Crucial Areas Planning System (CAPS)

Data Layer Documentation and Summary

Montana Fish, Wildlife and Parks

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Purpose:
To define the layers included in the Crucial Areas Planning System (CAPS), describe how they were constructed, and provide information about the data update process.

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List of acronyms and abbreviations used in this document:

Abbreviation	Full Text
AFWA	Association of Fish and Wildlife Agencies
CAPS	Crucial Areas Planning System
DS	Data Services Bureau
FIS	Fisheries Information System - Montana FWP
GAP	Gap Analysis Program (United States Geological Survey)
HUC	Hydrologic Unit Code
MFWP	Montana Fish, Wildlife & Parks
MRRE	Mandatory Reporting Response Entry
MTNHP	Montana Natural Heritage Program
MTNRIS	Montana Natural Resource Information Service
POD	Point Observation Database
SERI	Species of Economic or Recreational Importance
SGCN	Species of Greatest Conservation Need
SOC	Species of Concern
T/E	Threatened or Endangered
USGS	United States Geological Survey
WAFWA	Western Association of Fish and Wildlife Agencies
WGA	Western Governors Association
WGWC	Western Governors Wildlife Council
WIS	Wildlife Information System - Montana FWP

Contents

1. Introduction

With the adoption of its Wildlife Corridors Initiative Report in 2008, the Western Governors' Association (WGA) created the Western Governors' Wildlife Council (WGWC) and tasked its members with developing policies and tools to identify and conserve crucial wildlife habitat and corridors across the region. With the launch of the Western Governors' Crucial Habitat Assessment Tool (CHAT), the WGA and WGWC aim to bring greater certainty and predictability to planning efforts by establishing a common starting point for discussing the intersection of development and wildlife. CHAT is designed to reduce conflicts and surprises while ensuring wildlife values are better incorporated into land use planning, particularly for large-scale linear projects. It is a non-regulatory scoping tool that is not intended for project-level approval. CHAT is integrated with, and depicts, state specific information on priority species and habitats. In April 2015, the WGA transferred full responsibility for CHAT to the Western Association of Fish and Wildlife Agencies (WAFWA) and the Association of Fish and Wildlife Agencies (AFWA), and the tool was renamed the Western Association of Fish and Wildlife Agencies CHAT.

Montana Fish, Wildlife & Parks (MFWP) took the lead in conducting a statewide Crucial Areas Assessment for Montana in 2008. The Assessment evaluated the fish, wildlife and recreational resources of Montana in order to identify crucial areas and fish and wildlife corridors. This Assessment is part of the WAFWA CHAT, a larger conservation effort that recognizes the importance of landscape scale management of species and habitats by fish and wildlife agencies across the western United States. Within Montana, this effort resulted in a web-based Crucial Areas Planning System (CAPS)**,** a tool aimed at future planning for a variety of development and conservation purposes so fish, wildlife, and recreational resources can be considered early in the planning process.

The fish, wildlife, and recreational resources in Montana are represented by data layers available in CAPS. The overall Crucial Habitat Rank and Tier 1 layers are also available in the WAFWA CHAT along with other states' data. The remainder of this document outlines the process by which data layers for Montana were developed and how those data will be updated for MT CAPS and the WAFWA CHAT.

2. Montana CAPS Data Layers

Data layers are categorized as Final "roll up", Tier 1, Non-tier 1/Supporting data layers. WAFWA defines "Tier 1" as "the first tier being those data layers that are considered to be the foundation of any crucial habitat layers and which states commit to including, as a minimum, in their systems." The Crucial Habitat Rank and CAPS Tier 1 layers are the only CAPS layers that are shared with and shown on the WAFWA CHAT. CAPS non-tier 1 layers are specific to Montana and only shown in MT CAPS. Non-tier 1 layers are those from the original 2008 Crucial Areas Assessment which did not contribute to the Crucial Habitat Rank. A general overview of these datasets is discussed below.

Layers follow a hierarchy where supporting data and Tier 1 data contribute to an overall ranking or "score" for each hexagon displayed in the map. The hierarchy is outlined below.

1) Crucial Habitat Rank (Final "roll up" layer)
2) Crucial Habitat Tier 1 Inputs (Tier 1 layers):
    a. Habitat for Species of Concern
    b. Large Natural Areas
    c. Landscape Connectivity
    d. Species of Economic and Recreational Importance
    e. Wetland and Riparian Areas
3) Montana Pilot Data – Non-Tier 1 (Non-tier 1/Supporting data layers)
    a. Aquatic Connectivity
    b. Fish Native Species Richness
    c. Game Fish Life History
    d. Large Landscape Blocks and Habitat Connectivity
    e. Watershed Integrity

Crucial Habitat Rank

Summary: The Western Governors' Wildlife Council defines "crucial habitat" as places containing the resources (including food, water, cover, shelter and important wildlife corridors) that are necessary for the survival and reproduction of aquatic and terrestrial wildlife and to prevent unacceptable declines, or facilitate future recovery of, wildlife populations; or are important ecological systems with high biological diversity value. The compiled Crucial Habitat Rank layer can be used to determine areas containing high priority crucial habitats. This layer is a result of aggregating all crucial habitat input layers and can provide an initial overview of whether an area contains crucial habitat or important natural resources for fish and wildlife.

Last Update: December 2018

Aggregation Method: Categorical

Aggregation Details: Starts with the highest priority levels of the Habitat for Species of Concern (SOC) Tier 1 dataset and then in descending priority includes Species of Economic and/or Recreational Importance (SERI), Large Intact Blocks (LIB), Landscape Connectivity, and Wetland and Riparian Areas to generate the Crucial Habitat Rank priority levels.

Priority Level 1	SOC priority level 1 or 2.
Priority Level 2	SOC priority level 3 or Species of Economic and/or Recreational Importance (SERI) priority level 1 or Large Intact Block (LIB) priority level 1.
Priority Level 3	SOC priority level 4 or SERI priority level 2 or LIB priority level 2 or Landscape Connectivity priority level 1.
Priority Level 4	SOC priority level 5 or SERI priority level 3 or LIB priority level 3 or Landscape Connectivity priority level 2 or Wetland and Riparian Areas priority level 1.
Priority Level 5	SOC priority level 6 or Landscape Corridors priority level 3 OR Wetland and Riparian Areas priority level 2.
Priority Level 6	None of the above criteria apply.

Tier 1 - Crucial Habitat Input Data Layers

Habitat for Species of Concern

Summary: Species of state and/or national conservation importance, including those vulnerable to extinction or those undergoing regional decline or other species requiring special management attention.

Last Update: December 2018

Aggregation Method: Highest Priority Level

Aggregation Details:

Priority Level 1	Hexagons with at least one Federal Threatened, Federal Endangered, NatureServe G1 or NatureServe S1 species observation.
Priority Level 2	Hexagons with at least one NatureServe G2 or Natureserve S2 species observation.
Priority Level 3	Hexagons with at least one Federal Candidate, NatureServe G3 or NatureServe S3 species observation, or at least one Federal Threatened or Federal Endangered species modeled distribution.
Priority Level 4	Hexagons with a Federal Candidate species modeled distribution, or a cumulative modeled distribution count > 14 SGCN species.
Priority Level 5	Hexagons with a cumulative modeled distribution count > 11 SGCN species.
Priority Level 6	Hexagons with a cumulative modeled distribution count > 7 SGCN species.

Data Sources:

Name	Description	Type	Steward
Fish Distributions	Predicted fish distributions based on the best professional judgment of local fisheries biologists.	Modeled	MFWP
Fish Population Surveys	Fish census information collected by fisheries field biologists.	Observations	MFWP
Montana's Point Observation Database	State-wide, documented, and confirmed element occurrences of wildlife.	Observations	Montana NHP

GAP Distribution Models	Vertebrate distribution models for amphibians, birds, mammals, and reptiles occurring in the U.S.	Modeled	USGS GAP

Native and Unfragmented Habitat

At the west-wide scale, the category of Native and Unfragmented Habitat was used to represent habitat value and condition metrics which could include landscape condition, large natural areas, natural vegetative communities, ecological systems of concern, landscape corridors, and/or freshwater integrity. In Montana, large natural areas and landscape connectivity were used for this category.

Large Natural Areas

Summary: Large Intact Blocks or other datasets depicting large areas of native habitat that are relatively intact or have low levels of anthropogenic impact.

Last Update: 2015 – Input data layer changes not determined significant enough to warrant updates

Aggregation Method: Highest Priority Level

Aggregation Details: Selected the highest priority level of large natural areas within the boundary of a one square mile hexagon. Large natural areas depict those contiguous areas greater than 10,000 acres where >= 90% of native landcover remains after all anthropogenic features have been removed.

Priority Level 1	Hexagons with Large Natural Areas from the Montana evaluation occurring within the priority level 1 area of the west-wide Large Natural Areas layer.
Priority Level 2	Hexagons with Large Natural Areas from the Montana evaluation occurring within the priority level 2 area of the west-wide Large Natural Areas layer.
Priority Level 3	Hexagons with Large Natural Areas from the Montana evaluation occurring within the priority level 3 area of the west-wide Large Natural Areas layer.

Data Sources:

Name	Description	Type	Steward
Ski Areas	Ski area location boundaries	Observations	MFWP
Superfund areas	Superfund area location boundaries	Observations	EPA
Surface Mines	Coal, gravel, hardrock surface mining boundaries	Observations	MFWP
Wind Towers	Wind tower locations	Observations	MFWP
Communication Towers	Tower point locations	Observations	Federal Communications Commission
Transportation infrastructure	Roadway line locations	Observations	US Census Bureau
Oil and Gas Pipelines	Oil and gas pipeline locations	Observations	MT Dept of Environmental Quality
Oil and Gas Wells	Oil and gas well point locations	Observations	MT Board of Oil and Gas
Electrical Transmission Lines	Electrical Transmission Line locations	Observations	MT Dept of Environmental Quality
Montana Landcover	Ecological System landcover mapping	Modeled	MT Natural Heritage Program

Landscape Connectivity

Summary: Landscape - scale permeability or connectivity.

Last Update: 2015 – Input data layer changes not determined significant enough to warrant updates

Aggregation Method: Highest Priority Level

Aggregation Details: Selected the highest priority level of Landscape Connectivity within the boundary of a one square mile hexagon. Landscape Connectivity depicts those areas identified (on a relative ranking from most likely to be a corridor to least likely) between Large Natural Areas based on the selection for native habitats and the avoidance of anthropogenic features as determined by a least cost path analysis.

Priority Level 1	Hexagons with Landscape Connectivity area values 1 to 5 (top 5%).
Priority Level 2	Hexagons with Landscape Connectivity area values 6 to 10.
Priority Level 3	Hexagons with Landscape Connectivity area values 11 to 15.
Priority Level 4	Hexagons with Landscape Connectivity area values 16 to 25.
Priority Level 5	Hexagons with Landscape Connectivity area values 26 to 50.
Priority Level 6	Hexagons with Landscape Connectivity area values 51 to 100.

Data Sources:

Name	Description	Type	Steward
Ski Areas	Ski area location boundaries	Observations	MFWP
Superfund areas	Superfund area location boundaries	Observations	EPA
Surface Mines	Coal, gravel, hardrock surface mining boundaries	Observations	MFWP
Wind Towers	Wind Tower locations	Observations	MFWP
Communication Towers	Tower point locations	Observations	Federal Communications Commission
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Montana Landcover	Ecological System landcover mapping	Modeled	MT Natural Heritage Program

Species of Economic and Recreational Importance (SERI)

Summary: SERI data represent areas recognized as important for meeting the biological requirements and objectives of fish and wildlife species regulated by harvest such as important breeding areas or winter concentration areas.

Last Update: December 2018

Aggregation Method: Highest Priority Level

Aggregation Details: This layer represents the highest priority level from either the Terrestrial Game Quality or the Game Fish Quality layers that were developed for Montana's Crucial Areas Planning System (CAPS).

The Terrestrial Game Quality layer depicts the relative value of areas based on the specific habitat requirements of 12 native game species. These species were categorized into 4 functional groups: big game, bighorn sheep and mountain goat, prairie grouse, and forest carnivores. Area values were calculated by adding together the individual contribution of each species group, meaning that in areas of

overlap values will generally be higher. However, it is important to realize that an area with a lower cumulative value can still contain high value habitat for just one species group.

The Game Fish Quality layer depicts the relative quality of 46 cold and warm water game fish populations available to anglers in Montana.

Priority Level 1	Hexagons with Terrestrial Game Quality values > 71% OR Game Fish Quality values in the top 3% of waterbodies with sport fish.
Priority Level 2	Hexagons with Terrestrial Game Quality values of 48-71% OR Game Fish Quality values in the 90-97th percentile of all waterbodies with sport fish.
Priority Level 3	Hexagons with Terrestrial Game Quality values of 26-48% OR Game Fish Quality values in the 75-90th percentile of all waterbodies with sport fish.
Priority Level 4	Hexagons with Terrestrial Game Quality values of <26% OR Game Fish Quality values in the lowest 75% of all waterbodies with sport fish.
Priority Level 5	N/A
Priority Level 6	N/A

Data Sources:

Name	**Description**	**Type**	**Steward**
The first three layers below are inputs to Terrestrial Game Quality			
Montana Landcover 2017	Ecological System landcover mapping.	Modeled	MT Natural Heritage Program
Species Distributions	Biologist reviewed models for species habitat value for forest carnivores and sharp-tailed grouse	Modeled	MFWP
Species Distributions	Species locations and areas designated via expert knowledge as important for prairie grouse. Expert knowledge big game species distribution for general and winter ranges.	Observations	MFWP
The following two layers are inputs to Game Fish Quality			
Fish Population Surveys	Fish census information collected by fisheries field biologists.	Observations	MFWP
Fish Distributions	Predicted fish distribution and associated relative abundance based upon the best professional judgment of local fish biologists.	Modeled	MFWP

Game Fish Quality

Summary: This layer depicts the relative quality of 46 cold and warm water game fish populations available to anglers in Montana.

Last Update: December 2018**Measurement Unit**: River segments for flowing water and entire waterbodies for lakes/reservoirs. River segments are uniquely identified by river mile and latitude/longitude.

Data Source(s) / Quality: Montana FWP internal centralized data repositories for fish species and abundance was the source of most data utilized in this assessment. Fish distribution, size, and relative abundance data were extrapolated from fisheries surveys conducted by FWP and collector permit holders from state and federal agencies and non-governmental organizations for the past 10 years. Distribution and abundance data were updated by FWP biologists using raw survey data. MFWP biologists also used survey data and knowledge of game fish populations to delineate stream reaches with unique or exceptionally large game species present.

Methods: Each game fish species within a waterbody (stream or lake) received a score based on 1) fish size, 2) relative abundance and 3) a tier based on angler preference. Regulated species were assigned to a tier based on daily possession limit: Tier 1*, <= 5 fish/day and Tier 2**, > 5 fish/day. Unregulated species recognized as sport fish by the International Game Fish Association were assigned Tier 3. Tiers 1, 2, and 3 were assigned 4, 2, or 1 point(s), respectively.

*Exceptions: Redband trout and burbot were demoted to Tier 2 when not indicated as fishable in the Montana Fishing Regulations.

**Exceptions: Black and white crappie, yellow perch, and kokanee were promoted to Tier 1 based on expert knowledge of desirability.

Relative size was determined by species-specific length categories from literature to determine if species present were less than fishable size, of fishable size, or of trophy potential, with 1, 2, or 4 point(s) possible, respectively. The maximum size of a species captured in a survey determined size potential for each species. MFWP biologists assigned relative abundance values of rare, common, or abundant to each species' distribution and scores of 1, 2, or 4 point(s) were assigned to each abundance value, respectively.

A score for each species was created by multiplying **Tier** x **Size** x **Abundance**, for a maximum score of 64 points possible per species. Species scores were then summed for each river reach or waterbody. Additional points were given for: presence of unique species (10 points), exceptional numbers (>2500/mi) of a single species (32pts), and presence of a trophy fishery (20 points), based on MFWP expert knowledge.

Final Categorization: Four categories, representing a gradient of sport fish quality from high to low, were created based on breaks at the 97th, 90th, and 75th percentiles within each type of fishery, either cold or warm water. Cold or warm water designation was based on generalized species presence and

composition at the 6th Code HUC scale. The final breaks used to classify fisheries from highest to lowest quality were reviewed with area biologists.

Terrestrial Game Quality

Summary: This layer depicts the relative value of areas based on the specific habitat requirements of 12 native game species. These species were categorized into 4 functional groups: big game, bighorn sheep and mountain goat, prairie grouse, and forest carnivores. Area values were calculated by adding together the individual contribution of each species group, meaning that in areas of overlap, values will generally be higher. However, it is important to realize that an area with a lower cumulative value can still contain high value habitat for a single species group. The 12 species were selected to represent the areas of highest value for native game in Montana.

Last Update: December 2018

Measurement Unit: One square mile hexagon.

Mapping Considerations: Indian Reservations and National Parks were not included in the evaluation due to lack of data.

Data Source(s) / Quality:
Big Game:
Last Update: December 2018
Metric evaluated: winter range habitat value
Species: pronghorn antelope, elk, moose, mule deer ,and white-tailed deer
Data layers: big game distribution - publicly available for individual species, maintained by MFWP. Layers are updated using expert knowledge, including known habitat associations and extrapolation from survey data. Resolution is based on one square mile public land survey sections; Montana Land Cover Classification 2017 – layer maintained by the Montana Natural Heritage Program (NHP) Spatial Analysis Lab, University of Montana. Classification based on remote sensing. Resolution is 30 meters.

Bighorn sheep and mountain goat:
Last Update: 2015 – No input data layer changes
Metric evaluated: general and winter distribution
Data layer: big game distribution – see additional information in Big Game section above

Forest carnivores:
Last Update: 2015 – No input data layer changes
Metric evaluated: habitat suitability
Species: wolverine, fisher, marten
Data layers: furbearer harvest locations – maintained by MFWP Mandatory Reporting System. Reporting at public lands survey section level by trappers; furbearer observation records – Maintained in MT NHP Point Observation Database. Accuracy verified by MT NHP staff; wolverine primary habitat model – produced by the Wildlife Conservation Society; fisher and marten habitat suitability model developed using known locations and reviewed by MFWP biologists. Resolution is 90 meters.

Prairie grouse:
Last Update: December 2018
Metric evaluated: core habitat areas, lek areas, and habitat suitability
Species: sage-grouse, sharp-tailed grouse
Data layers: sage-grouse and sharp-tailed grouse lek locations and observations collected via ground and aerial surveys by MFWP and Bureau of Land Management (BLM) biologists – maintained in MFWP sage-grouse database; sage-grouse core areas – developed and maintained by MFWP with input from BLM. Publicly available layer based on expert knowledge review of sage-grouse habitat suitability model using lek locations and limited to areas of highest male density; sharp-tailed grouse habitat suitability model - developed using lek locations and reviewed by MFWP biologists. Resolution is 90 meters.

Methods:
Big game values were determined based on the presence of winter range habitat. The score assigned to particular areas varied by MFWP Region (R#). In the western mountains, areas identified as winter use areas for any species' distribution layers received one point. In the northwest (R1), winter use by elk or white-tailed deer was given an additional point. In the southwest (R2-3), winter use by elk or mule deer was given an additional point. For the rest of the state, areas identified as winter use areas for any species, as well as areas containing >50% sagebrush grassland, received one point. Areas identified as winter use for more than one species, or containing >75% sagebrush grassland were given an additional point. The resulting scores ranged from 0 to 2. A score of 0 indicates the area was not identified as having winter range habitat. A score of 1 indicates important winter range habitats. A score of 2 indicates highly valued winter range habitats.

Bighorn sheep and mountain goat received 1 point for overall distribution and 2 points for winter use. In areas of species overlap, values were not cumulative, the highest value was chosen. The resulting scores ranged from 0 to 2.

Forest carnivore habitat values were 2 points for wolverine habitat; 2 points for highly suitable marten or fisher habitat; and 1 point for moderately suitable marten or fisher habitat. In areas of species overlap, values were cumulative. Values were only calculated in western forest habitats where forest carnivores were expected. The resulting scores ranged from 0 to 6.

Prairie grouse habitat was valued by assigning 3 points to sage-grouse core areas. Outside of sage-grouse core areas, 2 points were assigned to sage-grouse lek areas. For sharp-tailed grouse, 2 points were assigned to highly suitable habitat and 1 point to moderately suitable habitat. In areas of species overlap, values were cumulative. Values were only calculated in prairie areas where prairie grouse were expected. The resulting scores ranged from 0 to 5.

Overall: Within each species group, values were rescaled by dividing by the maximum number of points to give each category a value ranging from 0 to 1. In this way, each group received equal weight. In the final calculation, big game winter range habitat was given twice the weight of the other species categories based on its level of importance. These values were summed, and the result was again rescaled to 0 to 1 by dividing by the total possible score for that area. For example, in eastern prairie areas, the total possible score did not include forest carnivores.

Final Categorization: The resulting scores ranged from 0 to 1. The mean and the standard deviation of the final scores were calculated. Final categories were determined by assessing the deviation from the mean value. The highest category had values > 1.5 SD from the mean. The high category was 0.5 to 1.5 SD from the mean value. The moderate category ranged from -0.5 SD below the mean to 0.5 SD above the mean. The low category was < -0.5 SD from the mean.

Wetland and Riparian Areas

Summary: Areas that represent unique and/or sensitive environments and function to support animal and plant diversity with respect to wildlife objectives and connectivity.

Last Update: December 2018

Aggregation Method: Highest priority level.

Aggregation Details: This layer represents the highest priority level from either the Wetland or Riparian layers that were developed for Montana's Crucial Areas Planning System.
The Riparian layer depicts specific landcover classes present within a square-mile hexagon.
The Wetland layer depicts total area of wetlands present within a square-mile hexagon.

Priority Level 1	Hexagons with Riparian landcover class "Northwestern Great Plains Floodplain" - OR - Total Wetland Area >=10% of hexagon area.
Priority Level 2	Hexagons with Riparian landcover classes "Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland", "Northwestern Great Plains Riparian", or "Rocky Mountain Lower Montane Foothill Riparian Woodland and Shrubland" >=5% of hexagon area - OR - Total Wetland Area >=5% of hexagon area.
Priority Level 3	N/A
Priority Level 4	N/A
Priority Level 5	N/A
Priority Level 6	N/A

Data Sources:

Name	Description	Type	Steward
Montana Landcover 2017 Framework Level 2	Ecological System landcover mapping	Modeled	MT Natural Heritage Program
National Wetlands Inventory (NWI)	Wetland locations	Modeled	USFWS/ MT Natural Heritage Program

Montana Pilot Data – Non-Tier 1/Supporting Layers

Non-Tier 1 layers are those from the original 2008 Crucial Areas Assessment which did not contribute to the Crucial Habitat Rank. These data were considered pilot data as the different states conducting the original assessment efforts were exploring various techniques that would be presented as options for inputs to the identification of an overall crucial habitat rank. After a number of states completed these initial efforts, state representatives evaluated which data layers would be considered for Tier 1 status and contribute to the overall Crucial Habitat Rank in the west-wide CHAT. The layers in this non-Tier 1 list did not make the west-wide list, but are considered to have value in Montana.

Aquatic Connectivity

Summary: The Aquatic Connectivity layer depicts important stream corridors for fish species that require connected habitats to complete all or a portion of their life history. Corridor importance was determined using an approach that considered corridor size as well as species utilization of known corridors for eight aquatic ecoregions in Montana. Corridor size was inferred from stream order. Corridor utilization by selected species was determined by selecting a species in each ecoregion that is most sensitive to loss of connected habitats for some or all of its life history needs. These 'focal species' serve as surrogates for preserving high priority corridors for many other important sport fish and species of concern. Preserve the corridors and connected habitats for this focal species, and many or most other species will likely benefit.

Last Update: December 2018

Measurement Unit: River segments, uniquely identified by river mile and latitude/longitude.

Data Source(s) / Quality: Montana FWP internal centralized data repositories were the source of fish distribution data utilized in this layer. Data within the repositories include MFWP data and collector permit holders from state and federal agencies and non-governmental organizations for the past 10 years. Distribution and abundance data were updated by MFWP biologists using this raw survey data.

The most current Montana MFWP Yellowstone cutthroat trout assessment was the source of cutthroat distribution data for streams in the upper Yellowstone aquatic ecoregion. Stream order methodology developed by the National Hydrography Dataset (NHD), 2009.

Methods: Aquatic corridors for species within and among eight different aquatic ecoregions in Montana were considered. The eight aquatic ecoregions were delineated based on major drainage area and species composition (warm vs cold water species). Focal species were selected for each aquatic ecoregion through a ranking process that considered species mobility characteristics (long distance migrations of greater than 10 miles or movement within and among metapopulations) and threat vulnerability (climate change, manmade infrastructure, and habitat alteration). Species selected for each ecoregion were: **sauger** (lower Missouri and lower Yellowstone), **burbot** (middle Missouri and

middle Yellowstone), **Yellowstone cutthroat trout** (upper Yellowstone), **bull trout** (Hudson Bay and Columbia), and **Arctic grayling** (upper Missouri). Stream orders were delineated for all streams in Montana using a USGS National Hydrography Dataset (NHD) algorithm. Migratory Yellowstone cutthroat trout were assumed to be present upstream to natural or manmade barriers. Barrier information for Yellowstone streams was obtained from the Yellowstone cutthroat trout assessment. Stream order methodology developed by the NHD, 2009.

Final Categorization: Stream order (SO) and focal species information were integrated to create a corridor priority system. Four categories were created, representing a gradient, based on current knowledge and past research that suggests increasing corridor importance as SO increases. Highest priority corridors are those habitats where focal species exist, regardless of abundance or SO. High priority corridors are areas where large rivers occur (SO>4), but no focal species are present. Moderate priority streams are moderate size (SO=4 or SO=3) with no focal species present. Undesignated waters are small streams (SO<3) with no focal species present. Small streams were not ranked because certain tributaries that connect to large river systems are important and would be undervalued using this rule-based approach for valuing aquatic connectivity.

Fish Native Species Richness

Summary: Ecologists have frequently proposed that habitats high in species richness are more functionally diverse, and this natural diversity produces an increase in ecological stability, resiliency, and maintenance of food web dynamics. To account for native biodiversity as an important aquatic resource value, a species richness layer was created using a count of native fishes present in waterbodies and stream reaches within eight aquatic ecoregions in Montana.

Last Update: December 2018**Measurement Unit**: River segments for flowing water and entire waterbodies for lakes/reservoirs. River segments are uniquely identified by river mile and latitude/longitude.

Data Source(s) / Quality: Montana FWP internal centralized data repositories for fish species and abundance were the source the source of most data utilized in this assessment. Fish distribution data were extrapolated by local fisheries biologists from fisheries surveys conducted by MFWP and collector permit holders from state and federal agencies and non-governmental organizations for the past 10 years.

Methods: A species richness layer based on a count of native fishes present in waterbody reaches within eight aquatic ecoregions in Montana was created. Ecoregions were based on the intersection of major watershed (4^{th} Code HUC) boundaries and generalized species composition (warm vs cold water). Ecoregions were evaluated separately for their species richness because large differences in species richness are inherently associated with drainage patterns, geographical extents, and inherent differences in productivity.

Native fish species distributions were extrapolated by local biologists from fisheries surveys conducted by MFWP and collector permit holders from state and federal agencies and non-governmental organizations for the past 10 years. The number of unique native fish species within a stream segment or waterbody was counted, regardless of rarity.

Final Categorization: Four categories, representing a gradient of diversity from high to low, were created based on breaks that differed between ecoregion. Categorical designations (n=4) were created using Jenks' natural breaks methodology for each of the eight aquatic ecoregions in Montana.

Game Fish Life History

Summary: This layer depicts habitats that support at least one of 43 recognized game fish species during essential and important life history stages, including habitats that support spawning, rearing, and are a source of thermal refuge during seasonal periods of stress.

Last Update: December 2015

Measurement Unit: River segments for flowing water and entire waterbodies for lakes/reservoirs. River segments are uniquely identified by river mile and latitude/longitude.

Data Source(s) / Quality: MFWP biologists' expert knowledge, supported by survey data from Montana FWP internal centralized data repositories and telemetry, tagging, redd count, and creel data. Fisheries surveys conducted by MFWP and collector permit holders from state and federal agencies and non-governmental 0rganizations for the past 10 years.

Methods: Habitats or locations where fish congregate to complete important, often limiting, life history strategies such as spawning, rearing, or seeking thermal refuge are considered life history support areas. These life history support areas can be classified by their level of importance to the associated sport fish population as either essential or important. Local MFWP biologists delineated and designated life history support areas by interpreting a combination of survey, telemetry, tagging, redd count, or creel data. **Essential habitat** are defined as spawning, rearing, and thermal refuge habitats for migratory sport fish species that, if lost, would severely impact the associated sport fishery for that species. **Important habitats** are defined as spawning, rearing, and thermal refuge areas for migratory sport fish that cumulatively benefit the associated sport fishery. Impacts to these habitats would result in declines in abundance or distribution of the associated sport fishery for that species, however, the declines would not be as severe as losses to essential habitats.

Final Categorization: Life history support areas for maintaining an associated sport fishery were categorized as either essential or important. Essential habitats were chosen as the most important category of life history support areas. These areas, as defined above, often limit the production and

maintenance of many sport fisheries and, if lost, would severely impact an associated sport fishery for many species. Important habitats, as defined above, are shown as highly important, however, they are somewhat less important than essential habitats in that loss of one of these habitats may not result in severe population level declines. Cumulatively, however, these areas are highly beneficial to the overall maintenance of sport fisheries across the state.

Large Landscape Blocks and Habitat Connectivity

Summary: A landscape integrity approach to identify large areas of native habitat that may serve as source and destination patches for a variety of game and non-game species and the most likely connections between them. Blocks represent areas with the lowest direct effects of the "human footprint". Connectivity represents the lowest likely cost of movement between blocks. Five categories of large landscapes were analyzed: All Native Habitat, Alpine Habitat, Forest Generalist Habitat, Forest Specialist Habitat, and Grass/Shrub Habitat.

Last Update: 2015

Measurement Unit: One square mile hexagon.

Data Source(s) / Quality: Montana Landcover 2010 – layer maintained by the Montana Natural Heritage Program (NHP) Spatial Analysis Lab, University of Montana. Classification based on remote sensing. Resolution is 30 meters. Roadways, structures, incorporated areas – from Montana Spatial Data Infrastructure layers, available from the Montana State Library Data List; Coal and Pit mines, Gravel Pit, Transmission lines, Wind Turbine locations, Superfund sites – from Montana Department of Environmental Quality; Oil and Gas Well locations – from Montana Board of Oil and Gas; Cell and Radio Towers – Federal Communications Commission; Ski Areas – digitized by MFWP.

Methods: Page numbers and appendices reference the full Connectivity Project documentation available at http://fwp.mt.gov/fwpDoc.html?id=53366.

Methods were replicated for each of the 5 habitat categories. LARGE BLOCKS: Identified "native" land cover for each category (Appendix H Table 1 pg. 265) using the Montana Land Cover Classification layer at 90m raster cell resolution. Eliminated all cover types that are non-native cover types with the exception of open water (reservoirs) and the harvested forest classes if applicable. Identified features representing human influence buffering each feature by one cell at 100 meter resolution and then removed those areas from the native cover (Appendix H Table 2). After removal, if 90% of the surrounding 20 x 20 cells remained native cover, the cell was considered to be "intact". All intact cells were merged to create contiguous polygons of intact habitat. These constituted the blocks, which were then filtered to use only those large blocks of 5,000 acres or more. CONNECTIVITY: Assigned a cost of movement for each cell on the landscape ranging from 0-no cost to 100-high cost (pp 140-141). Cost was first calculated for moving across a cell containing a specific land cover value. These costs differed for each of the 5 categories depending on the cover types presumed to be more or less preferred within that category. Cost was also calculated for each cell containing a mapped human influence, as well as a descending cost value for areas out to 1,000 meters from each influence. The maximum score for a cell

was used considering all cost inputs. Connectivity models were then calculated between each large landscape block. These models were run locally from each block, using all surrounding blocks within 10 km. In addition, regions were identified by combining all blocks within 5 km of one another and then running models between all regions within 70 km of one another. This local and regional approach alleviated problems whereby lower costs due to cores within close proximity did not overwhelm, or falsely represent, areas beyond the most likely area of connectivity for that pair of blocks. Model scores were relative and ranged from 0, with the lowest pair wise cost of movement, to 100, with the highest cost. Costs were considered 0 within landscape blocks.

Final Categorization: Landscape Blocks have a single metric (1/0) indicating if the area is a block or not. Connectivity scores are split into 6 categories covering the 0-100 score, with a score of 6 being most likely to represent an area of connectivity. Category scores were as follows: Category 6 (scores 0-5); 5 (scores 6-10); 4 (scores 11-15); 3 (scores 16-25); 2 (scores 26-50); 1 (scores 51-100).

Watershed Integrity

Summary: The level of human impact on streams and river basins was characterized by creating a score of watershed integrity for each river basin and sub-basin in Montana. Watershed integrity (WI) is a summation of human impacts that contribute to the impairment of streams and watersheds. The 13 variables are supported by literature as best predictors of watershed health in Pacific Northwest and Rocky Mountain streams and include impacts that are likely to affect water quality, water quantity, watershed connectivity, stream function, and the overall health of stream systems.

Last Update: December 2015

Measurement Unit: Upper and lower portions of watersheds (6th Code Hydrologic Unit).

Data Source(s) / Quality: Variables include: 1) % urban, 2) % riparian buffer as urban, 3) % cultivated cropland, 4) % riparian buffer as cultivated cropland from the Montana Department of Revenue Farm Land Use Type layer, 5) road density, and 6) road density in riparian buffer from the US Census Bureau, 7) # producing oil / gas wells from the Montana Board of Oil and Gas, 8) # unique points of irrigation diversion from the Montana Department of Natural Resources and Conservation, 9) # surface / placer mines, 10) # dams with storage >20 surface acres, 11) presence of large in-stream reservoirs from the Montana Natural Resource Information System, 12) presence of impaired streams (303d listed by the Montana Department of Environmental Quality), 13) # of Wetland Modification Project Permits (Army Corps of Engineer 404 permits).

Methods: Variables were summarized by 6th code HUC and each HUC was given a score based on density, frequency or presence of each variable. In HUCs west of the lower Yellowstone and Missouri basins, HUCs were split into valley and mountain portions to account for differences in land use management and stream gradient. Valley segments of watersheds are generally lower in gradient, have a different suite of native species present, and have different ownership characteristics than mountainous stream reaches that are generally high gradient and publicly owned.

Variables used to represent watershed integrity were selected from literature as best explaining the variability seen in watershed health throughout Pacific Northwest and high elevation prairie streams. The presence, density, or frequency variables were summarized by 6th code HUCs in prairie systems (lower Missouri and Yellowstone) and by sub-basin (upper and lower) for streams west of the lower Missouri and Yellowstone ecoregions. The elevation contour that best explained the division between valley and mountain topography was selected as the division between upper and lower portions of most western HUCs.

HUC scores for each variable ranged from 0 to 30 with five categories possible for most variables. Scoring breaks for each variable were made using the Natural Breaks (Jenks) Method of categorization. Variables shown by literature as being highly correlated to watershed health (% cultivated cropland, road density, % urban) received more weight than others. Calculations for riparian buffers are based on increasing buffer widths for stream orders 2 – 8, with buffers 5 to 246 meters, respectively. Each 6 th code HUC score was calculated by adding scores for each variable and dividing by the total possible points (e.g. WI Score = HUC total / total possible).

Final Categorization: Scores for watershed integrity were normally distributed. Four categories of watershed integrity were created based on quartiles that represented a gradient of integrity from highest to low. The highest score for a watershed was 1.00 and the lowest score for a watershed was 0.48.

3. Data Sources

Summary of the data sources for each layer in the Montana CAPS application. The following table indicates the type or category of data used as inputs. Layers are listed in the order they appear in the CAPS application.

Layer Name	Survey data counts or estimates	Survey data categorical	Expert opinion based on observation	Extrapolated from existing GIS layers
Habitat for Species of Concern	x	x	x	
Large Natural Areas				x
Landscape Connectivity				x
Species of Economic and Recreational Importance (SERI)	x	x	x	
Game Fish Quality	x	x	x	
Terrestrial Game Quality	x	x	x	
Big Game Winter Range Habitat			x	
Bighorn Sheep and Mountain Goat Habitat			x	
Forest Carnivore Habitat		x		
Prairie Grouse Habitat	x	x	x	
Riparian Areas				x
Wetland Areas				x
Aquatic Connectivity	x	x	x	
Fish Native Species Richness	x	x	x	
Game Fish Life History	x	x	x	
Large Landscape Blocks				x
Habitat Connectivity				x
Watershed Integrity	x	x		

4. Data Extrapolation Techniques

In an effort to provide consistent information throughout each region of the state, biologists were often asked to provide interpretations of survey data for each of the data categories and layers presented in CAPS. Where survey data were not easily available, for either spatial or temporal reasons, some layers relied on one or more data extrapolation techniques to depict a value. Extrapolation is an estimation of a value based on extending a known sequence of values or facts beyond the area that is certainly known. Inductive modeling refers to the logic of making specific observations (facts) and drawing broad conclusions based on those observations. Deductive modeling, also called top-down logic, refers to the logic of using a specific set of rules to narrow the scope of possible conclusions. Layers are listed in the order they appear in the CAPS application.

Layer Name	Modeling of habitat associations - Deductive	Statistical Modeling (Inductive)	Extrapolation to habitat unit (e.g. stream section)	Extrapolation based on expert opinion	None
Habitat for Species of Concern		x	x	x	
Large Natural Areas	x				
Landscape Connectivity	x	x			
Species of Economic and Recreational Importance (SERI)	x	x	x	x	
Game Fish Quality			x	x	
Terrestrial Game Quality	x	x		x	
Big Game Winter Range Habitat	x			x	
Bighorn Sheep and Mountain Goat Habitat				x	
Forest Carnivore Habitat	x	x			
Prairie Grouse Habitat		x		x	
Riparian Areas			x		
Wetland Areas					x
Aquatic Connectivity		x	x	x	
Fish Native Species Richness			x	x	
Game Fish Life History			x	x	
Large Landscape Blocks	x				
Habitat Connectivity	x	x			
Watershed Integrity			x		

5. Additional Data Layers

Additional data layers have been added to CAPS to provide supplementary information for users. The layers include State Wildlife Action Plan (SWAP) layers, Development and Infrastructure layers (Energy, Residential, and Transportation) and Reference and Landscape layers. These data layers were not created for CAPS. These layers have description information and data source links in CAPS. Detailed information about these layers is not included in this document.

6. Data Layer Update Process and Staff Responsibilities

MFWP's Geographic Data Services Bureau staff maintains the data layers represented in CAPS and the WAFWA CHAT as outlined in this document. MFWP Fisheries and Wildlife staff direct the review of CAPS data layers and any data sources listed which are produced by MFWP. The timing of updates to data layers not maintained by MFWP may influence the CAPS layers.

New techniques for display, representation, and validation of natural resource data are constantly being developed, and it is therefore beneficial to occasionally review the procedures used to generate CAPS layers. The process to develop new methods and review resulting data can be resource intensive. Therefore, review of the data generation procedures, and the staff required, will be initiated by MFWP staff when time and resources are most appropriately allocated toward that effort.