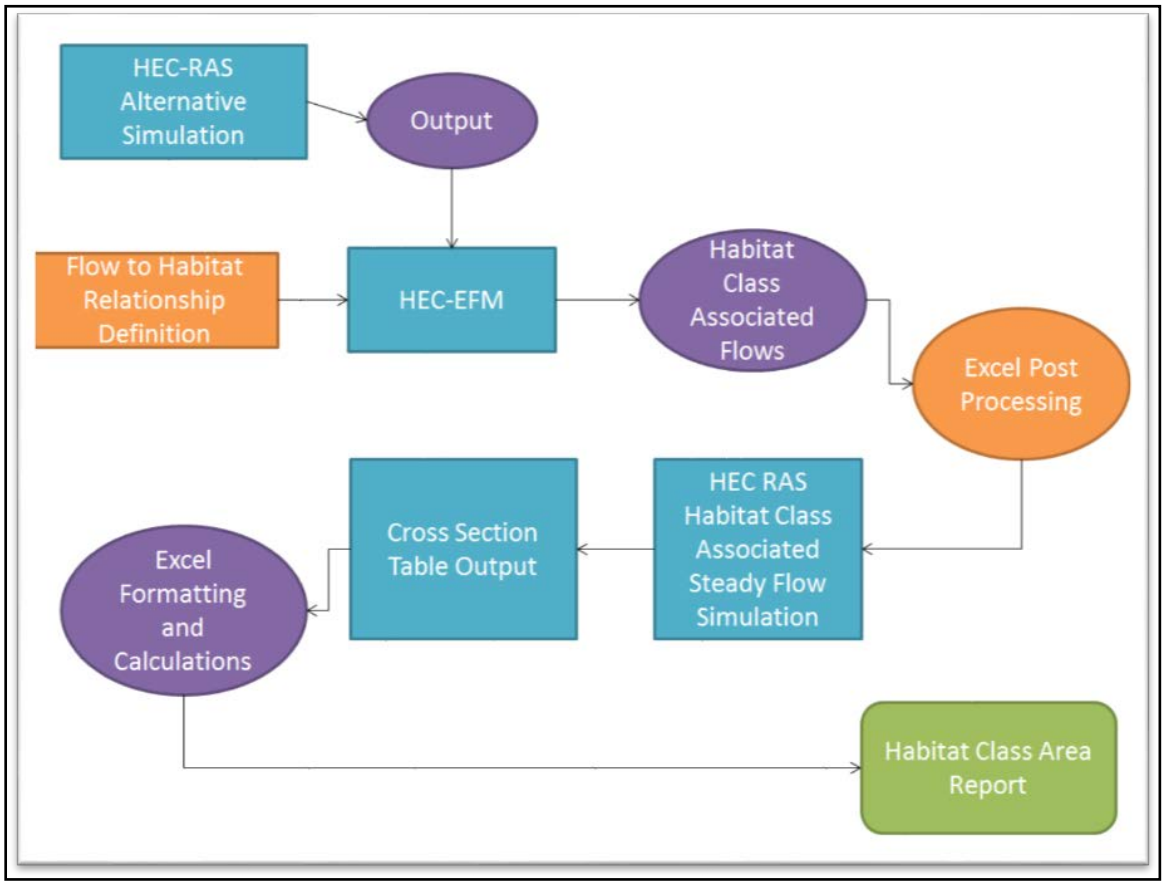

Figure 2. Modeling Process Work Flow Chart

The study area consists of the Missouri River and adjacent area from Fort Peck, Montana to the confluence with the Mississippi River in St. Louis, Missouri. For the purposes of this modeling effort, eight river 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

	River Reach
North of Gavins Point Dam	Fort Peck Dam to Garrison Dam
	Garrison Dam to Oahe Lake
	Fort Randall Dam to Gavins Point Dam
South of Gavins Point Dam	Gavins Point Dam to Rulo, NE
	Rulo, NE to Kansas River
	Kansas River to Grand River
	Grand River to Osage River
	Osage River to Mouth

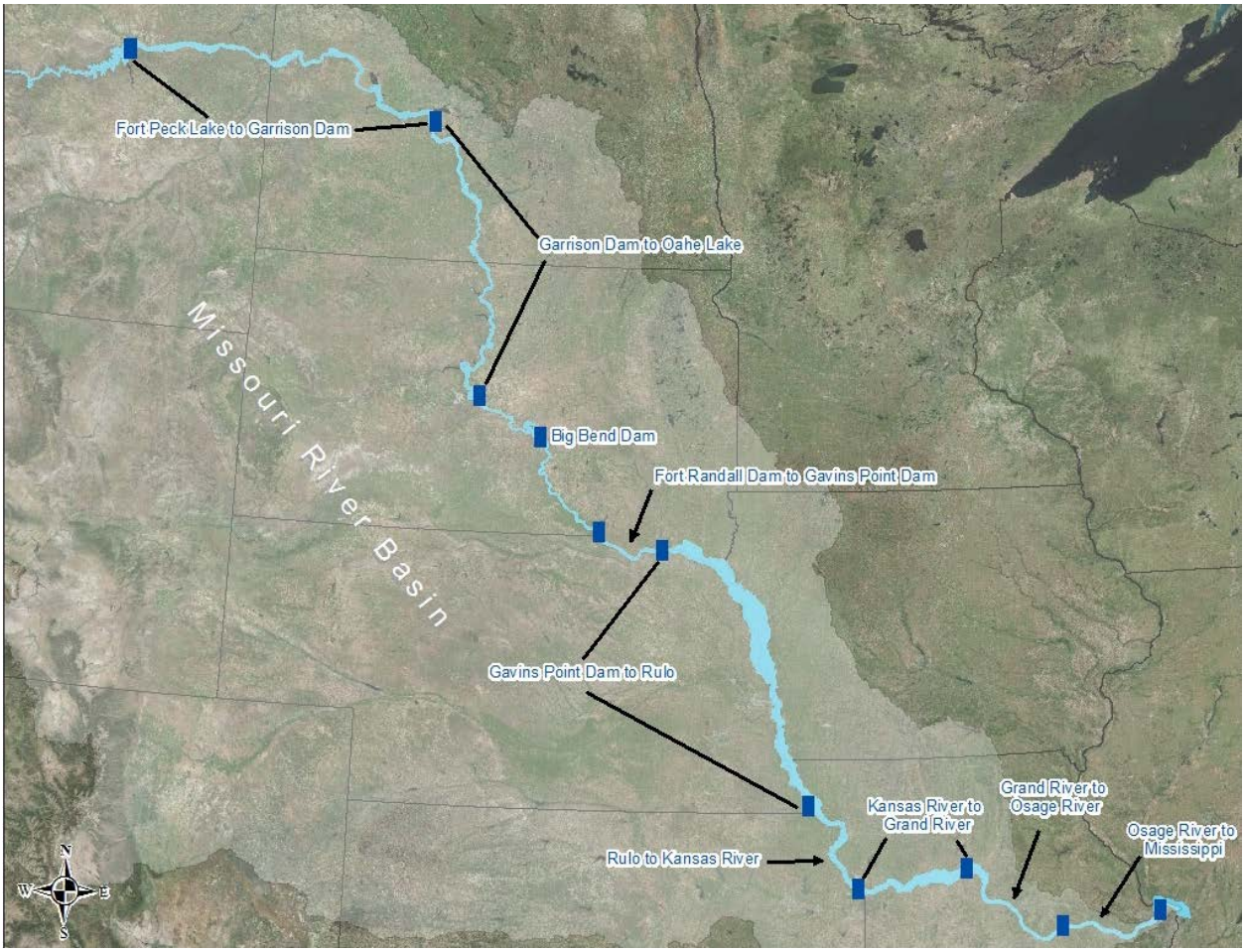

Figure 3. Missouri River Study Reaches

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 river 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). 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, a specific number of days of inundation were assumed for modeling purposes. 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 (# of Days Inundated)**
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

HEC-EFM Relationships				
Geographic Region	**Habitat Class**	**Season (Dates)**		**Duration (# of Days Inundated)**
	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
	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

Table 3. Missouri River Habitat Classes and Vegetation Community Composition

River Reaches	Habitat Class	Habitat Composition Description
Fort Peck to Garrison Garrison to Oahe Fort Randall to Gavins	Open Water	Main Channel, Chutes/Secondary Channels, Open Water Sloughs, Oxbows, Pools, and Backwaters
	Emergent Wetland	Cattail Semi-permanently Flooded Wetland, Cattail Seasonally Flooded Wetlands, Nebraska Sedge Seasonally Flooded Wetland, and Cordgrass Temporarily Flooded Wetlands

River Reaches	Habitat Class	Habitat Composition Description
	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 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 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.

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 river reaches being 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 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 are 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 is 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 can be built in HEC-EFM, a new HEC-EFM model file must be created. Each river reach is evaluated in a separate HEC-EFM model; since there are eight reaches being evaluated in this effort, eight separate HEC-EFM models were created. HEC-EFM takes user defined river miles to evaluate specific locations. These locations are entered as Flow Regimes in the HEC-EFM Properties window. For this modeling effort, the flow regime is the output from a USACE, Hydrologic Engineering Center, River Analysis System (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 is the flow regime input queried in HEC-EFM and consists of the geographic locations or river cross sections selected for analysis. Each cross section must be entered separately as a unique Flow Regime. The same .dss file is used for each Flow Regime, but the separate cross sections are 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.

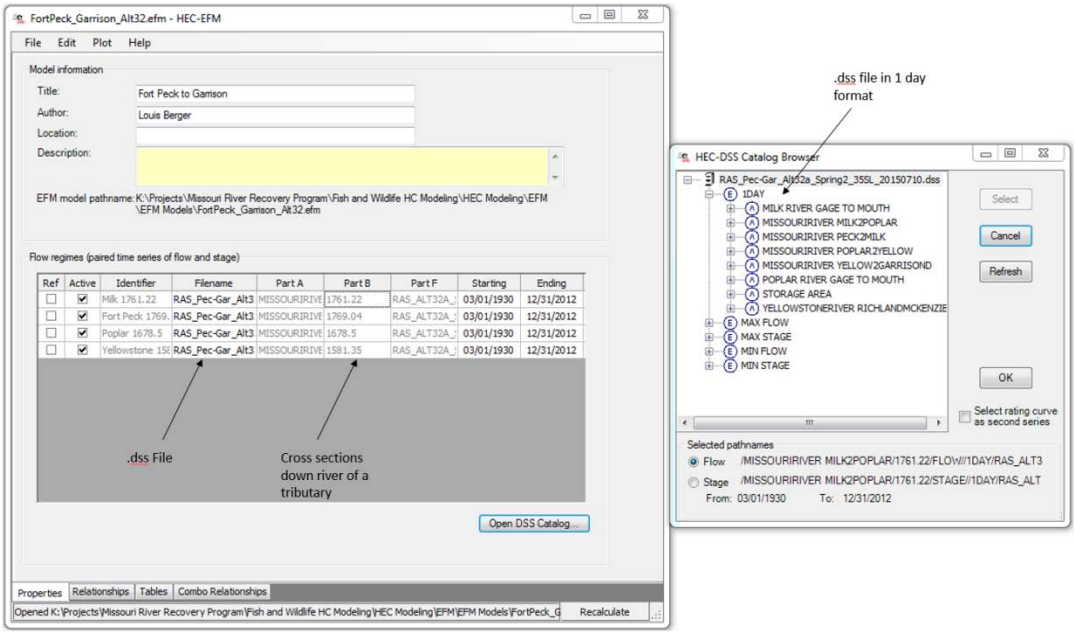

Figure 4. Example of DSS Catalog Window

After the flow regimes are entered into the HEC-EFM model, the relationships are created in the Relationships window of the specific HEC-EFM model being built (Figure 5). The relationships are 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, the season and Duration of Days information must be populated. Also previously defined, under the Time series specifications section on the bottom left portion of the Relationships window, the percent exceedance (n-yr) information must be entered. The Season information is 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 will be 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, there are two drop down menus that will 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 is entered into the percent exceedance box as earlier discussed, telling HEC-EFM to select the 50th percentile of the data representing a typical day of flows. It will give the median value for flows out of every individual day over the entire POR.

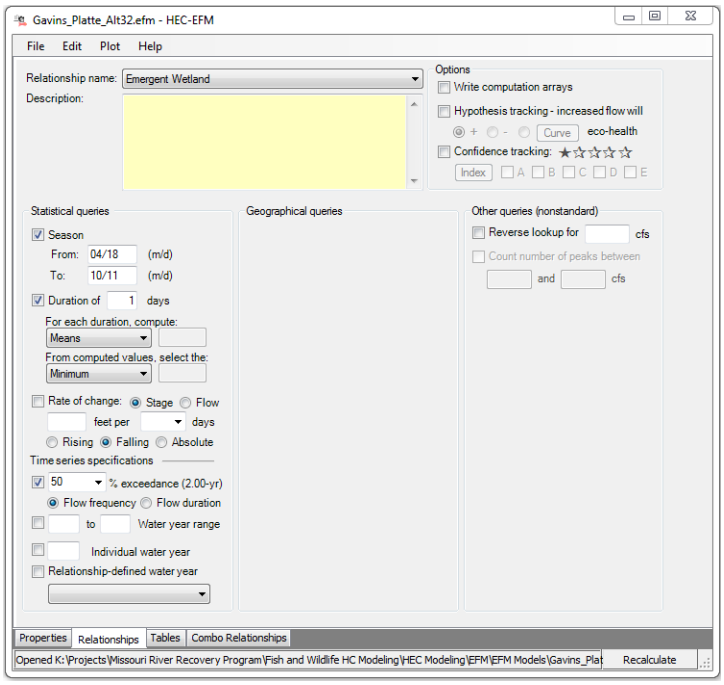

Figure 5. Example of HEC-EFM Relationships Window

After each flow regime and relationship is built in HEC-EFM, the model can be run by clicking the Recalculate button in the lower right corner of the HEC-EFM window. The results of the model will then populate in the Tables window. 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 are run through the baseline geometry in a steady flow simulation in HEC-RAS (Figure 6). Before the HEC-EFM output can be entered into HEC-RAS, it is more efficient to prepare the data in excel before entering it into HEC-RAS. When the data is entered into HEC-RAS, the habitat classes are 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 is in a format that matches HEC-RAS, it can be copied and pasted into the Steady Flow Data window. 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 provided by the USACE for the tributaries. The provided tributary flows are added into the steady flow data table in the column corresponding to the correct tributary and habitat class.

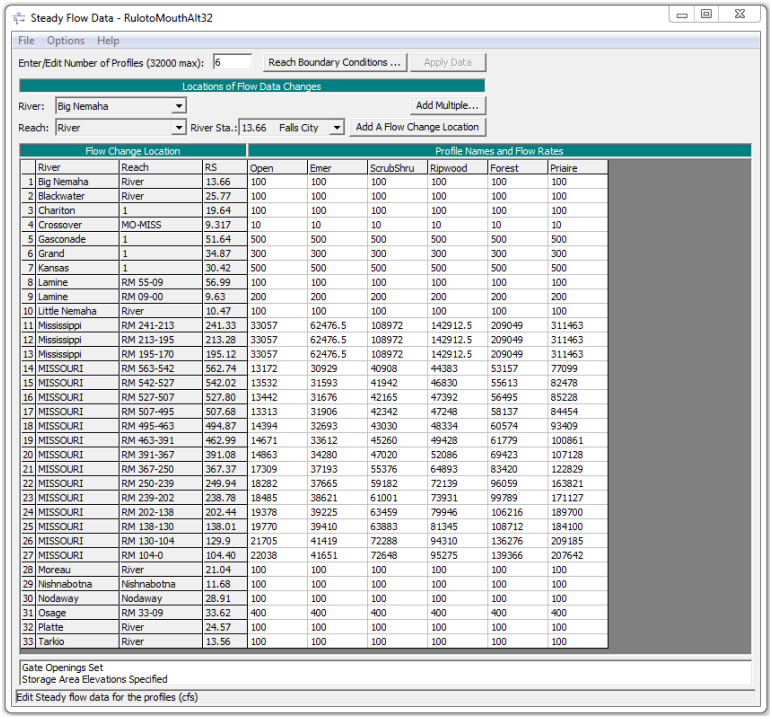

Figure 6. Example of HEC-RAS Steady Flow Data Window

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 provided by the USACE. The geometry file is imported into the HEC-RAS project through the Edit/Enter geometric data menu. Once the data is entered, it can be viewed, the cross sections previously selected, and input as flow regimes in 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 be completed before the flow data can be entered and the model parameters set correctly. First, each habitat class is added as a profile and renamed to the habitat class name. Then the flows are added by copying and pasting from the preformatted table in Excel to the table in the HEC-RAS steady flow data window. Second, the gate openings and storage area elevations need to be set. Both of these parameters are found in the options drop down menu from the Steady Flow Data window. After clicking on the Gate Openings option, the Spillway Gate Openings window will open. The numbers used to populate this table were provided by the USACE. 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 will populate the storage area elevations automatically. The final step to complete the Steady Flow Data portion of the HEC-RAS project is to set the boundary conditions. This is completed in the Steady Flow Boundary Conditions window, which is opened by clicking on 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. That informs 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, click on the Perform a steady flow simulation button at the top of the HEC-RAS main window to open the Steady Flow Analysis window. The simulation will run after clicking the Compute button at the bottom of the window.

Once the steady flow simulation has completed, the results must then be exported from HEC-RAS and copied into an excel sheet so that acres of habitat can be summed and reported. In order to do this, click on 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 must be defined. To define the locations that will be reported in the output table, click on the Define Location List… from the Location drop down menu. First, in the Select Nodes for PF Table, click on the Node Types button and deselect all node types except for Cross Sections. Once Cross Sections is the only node type with a check in the box to its left, click outside of the drop down menu to close it. From the River drop down list, select the river for which you are interested in viewing profiles from; in this case it would the Missouri River. Once the river is selected, the reaches are 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 have been defined and all desired cross sections are in the Selected Locations menu on the right side of the Select Nodes for PF Table, click OK. To define the profile information that will be reported in the table at each of the locations, select Define Table… from the Options drop down menu. Once in the Create a Table Heading window, select the variables to be included into the output table by double clicking them from the Available Variables list. Upon double clicking on the desired variables, they will 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 are selected and displayed in the Table column Headings window, click OK. Now the output table can 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 is in Excel, reach length is 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 is further defined as various depth classes. These depth class habitat classes are 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, provided by USACE, 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 are uploaded into the software for each of the river reach databases, and then the depth distribution is tabulated and output as a histogram displaying acres of habitat over the depth classes.

The frequency of the occurrence of flows below 9,000 cfs in the Fort Randall reach is 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 Management Plan 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 period of record. 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 Management Plan 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 7 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 alterative 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.

The one-time spawning cue test (Level 2) release that may be implemented under Alternatives 3, 4, and 5 was not included in the hydrologic modeling for these alternatives because of the uncertainty of the hydrologic conditions that would be present if implemented. Hydrologic modeling for Alternative 6 simulates reoccurring implementation (Level 3) of this spawning cue over the wide range of hydrologic conditions in the POR. Therefore, the impacts from the potential implementation of a one-time spawning cue test release would be bound by the range of impacts described for individual releases under Alternative 6.

Table 4. Overall Change in Aquatic/Floodplain Habitat Classes

Habitat Types	Alternative 1 No Action (Current System Operation and Current MRRP Implementation)	Alternative 2 BiOP		Alternative 3 All Mechanical		Alternative 4 Spring Release		Alternative 5 Fall Release		Alternative 6 Spawning Cue	
	Acres of Habitat	Change in Area (acres) and % Change									
Open Water	213,527	197	0%	1,071	1%	−127	0%	317	0%	665	0%
Emergent Wetland	46,938	2,086	4%	703	1%	−2,599	−6%	1,677	4%	1,302	3%
Scrub Shrub Wetland	94,408	4,883	5%	−1,672	−2%	2,538	3%	−2,128	−2%	1,097	1%
Riparian Woodland/Forested Wetland	23,891	2,356	10%	2,458	10%	1,358	6%	2,306	10%	1,225	5%
Forest	26,162	−692	−3%	−3,457	−13%	−319	−1%	−3,314	−13%	−4,332	−17%
Upland Grassland	63,768	−7,199	−11%	−5,095	−8%	−232	0%	−4,300	−7%	−3,115	−5%

Table 5. Overall Change in Wetland Habitat Classes

Habitat Types	Alternative 1 No Action (Current System Operation and Current MRRP Implementation)	Alternative 2 BiOP		Alternative 3 All Mechanical		Alternative 4 Spring Release		Alternative 5 Fall Release		Alternative 6 Spawning Cue	
	Acres of Habitat	Change in Area (acres) and % Change									
Emergent Wetland	46,938	2,086	4%	703	1%	−2,599	−6%	1,677	4%	1,302	3%
Scrub Shrub Wetland	94,408	4,883	5%	−1,672	−2%	2,538	3%	−2,128	−2%	1,097	1%
Riparian Woodland/Forested	23,891	2,356	10%	2,458	10%	1,358	6%	2,306	10%	1,225	5%

Table 6. Overall Change in Depth Classes

Depth Class	Alternative 1 No Action (Current System Operation and Current MRRP Implementation)	Alternative 2 BiOP		Alternative 3 All Mechanical		Alternative 4 Spring Release		Alternative 5 Fall Release		Alternative 6 Spawning Cue	
	Acres of Habitat	Change in Area (acres) and % Change									
Overwintering Late											
0-3	233,368	3,596	1.5%	167	0.1%	−1,097	−0.5%	−2,145	−0.9%	187	0.1%
3-6	319,495	400	0.1%	158	0.0%	−466	−0.1%	28,615	9.0%	−555	−0.2%
6-9	619,023	4,250	0.7%	207	0.0%	14,168	2.3%	208,292	33.6%	5,022	0.8%
9-12	1,529,163	27,046	1.8%	−474	0.0%	17,862	1.2%	−42,663	−2.8%	2,311	0.2%
12-18	3,355,486	−12,174	−0.4%	3,432	0.1%	−22,151	−0.7%	−139,051	−4.1%	2,648	0.1%
>18	1,097,356	−23,255	−2.1%	−3,528	−0.3%	−16,043	−1.5%	−145,344	−13.2%	−15,438	−1.4%
Early Spawning											
0-3	240,741	3,111	1.3%	−27	0.0%	270	0.1%	−32,363	−13.4%	318	0.1%
3-6	308,280	3,082	1.0%	73	0.0%	955	0.3%	26,210	8.5%	594	0.2%
6-9	463,740	−15,979	−3.4%	−80	0.0%	−383	−0.1%	135,562	29.2%	−3,240	−0.7%
9−12	847,184	28,781	3.4%	4,142	0.5%	−4,566	−0.5%	−58,964	−7.0%	−3,927	−0.5%
12-18	2,470,529	−11,769	−0.5%	−11,988	−0.5%	−38,113	−1.5%	27,948	1.1%	−10,420	−0.4%
>18	3,370,840	10,722	0.3%	16,814	0.5%	74,692	2.2%	−162,386	−4.8%	29,646	0.9%
Late Spawning											
0-3	275,761	10,626	3.9%	1,489	0.5%	1,261	0.5%	−12,767	−4.6%	3,016	1.1%
3-6	250,567	4,101	1.6%	−651	−0.3%	−1,280	−0.5%	23,886	9.5%	658	0.3%
6-9	359,266	−14,332	−4.0%	20,982	5.8%	19,275	5.4%	−24,871	−6.9%	−12,078	−3.4%
9-12	731,407	−70,715	−9.7%	−75,823	−10.4%	−75,594	−10.3%	−38,679	−5.3%	−52,846	−7.2%
12-18	2,176,821	−175,039	−8.0%	4,508	0.2%	552	0.0%	−251,082	−11.5%	−37,472	−1.7%
>18	4,357,841	299,558	6.9%	11,975	0.3%	5,814	0.1%	−88,092	−2.0%	108,630	2.5%

Depth Class	Alternative 1 No Action (Current System Operation and Current MRRP Implementation)	Alternative 2 BiOP		Alternative 3 All Mechanical		Alternative 4 Spring Release		Alternative 5 Fall Release		Alternative 6 Spawning Cue	
Summer Rearing and Growth											
0-3	255,684	289	0.1%	−6,971	−2.7%	2,008	0.8%	24,245	9.5%	−1,396	−0.5%
3-6	306,593	2,351	0.8%	−9,776	−3.2%	−22,448	−7.3%	−62,353	−20.3%	556	0.2%
6-9	390,371	−9,973	−2.6%	−9,014	−2.3%	30,552	7.8%	−28,979	−7.4%	−11,195	−2.9%
9-12	593,440	98,560	16.6%	36,535	6.2%	78,802	13.3%	−7,083	−1.2%	97,980	16.5%
12-18	2,056,428	170,885	8.3%	−172,443	−8.4%	132,111	6.4%	−34,124	−1.7%	72,832	3.5%
>18	4,317,730	−213,306	−4.9%	−46,940	−1.1%	−166,824	−3.9%	−24,967	−0.6%	−92,354	−2.1%
Overwintering Early											
0-3	227,004	−2,753	−1.2%	−1,770	−0.8%	−4,571	−2.0%	53,606	23.6%	−4,019	−1.8%
3-6	334,654	2,176	0.7%	−1,109	−0.3%	668	0.2%	−75,666	−22.6%	−2,173	−0.6%
6-9	582,476	5,462	0.9%	−132	0.0%	14,797	2.5%	−171,303	−29.4%	−1,625	−0.3%
9-12	660,294	97,733	3.9%	95,276	14.4%	126,830	19.2%	83,200	12.6%	120,315	18.2%
12-18	2,448,986	23,672	1.0%	−56,509	−2.3%	6,747	0.3%	191,415	7.8%	43,801	1.8%
>18	3,416,477	−23,670	−0.7%	62,347	1.8%	−67,473	−2.0%	164,535	4.8%	−79,966	−2.3%

Table 7. Flow Occurrences below 9,000 cfs

	Alternative 1 No Action (Current System Operation and Current MRRP Implementation)	Alternative 2 BiOP	Alternative 3 All Mechanical	Alternative 4 Spring Release	Alternative 5 Fall Release	Alternative 6 Spawning Cue
Total Number of Flow Occurrences <9,000 cfs	150,508	161,248	150,030	155,588	152,620	153,182
Average Number of Flow Occurrences <9,000 cfs per day	4.97	5.33	4.96	5.14	5.04	5.06

3.1 Alternative 1 (Current System Operations and MRRP Management Actions)

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 below in Table 8 for upper river reaches and Table 9 for lower river reaches.

Table 8. All Habitat Classes – Upper River

Habitat Types	Acres of Habitat
Fort Peck to Garrison	
Open Water	62,929
Emergent Wetland	9,044
Scrub Shrub Wetland	56,758
Riparian Woodland/Forested Wetland	19,369
Forest	14,913
Upland Grassland	22,796
Garrison to Oahe	
Open Water	62,476
Emergent Wetland	13,030
Scrub Shrub Wetland	11,608
Riparian Woodland/Forested Wetland	539
Forest	4,174
Upland Grassland	8,808
Fort Randall to Gavins	
Open Water	8,927
Emergent Wetland	5,031
Scrub Shrub Wetland	13,822
Riparian Woodland/Forested Wetland	1,215
Forest	2,620
Upland Grassland	3,297

Table 9. All Habitat Classes – Lower River

Habitat Types	Acres of Habitat
Gavins to Rulo	
Open Water	26,588
Emergent Wetland	7,710
Scrub Shrub Wetland	3,799
Riparian Woodland/Forested Wetland	386
Forest	551
Upland Grassland	710
Rulo to Kansas River	
Open Water	10,700
Emergent Wetland	2,475
Scrub Shrub Wetland	1,131
Riparian Woodland/Forested Wetland	146
Forest	292
Upland Grassland	6,701
Kansas River to Grand River	
Open Water	12,127
Emergent Wetland	2,803
Scrub Shrub Wetland	1,287
Riparian Woodland/Forested Wetland	418
Forest	664
Upland Grassland	4,634
Grand River to Osage River	
Open Water	12,978
Emergent Wetland	3,657
Scrub Shrub Wetland	2,271
Riparian Woodland/Forested Wetland	480
Forest	1,181
Upland Grassland	8,402
Osage River to Mississippi River	
Open Water	16,801
Emergent Wetland	3,189
Scrub Shrub Wetland	3,733
Riparian Woodland/Forested Wetland	1,337
Forest	1,767
Upland Grassland	8,420

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 below in Table 10 for upper river reaches and Table 11 for lower river reaches.

Table 10. Acres of Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	119,549	118,892	151,065	120,704	100,667
3-6	170,378	173,262	115,432	167,311	193,434
6-9	221,793	274,496	189,730	223,707	356,934
9-12	349,934	400,025	382,191	277,449	225,807
12-18	405,837	301,276	519,973	392,911	279,709
>18	217,286	207,776	260,752	214,744	195,680
Garrison to Oahe					
0-3	70,617	70,886	70,520	70,588	68,247
3-6	78,117	80,464	82,246	82,198	87,843
6-9	136,958	133,857	120,075	120,059	164,645
9-12	212,446	191,852	189,620	190,602	228,462
12-18	364,270	380,093	390,649	389,953	360,648
>18	174,080	185,907	200,066	200,065	99,502
Fort Randall to Gavins					
0-3	13,702	18,373	21,503	28,589	21,331
3-6	31,013	23,825	22,350	22,726	22,364
6-9	41,322	21,039	22,424	17,692	23,430
9-12	43,599	39,272	31,329	20,120	31,153
12-18	60,409	83,894	83,661	94,130	83,471
>18	29,952	50,839	64,482	72,911	63,340

Table 11. Acres of Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	13,400	19,965	23,361	22,081	21,059
3-6	22,076	14,824	18,091	17,811	15,064
6-9	196,976	18,178	11,818	12,285	19,338
9-12	881,215	197,735	111,425	85,538	152,989
12-18	2,149,128	1,625,096	1,138,703	1,054,652	1,514,812
>18	42,1138	2,294,038	3,103,536	3,251,896	2,576,206
Rulo to Mississippi River					
0-3	16,100	12,626	9,312	13,723	15,698
3-6	17,910	15,906	12,447	16,547	15,948
6-9	21,974	16,170	15,219	16,629	18,129
9-12	41,969	18,300	16,842	19,731	21,883
12-18	375,842	80,170	43,835	124,782	210,346
>18	254,900	632,280	729,005	578,114	481,749

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 150,508 for the POR and the average number of flow occurrences below 9,000 cfs per day would be 4.97, as modeled for the POR.

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 below in Table 12 for upper river reaches and Table 13 for lower river reaches.

Table 12. All Habitat Classes – Upper River

Habitat Types	Acres of Habitat	Change in Acres	% Change
Fort Peck to Garrison			
Open Water	62,914	−15	0%
Emergent Wetland	9,577	533	6%
Scrub Shrub Wetland	56,722	−36	0%
Riparian Woodland/Forested Wetland	19,651	282	1%
Forest	14,351	−562	−4%
Upland Grassland	22,889	92	0%

Habitat Types	Acres of Habitat	Change in Acres	% Change
Garrison to Oahe			
Open Water	62,795	319	1%
Emergent Wetland	12,340	−689	−5%
Scrub Shrub Wetland	14,221	2,614	23%
Riparian Woodland/Forested Wetland	1,335	796	148%
Forest	1,947	−2,227	−53%
Upland Grassland	3,395	−5,413	−61%
Fort Randall to Gavins			
Open Water	8,906	−21	0%
Emergent Wetland	6,394	1363	27%
Scrub Shrub Wetland	12,994	−828	−6%
Riparian Woodland/Forested Wetland	1,807	592	49%
Forest	3,477	857	33%
Upland Grassland	3,149	−148	−4%

Table 13. All Habitat Classes – Lower River

Habitat Types	Acres of Habitat	Change in Acres	% Change
Gavins to Rulo			
Open Water	26,567	−21	0%
Emergent Wetland	7,936	226	3%
Scrub Shrub Wetland	4,394	595	16%
Riparian Woodland/Forested Wetland	482	96	25%
Forest	1,436	885	161%
Upland Grassland	1,223	513	72%
Rulo to Kansas River			
Open Water	10,702	2	0%
Emergent Wetland	2,710	235	9%
Scrub Shrub Wetland	1,466	336	30%
Riparian Woodland/Forested Wetland	407	261	178%
Forest	596	304	104%
Upland Grassland	5,381	−1,320	−20%
Kansas River to Grand River			
Open Water	12,096	−31	0%
Emergent Wetland	3,098	295	11%
Scrub Shrub Wetland	2,256	969	75%
Riparian Woodland/Forested Wetland	674	256	61%

Habitat Types	Acres of Habitat	Change in Acres	% Change
Forest	875	211	32%
Upland Grassland	4,277	−357	−8%
Grand River to Osage River			
Open Water	12,911	−67	−1%
Emergent Wetland	3,832	175	5%
Scrub Shrub Wetland	2,722	451	20%
Riparian Woodland/Forested Wetland	738	258	54%
Forest	1,128	−52	−4%
Upland Grassland	8,155	−247	−3%
Osage River to Mississippi River			
Open Water	16,833	31	0%
Emergent Wetland	3,137	−52	−2%
Scrub Shrub Wetland	4,516	783	21%
Riparian Woodland/Forested Wetland	1,153	−184	−14%
Forest	1,661	−106	−6%
Upland Grassland	8,102	−318	−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 below in Table 14 through Table 16 for upper river reaches and Table 17 through Table 19 for lower river reaches.

Table 14. Acres in Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	120,574	119,622	150,982	120,696	99,885
3-6	171,118	174,322	115,419	167,312	192,703
6-9	221,401	256,905	189,538	223,737	362,564
9-12	366,167	417,567	329,753	362,871	318,238
12-18	390,265	299,470	524,354	395,557	275,771
>18	214,856	209,720	261,006	214,755	195,952
Garrison to Oahe					
0-3	70,627	70,690	70,609	70,768	67,932
3-6	77,576	80,081	82,566	82,939	87,772
6-9	138,976	133,679	108,227	108,353	164,696
9-12	213,299	203,134	198,434	198,505	225,797

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
12-18	361,389	371,453	395,337	394,953	365,318
>18	174,223	182,511	200,116	199,950	98,067
Fort Randall to Gavins					
0-3	13,718	18,571	25,137	27,612	19,490
3-6	31,008	23,830	22,675	22,667	21,967
6-9	41,314	21,045	17,886	17,798	22,524
9-12	43,598	39,314	24,840	22,331	38,723
12-18	61,445	77,957	92,701	94,080	76,364
>18	28,678	56,578	69,050	71,520	61,622

Table 15. Change in Acres in Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	1,025	730	−83	−8	−783
3-6	741	1,061	−13	1	−730
6-9	−392	−17,592	−192	30	5,631
9-12	16,233	17,542	−52,438	85,422	92,431
12-18	−15,572	−1,806	4,381	2,646	−3,938
>18	−2,430	1,944	254	11	272
Garrison to Oahe					
0-3	10	−196	89	180	−315
3-6	−541	−382	320	740	−71
6-9	2,017	−178	−11,848	−11,705	51
9-12	853	11,282	8,814	7,903	−2,665
12-18	−2,881	−8,640	4,688	5,000	4,670
>18	144	−3,396	51	−116	−1,435
Fort Randall to Gavins					
0-3	16	199	3634	−977	−1,841
3-6	−6	5	324	−59	−397
6-9	−8	6	−4,539	107	−906
9-12	−1	42	−6,489	2,211	7,570
12-18	1,036	−5,937	9,040	−50	−7,107
>18	−1,274	5,739	4,567	−1,391	−1,717

Table 16. Percent Change in Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	0.9%	0.6%	−0.1%	0.0%	−0.8%
3-6	0.4%	0.6%	0.0%	0.0%	−0.4%
6-9	−0.2%	−6.4%	−0.1%	0.0%	1.6%
9-12	4.6%	4.4%	−13.7%	30.8%	40.9%
12-18	−3.8%	−0.6%	0.8%	0.7%	−1.4%
>18	−1.1%	0.9%	0.1%	0.0%	0.1%
Garrison to Oahe					
0-3	0.0%	−0.3%	0.1%	0.3%	−0.5%
3-6	−0.7%	−0.5%	0.4%	0.9%	−0.1%
6-9	1.5%	−0.1%	−9.9%	−9.7%	0.0%
9-12	0.4%	5.9%	4.6%	4.1%	−1.2%
12-18	−0.8%	−2.3%	1.2%	1.3%	1.3%
>18	0.1%	−1.8%	0.0%	−0.1%	−1.4%
Fort Randall to Gavins					
0-3	0.1%	1.1%	16.9%	−3.4%	−8.6%
3-6	0.0%	0.0%	1.5%	−0.3%	−1.8%
6-9	0.0%	0.0%	−20.2%	0.6%	−3.9%
9-12	0.0%	0.1%	−20.7%	11.0%	24.3%
12-18	1.7%	−7.1%	10.8%	−0.1%	−8.5%
>18	−4.3%	11.3%	7.1%	−1.9%	−2.7%

Table 17. Acres in Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	14,179	19,723	27,921	21,707	21,158
3-6	22,220	16,963	19,412	18,326	16,744
6-9	199,203	18,463	13598	13,156	19,687
9-12	889,594	197,650	89754	88,367	153,332
12-18	2,149,213	1,629,713	948,978	1,207,898	1,539,796
>18	409,605	2,300,770	3,389,894	3,053,002	2,561,241

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Rulo to Mississippi River					
0-3	17,866	15,246	11,737	15,191	15,786
3-6	17,972	16,164	14,596	17,701	17,644
6-9	22,379	17,669	15,685	17,354	18,466
9-12	43,551	18,300	17,911	19,926	21,937
12-18	381,000	80,167	40,412	134,825	215,409
>18	246,738	631,984	737,334	565,198	475,925

Table 18. Change in Acres in Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	779	−241	4,560	−375	98
3-6	144	2,140	1,321	515	1,680
6-9	2,227	286	1,781	871	349
9-12	8,379	−85	−21,671	2,829	343
12-18	85	4,617	−189,725	153,246	24,984
>18	−11,533	6,732	286,358	−198,894	−14,964
Rulo to Mississippi River					
0-3	1,766	2,620	2,426	1,468	87
3-6	62	258	2,148	1,153	1,696
6-9	405	1,499	466	725	337
9-12	1,582	0	1,069	195	54
12-18	5,158	−3	−3,423	10,043	5,063
>18	−8,162	−297	8,329	−12,916	−5,825

Table 19. Percent Change in Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	5.8%	−1.2%	19.5%	−1.7%	0.5%
3-6	0.7%	14.4%	7.3%	2.9%	11.2%
6-9	1.1%	1.6%	15.1%	7.1%	1.8%
9-12	1.0%	0.0%	−19.4%	3.3%	0.2%
12-18	0.0%	0.3%	−16.7%	14.5%	1.6%
>18	−2.7%	0.3%	9.2%	−6.1%	−0.6%
Rulo to Mississippi River					
0-3	11.0%	20.8%	26.0%	10.7%	0.6%
3-6	0.3%	1.6%	17.3%	7.0%	10.6%
6-9	1.8%	9.3%	3.1%	4.4%	1.9%
9-12	3.8%	0.0%	6.3%	1.0%	0.2%
12-18	1.4%	0.0%	−7.8%	8.0%	2.4%
>18	−3.2%	0.0%	1.1%	−2.2%	−1.2%

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 greater under Alternative 2 than Alternative 1 as modeled for the POR.

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 below in Table 20 for upper river reaches and Table 21 for lower river reaches.

Table 20. All Habitat Classes – Upper River

Habitat Types	Acres of Habitat	Change in Acres	% Change
Fort Peck to Garrison			
Open Water	63,214	286	0%
Emergent Wetland	9,150	105	1%
Scrub Shrub Wetland	56,733	−25	0%
Riparian Woodland/Forested Wetland	20,338	968	5%
Forest	13,716	−1,197	−8%
Upland Grassland	22,793	−3	0%

Habitat Types	Acres of Habitat	Change in Acres	% Change
Garrison to Oahe			
Open Water	62,877	401	1%
Emergent Wetland	12,946	−83	−1%
Scrub Shrub Wetland	11,855	247	2%
Riparian Woodland/Forested Wetland	694	154	29%
Forest	2,738	−1,436	−34%
Upland Grassland	3,467	−5,342	−61%
Fort Randall to Gavins			
Open Water	9,211	284	3%
Emergent Wetland	6,801	1,770	35%
Scrub Shrub Wetland	11,726	−2,097	−15%
Riparian Woodland/Forested Wetland	1,858	643	53%
Forest	1,649	−971	−37%
Upland Grassland	3,024	−272	−8%

Table 21. All Habitat Classes – Lower River

Habitat Types	Acres of Habitat	Change in Acres	% Change
Gavins to Rulo			
Open Water	26,567	−21	0%
Emergent Wetland	7,268	−442	−6%
Scrub Shrub Wetland	3,551	−248	−7%
Riparian Woodland/Forested Wetland	489	103	27%
Forest	666	115	21%
Upland Grassland	724	14	2%
Rulo to Kansas River			
Open Water	10,709	9	0%
Emergent Wetland	2,111	−364	−15%
Scrub Shrub Wetland	878	−253	−22%
Riparian Woodland/Forested Wetland	253	107	73%
Forest	341	49	17%
Upland Grassland	7,259	558	8%
Kansas River to Grand River			
Open Water	12,145	18	0%
Emergent Wetland	2,778	−25	−1%
Scrub Shrub Wetland	1,668	381	30%
Riparian Woodland/Forested Wetland	645	227	54%

Habitat Types	Acres of Habitat	Change in Acres	% Change
Forest	673	9	1%
Upland Grassland	4,553	−81	−2%
Grand River to Osage River			
Open Water	13,008	30	0%
Emergent Wetland	3,465	−193	−5%
Scrub Shrub Wetland	2,241	−30	−1%
Riparian Woodland/Forested Wetland	608	128	27%
Forest	1,197	16	1%
Upland Grassland	8,579	177	2%
Osage River to Mississippi River			
Open Water	16,866	65	0%
Emergent Wetland	3,123	−66	−2%
Scrub Shrub Wetland	4,087	353	9%
Riparian Woodland/Forested Wetland	1,464	127	10%
Forest	1,725	−42	−2%
Upland Grassland	8,274	−146	−2%

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 22 through Table 24 for upper river reaches and Table 25 through Table 27 for lower river reaches.

Table 22. Acres in Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	119,644	119,339	151,339	120,714	100,403
3-6	170,420	174,204	115,637	167,328	193,474
6-9	221,817	274,508	189,949	225,893	356,923
9-12	349,094	400,050	332,819	367,193	321,591
12-18	407,266	298,839	520,639	388,895	277,396
>18	216,677	209,780	260,878	214,745	195,773
Garrison to Oahe					
0-3	70,664	70,869	70,736	63,949	68,182
3-6	78,295	80,371	81,611	74,227	87,327
6-9	137,112	133,835	134,554	108,851	164,553
9-12	212,462	191,845	180,775	145,267	231,853

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
12-18	364,270	380,144	390,322	220,846	358,893
>18	173,994	185,946	192,004	131,792	97,910
Fort Randall to Gavins					
0-3	13,695	18,264	22,139	28,728	21,440
3-6	31,019	23,865	22,311	22,722	22,381
6-9	41,322	20,998	22,445	17,674	23,415
9-12	43,607	40,784	20,470	20,468	31,160
12-18	60,408	82,411	94,701	94,080	83,390
>18	29,952	50,876	64,333	72,833	63,305

Table 23. Change in Acres in Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	95	447	274	11	−265
3-6	42	943	205	17	40
6-9	24	12	219	2,186	−11
9-12	−840	25	−49,372	89,744	95,784
12-18	1,429	−2,437	666	−4,016	−2,313
>18	−610	2,005	126	1	92
Garrison to Oahe					
0-3	47	−17	216	−6,639	−65
3-6	178	−92	−635	−7,971	−517
6-9	153	−22	14,478	−11,208	−93
9-12	16	−7	−8,845	−45,335	3,391
12-18	0	51	−327	−169,107	−1,755
>18	−86	39	−8,062	−68,273	−1,592
Fort Randall to Gavins					
0-3	−7	−109	636	139	109
3-6	6	40	−39	−3	16
6-9	0	−41	20	−17	−15
9-12	8	1,512	−10,859	348	7
12-18	−1	−1,483	11,040	−50	−81
>18	0	37	−149	−78	−35

Table 24. Percent Change in Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	0.1%	0.4%	0.2%	0.0%	−0.3%
3-6	0.0%	0.5%	0.2%	0.0%	0.0%
6-9	0.0%	0.0%	0.1%	1.0%	0.0%
9-12	−0.2%	0.0%	−12.9%	32.3%	42.4%
12-18	0.4%	−0.8%	0.1%	−1.0%	−0.8%
>18	−0.3%	1.0%	0.0%	0.0%	0.0%
Garrison to Oahe					
0-3	0.1%	0.0%	0.3%	−9.4%	−0.1%
3-6	0.2%	−0.1%	−0.8%	−9.7%	−0.6%
6-9	0.1%	0.0%	12.1%	−9.3%	−0.1%
9-12	0.0%	0.0%	−4.7%	−23.8%	1.5%
12-18	0.0%	0.0%	−0.1%	−43.4%	−0.5%
>18	0.0%	0.0%	−4.0%	−34.1%	−1.6%
Fort Randall to Gavins					
0-3	0.0%	−0.6%	3.0%	0.5%	0.5%
3-6	0.0%	0.2%	−0.2%	0.0%	0.1%
6-9	0.0%	−0.2%	0.1%	−0.1%	−0.1%
9-12	0.0%	3.9%	−34.7%	1.7%	0.0%
12-18	0.0%	−1.8%	13.2%	−0.1%	−0.1%
>18	0.0%	0.1%	−0.2%	−0.1%	−0.1%

Table 25. Acres in Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	13,490	19,239	22,649	21,438	20,261
3-6	22,004	14,821	17,452	17,109	14,843
6-9	196,984	18,123	18,530	12,305	19,340
9-12	881,551	200,271	104,702	77,334	149,108
12-18	2,150,922	1,612,229	1,132,864	1,056,583	1,461,974
>18	418,992	2,314,207	3,122,196	3,272,253	2,640,714

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Rulo to Mississippi River					
0-3	16,041	13,005	10,387	13,884	14,948
3-6	17,915	15,091	12,905	15,430	15,521
6-9	21,996	16,196	14,771	16,634	18,113
9-12	41,975	18,376	16,818	19,713	21,858
12-18	376,052	84,918	42,803	123,581	210,824
>18	254,213	626,845	730,406	579,166	481,123

Table 26. Change in Acres in Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	90	−726	−713	−643	−799
3-6	−73	−3	−640	−702	−222
6-9	8	−55	6,713	20	2
9-12	336	2,536	−6,723	−8,204	−3,881
12-18	1,794	−12,867	−5,839	1,931	−52,838
>18	−2,146	20,168	18,660	20,357	64,508
Rulo to Mississippi River					
0-3	−59	379	1,075	161	−751
3-6	4	−815	458	−1,117	−427
6-9	22	26	−448	5	−16
9-12	6	76	−24	−18	−25
12-18	210	4,748	−1,032	−1,201	478
>18	−686	−5,435	1,401	1,052	−627

Table 27. Percent Change in Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	0.7%	−3.6%	−3.1%	−2.9%	−3.8%
3-6	−0.3%	0.0%	−3.5%	−3.9%	−1.5%
6-9	0.0%	−0.3%	56.8%	0.2%	0.0%
9-12	0.0%	1.3%	−6.0%	−9.6%	−2.5%
12-18	0.1%	−0.8%	−0.5%	0.2%	−3.5%
>18	−0.5%	0.9%	0.6%	0.6%	2.5%
Rulo to Mississippi River					
0-3	−0.4%	3.0%	11.5%	1.2%	−4.8%
3-6	0.0%	−5.1%	3.7%	−6.8%	−2.7%
6-9	0.1%	0.2%	−2.9%	0.0%	−0.1%
9-12	0.0%	0.4%	−0.1%	−0.1%	−0.1%
12-18	0.1%	5.9%	−2.4%	−1.0%	0.2%
>18	−0.3%	−0.9%	0.2%	0.2%	−0.1%

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.

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 below in Table 28 for upper river reaches and Table 29 for lower river reaches.

Table 28. All Habitat Classes – Upper River

Habitat Types	Acres of Habitat	Change in Acres	% Change
Fort Peck to Garrison			
Open Water	62,310	−619	−1%
Emergent Wetland	8,798	−246	−3%
Scrub Shrub Wetland	58,446	1,688	3%
Riparian Woodland/Forested Wetland	19,002	−368	−2%
Forest	14,834	−78	−1%
Upland Grassland	21,379	−1,417	−6%
Garrison to Oahe			
Open Water	63,015	539	1%
Emergent Wetland	11,501	−1,529	−12%
Scrub Shrub Wetland	12,526	918	8%
Riparian Woodland/Forested Wetland	1,110	570	106%
Forest	4,011	−164	−4%
Upland Grassland	8,115	−693	−8%
Fort Randall to Gavins			
Open Water	8,975	47	1%
Emergent Wetland	5,810	779	15%
Scrub Shrub Wetland	12,786	−1,036	−7%
Riparian Woodland/Forested Wetland	1,652	437	36%
Forest	2,094	−526	−20%
Upland Grassland	4,991	1,694	51%

Table 29. All Habitat Classes – Lower River

Habitat Types	Acres of Habitat	Change in Acres	% Change
Gavins to Rulo			
Open Water	26,550	−38	0%
Emergent Wetland	6,945	−765	−10%
Scrub Shrub Wetland	3,892	93	2%
Riparian Woodland/Forested Wetland	372	−14	−4%
Forest	693	142	26%
Upland Grassland	1,097	387	55%
Rulo to Kansas River			
Open Water	10,657	−44	0%
Emergent Wetland	2,145	−330	−13%
Scrub Shrub Wetland	955	−176	−16%
Riparian Woodland/Forested Wetland	308	162	111%
Forest	474	181	62%
Upland Grassland	6,761	60	1%
Kansas River to Grand River			
Open Water	12,084	−43	0%
Emergent Wetland	2,665	−138	−5%
Scrub Shrub Wetland	1,841	554	43%
Riparian Woodland/Forested Wetland	668	250	60%
Forest	746	82	12%
Upland Grassland	4,559	−75	−2%
Grand River to Osage River			
Open Water	12,968	−10	0%
Emergent Wetland	3,410	−247	−7%
Scrub Shrub Wetland	2,333	62	3%
Riparian Woodland/Forested Wetland	642	162	34%
Forest	1,272	91	8%
Upland Grassland	8,452	50	1%
Osage River to Mississippi River			
Open Water	16,841	40	0%
Emergent Wetland	3,065	−124	−4%
Scrub Shrub Wetland	4,167	434	12%
Riparian Woodland/Forested Wetland	1,496	159	12%
Forest	1,719	−48	−3%
Upland Grassland	8,182	−238	−3%

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 below in Table 30 through Table 32 for upper river reaches and Table 33 through Table 35 for lower river reaches.

Table 30. Acres in Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	118,493	119,297	151,367	123,567	99,805
3-6	170,352	174,240	115,626	148,513	195,862
6-9	225,165	274,517	189,022	240,041	372,568
9-12	360,057	400,074	325,632	354,983	320,976
12-18	392,167	298,847	529,734	408,431	258,489
>18	217,350	209,791	260,825	215,791	195,970
Garrison to Oahe					
0-3	70,641	70,950	70,871	70,895	68,201
3-6	77,567	81,067	81,154	80,966	87,201
6-9	138,961	134,125	134,182	134,214	164,530
9-12	213,296	188,345	188,297	188,099	231,842
12-18	361,399	380,964	381,638	384,069	359,809
>18	174,140	193,126	191,943	187,055	96,935
Fort Randall to Gavins					
0-3	13,709	18,464	22,572	28,063	19,221
3-6	31,005	23,815	22,587	22,688	21,882
6-9	41,308	21,035	22,444	17,735	22,533
9-12	43,581	39,299	20,438	21,026	38,700
12-18	61,459	81,491	94,880	95,114	76,418
>18	28,677	53,164	64,302	71,419	61,690

Table 31. Change in Acres in Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	−1,056	405	302	2,864	−863
3-6	−25	978	194	−18,798	2,428
6-9	3,372	20	−708	16,334	15,634
9-12	10,123	49	−56,559	77,534	95,169
12-18	−13,670	−2,429	9,761	15,520	−21,220
>18	64	2,015	73	1,047	290
Garrison to Oahe					
0-3	25	64	351	307	−46
3-6	−550	604	−1,092	−1,232	−642
6-9	2,003	268	14,107	14,156	−115
9-12	850	−3,507	−1,323	−2,503	3,380
12-18	−2,871	871	−9,011	−5,884	−839
>18	60	7,219	−8,123	−13,011	−2,567
Fort Randall to Gavins					
0-3	7	91	1069	−526	−2110
3-6	−8	−10	237	−37	−482
6-9	−13	−4	20	43	−896
9-12	−18	27	−10,891	906	7,547
12-18	1,050	−2,403	11,219	984	−7,053
>18	−1,275	2,325	−181	−1,492	−1,650

Table 32. Percent Change in Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	−0.9%	0.3%	0.2%	2.4%	−0.9%
3-6	0.0%	0.6%	0.2%	−11.2%	1.3%
6-9	1.5%	0.0%	−0.4%	7.3%	4.4%
9-12	2.9%	0.0%	−14.8%	27.9%	42.1%
12-18	−3.4%	−0.8%	1.9%	4.0%	−7.6%
>18	0.0%	1.0%	0.0%	0.5%	0.1%

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Garrison to Oahe					
0-3	0.0%	0.1%	0.5%	0.4%	−0.1%
3-6	−0.7%	0.8%	−1.3%	−1.5%	−0.7%
6-9	1.5%	0.2%	11.7%	11.8%	−0.1%
9-12	0.4%	−1.8%	−0.7%	−1.3%	1.5%
12-18	−0.8%	0.2%	−2.3%	−1.5%	−0.2%
>18	0.0%	3.9%	−4.1%	−6.5%	−2.6%
Fort Randall to Gavins					
0-3	0.1%	0.5%	5.0%	−1.8%	−9.9%
3-6	0.0%	0.0%	1.1%	−0.2%	−2.2%
6-9	0.0%	0.0%	0.1%	0.2%	−3.8%
9-12	0.0%	0.1%	−34.8%	4.5%	24.2%
12-18	1.7%	−2.9%	13.4%	1.0%	−8.4%
>18	−4.3%	4.6%	−0.3%	−2.0%	−2.6%

Table 33. Acres in Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	13,363	19,533	22,087	21,077	20,329
3-6	22,170	15,065	17,274	16,607	14,748
6-9	205,645	18,060	18,429	12,220	19,196
9-12	887,510	197,397	104,835	88,128	173,502
12-18	2,139,326	1,610,225	1,129,270	1,170,566	1,540,293
>18	411,492	2,325,349	3,106,237	3,105,659	2,524,571
Rulo to Mississippi River					
0-3	16,064	12,768	10,125	14,091	14,877
3-6	17,935	15,048	12,646	15,370	15,628
6-9	22,112	15,620	14,463	16,714	18,446
9-12	42,581	17,503	16,611	20,006	22,104
12-18	378,984	60,889	41,851	130,359	220,724
>18	249,653	664,102	740,349	570,981	469,837

Table 34. Change in Acres in Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	−37	−432	−1,274	−1,005	−730
3-6	93	241	−817	−1,204	−317
6-9	8,669	−118	6,611	−65	−143
9-12	6,295	−338	−6,590	2,590	20,513
12-18	−9,802	−14,871	−9,433	115,914	25,481
>18	−9,646	31,311	2,701	−146,237	−51,634
Rulo to Mississippi River					
0-3	−36	142	813	368	−821
3-6	25	−858	198	−1,177	-320
6-9	137	−550	−755	85	317
9-12	612	−797	−231	275	221
12-18	3,142	−19,281	−1,984	5,577	10,378
>18	−5,247	31,822	11,343	−7,133	−11,912

Table 35. Percent Change in Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	−0.3%	−2.2%	−5.5%	−4.6%	−3.5%
3-6	0.4%	1.6%	−4.5%	−6.8%	−2.1%
6-9	4.4%	−0.6%	55.9%	−0.5%	−0.7%
9-12	0.7%	−0.2%	−5.9%	3.0%	13.4%
12-18	−0.5%	−0.9%	−0.8%	11.0%	1.7%
>18	−2.3%	1.4%	0.1%	−4.5%	−2.0%
Rulo to Mississippi River					
0-3	−0.2%	1.1%	8.7%	2.7%	−5.2%
3-6	0.1%	−5.4%	1.6%	−7.1%	−2.0%
6-9	0.6%	−3.4%	−5.0%	0.5%	1.7%
9-12	1.5%	−4.4%	−1.4%	1.4%	1.0%
12-18	0.8%	−24.1%	−4.5%	4.5%	4.9%
>18	−2.1%	5.0%	1.6%	−1.2%	−2.5%

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.

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 below in Table 36 for upper river reaches and Table 37 for lower river reaches.

Table 36. All Habitat Classes – Upper River

Habitat Types	Acres of Habitat	Change in Acres	% Change
Fort Peck to Garrison			
Open Water	63,158	229	0%
Emergent Wetland	9,145	101	1%
Scrub Shrub Wetland	56,796	38	0%
Riparian Woodland/Forested Wetland	20,340	970	5%
Forest	13,653	−1,260	−8%
Upland Grassland	22,646	−150	−1%
Garrison to Oahe			
Open Water	62,326	−150	0%
Emergent Wetland	14,065	1,035	8%
Scrub Shrub Wetland	11,321	−287	−2%
Riparian Woodland/Forested Wetland	662	122	23%
Forest	2,887	−1,287	−31%
Upland Grassland	3,819	−4,989	−57%
Fort Randall to Gavins			
Open Water	9,215	288	3%
Emergent Wetland	6,482	1,451	29%
Scrub Shrub Wetland	11,833	−1,989	−14%
Riparian Woodland/Forested Wetland	1,769	554	46%
Forest	1,799	−821	−31%
Upland Grassland	4,012	715	22%

Table 37. All Habitat Classes – Lower River

Habitat Types	Acres of Habitat	Change in Acres	% Change
Gavins to Rulo			
Open Water	26,557	−31	0%
Emergent Wetland	7,308	−401	−5%
Scrub Shrub Wetland	3,457	−341	−9%
Riparian Woodland/Forested Wetland	466	81	21%
Forest	570	19	3%
Upland Grassland	926	216	30%
Rulo to Kansas River			
Open Water	10,665	−35	0%
Emergent Wetland	2,155	−320	−13%
Scrub Shrub Wetland	881	−250	−22%
Riparian Woodland/Forested Wetland	247	100	69%
Forest	348	56	19%
Upland Grassland	6,647	−54	−1%
Kansas River to Grand River			
Open Water	12,117	−10	0%
Emergent Wetland	2,805	2	0%
Scrub Shrub Wetland	1,667	380	30%
Riparian Woodland/Forested Wetland	648	230	55%
Forest	664	0	0%
Upland Grassland	4,561	−74	−2%
Grand River to Osage River			
Open Water	12,979	1	0%
Emergent Wetland	3,493	−164	−4%
Scrub Shrub Wetland	2,238	−33	−1%
Riparian Woodland/Forested Wetland	601	121	25%
Forest	1,202	22	2%
Upland Grassland	8,583	181	2%
Osage River to Mississippi River			
Open Water	16,827	26	0%
Emergent Wetland	3,161	−27	−1%
Scrub Shrub Wetland	4,087	353	9%
Riparian Woodland/Forested Wetland	1,464	127	10%
Forest	1,725	−42	−2%
Upland Grassland	8,274	−146	−2%

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 below in Table 38 through Table 40 for upper river reaches and Table 41 through Table 43 for lower river reaches.

Table 38. Acres in Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	119,598	87,500	144,042	152,033	155,697
3-6	201,617	200,790	147,621	115,013	118,326
6-9	414,965	410,131	156,736	192,719	186,610
9-12	314,241	335,601	416,113	326,300	314,528
12-18	228,362	232,673	436,683	527,033	526,526
>18	122,959	157,152	233,421	260,550	288,973
Garrison to Oahe					
0-3	68,509	70,803	64,037	64,056	68,075
3-6	75,481	80,290	74,038	74,035	87,884
6-9	151,937	133,785	121,904	121,904	164,785
9-12	204,911	191,796	134,557	134,562	225,802
12-18	389,342	383,397	218,194	218,184	363,603
>18	138,387	182,457	131,646	131,638	99,688
Fort Randall to Gavins					
0-3	13,693	17,999	21,886	28,509	21,663
3-6	31,020	23,877	22,603	22,729	22,385
6-9	41,321	20,987	22,448	17,695	22,375
9-12	43,613	41,649	20,454	20,117	32,326
12-18	60,407	81,488	94,683	94,137	83,315
>18	29,952	50,663	64,321	72,953	63,615

Table 39. Change in Acres in Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	49	−31,392	−7,024	31,329	55,029
3-6	31,239	27,528	32,189	−52,298	−75,107
6-9	193,172	135,635	−32,994	−30,988	−170,324
9-12	−35,693	−64,424	33,922	48,851	88,721
12-18	−177,475	−68,603	−83,290	134,122	246,817
>18	−94,327	−50,624	−27,331	45,806	93,293
Garrison to Oahe					
0-3	−2,107	−83	−6,482	−6,532	−172
3-6	−2,637	−174	−8,208	−8,163	41
6-9	14,978	−72	1,828	1,845	140
9-12	−7,535	−56	−55,063	−56,040	−2,660
12-18	25,072	3,304	−172,455	−171,769	2,955
>18	−35,693	−3,450	−68,420	−68,427	186
Fort Randall to Gavins					
0-3	−9	−374	384	−80	331
3-6	7	53	253	3	20
6-9	−1	−52	24	3	−1,054
9-12	14	2,377	−10,875	−3	1,173
12-18	−2	−2,406	11,022	7	−156
>18	0	−176	−161	42	275

Table 40. Percent Change in Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	0.0%	−26.4%	−4.6%	26.0%	54.7%
3-6	18.3%	15.9%	27.9%	−31.3%	−38.8%
6-9	87.1%	49.4%	−17.4%	−13.9%	−47.7%
9-12	−10.2%	−16.1%	8.9%	17.6%	39.3%
12-18	−43.7%	−22.8%	−16.0%	34.1%	88.2%
>18	−43.4%	−24.4%	−10.5%	21.3%	47.7%

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Garrison to Oahe					
0-3	−3.0%	−0.1%	−9.2%	−9.3%	−0.3%
3-6	−3.4%	−0.2%	−10.0%	−9.9%	0.0%
6-9	10.9%	−0.1%	1.5%	1.5%	0.1%
9-12	−3.5%	0.0%	−29.0%	−29.4%	−1.2%
12-18	6.9%	0.9%	−44.1%	−44.0%	0.8%
>18	−20.5%	−1.9%	−34.2%	−34.2%	0.2%
Fort Randall to Gavins					
0-3	−0.1%	−2.0%	1.8%	−0.3%	1.6%
3-6	0.0%	0.2%	1.1%	0.0%	0.1%
6-9	0.0%	−0.2%	0.1%	0.0%	−4.5%
9-12	0.0%	6.1%	−34.7%	0.0%	3.8%
12-18	0.0%	−2.9%	13.2%	0.0%	−0.2%
>18	0.0%	−0.3%	−0.2%	0.1%	0.4%

Table 41. Acres in Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	13,397	19,005	22,447	21,285	20,267
3-6	22,081	14,452	17,329	17,101	14,844
6-9	197,002	18,171	18,541	12,391	19,341
9-12	881,183	200,769	104,777	85,494	149,107
12-18	2,159,712	1,715,504	1,133,237	1,055,534	1,461,968
>18	410,562	2,192,032	3,110,365	3,253,355	2,641,414
Rulo to Mississippi River					
0-3	16,024	13,071	10,582	14,047	14,908
3-6	17,911	15,080	12,861	15,363	15,549
6-9	22,092	16,227	14,766	16,683	18,062
9-12	42,552	18,405	16,827	19,884	21,731
12-18	378,612	85,415	42,942	127,416	204,989
>18	250,152	626,151	729,996	574,267	487,322

Table 42. Change in Acres in Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	−3	−959	−915	−796	−792
3-6	4	−372	−762	−710	−220
6-9	26	−6	6,723	106	3
9-12	−32	3,034	−6,648	−44	−3,882
12-18	10,584	90,408	−5,466	882	−52,844
>18	−10,576	−102,007	6,829	1,459	65,208
Rulo to Mississippi River					
0-3	−75	445	1,270	324	−791
3-6	0	−826	414	−1,185	−399
6-9	117	57	−453	54	−67
9-12	583	105	−15	153	−152
12-18	2,770	5,245	−893	2,634	−5,357
>18	−4,748	−6,130	991	−3,847	5,572

Table 43. Percent Change in Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	0.0%	−4.8%	−3.9%	−3.6%	−3.8%
3-6	0.0%	−2.5%	−4.2%	−4.0%	−1.5%
6-9	0.0%	0.0%	56.9%	0.9%	0.0%
9-12	0.0%	1.5%	−6.0%	−0.1%	−2.5%
12-18	0.5%	5.6%	−0.5%	0.1%	−3.5%
>18	−2.5%	−4.4%	0.2%	0.0%	2.5%
Rulo to Mississippi River					
0-3	−0.5%	3.5%	13.6%	2.4%	−5.0%
3-6	0.0%	−5.2%	3.3%	−7.2%	−2.5%
6-9	0.5%	0.4%	−3.0%	0.3%	−0.4%
9-12	1.4%	0.6%	−0.1%	0.8%	−0.7%
12-18	0.7%	6.5%	−2.0%	2.1%	−2.5%
>18	−1.9%	−1.0%	0.1%	−0.7%	1.2%

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.

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 below in Table 44 for upper river reaches and Table 45 for lower river reaches.

Table 44. All Habitat Classes – Upper River

Habitat Types	Acres of Habitat	Change in Acres	% Change
Fort Peck to Garrison			
Open Water	63,592	663	1%
Emergent Wetland	8,903	−141	−2%
Scrub Shrub Wetland	56,704	−54	0%
Riparian Woodland/Forested Wetland	19,946	577	3%
Forest	13,885	−1,028	−7%
Upland Grassland	22,790	−6	0%
Garrison to Oahe			
Open Water	62,544	68	0%
Emergent Wetland	13,770	740	6%
Scrub Shrub Wetland	13,519	1,912	16%
Riparian Woodland/Forested Wetland	639	100	19%
Forest	1,332	−2,843	−68%
Upland Grassland	3,792	−5,017	−57%
Fort Randall to Gavins			
Open Water	8,921	−6	0%
Emergent Wetland	6,924	1,893	38%
Scrub Shrub Wetland	12,248	−1,574	−11%
Riparian Woodland/Forested Wetland	1,359	144	12%
Forest	2,134	−486	−19%
Upland Grassland	3,904	608	18%

Table 45. All Habitat Classes – Lower River

Habitat Types	Acres of Habitat	Change in Acres	% Change
Gavins to Rulo			
Open Water	26,560	−28	0%
Emergent Wetland	7,168	−542	−7%
Scrub Shrub Wetland	3,694	−104	−3%
Riparian Woodland/Forested Wetland	383	−3	−1%
Forest	552	1	0%
Upland Grassland	1,280	570	80%
Rulo to Kansas River			
Open Water	10,672	−28	0%
Emergent Wetland	2,079	−396	−16%
Scrub Shrub Wetland	975	−155	−14%
Riparian Woodland/Forested Wetland	314	168	115%
Forest	339	46	16%
Upland Grassland	7,816	1,115	17%
Kansas River to Grand River			
Open Water	12,108	−19	0%
Emergent Wetland	2,759	−44	−2%
Scrub Shrub Wetland	1,667	380	29%
Riparian Woodland/Forested Wetland	715	297	71%
Forest	663	−1	0%
Upland Grassland	4,645	10	0%
Grand River to Osage River			
Open Water	12,967	−11	0%
Emergent Wetland	3,497	−160	−4%
Scrub Shrub Wetland	2,312	41	2%
Riparian Woodland/Forested Wetland	583	103	21%
Forest	1,165	−15	−1%
Upland Grassland	8,290	−111	−1%
Osage River to Mississippi River			
Open Water	16,827	26	0%
Emergent Wetland	3,140	−49	−2%
Scrub Shrub Wetland	4,386	652	17%
Riparian Woodland/Forested Wetland	1,177	−160	−12%
Forest	1,760	−7	0%
Upland Grassland	8,137	−283	−3%

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 below in Table 46 through Table 48 for upper river reaches and Table 49 through Table 51 for lower river reaches.

Table 46. Acres in Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	119,862	119,604	151,128	120,709	100,366
3-6	170,583	174,333	115,512	169,223	192,675
6-9	219,115	271,095	189,831	223,995	355,555
9-12	351,479	399,996	332,062	364,851	325,194
12-18	406,923	302,660	521,444	391,234	275,671
>18	217,252	209,721	260,840	214,745	195,786
Garrison to Oahe					
0-3	70,566	71,117	70,656	70,969	68,049
3-6	77,401	80,821	82,685	83,016	87,672
6-9	144,498	134,013	108,215	108,401	164,547
9-12	210,685	188,224	198,448	198,653	230,923
12-18	358,372	380,424	394,459	394,041	360,207
>18	174,174	191,612	200,884	200,759	97,407
Fort Randall to Gavins					
0-3	13,663	18,443	22,986	27,723	19,351
3-6	31,006	23,828	22,581	22,677	21,947
6-9	41,318	21,023	22,441	17,787	23,219
9-12	43,055	39,288	20,350	22,327	37,983
12-18	61,454	83,861	94,764	94,035	76,332
>18	28,677	50,816	64,222	71,466	61,596

Table 47. Change in Acres in Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	313	712	63	6	−302
3-6	206	1,072	80	1,912	−759
6-9	−2,678	−3,401	101	288	−1,379
9-12	1,545	−29	−50,129	87,402	99,387
12-18	1,086	1,384	1,471	−1,677	−4,038
>18	−34	1,946	88	1	106
Garrison to Oahe					
0-3	−51	231	136	381	−198
3-6	−717	358	439	818	−171
6-9	7,540	156	−11,860	−11,657	−98
9-12	−1,761	−3,628	8,828	8,051	2,461
12-18	−5,898	331	3,810	4,088	−441
>18	94	5,705	819	694	−2,095
Fort Randall to Gavins					
0-3	−40	71	1,483	−866	−1,980
3-6	−7	3	230	−49	−417
6-9	−4	−16	17	95	−210
9-12	−544	16	−10,979	2,207	6,830
12-18	1,045	−33	11,103	−95	−7,139
>18	−1,275	−23	−260	−1,445	−1,744

Table 48. Percent Change in Depth Classes – Upper River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Fort Peck to Garrison					
0-3	0.3%	0.6%	0.0%	0.0%	−0.3%
3-6	0.1%	0.6%	0.1%	1.1%	−0.4%
6-9	−1.2%	−1.2%	0.1%	0.1%	−0.4%
9-12	0.4%	0.0%	−13.1%	31.5%	44.0%
12-18	0.3%	0.5%	0.3%	−0.4%	−1.4%
>18	0.0%	0.9%	0.0%	0.0%	0.1%

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Garrison to Oahe					
0-3	−0.1%	0.3%	0.2%	0.5%	−0.3%
3-6	−0.9%	0.4%	0.5%	1.0%	−0.2%
6-9	5.5%	0.1%	−9.9%	−9.7%	−0.1%
9-12	−0.8%	−1.9%	4.7%	4.2%	1.1%
12-18	−1.6%	0.1%	1.0%	1.0%	−0.1%
>18	0.1%	3.1%	0.4%	0.3%	−2.1%
Fort Randall to Gavins					
0-3	−0.3%	0.4%	6.9%	−3.0%	−9.3%
3-6	0.0%	0.0%	1.0%	−0.2%	−1.9%
6-9	0.0%	−0.1%	0.1%	0.5%	−0.9%
9-12	−1.2%	0.0%	−35.0%	11.0%	21.9%
12-18	1.7%	0.0%	13.3%	−0.1%	−8.6%
>18	−4.3%	0.0%	−0.4%	−2.0%	−2.8%

Table 49. Acres in Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	13,439	19,105	23,820	20,859	20,265
3-6	22,036	14,808	17,753	16,829	14,638
6-9	197,063	18,164	11,896	12,274	19,211
9-12	883,721	197,639	111,149	85,664	164,506
12-18	2,153,925	1,617,647	1,086,815	1,120,550	1,564,354
>18	409,721	2,308,690	3,202,506	3,166,320	2,506,798
Rulo to Mississippi River					
0-3	16,026	12,791	10,187	14,029	14,954
3-6	17,914	15,083	12,695	15,405	15,550
6-9	22,052	16,205	14,805	16,719	18,318
9-12	42,534	18,110	16,552	19,925	22,003
12-18	377,460	75,517	41,867	129,400	216,223
>18	252,093	639,647	738,018	572,086	474,924

Table 50. Change in Acres in Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	38	−860	459	−1,223	−794
3-6	−41	−15	−338	−982	−427
6-9	87	−14	78	−11	−127
9-12	2,506	−96	−276	126	11,517
12-18	4,797	−7,449	−51,888	65,898	49,542
>18	−11,417	14,651	98,970	−85,576	−69,408
Rulo to Mississippi River					
0-3	−74	165	875	306	−744
3-6	4	−823	247	−1,142	−399
6-9	78	35	−413	90	189
9-12	565	−190	−290	194	120
12-18	1,618	−4,653	−1,968	4,618	5,877
>18	−2,806	7,367	9,013	−6,028	−6,825

Table 51. Percent Change in Depth Classes – Lower River

Depth Class	Overwintering Late	Early Spawning	Late Spawning	Summer Rearing and Growth	Overwintering Early
Gavins to Rulo					
0-3	0.3%	−4.3%	2.0%	−5.5%	−3.8%
3-6	−0.2%	−0.1%	−1.9%	−5.5%	−2.8%
6-9	0.0%	−0.1%	0.7%	−0.1%	−0.7%
9-12	0.3%	0.0%	−0.2%	0.1%	7.5%
12-18	0.2%	−0.5%	−4.6%	6.2%	3.3%
>18	−2.7%	0.6%	3.2%	−2.6%	−2.7%
Rulo to Mississippi River					
0-3	−0.5%	1.3%	9.4%	2.2%	−4.7%
3-6	0.0%	−5.2%	2.0%	−6.9%	−2.5%
6-9	0.4%	0.2%	−2.7%	0.5%	1.0%
9-12	1.3%	−1.0%	−1.7%	1.0%	0.5%
12-18	0.4%	−5.8%	−4.5%	3.7%	2.8%
>18	−1.1%	1.2%	1.2%	−1.0%	−1.4%

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

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