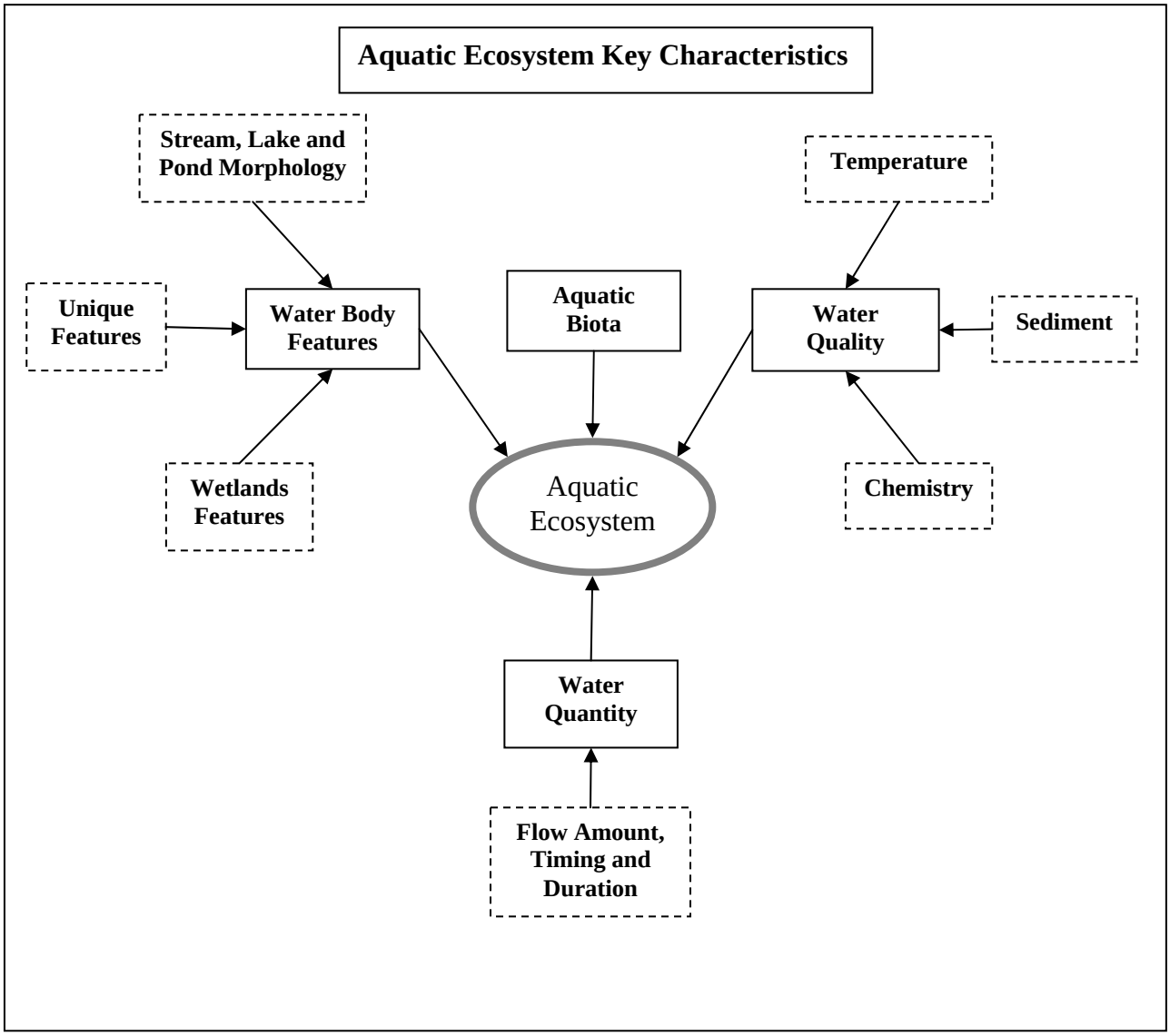
Aquatic Ecosystems



Aquatic Ecosystems - The stream channel, lake or estuary bed, water, and biotic communities and the habitat features that occur therein (FSM 2526.05). A basic ecological unit composed of living and nonliving elements interacting in an aqueous milieu.

There are three basic types of freshwater ecosystems:

Lentic: slow-moving water, including pools, ponds, and lakes.

Lotic: rapidly-moving water, for example streams and rivers.

Wetlands: areas where the soil is saturated or inundated for at least part of the time.

Two important subclasses of lakes are ponds, which typically are small lakes that intergrade with wetlands, and reservoirs. Pond ecosystems base trophic level is largely based on the autotrophic algae. The largest predator in a pond ecosystem will normally be a fish. It may have a scale of organisms from small bacteria to big creatures like water snakes, beetles, and turtles.

The major zones in river ecosystems are typically determined by the stream size and bed's gradient or by the velocity of the current (Vannote *et al.* 1980). The food base of streams within riparian forests is mostly derived from the trees, but wider streams and those that lack a canopy derive the majority of their food base from algae. Anadromous fish are also an important source of imported nutrients (Gende et al. 2002).

Wetlands are dominated by vascular plants that have adapted to saturated soil. Wetlands are the most productive natural ecosystems because of the proximity of water and soil. Wetlands are often classified based upon surface water availability, soil characteristics, and vegetation community. Examples of unique wetlands found within forests include vernal ponds, peat bogs, and cattail marsh.

Natural disturbance processes primarially affecting freshwater aquatic ecosystems within the planning area include: flood, fire, landslides, debris torrents, and eutrophication.
Changes in hydrologic regime could lead to vegetation succession and changes in the associated water regime and wetland plant communities. Climate change may also affect water bodies and wetlands, whose yearly water budgets are directly tied in large part to annual patterns of precipitation and drying. Human threats to aquatic ecosystems include climate change, loss of water, dams, stream sedimentation, channel modifications, chemical pollution, and introduced species.

Aquatic Ecosystem Components

An ecosystem is composed of biotic communities and abiotic environmental factors. The basic building blocks of the aquatic systems include:

- Aquatic biota.
- Water body features including stream channel morphology; pool, pond, lake and reservoir morphometry; and wetlands.
- Water quality including chemistry, temperature, and sediment.
- Water quantity including surface & ground water flow.

Aquatic ecosystems may include unique biotic and abiotic features which provide specialized habitat for plant and animal species. These features may be small ecosystems within the larger system such as a cave, or may be physical environment that provides certain site characteristics providing a niche for a particular species such as a wet cliff or waterfall. Unique features identified in the aquatic ecosystem are waterfalls and rock outcrops.

How Forest Plan Components Provide for Aquatic Ecosystem and Species Diversity

Aquatic ecosystem conservation cannot be accomplished by addressing a single risk or limiting factor. It requires a comprehensive approach that establishes a trajectory toward long-term sustainability. One of the forest plan goals is to establish a strategic management framework where rates and patterns of environmental variation are allowed.

The forest plan describes desired disturbance processes, and anticipates that those processes will continue to shape aquatic ecosystem physical features and the associated native plant and animal species. Within this context, plan components establish a management framework that provides for habitats where native plants and animals are found. These plan components are intended as an integrated conservation and restoration strategy; and to manage risk to native plants and animals from specific multiple use activities.

The combination of these ecosystem diversity and species diversity plan components provide a trajectory towards ecological conditions that in turn provide for native plant and animal species found within aquatic ecosystems. However, there are specific life history requirements of high risk or rare species that may require specific plan components (fine filter) to assure their continued existence within the plan area. For example, specific plan components were developed for bull trout and western pearlshell based upon their unique life

history and habitat requirements. Overall, the watershed and aquatic habitat plan components address the most significant features for this species group; abundance of clean cold water, complex habitat features, stable banks, etc.

Aquatic Biota

Plan components were developed to provide the aquatic habitats expected to support species diversity. These plan components targeted native cold water species present or with potential suitable habitat within the National Forest boundaries. From that group, representative species were chosen to develop and evaluate plan components. Plan components and species requirements were iteratively evaluated to address plan deficiencies.

Representative species chosen for detailed evaluation to develop plan components included:

Federally Threatened or Endangered Species

- Bull trout (Threatened)
- Steelhead (Threatened)
- Chinook salmon (Threatened – Salmon River)
- Sockeye Salmon (Endangered)

Species of Concern

- Westslope cutthroat trout
- Chinook salmon (Clearwater River spring/summer run)
- Aquatic invertebrates

Species of Interest

- Pacific Lamprey
- Western Pearlshell

Salmonid species are considered useful surrogates for the cold water group. Lee et al. (1997) in the Interior Columbia Basin assessment provided several reasons for focusing on salmonid species as cold water biota indicators. These include:

a. More is known about them, and therefore are more likely to discern important environmental relationships.

b. They are widely distributed, which allows for broad-scale comparisons.
c. They act as predators, competitors, and prey for a variety of other aquatic and terrestrial animals. Thus they are likely to influence the structure and function of aquatic ecosystems.
d. They are potentially more sensitive to disturbance than other species groups.

Biological evaluations were completed on those native species chosen as surrogates. The evaluations included status assessments of population size, distribution (both current an historic), movement and connectivity, threats to individuals or subpopulations, and genotypic and phenotypic diversity. Geographic scale of these evaluations was Clearwater and lower Salmon River basins. See supporting documents in the project file for additional information.

Habitat Needs

The cold water group requires stream environments that have clean, cold water. Native salmonids need diverse aquatic habitats such as pools, riffles, and runs. They also need cold water and clean gravels for spawning and egg incubation. Lee et al. (1997) provides detailed descriptions of habitat needs for native salmonids.

Stressors

Human stressors (threats) to the cold water group include climate change, dewatering, dams, stream sedimentation, channel modifications, chemical pollution, and introduced species. The subwatershed summaries (in the supporting documents) provide detailed information about threats to native salmonids. The level of Forest Service control over threats to the cold water group is variable. Table 1 provides a summary.

Table 1. Degree of Forest Service control on stressors.

Stressor	Relative Degree of Forest Service Control[1]
Sediment (road system)	High
Non-native fish species	Low

[1]Control over threats is also influenced by the relative proportion of Forest Service ownership in any given watershed or stream network.

Stream habitat connectivity	High
Mining	Moderate
Downstream dams (anadromous fish)	None
Grazing	High
Mixed Ownership	Low
Dewatering	Low

In some cases natural disturbances can exacerbate the level of stress on the cold water group. For example, forest fires that burn in areas with dense networks of roads can cause a high potential of sedimentation.

Forest Plan Guidance: Forest plan components which apply to aquatic biota were documented by cross-referencing to the specific plan components and briefly described (Table A).

Table A. Clearwater National Forest plan components for aquatic biota.

Forest Plan Components Section Reference	Plan Component Description
1.3.7.4	Water temperature desired conditions for salmonids.
1.3.7.4	Habitat connectivity desired condition.
1.3.7.5	Native and desired non-native aquatic species status and distribution desired conditions.
2.3.6.1	Watershed restoration objectives.
2.3.6.7	Aquatic habitat improvement objectives.
2.3.6.8	Fish passage objective.
2.3.6.9	Aquatic program partnerships objective.
3.2.7.3	Fish entrapment and entrainment guidelines.
3.2.7.6	Western pearlshell mussel colony protection guideline.
3.2.7.7	Stream crossing and fish passage guidelines.

By providing ecological conditions that sustain surrogate cold water species, the critical assumption is the ecological conditions necessary to sustain other aquatic animals are also provided. Even though these assumptions seem reasonable, there is some uncertainty because of the limited life history information on the aquatic animals in relation to the fish species evaluated. The higher risk scenario is that an individual species may have a unique habitat requirement that is not accounted for in the plan desired ecological conditions (coarse filter).

The forest plan monitoring program includes aquatic habitats and the process for adapting management plans based upon new information or changes in ecosystem characteristics.

Water Body Features - *Stream Channel Morphology*

Stream channel morphology refers to the shape and structure features of a stream channel. Morphological features most important in influencing aquatic habitat conditions are pool/riffle ratio (frequency of pools), wood, substrate size and distribution, channel bank steepness (angle), as well as channel width, depth, and gradient. These features are influenced by local geology and climate which can determine the amount and size of sediment, duration and size of peak flows, stream gradient, and channel bank steepness.

Pools are essential to fish because they provide a range of habitats, store nutrients for food, and act as buffers during sediment pulses. The frequency and size of pools are dependent on stream size, gradient, confinement, large woody debris, flow and sediment load. Pools quality as measured by pool size and depth is perhaps more important to fish than number of pools. Residual pool depth, area, and volume of pools can serve as sensitive indicators of changes in sediment load.

The interaction of woody debris and aquatic habitats is very dynamic. Down wood in streams affects the formation and distribution of habitat units, provides cover and complexity, and acts as a substrate for biological activity (Swanson et al. 1982, Harmon et al. 1986). Woody debris jams, and root wads can provide especially favorable complex habitats for fish. Wood can also influence channel morphology and the formation of pools (Bisson et al. 1987). Downstream transport rates of sediment and organic material are often controlled in part by storage of this material behind wood debris (Beschta 1979). Wood recruitment to aquatic habitats can occur through a variety of methods. Common sources of wood include: falling in, blow-down, landslides, and beaver activity. Most wood entering aquatic habitats comes from the riparian area closest to the aquatic habitat within approximately one tree height (VanSickle & Gregory 1990).

Substrate size composition is a key characteristic in the formation and maintenance of stream channel morphology. Larger substrates often provide habitat complexity and hydrologic diversity. Stream gradient and stream flow, which are indicators of a stream's energy and ability to move various substrate particles, is closely correlated to substrate size composition.

Inorganic substrate size distributions can provide an indication of suitability of aquatic habitats for various aquatic organisms. Aquatic macroinvertebrates are sensitive to differences in substrate composition and the amount of interstitial space between the particles. Large particle substrates embedded with fines provide very poor habitat for most aquatic invertebrates. Some aquatic organisms use substrate surfaces for egg attachment. An excess of fine substrate particles can also result in smothering of fish eggs in their redds (nests). Often pool tail fines are measured to determine the amount of fine particles in areas typically used by fish to spawn.

Bank stability is a key component in maintaining aquatic habitat integrity. Essentially the banks hold the habitat in place and help to minimize excessive erosion. Stable banks help to provide habitat diversity through development of deep and shallow water habitats. Unstable banks often result in overly wide streams with an overabundance of shallow water habitats and few deep water habitats such as pools. Bank stability often results in overhanging banks which are beneficial to aquatic organisms because they provide cover and shade.

Bank steepness and stability can be an important indicator of the condition of a given stream or watershed. Unstable banks contribute sediment to the stream by slumping and surface erosion, causing corresponding decreases in depth, which may rise maximum summer water temperatures and reduce cover for fish. Further, actively eroding stream banks support little or no vegetation, which can reduce both input of organic matter and habitat for other riparian dependent species. Factors that contribute to bank stability include soil rock content; vegetation vigor and rooting depth; and amount, timing, and duration of disturbance, such as seasonal high flows, grazing, or recreation use. Physical disturbance of banks can cause sloughing or breaking off of overhangs and result in bank angles greater than ninety degrees.

Management Influences: Listed are the primary land management actions that directly influence stream channel morphology. Italicized actions are ones that have the greatest potential to influence stream channel morphology:

- *Roads*: Roads can result in changes in channel morphology, especially at road crossing locations. Poorly placed roads can encroach on stream channel and floodplain areas. Many older roads were constructed very close to stream channel areas often in the floodplain. Often streams were straightened to accommodate road routing. Sometimes roads capture flow out of the channel and can result in stream rerouting down the road. Unpaved roads are the most common source of sediment to streams on National Forest lands. Excessive sediment loading often leads to changes in channel morphology because of pool filling, widening of the channel, and making the channel shallower. These types of changes in channel morphology reflect changes in width-to-depth ratios, number of pools, pool depth, bank angle, and amount of undercut bank.
- *Grazing*: Grazing near soft bank "sensitive" channel areas can result in dramatic changes in channel morphology. Livestock trailing, chiseling, and general soil displacement along stream bank areas can result in collapse of undercut bank areas and an overall increase in bank angles, loss of bank cover, and stream widening along the entire stream reach. Over long periods of time, grazing can lead to the entire channel becoming downcut to the point that a gully forms and a new channel is formed at the bottom of the gully. This type and extent of down-cutting results in an entire channel type change.
- *Dams*: Dams can change the natural flow regime substantially, ultimately affecting water channel morphology. Flow interruption halts downstream movement of stream bedload and suspended sediment, which can result in a different stream processes and composition of aquatic biota downstream of a dam.
- *Diversions*: Diversions result in a loss of riparian vegetation, which can lead to stream channel modifications, including changes in vegetation species, changes in stream channel substrate composition, and stream narrowing.

- *Harvest and fire*: Riparian vegetation removal influences channel morphology through increased potential sediment delivery to water bodies, reduced large wood recruitment, and subsequent changes in pool depth and complexity.
- *Recreation use, facilities, and mining*: Permanent development and campground facilities in riparian areas can result in sediment increases to nearby streams, loss of stream bank vegetation, and reduced water infiltration. Associated human activities such as off-highway vehicle use on trails and stream bank trampling can also decrease ground cover and increase soil disturbance. Direct effects to channel morphology are loss of pool volumes and habitat complexity, and a decrease in stream channel substrate size.

Forest Plan Guidance: Forest plan components which apply to stream channel characteristics were documented by cross-referencing to the specific plan components and briefly described (Table C).

Table C. Nez Perce National Forest plan components for stream channel characteristics.

Forest Plan Components Section Reference	Plan Component Description
1.3.7.4	Quantitative desired conditions for pool frequency, pool quality, stream substrate sizes, stream wood, width depth ratios, and bank stability.
2.3.6.7	Objective to improve 150 miles of streams.
3.2.7.6	Guides evaluation of stream features to hydrologic response reaches.

Water Body Features - *Pool, Pond, Lake & Reservoir Habitat Morphometry*

The geologic origin of a pool, pond, and lake sets the limits for the morphometry or shape of its basin. Since reservoirs are artificial they do not follow the natural form and function of other lentic habitats, however, many of their habitat characteristics are similar and are worth including in this section. Morphometric features most important in influencing lentic aquatic habitat conditions include surface area, depth, and amount of shoreline. Once the basin has formed, a variety of physical, chemical, and biological features interact to produce discernable structure within the water (Goldman & Horne 1983).

Lentic habitat morphometry has important effects in nearly all major physical, chemical, and biological lentic habitat characteristics including: habitat zonation (i.e. shallow, deep), thermal stratification, water chemistry, water movement (including mixing), aquatic vegetation and algal growth, nutrient cycling, and biological structure or food web development.

Substrate size composition influences lentic habitat morphometry and resistance to shoreline erosion. Larger substrates often provide habitat complexity and cover for aquatic species. For some aquatic organisms substrates provide surfaces for egg attachment.

Lentic habitats, like other aquatic habitats, are influenced by the watersheds in which they occur. Watershed conditions and geology affect the amount and timing of sediment, water, organic material, and nutrient delivery to lentic habitats. In addition, watershed geology often influences water chemistry.

Lentic habitats vary widely in size from very large (e.g. Flathead Lake) to very small such as individual vernal pools. Down wood provides additional habitat complexity to lentic habitats especially around the habitat margins. Lentic habitats support a wide variety of unique aquatic-dependent organisms including, but not limited to, benthic aquatic macroinvertebrates, crustaceans, amphibians, aquatic macrophytes, plankton, algae, and fish.

Management Influences: Listed are the primary land management actions that directly influence Pool, Pond, Lake, and Reservoir Habitat Morphometry. Both actions are italicized, as both have a high potential to influence this characteristic.

- *Grazing*: Livestock trampling and hoof chiseling along shorelines can increase ground exposure, surface erosion, and sedimentation. Concentrated livestock waste can cause eutrophication of lakes and ponds.
- *Prescribed fire*: Fire along shorelines can result in a variable amount and distribution of ground exposure. Moderate to light severity fires generally have little influence on shoreline vegetation and ground litter removal, and subsequent surface erosion.

Severe fires may remove virtually all shoreline vegetation and ground cover, and result in significant soil erosion and sedimentation to nearby water bodies, and result in the loss of important transitional habitats for aquatic species such as amphibians and insects.

Forest Plan Guidance: Forest plan components which apply to pool, pond, and lake characteristics were documented by cross-referencing to the specific plan components and briefly described (Table P).

Table P. Nez Perce National Forest plan components for pool, pond, and lake characteristics.

Forest Plan Components Section Reference	Plan Component Description
1.3.7.3	Riparian vegetation desired conditions as influenced by fire.
2.3.6.7	Objective to improve 50 lake acres.
2.6.1	Riparian conservation areas suitability.

Water Body Features – *Wetlands (includes peatlands, fens, bogs, seeps, and springs)*

Wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors, including human disturbance.

Wetlands are recognized as important features in the landscape that provide numerous benefits for water quality, and numerous aquatic and terrestrial species. Wetlands protect and improve water quality, store flood waters, and maintain surface water flow during dry periods. Wetlands are some of the most biologically productive natural ecosystems. Abundant vegetation and shallow water provide for a wide variety of plant, aquatic, and terrestrial species. Aquatic plant life flourishes in the nutrient-rich environment, and energy converted by the plants is passed up the food chain.

Management Influences: Listed are the primary land management actions that directly influence wetlands. All actions are italicized, as they each carry a high potential to influence wetlands.

- *Roads:* Roads can permanently affect wetlands by interrupting natural flow paths and reducing vegetation.
- *Timber harvest:* Harvest directly adjacent to wetlands can reduce shade, raise water temperatures, and reduce the potential for recruitment of woody material.
- *Grazing:* Grazing directly in wetlands or immediately adjacent to them can cause soil compaction, hommocking, and loss of vegetation. This ultimately inhibits sub-surface water flow.
- *Dams:* Dams and associated reservoirs can inundate wetlands. Dams can also reduce downstream wetland habitats where they are directly associated with streams or rivers.
- *Diversions:* Diversions can cause wetlands to shrink where they are directly associated with dewatered stream segments.
- *Recreation:* Recreation use (primarily ATV use) can cause soil compaction and loss of vegetation in wetlands and/or directly adjacent to them. This can reduce sub-surface water flow and increase surface runoff.
- *Facilities:* Facilities are similar to roads in terms of potential effects. Facilities can permanently affect wetlands by interrupting natural flow paths and reducing vegetation.
- *Mining:* Mining directly adjacent to wetlands, or within streams or floodplains that are connected to wetlands, can reduce water availability/flow and increase sedimentation and/or pollution.
- *Fire suppression:* Long-term suppression causes forest succession to continue, which can increase evapotranspiration and interception, resulting in less water available for wetlands.
- *Prescribed fire:* Prescribed fire can reduce vegetation upstream and around wetlands. This can cause delivery of sediment and nutrients from burned areas, as well as recruitment of woody material. Prescribed fire can also reduce evapotranspiration demands and make more water available for wetlands.

Forest Plan Guidance: Forest plan components which apply to wetland characteristics were documented by cross-referencing to the specific plan components and briefly described (Table W).

Table W. Nez Perce National Forest plan components for wetlands.

Forest Plan Components Section Reference	Plan Component Description
1.3.7.3	Riparian vegetation desired conditions as influenced by fire.
2.3.6.6	Objective to improve 100 wetland acres.
2.6.1	Riparian conservation areas suitability.
3.2.7.5	Riparian conservation area guidelines.
3.6.1	Other sources of guidance

Water Quality – *Chemistry*

Water chemistry in streams, lakes, and ponds is quite variable and dependent on a variety of environmental factors including climate, weathering, geologic parent material, soil type, flow regimes, and vegetation characteristics. Some important water chemistry parameters for the Cold Water Group include nutrient concentrations (primarily phosphorus and nitrogen), pH, conductivity, alkalinity, and dissolved oxygen.

Water chemistry is very important because cold water biota are dependent upon chemical characteristics that are within certain ranges. There are many natural processes that directly and indirectly affect water chemistry. For example, aquatic plants use nutrients (such as nitrogen and phosphorus) and carbon dioxide to grow and photosynthesize during the day. This releases oxygen into the water that can be used by other aquatic organisms. During the night, photosynthesis stops, so oxygen levels decrease and carbon dioxide increases. The diurnal shifts in carbon dioxide changes the amount of carbonic acid in the water, which ultimately changes the pH.

Some very important water chemistry characteristics are closely related to solar radiation and air temperature. Cold water holds more oxygen and has less potential to grow aquatic algae and plants. Warmer water that gets more sunlight tends to have less dissolved oxygen because of decomposition of rapidly growing algae and other aquatic plants.

Management Influences: Listed are the primary land management actions that directly influence water chemistry. All items are italicized, as each one has a high potential to influence water chemistry.

- *Riparian vegetation removal*: Management practices such as timber harvest, prescribed fire, wildland fire use, livestock grazing, placer mining, and facility construction can all result in removal of riparian vegetation. Loss of riparian vegetation can influence the amount of solar radiation and water temperature regimes. These changes can ultimately lead to shifts in dissolved oxygen and pH. In addition, removal of riparian vegetation can increase nitrate levels, which can increase the biological production in water.
- *Roads in riparian conservation areas:* Roads result in a form of semi-permanent vegetation removal. Loss of riparian vegetation can influence the amount of solar radiation and water temperature regimes. These changes can ultimately lead to shifts in dissolved oxygen and pH. In addition, removal of riparian vegetation can increase nitrate levels, which can increase the biological activity in water.
- *Fire suppression:* Suppression of natural fire regimes causes fuel loads to accumulate. When wildfires do occur, the intensity and severity are often higher than they would be with more natural levels of fuel. This can result in higher rates of fuel consumption and availability of ash and nutrients that can be delivered to aquatic environments.
- *Dams:* Dams can change the natural flow regime substantially, which can ultimately affect water chemistry. Water released from the bottom of a reservoir is often much colder than natural streams and contains high concentrations of nutrients. These changes can often result in a different composition of aquatic biota downstream of a dam.

- *Diversions:* Diversions can create changes in water chemistry by altering the temperature regime. Usually, smaller volumes of water tend to heat up faster than larger volumes. Higher water temperatures result in increased biological activity and decreased dissolved oxygen. Diversions can also result in a loss of riparian vegetation, which can exacerbate increased water temperatures.

Water Quality – *Temperature*

Water temperature in streams, lakes, and ponds is quite variable and dependent on a variety of environmental factors including climate, flow regime (surface and sub-surface), and riparian vegetation. Water temperatures are generally very cold at high elevations where streams are fed by springs and snowmelt. Water bodies at lower elevations generally have warmer temperature regimes.

Water temperature is a very important habitat parameter for the Cold Water Group. Cold water temperatures are particularly important for native salmonids. Cold water typically has high concentrations of dissolved oxygen.

Management Influences: Listed are the primary land management actions that directly influence water temperature. All actions are italicized, as each has a high potential to influence water temperature.

- *Riparian vegetation removal*: Timber harvest, prescribed fire, wildland fire use, livestock grazing, placer mining, and facility construction/use can all result in removal of riparian vegetation. Loss of riparian vegetation can influence the amount of solar radiation reaching a water body and increase water temperatures. Greater temperature fluctuations (diurnal and seasonal) can also occur when riparian vegetation is removed or decreased.
- *Roads:* Roads result in a form of semi-permanent vegetation removal. Loss of riparian vegetation can influence the amount of solar radiation and water temperature regimes. Loss of riparian vegetation can influence the amount of solar radiation reaching a water body and increase water temperatures. Greater temperature

fluctuations (diurnal and seasonal) can also occur when riparian vegetation is removed or decreased.

- *Dams:* Dams can change the natural flow regime substantially, which can ultimately affect water temperature. Water released from the bottom of a reservoir is often much colder than natural streams and contains higher concentrations of nutrients. These changes can often result in a different composition of aquatic biota downstream of a dam.
- *Diversions:* Diversions can create changes in water temperature by altering the flow regime. Usually, smaller volumes of water tend to heat up faster than larger volumes.

Forest Plan Guidance: Forest plan components which apply to water quality (temperature and chemistry characteristics) were documented by cross-referencing to the specific plan components and briefly described (Table Q).

Table Q. Nez Perce National Forest plan components for water quality (chemistry and temperature characteristics).

Forest Plan Components Section Reference	Plan Component Description
1.3.7.2	Water quality desired conditions for beneficial uses.
1.3.7.4	Desired condition for specific water temperatures for the cold water group.
2.3.6.2	Objective to complete 90% of TMDL implementation actions.
2.3.6.3	Public water supply sanitary survey objective.
3.2.7.1	TMDL project guidelines (3)
3.2.7.2	Drinking water guideline.

Water Quality – *Sediment*

Sediment is found in a variety of forms in all rivers, streams, ponds, and lakes. It can be in the form of suspended or bedload, and can range in size from large boulders to tiny clay particles. Large sediment material, such as boulders and cobbles are most often found in steep gradient streams, while gravels, sands, and clays are found in low gradient streams, rivers, lakes, and ponds.

Sediment is critically important because it is a basic building block of aquatic ecosystems and forms stream channels, banks, shorelines, and floodplains. It provides a medium for plant growth on stream beds, banks, and flood plains, and also provides a medium for aquatic macroinvertebrates and salmonid reproduction (spawning and egg incubation).

Even though sediment in a variety of forms is an essential building block of aquatic ecosystems, excessive amounts of it can degrade aquatic ecosystems and the Cold Water Group. In wildland watersheds, excessive sediment is often the most common pollutant. Sediment is also the primary vehicle for nutrients to enter aquatic ecosystems.

Management Influences: Listed are the primary land management actions that directly influence sediment. All actions are italicized, as each has a high potential to influence sediment.

- *Roads:* Roads have the potential to affect aquatic ecosystems and the Cold Water Group through several direct and indirect pathways. Roads have the potential to modify natural drainage patterns, which often lead to accelerated erosion of road surfaces and associated cut and fill slopes. This can lead to increased sediment delivery to streams, which can ultimately affect the Cold Water Group. Excess fine sediment can fill interstitial spaces in gravels and cobbles, which reduces available habitat for aquatic macroinvertebrates. In addition, this fine sediment reduces the quality of spawning gravels for salmonids and can ultimately reduce reproduction. Excess sediment can also reduce the quantity and quality of pool habitats. Roads can affect stream channels directly if they are located on active floodplains or directly adjacent to stream channels. For example, a road located adjacent to a stream is a chronic source of sediment. If the road changes the morphological characteristics of the stream, this can set fourth a chain reaction of channel adjustments that can result in accelerated bed and bank erosion, which produces excessive sediment.
- *Placer mining:* Mining of the stream channel causes direct increases of sediment. As equipment dredges stream channels, water flow immediately transports material downstream. In addition, placer mining can cause bank erosion from equipment use and loss of riparian vegetation.

- *Timber harvest:* Harvest of timber has the potential to cause accelerated erosion primarily through construction of temporary roads and skid trails.
- *Fire suppression:* Suppression of natural fire regimes causes fuel loads to accumulate. When wildfire does occur, the intensity and severity are often higher than they would be with more natural levels of fuel. This can result in higher rates of accelerated surface runoff and associated erosion and sediment delivery.
- *Grazing:* Livestock grazing has the potential to cause increased sediment delivery through trampling of stream banks and by removal of riparian vegetation.
- *Dams:* Dams interrupt sediment transport in streams and rivers, and they can change availability of sediment in two ways. Immediately downstream of dams, there is a deficiency of sediment which can cause channel degradation and accelerated bank erosion. These effects are variable and can be seen several miles downstream of a dam. Dams can sometimes cause channels to fill with sediment because they reduce the frequency and magnitude of floods.
- *Diversions:* Removal of water from streams during a substantial part of the year reduces the volume of water (energy) available to transport the sediment load, and this can result in aggradations downstream of the structure.

Forest Plan Guidance: Forest plan components which apply to sediment characteristics were documented by cross-referencing to the specific plan components and briefly described (Table S).

Table S. Nez Perce National Forest plan components for sediment characteristics.

Forest Plan Components Section Reference	Plan Component Description
1.3.7.1	Allows and describes erosion and sediment desired processes and recovery rates following soil disturbance at the subwatershed scale.
1.3.7.4	Desired condition for sediment within the stream channel.
2.3.6.5	Road decommissioning and soil/water improvement objectives.
3.2.7.1	TMDL project guidelines (3)
3.2.7.4	Sediment yield guideline.

Water Quantity – *Flow, Amount, Timing, and Duration*

Flow regime refers to the timing, duration, frequency, and magnitude of stream flow, and can be described in annual, seasonal, monthly, or daily terms. Other water bodies such as ponds, lakes, and reservoirs are strongly affected by the flow regime because they are most often directly connected to stream networks.

The flow regime in wildland watersheds is critically important to the Cold Water Group for a variety of reasons. The size and shape of streams (morphology) is directly related to the flow regime, sediment supply, and landform. Changes in the flow regime can alter sediment transport characteristics and riparian vegetation, which ultimately affect channel morphology and ultimately the Cold Water Group of aquatic species. In addition, the flow regime directly affects the water temperature regime and associated water chemistry characteristics.

Management Influences: Listed are the primary management actions that influence flow regime. Those in italics have the greatest potential for influence.

- *Roads:* Road systems alter natural flow patterns (particularly on hillslopes), reducing infiltration, and increasing surface runoff. Where a dense road network is well connected to the stream network, it can sometimes be considered an "extension" of the actual stream network. This results in a more rapid delivery of water to the mouth of a watershed during snow melt and storm events, which can increase peak flows.
- *Fire suppression:* Suppression of natural fire regimes results in forests that have more trees and associated leaf area. This results in higher evapotranspiration and interception levels, which leaves decreased amounts of water available for surface and sub-surface flow. Lower levels of streamflow can affect the Cold Water Group through warmer water temperatures and changes in water chemistry. In addition, fire suppression can cause fuels to accumulate above natural levels, which can cause wildfires to burn more severely. This process can change infiltration characteristics of the soil and change hydrologic characteristics.
- *Fire management:* Wildland fire use and prescribed fire can affect flow regimes by reducing evapotranspiration, interception, and snow accumulation patterns, and by increasing soil moisture and surface runoff.

- *Timber harvest:* Timber harvest can reduce evapotranspiration, interception, and snow accumulation patterns, and increase soil moisture and surface runoff. Changes in hydrologic processes can be most evident on temporary roads and skid trails.
- *Dams:* Dams can change flow regimes substantially. The types of changes are a function of how a particular dam is operated to achieve power generation and flood control goals. If a dam is operated for power generation, flows often fluctuate on a daily basis (ramping) for peak power demand. Annual floods are often "buffered" by dams and their reservoirs, resulting in smaller annual floods.
- *Diversions:* Diversions change flow regimes simply by making less water available, particularly during the summer months.

Forest Plan Guidance: Forest plan components which apply to water quantity characteristics were documented by cross-referencing to the specific plan components and briefly described (Table F).

Table F. Nez Perce National Forest plan components for water quantity.

Forest Plan Components Section Reference	Plan Component Description
1.3.7.2	Desired condition to sustain flow quantities for beneficial uses.
1.3.7.3	Minimum and maximum flow desired conditions for channel and floodplain maintenance (Gordon et al. 1993).
2.3.6.4	Instream flow special use permit and water rights processing objectives.
2.6.2	Water impoundment and diversion suitability.
3.2.7.5	RCA guidelines (1, 2, and 4)

Unique Features

The aquatic ecosystem may include unique biotic and abiotic features which provide specialized habitat for plant and animal species. These features may be small ecosystems within the larger system such as a cave, or may be physical environment that provides certain site characteristics providing a niche for a particular species such as a wet cliff or waterfall. No matter the size or complexity of the unique features, all ecosystem components are interconnected through a constant exchange of matter and energy. Change in any one

ecosystem component will cause subsequent changes throughout the system. Unique features identified in the aquatic ecosystem are waterfalls and rock outcrops.

Waterfalls and rock outcrops: The splash zones on rock faces adjacent to cascades and waterfalls are important habitats for a variety of plant species (especially mosses), aquatic invertebrates, and amphibians.

Management Influences: The primary land management actions that directly influence flow regime or water quality can change habitat characteristics for species dependent on this environment. Primary disturbances include road and trail construction, reconstruction and maintenance and construction. Mining and recreation use may have direct impact to rock substrate and species presence.

Forest Plan Guidance: Forest plan components which apply to unique features aquatic ecosystems were documented by cross-referencing to the specific plan components and briefly described (Table U).

Table U. Nez Perce National Forest plan components for unique features within aquatic ecosystems.

Forest Plan Components Section Reference	Plan Component Description
1.3.4.1	Desired condition for special habitats (wet fractured bedrock, rocky outcrops, calcareous geology, caves) are available for wildlife use.
3.2.4	Unique habitats guideline.

Integration: Plan components for land management actions that may influence aquatic features were reviewed for conflict or compatibility with achieving desired condition (Table I). The focus of this review was plan components other than the aquatic plan components. Criteria established for this matrix review include:

- Was there direct reference to the water or wetland features?

- Were there risks and uncertainties that might result in desired conditions not being met and therefore this characteristic not being able to contribute to ecosystem diversity?
- Did plan components allow for natural processes to occur (is the process hindered?) that will provide for the characteristic.

Table I. Results of forest plan components review to assess degree of compatibility or conflict with aquatic features desired conditions.

Forest Plan Contents	Water Quality	Water Quantity	Water Bodies	Remarks
Forest Vegetation	+	+	+	Desired condition supports natural watershed disturbance processes and patterns in riparian areas.
Grassland and Shrubland Vegetation	+	+	o	Desired condition supports nutrient cycling and maintaining water tables.
Terrestrial Wildlife Habitat	o	+	+	Snow interception and persistent wetlands desired conditions
Invasive Weeds	o	o	o	
Soil Productivity	o	+	o	Hydrologic functions within natural processes and disturbance.
Designated Wilderness	+	+	+	Desired condition supports natural disturbance processes in riparian conservation areas.
Research Natural Areas	+	+	+	Desired condition supports watershed natural disturbance processes and patterns.
Recommended Wilderness Areas	+	+	+	Desired condition supports natural disturbance processes in riparian conservation areas.
Road Management	o	o	o	
Motorized and Non-Motorized Recreation Use	o	+	+	Motorized travel on designated routes only.
Dispersed Recreation	o	o	o	
Developed Recreation Sites	o	+	+	Includes a RCA desired condition for stream banks, cover and shade.
Recreation Special Uses	o	o	o	
Timber Availability	+	+	+	Supports forest vegetation desired condition.
Wildland Fire, Fuels and Air Quality	--	+	+	Supports forest vegetation desired condition. Allows for some variability anticipated with wildland fires.
Livestock Management	+	o	o	Municipal watersheds are excluded for livestock grazing.
Minerals	o	o	o	
Utilities and Communication Sites	o	o	o	
Administrative Facilities	o	o	o	

Matrix values: Forest plan contents supports (+), did not address (o), or conflicts (--) with ecosystem sustainability element.

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