

# First Foods Upland Vision



Confederated Tribes of the Umatilla Indian Reservation  
Department of Natural Resources

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## **Vision**

To ensure healthy, resilient and dynamic upland ecosystems capable of providing First Foods that sustain the continuity of the Tribe's culture.

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## Introduction

First Foods have sustained tribal people since time immemorial and the relationship between First Foods and the Tribes is essential to the ongoing culture of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). The First Foods serve a fundamental role in the health, well-being and cultural identity of the Tribes. In 2007, to convey the important role of First Foods to the Tribes, the CTUIR's Department of Natural Resources (DNR) adopted a mission based on First Foods ritually served at tribal meals.

The CTUIR DNR considers First Foods to constitute the minimum ecological products necessary to sustain CTUIR subsistence and cultural needs. The mission was developed in response to long-standing and continuing community expressions of First Foods traditions and community member requests that all First Foods be restored for their respectful use, now and in the future.

### CTUIR Department of Natural Resources Mission

To protect, restore, and enhance the First Foods - water, salmon, deer, cou, and huckleberry - for the perpetual cultural, economic, and sovereign benefit of the CTUIR. We will accomplish this utilizing traditional ecological and cultural knowledge and science to inform: 1) population and habitat management goals and actions; and 2) natural resource policies and regulatory mechanisms.

In 2008, the CTUIR DNR published the Umatilla River Vision to assist Tribal and non-Tribal land managers in moving this mission statement from concept to application within the Umatilla River and adjacent basins (Jones et al. 2008). The overarching goal of the Umatilla River Vision is to support a healthy, dynamic river system that can sustain production of First Foods, with an emphasis on Water and Salmon. It presents the vision for desired ecological characteristics of river ecosystems and provides a framework for planning and restoration efforts with associated objectives for assessing the success of management activities.

In this document, we expand the First Foods conceptual framework to upland ecosystems that provide a wide range of First Foods, including Big Game, Roots and Berries. Our vision for upland landscapes is to: ***ensure healthy, resilient and dynamic upland ecosystems capable of providing First Foods that sustain the continuity of the Tribe's culture.***

The primary goals of this document are to:

1. Articulate the CTUIR's vision for upland resource management based on the First Foods mission.
2. Serve as the foundation for DNR staff to organize, plan, and manage land and natural resources.

3. Serve as a resource for non-Tribal land managers, policy makers and other stakeholders to enhance their understanding of the importance of First Foods to the CTUIR and to provide a framework to consider and incorporate First Foods concepts into their management activities within CTUIR's ceded territory where the Tribes retains hunting, fishing and gathering rights (among others).

This document outlines a vision for desired characteristics of upland ecosystems that will facilitate the production of First Foods and serve as a foundation for natural resource management and restoration activities to ensure healthy, resilient and dynamic upland ecosystems. These characteristics are founded on four fundamental "touchstones." These are:

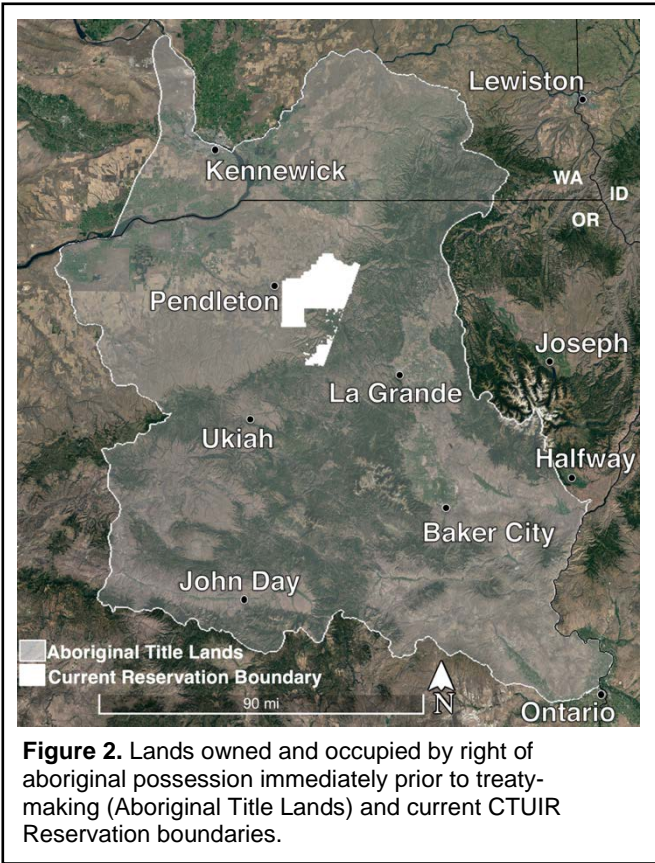
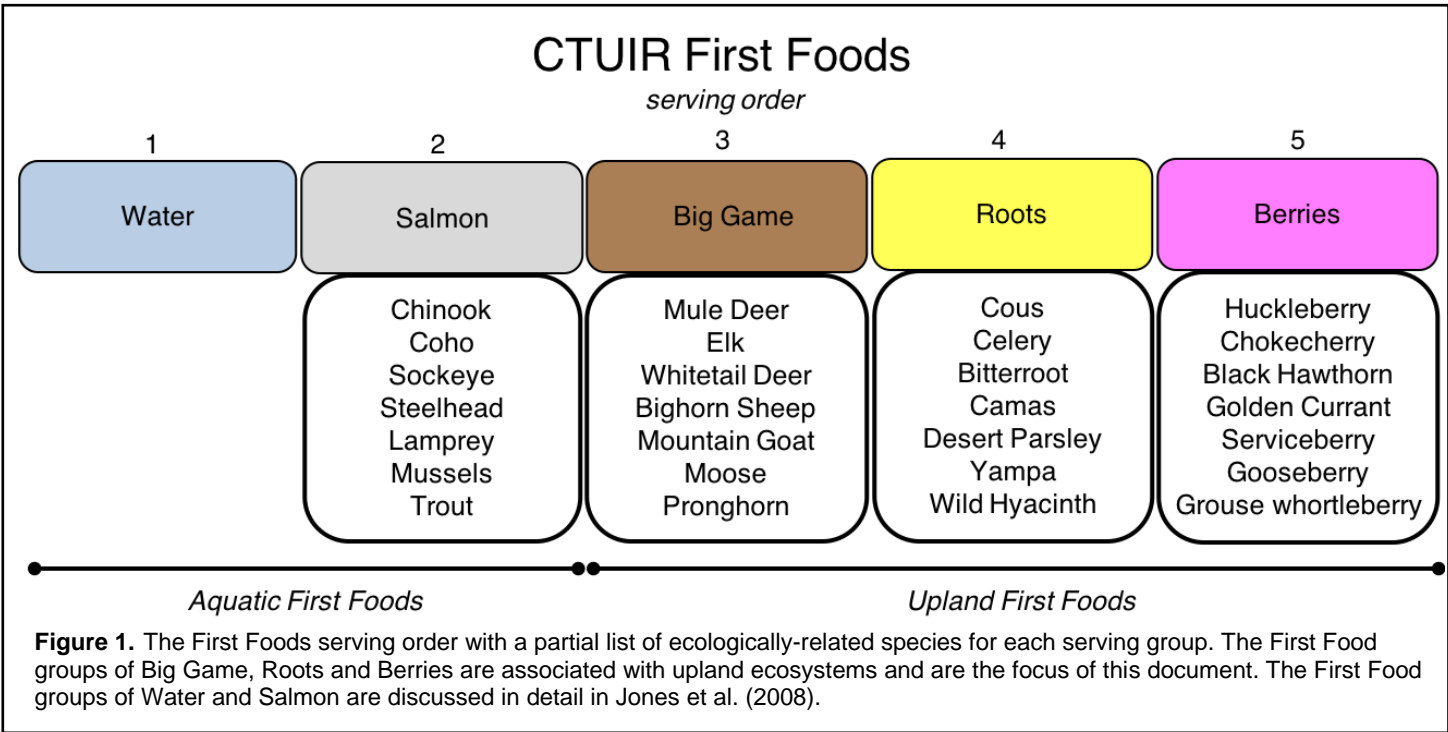
1. Soil Stability
2. Hydrologic Function
3. Landscape Pattern
4. Biotic Integrity

These touchstones and the interconnections between them, are central to the proper functioning of upland ecosystems and their ability to provide a range of ecosystem services, including First Foods. Our framework adopts a broad definition of healthy ecosystems and incorporates environmental, biological, ecological and cultural dimensions. It is based on the premise that healthy upland ecosystems are dynamic and resilient and will continue to produce the full range of First Foods into the future. The term 'dynamic' recognizes the spatial and temporal change inherent in ecological systems as living and non-living ecosystem components interact. 'Resilient' refers to the capacity of an ecosystem to recover from disturbance or withstand chronic stresses. Our framework utilizes these four touchstones to help guide the assessment, management and restoration of upland landscapes to support functional ecosystems capable of sustained natural production of First Foods.

## Scope

This document focuses on upland ecosystems and First Foods production within the ceded territory of the Cayuse, Umatilla and Walla Walla Tribes that constitute the CTUIR, with a focus on Big Game, Roots, and Berries (Figure 1). The First Food groups of "Water" and "Salmon" are the focus of the Umatilla River Vision (Jones et al. 2008) and thus will not be included directly in this document. However, when appropriate we will touch upon on relevant upland issues that also affect the health and function of river and riparian systems that provide these essential First Foods.

Geographically, this region covers a large portion of Southeast Washington and Northeast Oregon (Figure 2). In the Treaty of 1855, 6.4 million acres of Tribal land was ceded to the United States government, the majority of which



became private property of Euro-American settlers. Much of the remaining land not privatized continues to be owned and managed by United States government agencies such as the USDA Forest Service and Bureau of Land Management. Changes in land ownership and management have had

profound impacts on the CTUIR’s ability to access, harvest and manage First Foods.

The CTUIR traditionally harvest about 135 species of plants as sources of food (Hunn et al. 1998). Other plants and plant products are used for a variety of other purposes. For example, over 125 plants were used for dyes, cordage, containers, glues, weaving materials and other uses. Plateau cultures, including the tribes of the CTUIR also used over 125 plant species for medicinal and spiritual purposes (Hunn et al. 1998). While not First Foods, these culturally important resources are also a fundamental part of the health, cultural identity and sovereignty of the CTUIR. While not explicitly discussed within this document, utilitarian plant resources and medicines are likewise products of healthy upland ecosystems, and our conceptual framework and touchstones can be readily applied to these plant species.

This document is not intended to replace or substitute specific land management plans or other natural resource planning documents, but rather to provide a framework for managers to help ensure current and future management activities are aligned with and account for the protection and enhancement of the CTUIR’s First Foods. This vision document can be used to guide management plans and help inform policy.

### First Foods

Traditional foods of the CTUIR are referred to as the First Foods. Today, the First Foods are served at the Longhouse, the center of the CTUIR’s community. The serving order is

also practiced for feasts held out on the landscape and at people's homes. The First Foods include Water, Salmon, Big Game, Roots, and Berries. Each First Food represents a grouping of similar species (Figure 1, Table 1) – Salmon represent aquatic life forms (e.g. steelhead, lamprey, freshwater mussels, and various resident fish); Big Game represent large wildlife (e.g. mule deer, elk, bighorn sheep), Roots represents plant foods that are dug (e.g. biscuitroot, camas, bitterroot); Berries represents plant foods that are picked (e.g. huckleberry, chokecherry, golden currant). All meals begin and end with a drink of water, and the Foods are served in the same order at every meal. This order of presenting food in the Longhouse reflects the CTUIR's intimate connection to and ecologically informed view of the landscape (Quaempts 2008). The Cayuse, Umatilla and Walla Walla Tribes traditionally followed a seasonal round through their territory to obtain the food and resources essential to sustain life and for spiritual wellbeing (Hunn et al. 2015).

**Importance to CTUIR religion and culture**

In Tribal creation belief, in the time before people, the Creator gathered all the plants and animals and explained that there were going to be people and that they would be like infants and would need to learn about their new world. The Creator asked the plants and animals 'who will take care of the Indian people?' Salmon was the first to promise his knowledge and body, then other fish lined up behind salmon. Next came Deer and the other game animals, then *Cous* and other roots, then Huckleberry and all the other berries. In return, Indian people promised to respectfully harvest and care for the First Foods. The First Food serving ritual in the Longhouse is based on the order of the First Food promised themselves and serves as a reminder of the promise and people's reciprocal responsibility to respectfully use and take care of the foods. Embedded within this promise is that people need to harvest First Foods in order to fulfill their responsibility to the First Foods.

Many in the CTUIR, therefore, regard plants, like animals and other natural objects, to have a spirit and morality. For instance, the roots that are dug are 'persons' and you must treat them as you would treat an influential person, with respect and consideration for their feelings and needs. If you disrespect the *cous (Lomatium cous)*, it is offended, just as a

**Table 1.** A partial list of representative upland First Foods important to the Cayuse, Umatilla and Walla Walla tribes and the principal vegetation zones in which they are found.

Common Name	Scientific Name	Principal Vegetation Zone
<b>Big Game</b>		
Mule Deer	<i>Odocoileus hemionus</i>	All
Rocky Mountain Elk	<i>Cervis canadensis</i>	All
Bighorn Sheep	<i>Ovis canadensis</i>	Shrub-steppe
Whitetail Deer	<i>Odocoileus virginianus</i>	Riparian
Moose	<i>Alces alces</i>	Forest & Riparian
Pronghorn	<i>Antilocapra americana</i>	Shrub-steppe
<b>Roots (and celery)</b>		
Camas	<i>Camassia quamash</i>	Riparian & Shrub-steppe
Spring Beauty	<i>Claytonia lanceolata</i>	Dry Conifer Forest
Yellow Bell	<i>Fritillaria pudica</i>	Dry Conifer Forest
Bitterroot	<i>Lewisia rediviva</i>	Shrub-steppe
Desert Parsley	<i>Lomatium canbyi</i>	Shrub-steppe
Cous	<i>Lomatium cous</i>	Shrub-steppe
Spring Gold	<i>Lomatium grayi</i>	Shrub-steppe
Barestem Biscuitroot	<i>Lomatium nudicale</i>	Shrub-steppe
Yampa	<i>Perideridia gairdneri</i>	Shrub-steppe & Dry Conifer Forest
Wild Hyacinth	<i>Triteleia grandiflora</i>	Shrub-steppe & Dry Conifer Forest
<b>Berries</b>		
Serviceberry	<i>Amalanchier alnifolia</i>	Dry and Moist Conifer Forest
Black Hawthorn	<i>Crataegus douglasii</i>	Dry and Moist Conifer Forest
Chokecherry	<i>Prunus virginiana</i>	Dry and Moist Conifer Forest
Golden Current	<i>Ribes aureaum</i>	Riparian
Bigleaf Huckleberry	<i>Vaccinium membranaceum</i>	Moist Conifer Forest
Grouse Whortleberry	<i>Vaccinium scoparium</i>	Moist Conifer Forest

person might feel if disrespected. The consequences of such mistreatment are likewise analogous, the withdrawal of friendly contact, and exclusion from the web of mutual support. One's wellbeing literally depends upon maintaining good relations with your food and the ecosystem as a whole (Hunn 1990). In this system, you cannot just take what you want, that would be disrespectful.

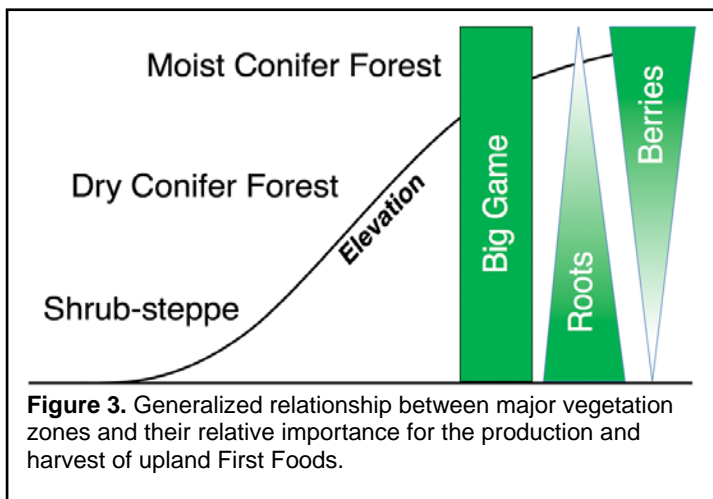
The longevity and constancy of the First Foods and serving rituals across generations, and their recognition through First Food ceremonies, demonstrate the cultural and nutritional value of First Foods to the CTUIR community. Though the means to locate, acquire, process and prepare First Foods have changed dramatically following Euro-American settlement, First Foods, their serving order, and ceremonies have remained constant. Moreover, First Foods have not been replaced in the serving ritual with new, readily-available introduced foods. For instance, introduced fish such as bass, or grains such as wheat, or fruit such as watermelon, have not replaced salmon, *cous* and huckleberry. When new foods are served at tribal meals, they are not recognized in the serving ritual; instead, they are served following the First Foods and with no formal order or sequence.

## Distribution, Use and Management

The ceded land of the CTUIR is a vast, heterogeneous landscape spanning a wide range of temperature, precipitation and soil gradients. This results in a diverse array of upland ecosystems, ranging from low elevation sagebrush-steppe to subalpine forest and grasslands. First Foods and other culturally important resources are found throughout this complex landscape, and their abundance and distribution is determined by the individual species' ecology and life history strategy, as well as current and historic land use patterns, management and disturbance regimes. In the most general terms, the First Foods serving order follows an elevation gradient, from lower elevation river, wetland and riparian systems (Water, Salmon), to higher elevation grassland (Roots) and forest (Berries), highlighting the importance of the entire landscape to support and produce the full array of First Foods (Figure 3). 'Big Game' occupy the full elevational gradient, with several species like mule deer, and elk seasonally migrating across ecosystems.

Since time immemorial, tribes of the CTUIR have managed this landscape to promote the production of First Foods and other important resources (Hunn et al. 2015, Lake et al. 2017). This is contrary to the modern-day concept of 'wilderness' and the long-held erroneous belief that pre-European landscapes were 'pristine' and 'untouched' landscapes (Anderson 2005, Diekmann et al. 2007). Moreover, traditional Native American wildland food and resource production systems have largely been described as 'hunter-gatherer' or 'forager' systems, which incorrectly implies a hand-to-mouth existence and a lack of long-term stewardship of the landscape or its resources. These beliefs have been shown to be wildly inaccurate (Johnson 1999, Anderson 2005, Deur 2009, Taylor et al. 2016, Lake et al. 2017), and Native American peoples, including the Tribes of the CTUIR actively managed landscapes for the sustained production of First Foods and other resources.

A wide range of management techniques were developed and utilized to manage natural resources across the landscape, including, but not limited to pruning, burning, sewing seeds following harvest, and coppicing. These management techniques were developed based on the collective knowledge of the natural world, acquired through hundreds of years of direct experience and contact with the environment. This is commonly referred to as Traditional Ecological Knowledge (TEK), and TEK-based stewardship has had a large and lasting impact on the structure, composition, diversity, and disturbance regimes of western landscapes, including the CTUIR ceded lands. This changed dramatically in the past 150-200 years, when Native American peoples were excluded from natural resource-decision making processes (Long and Lake 2018). Fire, in particular, was a key tool in natural resource stewardship utilized by the tribes of the CTUIR and across western North America (Lake et al. 2017); the exclusion of Native peoples and their extensive knowledge on the use of fire in natural resource stewardship



of western landscapes and the strong push to suppress fire across the landscape resulted in major changes to the structure, composition and function of many ecosystems (Taylor et al. 2016).

### Changes with Euro-American Settlement

Settlement of the CTUIR lands by Euro-Americans led to profound changes in First Food distribution, abundance and management. Large swaths of lower elevation areas dominated by Pacific Northwest bunchgrass and sagebrush steppe were settled by Euro-Americans and subsequently cultivated for agricultural production. This resulted in large reductions in the abundance of several First Foods, particularly for a number of roots (e.g. *Lomatium* spp.), while also reducing winter range habitat for elk and mule deer. Areas not converted to agricultural production have been exposed to decades of over-grazing by domestic livestock as well as the introduction of a non-native invasive plants such as annual bromes (*Bromus* spp.), North African bentgrass (*Ventenata dubia*), and medusahead (*Taeniatherum caput-medusae*). This has resulted in large alterations to grassland and shrubland composition, structure, and function (Johnson and Swanson 2005). At higher elevations dominated by ponderosa pine and mixed-conifer forests, large scale fire-suppression of both wildfires and Native American burning regimes across the landscape resulted in large changes in ecosystem structure, composition, and health. Historical forests were characterized by a diversity of successional stages, with a high proportion of relatively young stands (Odion et al. 2014, Taylor et al. 2016). This is much different than contemporary forests, which are characterized by reduced successional diversity, and the overabundance of dense, closed canopy mid- and late successional stands (Franklin et al. 2013).

The ability to harvest First Foods was further reduced by changes in land ownership which greatly impacted access to areas to dig, harvest and hunt. At the time of Treaty of 1855 signing, the CTUIR's ceded territory of 6.4 million acres, was



**Figure 4.** Roots are most abundant in lower elevation grassland and shrubland ecosystems (shrub-steppe vegetation zone). Roots are dug and celery (leaves and stems) are harvested spring through early summer. a) and b); harvest of bitterroot (*L. redivia*), c) digging bag and cupin, d) harvested cous (*L. cous*) and camas (*C. quamash*), e) cleaned bitterroot (*L. rediviva*) ready for boiling.

considered the core region for harvesting First Foods and other culturally important resources. This land base was *the minimum* amount of land need for the CTUIR’s ceremonial and subsistence needs. The CTUIR reservation boundaries of about 172,000 acres constitutes less than about 3% of the CTUIR’s 6.4 million acre of land that they had previously to the Treaty signing. The current land base is not large or ecologically diverse enough to provide the full array of First Foods resources. Privatization of land and agricultural development beyond reservation boundaries have also further reduced the CTUIR’s ability to access its traditional foods. Today, just 24% of the ceded territory are public land where Tribal members can exercise their treaty rights. While the CTUIR’s treaty guarantees the right of access, there is no guarantee that the Tribes’ First Foods and other culturally important resources will be present for them to harvest. Moreover, because the goals of state and federal land management agencies do not explicitly include management or stewardship for First Foods, it is the responsibility of the CTUIR to speak on behalf of the First Foods and engage public lands managers. This responsibility is part of the reciprocal relationship that the CTUIR has with their traditional foods and an acknowledgment that the First Foods are not only important for health, but also for cultural identity. Gathering traditional plant foods is an activity that is inextricably linked with the ceremonial and ritual life of the CTUIR and is essential for continued cultural identity and sovereignty.

**Implications for First Foods Management, Tribal Health and Cultural Traditions**

The myriad of changes that accompanied Euro-American settlement of CTUIR’s ceded territory affects the access, harvest and management of First Food resources by the CTUIR in four important ways: (1) a significant reduction in the amount of land area where Tribal members can exercise treaty rights, (2) in many areas still accessible, ecological conditions are outside of their historic range of variability; at some sites, degradation has resulted in local loss of First Food resources, (3) although the CTUIR manages First Food resources inside of the reservation boundaries, the reservation is not large enough and does not contain the variety of ecosystems required to provide all First Food resources, and (4) outside of reservation boundaries, but within their ceded lands, the CTUIR DNR is not the primary land manager and there are limited mechanisms by which the CTUIR is able to inform the decision-making process regarding land management issues that affect First Foods, a central component of the CTUIR culture and wellbeing. These factors as well as several others stemming from Euro-American settlement have fostered ‘socio-ecological traps’ that inhibit Tribes from continuing traditional land stewardship activities, such as managing for First Foods, that support the well-being



**Figure 5.** Huckleberry has been picked since time immemorial. The species dominates forest understories of many moist conifer forest stands and is also an important food source for wildlife.

of Tribal members, tribal sovereignty, and ecosystem health (Long and Lake 2018).

Barriers to access and use of First Foods can impact the health of the tribal community in a number of ways. Restricted access to harvesting areas could eliminate First Foods from the Longhouse, particularly if habitats supporting a First Food are rare and found only on private land. This is most problematic in lower elevation ecosystems including riparian, grassland and shrublands ecosystems. Additionally, habitat degradation and deviation from historical conditions can result in lower abundances and even local extirpation of certain First Foods requiring additional time and effort to access and harvest sufficient amounts of First Foods. Herbicide and pesticide application in wildland settings and along the agricultural-wildland interface may also affect health, as residue from these chemicals may remain on plant-based First Foods. Loss of traditional food resources exacerbates tribal health issues including poor fitness, diabetes, and other health challenges. Research has shown that the loss of traditional food resources is associated with lifestyle changes (e.g., increasing sedentary lifestyle while decreasing cultural-specific activities and food diversity) and health problems (increased diabetes, obesity, heart disease, etc.; Kuhnlein and Receveur 1996). Thus, ensuring abundant First Foods across the landscape and restoring tribal food resources is likely to benefit the health and culture of the tribal community by providing traditional food choices and promoting activities (e.g. hunting, digging, gathering, and fishing) that draw on tribal knowledge and skills.

Managing ecosystems and landscapes for First Foods is a cultural strategy of natural resource management. It incorporates spatial, temporal and phenological



**Figure 6.** Tiyá-po Farrow (white shirt) and Jace Ashley. Tiyá-po was hunting for the annual Children's Root Feast. Jace was brought along to learn from Tiyá-po and the other hunters. Tiyá-po was the lead hunter for the feast. The Children's Root Feast is a ceremonial event to recognize new food (root) gatherers. A traditional meal, with some of the roots gathered by the children, are eaten at the meal. Tiyá-po had his first kill ceremony when he was 9 years old. At that ceremony he was recognized as a provider of that First Food for his family and tribal community. Photo by T. Farrow Ferman.



considerations because resources are used throughout the landscape and year based on availability and seasonality. It also integrates natural resources management with tribal resource needs. The longevity and constancy of the First Foods ritual at tribal ceremonies underscores their importance to the tribal community and highlights the strong connections between cultural traditions and ecosystem health across the landscape. Additionally, First Foods may provide an appropriate context in which to evaluate habitat management and restoration progress to the tribal community. In fact, each First Food and its grouping could be considered a potential unit for reporting metrics such as abundance, distribution, restoration efforts, restoration achievements, and policy and regulatory mechanisms. Ultimately, the most direct and culturally appropriate indication of the CTUIR DNR's progress is measured by the CTUIR community's continued ability to access, harvest, process, preserve, and share First Foods at the Longhouse and in their homes.

### **Upland Ecosystems (Touchstones)**

The availability and long-term production of First Foods in the uplands throughout ceded lands requires healthy, functional ecosystems. Healthy ecosystems maintain their full array of ecosystem services, which are the benefits supplied to society by natural ecosystems (Alcamo et al. 2003, Chapin et al. 2011). The Millennium Ecosystem Assessment (Alcamo et al. 2003) categorized ecosystem services into four groups: (1)

Provisioning Services, which are goods or products that people can use directly, such as fresh water, fiber, wood, genetic resources, medicine and food, including First Foods; (2) Regulating Services, which includes processes such as climate regulation, disease and pest regulation, pollination, erosion control, flood regulation, and water filtration; (3) Cultural Services which encompass non-material benefits such as cultural identity and heritage, spiritual, inspirational and aesthetic benefits, recreation, and tourism; and (4) Supporting Services, which are necessary for the production of all the other services and include maintenance of soil resources, water cycling, carbon and nutrient cycling, maintenance of disturbance regimes and biological diversity. This section provides a general framework centered around four primary ecological components or touchstones, associated with healthy upland ecosystems that provide their full array of ecosystem services, including the continued natural production of First Foods for utilization by the CTUIR community. These touchstones are 1) *Soil Stability*, 2) *Hydrologic Function*, 3) *Landscape Pattern* and 4) *Biotic Integrity* (Table 2). These touchstones support the maintenance of ecosystems, species, and associated ecological processes and interactions within their natural ranges of variability (Poiani et al. 2000). Because the touchstones are interrelated, they must be considered in concert with respect to First Foods production, restoration and management.

**Table 2.** Ecological touchstones (Soil Stability, Hydrological Function, Landscape Pattern, Biotic Integrity) and key attributes that support the maintenance of ecosystems, species and associated ecological processes and interactions, including First Foods.

Soil Stability	Hydrological Function	Landscape Pattern	Biotic Integrity
<ul style="list-style-type: none"> <li>Physical</li> <li>Chemical</li> <li>Biological</li> </ul>	<ul style="list-style-type: none"> <li>Water capture</li> <li>Water storage</li> <li>Water release</li> <li>Water quality</li> </ul>	<ul style="list-style-type: none"> <li>Patch size and extent</li> <li>Heterogeneity</li> <li>Arrangement</li> <li>Connectivity</li> </ul>	<ul style="list-style-type: none"> <li>Composition</li> <li>Structure</li> <li>Species interactions</li> <li>First Foods</li> </ul>

### Soil Stability

Soil stability refers to the capacity of a site to stabilize and maintain soil structure and resources (soil, nutrients, organic matter, water) which are critical to support living communities (Pellant et. al, 2005). Stable soils promote and support soil health which is the continued capacity of soil to function as a vital living ecosystem sustaining plants, animals and humans (USDA NRCS 2018). The importance of physical (depth, texture, structure, organic matter, bulk density, porosity, water holding capacity, etc.), chemical (pH, cation exchange capacity, available nutrients, etc.), and biological properties (biotic crust, fungi, bacteria and other microfauna, etc.) to soil stability and health is well documented (Faist et al. 2017) and a range of indicators have been developed to assess and evaluate soil stability, health and function (Pellant et al. 2005). Many of these indicators are also utilized to evaluate hydrologic function (below).

Baseline soil properties of an area are greatly influenced by physical factors such as climate, hydrology, geology, substrate and physiographic features (slope, aspect, elevation, topographic position, etc.). Due to the wide range in physical conditions throughout the ceded land of the CTUIR, the physical, chemical and biological properties of soil, their capacity to support plant and animal productivity, including First Foods, varies substantially from site to site across the landscape. Biological factors (e.g. plant species occurrence, composition, production, species interactions), disturbances (e.g. fire regimes, timber harvest, invasive species, drought) and land management activities (e.g. livestock grazing, prescribed fire) also affects soil stability by altering physical, chemical and/or biological properties of the soil (Whisenant 1999, Wilcox et al. 2017).

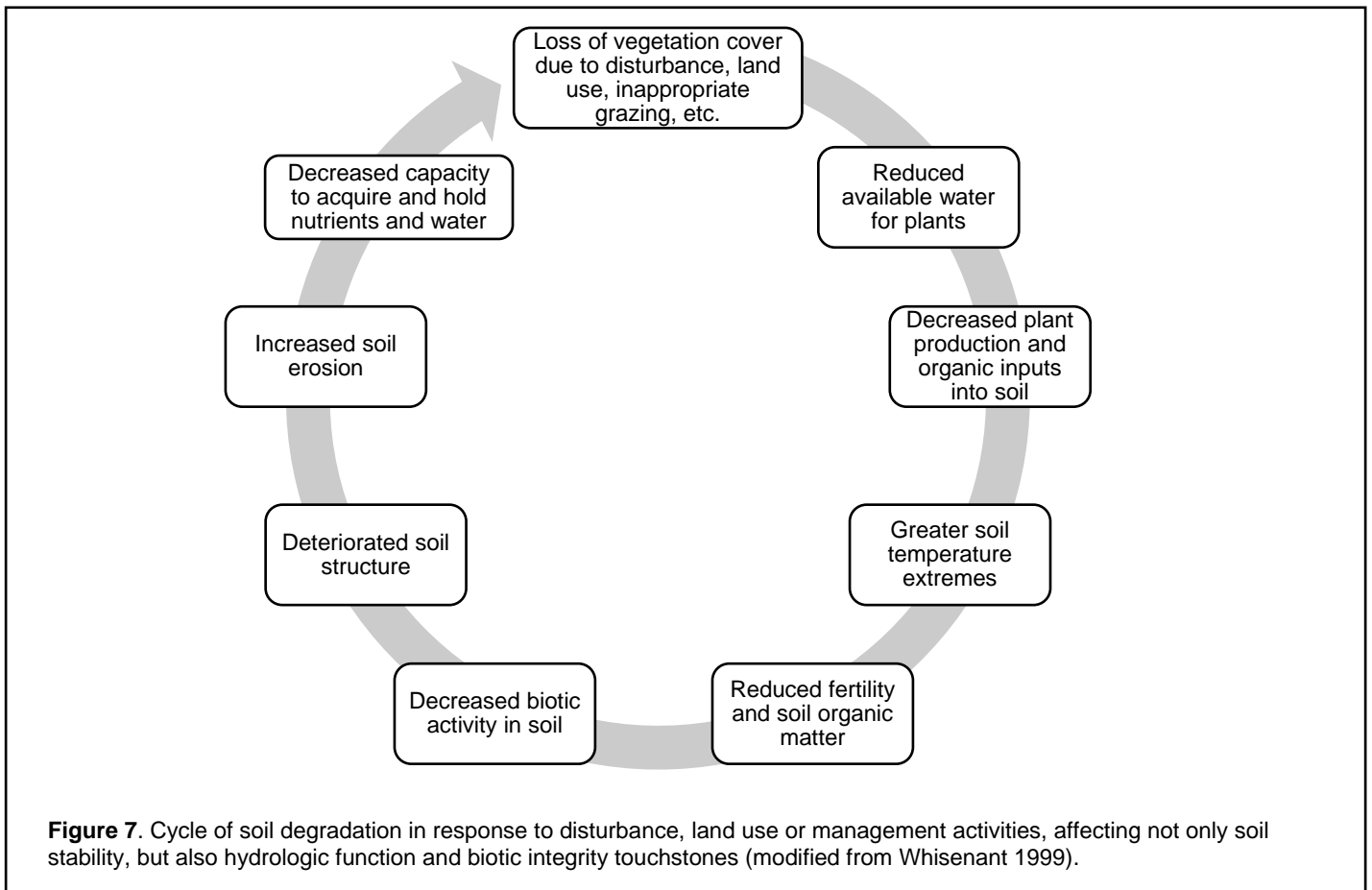
Maintaining soil stability is an important management issue because of its role influencing numerous ecological patterns and processes necessary for the production of ecosystems services including First Foods. These include biodiversity, vegetation production, cover and composition, nutrient and water cycling (acquisition, storage, release) and more (Evans et al. 2017). Land use and management activities that negatively affect soil properties can create feedback loops that support continued degradation of the site and multiple ecological touchstones (Figure 7). For example, water infiltration rates into soil are directly linked to management practices and disturbances (grazing systems, fire, shrub

management, invasive species) that alter soil structure and vegetation cover (e.g. compaction, loss of biological soil crusts, type of vegetation; Pierson et al. 2011, Belnap et al. 2013, Wilcox et al. 2017). Water that does not infiltrate into the soil leaves a site via overland flow, not only reducing the water available for vegetation uptake or groundwater recharge, but also contributing to soil erosion, further affecting soil stability, health, and productivity, and ultimately First Foods production.

### Hydrologic Function

This refers to the capacity of an area to (1) capture, store, and safely release water from precipitation and run-on from adjacent areas, (2) to resist reductions in this capacity and recover following disturbance events (resistance and resilience), and (3) the ability of a site to process and filter nutrients, sediments, and pollutants as water moves through upland ecosystems into streams and rivers. Baseline hydrologic capacity and function of a site is a product of climatic, geological and physiographic attributes (slope, aspect, substrate type, soil depth, etc.). Additionally, hydrologic function is closely tied to soil stability and vegetation structure and cover (Biotic Integrity). These factors influence hydrologic function by affecting whether water infiltrates into the soil or becomes overland flow, and whether water entering the soil drains out of the root zone, is absorbed by plants, or is lost to evaporation from the soil surface (Wilcox et al. 2017). This has implications to First Foods production as hydrologic function greatly affects water availability for plants, and the capacity of site to support food webs and all trophic levels.

How upland ecosystems are managed, particularly with respect to their surface cover, greatly influences hydrologic function. In general, vegetative cover, biological soil crusts and soil organic matter promote infiltration of water into the soil (Whisenant 1999, Snyman and du Preez 2005). The rooting depth of plant species on a site also influences whether water drains out of the root zone, whether soil water evaporates, or is absorbed and used by plants. Land management and disturbance regimes can affect this by influencing the species composition, structure, and diversity of a site (biotic integrity). For example, degraded shrub-steppe ecosystems dominated by shallow-rooted non-native annual grass species have a much-reduced rooting profile than intact areas dominated by a mix of shrubs, perennial



bunchgrass and forb species, whose rooting profile is deeper and multi-layered which allows for greater water capture by plants. Increased shading of the soil surface by vegetation as well as the presence of biological soil crusts, litter and soil organic matter may also reduce soil evaporation rates from the soil surface. Damage to soil due to inappropriate management can also affect water quality. As water infiltration into the soil is reduced from loss of vegetation, roots, overland flow increases, reducing water quality, by increasing sedimentation rates into nearby stream and riparian ecosystems.

### Landscape Pattern

This refers to spatial arrangement, or pattern, of ecosystems across the landscape. Spatial heterogeneity within and among ecosystems across the landscape affects the functioning of individual ecosystems, their component parts, and the ecological services they provide. Landscapes can be described as a mosaic of 'patches' that differ in their ecological properties, including their structure, composition and function (e.g. Ponderosa pine stand, camas meadow; Chapin et al. 2011). The size, shape and spatial arrangement of patches influences the ecological functioning of each individual patch, as well as interactions among patches, and the behavior and functioning of the entire landscape (Turner 1989, Chapin et al. 2011). Landscape pattern is principally

driven by spatial variation in (1) abiotic and environmental factors (e.g. topography, substrate/soil characteristics, slope, aspect, temperature, precipitation), (2) interactions between dominant plant species and disturbance events (fire, insect outbreak, etc.), and (3) land use and management activities.

Landscape factors that affect ecological patterns and processes include patch size, patch shape, and the spatial configuration and connectivity of patches. Patch size influences habitat heterogeneity and biotic integrity. For example, larger patches have greater internal heterogeneity than smaller patches, and as a result contain greater species richness and diversity. Together, patch size and shape determines the ratio of edge to interior habitat, which can affect the habitat suitability of different species. Patches with a large proportion of edge habitat (e.g. small, narrow patches) are heavily influenced by the adjacent patches, while large patches, with more interior habitat are less influenced by their neighbors. This can have important implications for ecosystem structure, composition and function. For example, small remnants of shrub-steppe surrounded by dryland farms, support fewer species and are much more susceptible to invasion by non-native invasive plants, as compared to large intact habitats.

The configuration, or spatial arrangement of patches across a landscape is also important because it determines the degree to which patches interact. Spatial configuration, in concert with the size and shape of patches, influences the connectivity among patches. This dictates the movement and exchange of organisms across the landscape (e.g. migration, geneflow, dispersal, colonization) and can greatly affect species population dynamics (Mittelbach 2012, Primack 2012). Patch size, shape, configuration and connectivity can also influence the movement and spread of disturbances across the landscape including fire, insect outbreaks, and disease. Land use activities and management, both past and present greatly influence landscape pattern, and subsequent ecological functioning. Within ceded lands of the CTUIR, habitat reduction and fragmentation, the creation of barriers (e.g. roads) across important wildlife migratory routes, increased forest stand homogeneity due to fire suppression, and loss of winter range for wildlife are some of major changes to landscape pattern since Euro-American settlement.

### **Biotic Integrity**

Biotic integrity is the ability of the biotic community to support ecological processes and interactions within the historic range of variability; this supports ecosystem resistance and resilience following disturbance events and promotes the long-term production of ecosystem services, including First Foods. In general, healthy functioning ecosystems rely on biota to control primary processes (capture, storage and release of water, nutrients and energy) and are able to ‘self-repair’ or recover following disturbance events (Whisenant 1999, McDonald et al. 2016). Therefore, biotic integrity is a critical touchstone that affects, and is affected by, the other touchstones (soil stability, hydrologic function and landscape pattern). Key components of biotic integrity include species composition, richness, diversity and structure. These are necessary to support critical ecological processes and interactions including seed dispersal, pollination, mutualisms, food webs, and trophic cascades, in addition to being important for the sustained production of ecological services, including First Foods.

Loss of First Food species can occur directly as a result of particular disturbances or land use activities (e.g. cultivation, over-hunting, improper management or use). Changes in ecosystem structure, or disruption of species interactions can also result in major reductions in First Food availability indirectly by altering ecosystem structure and dynamics in ways that reduce their abundance and population dynamics. For example, fire suppression in huckleberry-dominated moist conifer forests increases the density of overstory conifers and reduces canopy openness. This change in forest structure reduces light availability in the understory which in turn can reduce the abundance and fruit production (Holloway and Endress 2018). Upland food webs and species



**Figure 8.** Key components of biotic integrity include species composition (richness, diversity), structural complexity and species interactions (food webs, pollination, etc.). This supports the ability of ecosystems to maintain their full array of ecosystem services, including the production of First Foods. Photo by E.J. Quaempts.

interactions are critical to the sustained production of ecosystem services because of their role in “supporting services” such as primary productivity, carbon storage, and the cycling of nutrients and water.

### **Upland Vision**

Our vision for upland landscapes is to ensure healthy, resilient and dynamic upland ecosystems capable of providing First Foods that sustain the continuity of the Tribe’s culture. The four touchstones described above support the maintenance of ecosystems, species and associated ecological processes and interactions necessary to achieve this vision. Because the production of First Foods is tied to soil stability, hydrologic function, landscape pattern and biotic integrity, the Upland Vision must address attributes of each of these touchstones. The uplands of CTUIR ceded lands are incredibly diverse, spanning multiple ecoregions, and

hundreds of vegetation communities and plant associations have been defined (Johnson and Simon 1987, Johnson 2004, Powell 2017).

Biophysical characteristics, disturbance regimes, historic and contemporary land use and management activities, alterations since Euro-American settlement and the presence, abundance and distribution of First Foods vary widely across this heterogenous landscape.

This makes it difficult to generalize and identify key touchstone attributes, ecological processes and critical management issues that are uniformly relevant across all upland environments. Here, we focus on three broadly-defined, widely-distributed vegetation zones that cover the majority of the CTUIR ceded lands: Shrub-Steppe, Dry Conifer Forest, Moist Conifer Forest. For each, we will highlight alterations to touchstones since Euro-American settlement and discuss and identify key attributes, and issues relevant to the harvest, management and restoration of First Foods within this upland vision framework.

It is important to recognize that within each of the broad vegetation zones discussed below, there exists a wide range of ecological and biophysical conditions, and numerous other ecosystems and plant community types exist within the CTUIR ceded lands (aspen stands, alpine/subalpine grasslands, etc.). While it is not within the scope of this document to specifically address each in depth, the upland vision framework and focus on touchstone attributes remains applicable to these systems.

### Shrub-Steppe

Shrub-steppe covers a large portion of the CTUIR-ceded lands across the Columbia Plateau, Blue Mountains, and Snake River Plain ecoregions. Climatically, shrub-steppe occupies arid to semi-arid areas, with hot, dry summers, and cold winters (Franklin and Dyrness 1988). Shrub-steppe communities span a large elevation range and vary from shrub-dominated (e.g. sagebrush species, rabbitbrush) to bunchgrass-dominated (e.g. Idaho fescue, bluebunch wheatgrass, Sandberg's bluegrass) with a diverse native forb component (e.g. biscuitroot, bitterroot, mule's ears). For purposes on this document, vegetation classified as Pacific Northwest Bunchgrass (Johnson and Simon 1987, Johnson and Swanson 2005) are included within the shrub-steppe vegetation zone. Variation and species composition is strongly influenced by abiotic factors (temperature, precipitation, elevation, slope, aspect, soil properties, water availability, etc.), in addition to land use, management and disturbance regimes that have changed dramatically since Euro-American settlement (Johnson and Swanson 2005). Of the broad upland ecosystem types within the CTUIR-ceded lands, shrub-steppe is the most heavily altered since Euro-American settlement. This has affected the production of a wide range of ecosystem services, including First Food



**Figure 9.** Photograph from 1915 depicting extensive soil disturbance and degradation in the North Fork John Day Ranger District, Umatilla National Forest (Kellogg, 1915).

abundance, by altering touchstone attributes in significant ways. It is important to stress the interconnectedness of the touchstones, and alterations to one have implications for the others. The primary drivers of altered touchstones in shrub-steppe include: (1) the introduction of livestock and decades of overgrazing, (2) invasion by non-native plant species, (3) changes in fire regimes, and (4) the conversion of large areas of shrub-steppe to cropland.

**Alterations to Soil Stability—** As Euro-Americans settled the region, they brought herds of livestock, first with large numbers of cattle in the 1860's and 1870's whose numbers peaked at the turn of the nineteenth century, followed by sheep, whose numbers peaked in the 1930s and 1940s (Galbraith and Anderson 1971, Reid et al. 1991, Johnson 2004). High stocking rates and decades of overgrazing by domestic livestock (sheep, horses, cattle) led to degradation of soil across the region, including soil loss, degradation of biological soil crusts, reduced water infiltration into the soil, soil compaction, declines in soil organic matter, and nutrient depletion. Some sites in eastern Oregon lost as much as 6-10 inches of topsoil (Reid et al. 1991; Figure 9). Damage to soil structure and health resulted in long-term loss of productivity. Changes to grazing systems and lower stocking densities of livestock since the 1950s have improved the situation, with many areas in a state of recovery, though it is unclear if or when some areas will ever recover to pre-settlement productivity (Johnson and Swanson 2005). The introduction and spread of non-native plant species, particularly annual grass species exacerbated the effects of overgrazing by quickly colonizing disturbed areas. Invasion of shrub-steppe by non-native annual grasses such as annual bromes (*Bromus tectorum*, *B. arvensis*, *B. hordeaceus*, etc.),

ventenata (*Ventenata dubia*), and medusa-head (*Taeniatherum caput-medusae*) altered fire frequency and intensity, particularly in low-elevation areas. This resulted in larger, more intense and frequent wildfires that eliminate fire-intolerant shrubs and further increasing bare ground, susceptibility to erosion, and loss of biological soil crust. Inappropriate grazing, increasing fire frequency and intensity and other disturbances facilitate feedback loops that support continued degradation of not only soil stability and health but also hydrological function and biotic integrity touchstones (Figure 7).

**Alterations to Hydrologic Function**— Alterations to hydrological function accompanied the loss of vegetative cover and reduced soil stability caused by improper grazing, changing fire regimes, and increased dominance of non-native annual grasses. The magnitude, scope and scale of changes to hydrologic function depend on the degree to which vegetation, soil stability and disturbance regimes were altered. Areas heavily overgrazed and/or with frequent fire return intervals show reduced capacity to absorb and hold water which lowers water availability to plants and reduced biotic activity in the soil which in turn facilitates further alterations to soil stability and biotic integrity touchstones (Norris 1990, McNabb and Swanson 1990). Indicators of reduced hydrologic function include the presence of pedestals, terracettes, gullies and bareground (Pellant et al. 2005) and declines in function tend to be exacerbated on steep slopes. At higher elevations within the shrub-steppe ecosystem, fire suppression efforts that began in the early twentieth century changed hydrologic function in other ways. In the absence of fire, western juniper has increased over tenfold and shrub-steppe ecosystems have been transitioning into juniper woodlands. Juniper encroachment into high elevation shrub-steppe results in reduced understory vegetation and the creation of extensive bareground in the intercanopy (Pierson et al. 2013). Change in vegetation and cover reduce infiltration of rainfall and promote overland flow during precipitation events, reducing water availability and increasing soil erosion rates (Pierson and Williams 2016).

**Alterations to Biotic Integrity**— Change in land use and management have altered species abundance, structure, composition, and species interactions, resulting in profound changes to biotic integrity including the availability and abundance of First Foods. Across much of the shrub-steppe, the abundance of native perennial grass, forb, and shrub

species have declined as a result of the combination of improper grazing, non-native species introductions, and changing fire regimes that facilitated the dominance of non-native plant species and/or the establishment of juniper. Changes in vegetation structure, composition, and diversity in addition to loss of habitat due and landscape fragmentation also affected a wide range of wildlife by altering habitat, food resources, and migratory routes, resulting in declining numbers of many species.

**Alterations to Landscape Pattern**—Vast areas of shrub-steppe, particularly in areas with deeper soils have been converted into cropland. Large areas of shrub-steppe within the CTUIR-ceded lands, particularly in the Columbia Plateau and Snake River Plain ecoregions was plowed and shrub-steppe is now fragmented with small patches of native vegetation isolated and embedded within a landscape dominated by irrigated and dryland fields with few corridors that connect isolated patches (Figure 10). These remnant patches are highly susceptible to invasion by non-native species and tend to have low species richness and diversity affecting their biotic integrity. Fewer changes in landscape pattern are evident in areas not as heavily impacted by cultivation. However, roads bisect the region, which affect migration routes of wildlife, particularly species who use lower elevation shrub-steppe as winter range (e.g. elk, deer). In recent years, wind energy developments have expanded, and the turbines and associated infrastructure (pads, roads, etc.) have increased landscape fragmentation and reduced connectivity. Additionally, changes in fire regimes have altered landscape pattern of remaining shrub-steppe



**Figure 10.** Large portions of shrub-steppe have been converted to cropland reducing the extent of shrub-steppe vegetation and altering landscape pattern.

ecosystems. Prior to Euro-American settlement, it is though the historic fire regime primarily consisted of small, high intensity fires at an interval of 30-80 years which created a heterogeneous landscape with patches of shrub-steppe dominated by different species and in various stages of recovery (Brown and Smith 2000). As fire return intervals have shortened and the size of fires increased, structural and species complexity of shrub-steppe has been simplified and large areas are dominated by non-native invasive grass and forb species affecting biotic integrity of the system.

### Shrub-Steppe: Implications for First Foods

**Water and Salmon**—The two First Food groups of “Water” and “Salmon” are the primary focus of the Umatilla River Vision (Jones et al. 2008) and are discussed in depth within that document. However, it is important to consider how management of shrub-steppe affects both of these First Foods groups. Of primary concern is increased surface runoff and sedimentation caused by damage to the four touchstones, particularly soil stability and hydrologic function. Improper grazing, changes in fire regimes, loss or removal of woody species, and conversion of large areas to non-native annual grasses can increase surface runoff and sedimentation into rivers and streams (Brooks et al. 2013) affecting water quality and fish habitat (Megahan et al. 1992, Waters 1995, Wood and Armitage 1997). In particular, fire can affect soil stability, hydrologic function, and biotic integrity resulting in amplified overland flow (runoff) and erosion which can enter and impact streams and rivers. Effects are greatest in situations where fire increased bareground cover over 50-60% on slopes >15% (Pierson et al. 2008, 2011, 2013). Therefore, within shrub-steppe ecosystems, supporting ecological attributes and processes that maintain soil stability and hydrologic function will help support the sustained production of Water and Salmon. Management and restoration actions that support functional shrub-steppe communities with respect to Water and Salmon include the maintenance and establishment of native plant assemblages and biological soil crusts, which stabilizes soil, protects the soil surface, and supports the capture, storage and release of water at rates within a sites natural range of variability.

**Big Game**—Numerous species including, mule deer, rocky mountain elk, whitetail deer, bighorn sheep and more inhabit the shrub-steppe vegetation zone. Since Euro-American settlement, changes to biotic integrity and landscape pattern have affected these First Foods in two principle ways. First, reductions in native perennial plants and the conversion of large areas of native vegetation to non-native annual grasslands have reduced forage quantity and quality in many areas (Johnson and Swanson 2005). This in turn, may affect the health and functioning of adjacent riparian ecosystems (and associated First Foods) by increasing browse pressure on riparian vegetation, particularly woody shrubs and trees that are important for Salmon. Second, habitat loss due to the conversion of shrub-steppe to cropland and subsequent



**Figure 11.** Recovery of upland native vegetation at the Southern Cross property, near Union, Oregon. Decades of over-grazing by livestock and subsequent non-native species invasions have altered touchstones in shrub-steppe ecosystems throughout the region, reducing First Foods resources. However, with proper management, many of these areas can recover. Photo by B.A. Endress.

fragmentation of the landscape not only reduced the amount of available habitat, but also has impeded and altered the movement and migratory routes. Healthy, functional ecosystems will support sufficient quantity and quality of forage, habitat elements that provide cover, and corridors and connections across the landscape to allow for the movement of species across the landscape to ensure healthy populations of species now and into the future.

**Roots**— Shrub-steppe is the most important vegetation zone for the production of Roots across the landscape. Cous (*L. cous*), bitterroot (*L. rediviva*), wild onions (*Allium* spp.), wild hyacinth (*T. grandiflora*), camas (*C. quamash*), celery (*Lomatium* spp.) and many other First Foods are found throughout this zone. The natural history and ecology of most of these species is poorly documented, making it difficult unequivocally state how alterations to the four touchstones directly affect these First Foods or to develop evidence-based



**Figure 12.** Bighorn Sheep and other big game (mule deer, elk, etc.) rely on healthy shrub-steppe vegetation to provide high quality forage. Shrub-steppe is particularly important for big game in the winter when many species migrate to these lower elevation areas in search of forage. Photo by E.J. Quempt.

management and restoration plans to support their productivity. For example, little is known about how fire, invasive species, or herbivory by domestic livestock or wild ungulates affects abundance, distribution or population dynamics of many of these species. Prior to Euro-American settlement, members of the CTUIR frequently burned shrub-steppe as part of their management of First Foods (Oral History Interview #224), indicating that many of these species are likely fire tolerant of low severity fires. As non-native species have invaded many shrub-steppe areas, fires are thought to have increased in severity, and responses of roots to these altered fire regimes is unknown. Non-native plants species such as *venenata*, annual bromes and medusahead are thought to displace and outcompete native species, though no research has shown this to be the case with respect to these species. Herbivory by livestock and wild ungulates may also impact root production. Elk, deer, and cattle have been observed to browse many of these species (e.g. camas) in late spring and early summer, and future research should explore the potential impacts of domestic and wild ungulates in affecting the abundance and population dynamics of Root species. Alterations to landscape pattern (loss and fragmentation of habitat) and biotic integrity (reduction in perennial bunchgrasses and other forage species) may increase browse pressure on roots with potential consequences on Root abundance and production. Livestock grazing also likely increases pressure on these species in late spring to early summer. Research on the natural history, distribution, ecology, and management of these species is critically important in order to more fully inform management and restoration activities.

Another challenge to the management of Roots is that inventory and abundance data related to many of these species is not widely available and can be difficult to acquire as most of these species are spring ephemerals. That is, they

grow, flower, and then senesce in the spring and early summer. By mid-summer all above-ground evidence of their presence may be gone, making it difficult at times to properly determine their presence and abundance. Therefore, assessments and surveys for these roots must be conducted early in the growing season (~March to mid-June). Despite uncertainties with respect to the ecology and management of Roots, land managers and decision makers can support continued production and availability of these First Foods by supporting and enhancing the key attributes of the four touchstones within their natural ranges of variability.

**Berries**— Shrub-steppe ecosystems do not contain large abundances or types of Berries. However, a number of species occur here, often at the ecotone between shrub-steppe and other vegetation zones (e.g. riparian areas). Some of the more common berry-producing species include serviceberry (*Amalanchier alnifolia*), black hawthorn (*Crataegus douglasii*) and chokecherry (*Prunus virginiana*). Species are most abundant ravines, draws and gullies where sufficient soil moisture and water availability supports their occurrence. It is important to note that many of these First Food species are also important forage for livestock and big game, and fruit from these species are consumed by a wide range of wildlife (e.g. birds, small mammals). In some areas with high densities of domestic livestock (horses, cattle) and/or wild ungulates (elk and deer) and a limited forage base (caused by dominance of non-native plants and habitat fragmentation), heavy browse pressure, particularly in late fall and winter, may reduce fruit production and availability as well as seedling recruitment. Functional shrub-steppe ecosystems then, are dependent on sufficient fruit production, seed dispersal and seedling establishment to ensure stable populations of these species.





**Figure 13.** A meadow of wild onions (*Allium* spp.) and other Roots near Mission, Oregon. Photo by E.J. Quaempts.

### **Dry Conifer Forests**

Dry conifer forest ecosystems are dominated by ponderosa pine and associated conifer species (Table 3), and generally occupy low to mid-elevations that are moisture limited with frequent fire events (Franklin and Dyrness 1988, Franklin et al. 2013). A number of different forest classification systems exist for dry forests that encompass CTUIR-ceded lands (Powell 2007, Franklin and Johnson 2012, Franklin et al. 2013, Powell 2017). For purposes of this document, dry forests refer to ponderosa pine and dry mixed-conifer forest stands as described by Franklin et al. 2013, which generally fall within the “Dry Upland Forest” described by Powell (2017; please refer to both Franklin et al. 2013 and Powell 2017 for specifics). Dry forest landscapes often include and are inter-mixed with grasslands (e.g. meadows, scab-flats, Pacific Northwest bunchgrass). These will be briefly discussed in this section; however, land use history, alterations to touchstones, common First Foods and their management are addressed in the shrub-steppe section (above).

Dry Forests have undergone a myriad of changes since Euro-American settlement, the most significant of which has been altered fire regimes. Prior to Euro-American settlement, fires in dry forests were primarily low severity, as frequent Native American prescribed fires reduced fuel loads and moderated the intensity and extent of wildfires (Taylor et al. 2016). Mixed-severity and high severity fires also occurred in dry forests, but to a lesser extent. When Native peoples were excluded from natural resource management activities and fire suppression became a primary management objective, fire regimes changed dramatically, affecting touchstone attributes. Other factors that have altered touchstones in dry forests include timber harvest, livestock grazing and the introduction of non-native species. Of the four touchstones, biotic integrity has been the most altered since Euro-American settlement, particularly in terms of forest composition and structure.

**Alterations to Soil Stability**— As noted above, fires regimes (size, frequency, severity) changed dramatically following Euro-American settlement. Fire affects soil stability and

**Table 3.** Common trees of dry conifer forests within CTUIR-ceded lands and some of their ecological attributes (Modified from Franklin et al. 2013).

Common Name	Species	Drought Resistance	Wildfire Resistance	Bark Beetle Risk	Climate Adapted?
Ponderosa pine	<i>Pinus ponderosa</i>	High	High	Moderate	Yes
Douglas-fir	<i>Pseudotsuga menziesii</i>	Moderate	Moderate	Moderate	Moderate
Western larch	<i>Larix occidentalis</i>	Moderate	High	Low	Yes
Grand (white) fir	<i>Abies grandis</i>	Low	Low	Moderate	No

health in a number of ways, including disrupting nutrient cycling, reducing biotic activity in the soil, increasing soil erosion, and reducing water infiltration into the soil (Norris 1990, McNabb and Swanson 1990, McNabb and Cromack 1990). The magnitude of fire impacts to soil attributes depends primarily on fire frequency and severity. Fire suppression, which began in the early 1900's resulted in increased stand density, fuel loads, and the abundance of fire intolerant species (e.g. grand-fir) within forest stands. As a result, fire regimes have changed from predominantly small, frequent, low-severity fires, to large, infrequent, high severity fires (Franklin et al. 2013). This alters soil attributes as increased fire severity reduces nutrients (especially nitrogen; McNabb and Cromack 1990), organic matter (Beschta 1990) and soil microorganisms (fungi, bacteria, etc.; Borchers and Perry 1990). Increased fire severity also increases injury and mortality rates of plants, whose roots help stabilize soil and prevent erosion. Alterations to soil stability attributes in turn affect other touchstones, principally hydrologic function and biotic integrity. Soil disturbance associated with timber harvest (e.g. roads, skid trails, landings) particularly on steep slopes, also affect soil stability by increasing erosion and negatively affecting hydrologic function, most notably water quality (Brooks et al. 2011).

**Alterations to Hydrologic Function**— The structure and composition of forests and hydrologic function across the landscape are intrinsically connected (Brooks et al. 2013). Increased tree density and canopy cover of dry forests due to changes in land management that accompanied Euro-American settlement can alter patterns of water capture, storage and release in addition to affecting water quality. While specific data is lacking for the dry conifer forests of the region, increased tree cover is associated with increased canopy interception and evapotranspiration, resulting in declines in water yield (Ahl and Woods 2006, Brooks et al. 2013). Fire and other disturbance agents that reduce tree cover (e.g. timber harvest) have been shown to increase water yield in the short-term, though as the size and severity of disturbance events increases, increased damage to soil stability occurs, reducing water infiltration, promoting overland flow (erosion) and increasing sedimentation and reduced water quality (Beschta 1990, Brooks et al. 2013).

**Alterations to Landscape Pattern**— Alterations to landscape pattern since Euro-American settlement, while not as readily visible as in the shrub-steppe, have been significant. The primary drivers of changes to landscape pattern have been

timber harvest and altered fire regimes, which have affected three key landscape attributes. First, there has been a loss of spatial heterogeneity. Historically, the dry forest ecosystems were an uneven-aged mosaic of isolated trees, tree clusters, and forest openings including varied spatial arrangements and a diversity of structural characteristics (Larson and Churchill 2012, Franklin et al. 2013). This heterogeneity is integral to the function of dry forest landscapes and the production of ecosystem services including First Foods. Second, the loss of heterogeneity, increased connectivity of forest stands across the landscape. With fire suppression, increased connectivity of dense forest stands (beyond historic ranges of variation) increased the number of large stand-replacing fires, which were historically rare (Franklin and Agee 2003, Odion et al. 2014). Third, decades of timber harvest focused on large, drought tolerate species (e.g. Ponderosa pine); this eliminated or severely reduced large old-growth ponderosa pine stands, which are considered a key component to dry forest ecosystem resistance and resilience as well as ecosystem function (Henjum et al. 1994, Wisdom et al. 2000). These alterations have result in a landscape with a disproportionately large amount of forest stands that are either mid- or late successional closed canopy forest, while old growth open canopy forest stands are underrepresented (USDA Forest Service, Eastside Restoration report 2013). Alterations to landscape pattern have in turn, led to and contributed to alterations to biotic integrity (below).

**Alterations to Biotic Integrity**—Attributes of biotic integrity have changed substantially since Euro-American settlement. In terms of structure and composition, the combination of fire suppression and harvest of large, old-growth trees, resulted (1) increased tree densities, (2) increased abundances of less fire-tolerant species such as grand-fir, and (3) altered stand structure, with fewer large drought and fire tolerant individuals (e.g. ponderosa pine, western larch) and high densities of small, fire-intolerant species. These changes increased fuel loading of forest stands which increases the probability of large, high severity stand replacing fires. Additionally, increased tree densities increase competitive interactions among trees resulting in increased stress to drought, pathogens, bark beetle infestations and other disturbances resulting in losses of mature trees faster than they can be replaced (Lutz et al. 2009, Spies et al. 2011, Franklin et al. 2013). Finally, the loss of stand heterogeneity, particularly the loss of open, old growth stands affects wildlife species by eliminating important habitat elements



**Figure 14.** Ensuring connectivity between ecosystems is critical for big game that cross large elevation gradients each year in search of forage and cover. Here a herd of elk at the interface between shrub-steppe and dry conifer forest zones. Photo by E.J. Quampts.

and reducing understory vegetation (forage). This homogenization of dry conifer forest structure and composition reduces biodiversity and negatively affects ecosystem function and the production of ecosystem services.

#### **Dry Conifer Forest: Implications for First Foods**

**Water and Salmon**—With respect to Water and Salmon, soil stability and hydrologic function attributes within dry conifer forests should be of primary consideration. Soil erosion, increased overland flow and subsequent sedimentation of streams and rivers beyond natural ranges can affect habitat and water quality. Land management and natural resource use activities (e.g. timber harvest, recreation, fuels reduction treatments, prescribed fire) can affect the condition and function of these touchstone attributes, so management should include considerations to ensure the maintenance and functioning of soil stability, hydrologic function and other touchstones. It is important to stress that fire and other disturbance events (e.g. bark beetle outbreaks), that can and do alter touchstone attributes are fundamental components of healthy, properly functioning dry forest landscapes. Functional dry forest ecosystems are ones where disturbance events (timber harvest, wildfire, fuels reduction treatments, etc.) and regimes (frequency, size, severity), remain within the natural range of variation, and the dry conifer forest ecosystems maintain ecological resistance and resilience.

**Big Game**—The health and function of dry forest ecosystems are important for the continued production of several First

Foods in this group, including mule deer, rocky mountain elk, and whitetail deer. Alterations to touchstone attributes that affect forage, cover, and movement across the landscape should be primary considerations with respect to dry forest use, management and restoration activities. Attributes of biotic integrity, namely, vegetation composition and structure influence forage abundance and availability. The diet of these species includes a wide range of grass, forb, and shrub species, and their relative importance changes throughout the year; grass and forb species dominate the diet from spring through summer, while shrubs become an important component of diets from late summer through winter as grass and forb species senesce. Therefore, factors that affect understory plant composition, diversity, and structure also affect forage quantity and quality. Increased stand density and higher tree canopy cover caused by over a century of fire suppression reduces light in the understory, negatively affecting plant productivity and forage availability. In addition, fire suppression activities reduced the amount and distribution of early-successional forest stands which are important for the regeneration of many preferred forage species. These early succession post-fire stands are important forage areas for elk and deer (Vavra et al. 2004, Vavra et al. 2007, Long et al. 2008). Forage production can also be impacted by the invasion of dry forest understories by non-native species, the majority of which are unpalatable and/or have less nutritive quality than native species. Annual bromes (cheatgrass), medusahead, and ventenata all readily invade dry conifer forest reducing forage quantity and quality. Forage availability may also be affected by other land use

activities, particularly grazing by livestock (e.g. cattle, horses, sheep). Livestock grazing is a common activity in dry forest ecosystems within CTUIR-ceded lands, and there is some diet overlap between the livestock and wild ungulates, particularly in spring (bunchgrass species) and late fall (deciduous woody shrubs), and high densities of livestock and wild ungulates may reduce forage availability. Reductions in available forage in dry conifer forests, in turn, may increase browse pressure in other areas, such as riparian ecosystems, whose health and functioning are important to other First Foods (Water, Salmon).

Dry conifer forest stand composition, diversity and structure (biotic integrity attributes) as well as spatial heterogeneity and patch size/shape (landscape pattern attributes) can affect Big Game abundance and health by altering the amount and distribution of security cover for these species. The uneven-aged mosaic of solitary trees, tree clusters, and forest openings that typified dry forest ecosystems prior to Euro-American settlement provided key security cover for elk and deer (tree clusters) surrounded by a matrix of areas of abundant forage (forest openings). Functional dry forest ecosystems would maintain this mosaic and include stands with higher tree densities that serve as cover.

Supporting Big Game production and abundance also requires consideration of landscape attributes, particularly connectivity and the spatial arrangement of patches. These are important not only to facilitate movement throughout dry forest zones, but also to support movement across the larger landscape as elk, deer and other species move between shrub-steppe, dry conifer, and moist conifer forest zones. Roads are well known barriers to the movement of elk and deer. Roads are thought to be a driving factor in determining elk distribution across seasons and landscapes (Lyon 1983). Elk avoid roads resulting in distribution shifts of populations away from roads and concerns about increased flight responses and associated energetic costs, reduced foraging time and reducing the total amount of effective habitat (Lyon 1983, Rowland et al. 2004). Roads also facilitate other human activities such as recreation, which can also affect habitat use and behavior of Big Game. Recent research shows that elk respond similarly to trail-based recreation (e.g. ATV riding, mountain biking, hiking, horseback riding) (Naylor et al. 2009, Wisdom et al. 2018). Mule deer also migrate long distances between summer and winter, and roads can impede or alter migratory routes affecting their abundance and population dynamics.

In summary, healthy, functional dry conifer forest ecosystems that support Big Game abundance and productivity are those that contain an uneven-aged mosaic of isolated trees, tree clusters, and forest openings including varied spatial arrangements and a diversity of structural characteristics that support key requirements, including forage, cover, and the ability to move across the landscape.

**Roots**— Several species of Roots are found in dry conifer forests, some of which can be locally abundant. Common roots include, yampa (*Perideridia gairdneri*), biscuitroot (cous, *L. cous*), wild onions (*Allium* spp.), wild hyacinth (*T. grandiflora*), camas (*C. quamash*), and yellow bell (*F. pudica*). The distribution and abundance of these species is highly variable and appears to be driven primarily by environmental variables (soil, slope, aspect, canopy cover, etc.). Species often occupy different niches within dry forests. Yampa and Spring Beauty, for example, are most commonly encountered in areas with a low overstory tree densities or near the edges of forest openings. Biscuitroot and wild onions are found in forest openings, often associated with clay soils ('scab flats'), while camas is generally found in forest opening with deeper soils (Averett and Endress, unpublished data). These species all tend to be spring ephemerals. That is, they grow, flower, and then senesce in the spring and early summer. By mid-summer all above-ground evidence of their presence may be gone, making it difficult at times to properly determine their presence and abundance. Therefore, assessments and surveys for these roots must be conducted early in the growing season (~March to mid-June).



**Figure 15.** A meadow of cous (*L. cous*) embedded with the ponderosa pine-dominated dry conifer forests of the region. Photo by E.J. Quaempts.

As noted previously (see shrub-steppe section above), the natural history and ecology of these species is largely unknown making it difficult to clearly establish how alterations to touchstones impact Root availability and production or to develop management and restoration plans based on empirical data. In the most general terms, functional dry conifer forests are those whose soil stability, hydrologic function, landscape pattern, and biotic integrity attributes remain within historic natural ranges of variation in order so that these ecosystems remain capable of providing the roots that sustain the continuity of the Tribe's culture. Despite some uncertainties, it is likely that alterations to soil stability, hydrologic function and biotic integrity are most important in affecting the sustained production of roots. For example, changes in the composition and structure of dry conifer forests as a result of fire suppression, may reduce light availability in the understory, thereby negatively affect roots associated with open forest stands and forest edges (e.g. yampa). Open meadows and scab flats are often locations where, during timber harvest, logs are yarded and loaded and where slash piles are placed. These activities can increase soil disturbance and compaction, altering both soil stability and hydrologic function in ways that reduce productivity of roots. The role of fire, invasive species and herbivory in altering touchstone attributes with respect to root production is unclear.

**Berries**— In general, berries are not as abundant in dry conifer forests as in higher elevation moist conifer forests (see below), but a number of species are common in dry conifer forest understories. Commonly encountered species include serviceberry (*Amelanchier alnifolia*), black hawthorn (*Crataegus douglasii*), chokecherry (*Prunus virginiana*), and currants (*Ribes* spp.). Huckleberry (*Vaccinium membranaceum*) while largely associated with higher elevation moist conifer forests, can also be found in some dry forests, generally in low abundances with limited fruit production. In general, abundances of these species are lower in ponderosa-pine dominated stands that are associated with drier sites, while abundances increase in Douglas-fir, grand-fir and dry mixed conifer stands on sites with greater water availability (e.g. areas with deeper soils, greater precipitation, and/or more northerly aspects).

Implementing the upland vision with respect to berries in dry forests requires touchstone attributes, primarily associated with biotic integrity and landscape pattern to remain functional and within natural ranges of variation. Changes in the overstory structure and composition (e.g. increased stand density and canopy cover) due to management may affect understory conditions that would affect berry production. Fire, a natural component of functional dry forest ecosystems, will in the short term, negatively affect some of these species (e.g. serviceberry, Hall Defrees 2018), and recovery may take 20 years or more. For other species (e.g. huckleberry), these disturbances are critical for their

establishment and growth. Therefore, ensuring a landscape mosaic of forest stands of varied successional stages is critical to continued production of berries.

Abundance and health of berries also depend on other factors such as herbivory by cattle, horses, elk and deer. Recent research indicates that recovery will be slower following fires in areas with high abundances of cattle, elk, and mule deer, as several of these species (e.g. serviceberry) are preferred forage in late summer and fall as grass and forb species senesce (Hall Defrees 2018). Increased browse can eliminate species in areas recovering from disturbance, as well as reducing berry production and availability as plants allocate more resources to replacing leaves at the expense of fruit production (Endress and Averett, unpublished data). Because of the myriad of factors affecting these species, use and management activities must not only consider touchstone attributes at the stand level, but also incorporate landscape level considerations ensure availability and production of berries across dry forests. A functional dry forest landscape maintains a mosaic of forest stands in a variety of conditions, from old-growth to recently disturbed in order to provide the variety of biological and environmental condition that supports the growth, establishment and health Berries and other First Foods.

### **Moist Conifer Forests**

Moist forests occupy higher elevation areas within CTUIR-ceded lands. These forests are associated with cooler temperatures and greater precipitation (Franklin and Dyrness 1988) than other upland ecosystems in the region. For purposes of this document, moist conifer forests include forests classified Powell (2017) as "Moist Upland Forest," and by Franklin et al. (2013) as "Moist Mixed Conifer" or "Moist Forest." Most Forests are generally bound by dry forests at lower elevation and, if elevations are sufficiently high, subalpine grasslands above (Franklin and Dyrness 1988, Johnson 2004). These forests are dominated by grand fir, Douglas-fir, and subalpine fir but also include lodgepole pine, western larch, ponderosa pine, and other species. Dozens of stand types have been identified within moist forests (see Franklin et al. 2013 and Powell 2017 for details), and stand type is heavily influenced by environmental factors (elevation, climate, soil characteristics, etc.) and fire regimes (frequency and severity). Fire frequency and severity varies considerably across moist conifer forests. Some stands have less frequent but more intense fire regimes, while other stands have fire regimes similar to dry forests (frequent low-to moderate severity fires). Stands with infrequent, high severity fires generally have high stem densities of primarily fire intolerant species (e.g. grand fir, subalpine fir), while stands with low- to moderate severity fire regimes have low density stands with a greater abundance of fire-tolerant species such as ponderosa pine, larch, and Douglas-fir. Variation in fire regimes and environmental factors created a heterogeneous landscape mosaic of forests stands that varied in their structure and composition.



**Figure 16.** Moist conifer forests dominated by species such as grand fir, subalpine fir, Douglass-fir, and western larch are important areas for berry production, particularly huckleberry and also serve a critical summer range for big game such as elk. Photos by B.A. Endress.

In general, alterations to ecological touchstones within moist forests have been less dramatic than those of shrub-steppe and dry forest ecosystems. Fire suppression and removal of large-old growth trees are two of the largest drivers of altered touchstones. Impacts of fire suppression has been less significant in moist forests than dry forests because many forest stands, particularly those at higher elevations, are adapted to low frequency, high severity (stand-replacing) fires, something that fire suppression has little effect on. Less dense moist conifer forest stands with historic fire regimes consisting of low- and moderate-severity fires have been more impacted by fire suppression. These stands share the same alterations to touchstones as the dry conifer forests described above (see Dry Forests). The only difference would be moist mixed-conifer forests would have a greater proportion of higher density stands. Historic timber harvest of large old-growth trees, particularly fire-tolerant species, have impacted forest composition and structure (biotic integrity), with potential impacts on wildlife habitat.

**Alterations to Soil Stability**—Large alterations to the capacity of moist conifer forest sites to stabilize and maintain soil structure and resources (soil, nutrients, organic matter, water) have not been noted within CTUIR ceded lands. Short-term impacts on soil stability do occur in response to disturbance events (timber harvest, wildfire, etc.), and the potential for long-term impacts on soil stability should be considered, particularly when vegetation is removed and soil is exposed. The greater precipitation and often steep slopes associated with moist conifer forests can increase soil erosion and loss of stability following severe disturbances. Higher elevation moist conifer forests (generally those dominated by grand fir, subalpine fir and/or lodgepole pine) historically were characterized by low frequency, high severity fires, which can drastically impact soil stability attributes.

Indicators of reductions in soil stability include the presence of bareground, rills, and gullies. Therefore, in order to support the production of First Foods within moist conifer forests, it is important that management plans incorporate actions that facilitate and strengthen soil stability components (structure, chemical, biological) and limit the redistribution and loss of soil resources (e.g. nutrients, organic matter) by wind and water following disturbance events.

**Alterations to Hydrologic Function**—Alterations to hydrologic function across moist conifer forest stands have been less pronounced than in shrub-steppe and dry conifer forests. Wildfires, timber harvest, silvicultural treatments, road development and other activities that remove vegetation and disturb soil can impact a sites ability to capture, store, retain, and release water, but widespread alterations to hydrologic function have not been documented. The potential for negative impacts on hydrologic function remain and therefore ensuring a sites ability to not only function properly in terms of water capture, storage and release, but also retain its capacity to recover following disturbances is critically important to support the production of First Foods in moist conifer forests.

**Alterations to Landscape Pattern**— Alterations to landscape pattern since Euro-American settlement in moist forests are similar to those of dry conifer forests. Timber harvest, silviculture practices and fire suppression have led to a more homogenous forest landscape than existed prior to Euro-American settlement with declines in low-density moist forest stands (due to fire suppression) and fewer old-growth forest-stands (due to timber harvest). Much of the moist forest within CTUIR ceded lands is managed by the USDA Forest Service and is maintained as forest land. Thus, few

changes in connectivity and spatial arrangement have occurred. At lower elevations near the dry conifer forest zone, fire regimes were historically more similar to dry forests and characterized by a mix of high-severity and low-severity regimes. Therefore, fire suppression in these stands (often mixed conifer stands dominated by grand-fir and Douglas fir, but also containing more fire tolerant species) has led to increase connectivity and homogenization, which can impact production of First Foods, particularly Big Game and Berries. Higher elevation forests, often dominated by grand fir, subalpine fir and/or lodgepole pine have not been as altered in terms of landscape pattern attributes.

**Alterations to Biotic Integrity**— Primary alterations to biotic integrity as a result of changes in moist conifer forest use and management since Euro-American settlement include changes to forest composition, structure, and species interactions. In terms of structure and composition, declines in fire-tolerant species as well old-growth forest stands, have occurred, particularly in the lower elevation moist mixed conifer stands (Franklin et al. 2013), with implications for the sustained production of First Foods, primarily Big Game and Berries. Increased stand density and overstory canopy cover reduces understory vegetation, forage quantity and quality, and fire suppression hinders the abundance of fire-dependent First Foods, such as huckleberry, which responds positively to fire disturbances. Factors that affect biotic integrity of shrub-steppe and dry conifer forests, such as non-native plant invasions, are currently not as relevant to moist conifer forests. Attributes of biotic integrity including diversity, structure and composition must be managed to maintain moist conifer forest communities that support and provide First Foods.

### **Moist Conifer Forest: Implications for First Foods**

**Water and Salmon**—The proper functioning of soil stability and hydrologic function attributes should be considered with respect to Water and Salmon. Streams that pass through moist conifer forests are often important for Salmonids (spawning and rearing), lamprey and associated species, and land management and disturbance events can remove vegetation and group cover, exposing soil and increasing soil erosion, overland flow and subsequent sedimentation of streams and rivers beyond natural ranges. This can affect stream habitat and water quality, so management should include considerations to ensure the maintenance and functioning of soil stability, hydrologic function and other touchstones. As noted above for dry conifer forests, fire and other disturbance events (e.g. bark beetle outbreaks) are also fundamental components of healthy, properly functioning moist conifer forests. Therefore, in order to support First



**Figure 17.** The understory of moist conifer forests stands contain a wide range of grass, forb, and shrub species, providing important forage and security cover for elk and other wildlife. Photo by B.A. Endress.

Foods production, the goal is not to eliminate disturbances events but rather to ensure that disturbance events and regimes remain within the natural range of variation, and that ecological systems are capable of recovering touchstone attributes following disturbance.

**Big Game**—Moist conifer forests serve as important summer range for mule deer, elk and other ungulates. As forage senesces at lower elevations in the summer, ungulates move up to higher elevation moist conifer forests. As such, the health and function of moist conifer forest ecosystems are important to support the health and availability of these First Foods. In particular, alterations to attributes discussed above for dry conifer forests (see above), namely alterations that affect forage, cover, and movement across the landscape are also relevant for moist conifer forests. Attributes of biotic integrity (composition, structure) have a large impact on forage abundance and availability. Thus, factors that affect understory plant composition, diversity, and structure will also affect forage quantity and quality. Fire suppression, particularly in the lower elevation moist mixed conifer forests, has increased stand density and canopy cover thereby reducing forage abundance in the understory, while also eliminating the amount of early-successional forests that are important forage resource areas. Livestock grazing is common in many moist conifer forests and high densities of livestock and wild ungulates may reduce forage availability and, as noted above, this may increase pressure on riparian ecosystems, whose health and functioning are important to other First Foods (Water, Salmon). Other considerations to management of Big Game includes to importance of appropriate security cover (e.g. thickets, coarse woody debris) and connectivity to promote movement across the landscape.



**Figure 18.** Bigleaf huckleberry (*V. membranaceum*) is abundant in moist conifer forests across the region. Historically, Tribal members use prescribed fire to increase berry production (Fisher 2002, Hunn et al. 2015). Fire suppression has resulted in denser forest stands reducing light availability in the understory; it is thought that the increased shade and lack of fire reduces fruit production. Photos by E.J. Quaempts.

**Roots**—Moist conifer forests are not primary locations for the digging and harvest of Roots. However, forest openings and meadows often contain many of these First Foods, and alterations to touchstones can affect the abundance and production of roots in moist conifer forests. These issues are covered in the dry conifer forest section above.

**Berries**— Moist conifer forests are some of the most productive and important areas for berry harvest. Many berries, most notably, big huckleberry (*V. membranaceum*), grouse huckleberry (*V. scoparium*), and serviceberry (*A. alnifolia*) can occur in high abundances. In particular, huckleberry dominates the understory of several moist conifer forest types and is one of the most abundance understory shrubs throughout all grand fir and subalpine fir plant associations in the Blue and Wallowa Mountains (Johnson 2004). Not only is big huckleberry a key First Food for the CTUIR, fruit are an important part of the diet of many wildlife species.

Supporting the sustained production of Berries within moist conifer forests requires particular attention biotic integrity attributes. Despite the ecological and cultural importance of many of these species, especially big huckleberry, research on the ecology and management of these species is largely lacking. In general, understory species respond to the removal or loss of overstory trees (due to stand thinning, wild or prescribed fire, timber harvest, bark beetle outbreaks, etc.) with increased biomass and cover, especially for woody and/or clonal species such as big huckleberry (Bailey et al. 1998, Kerns et al. 2004). It is thought this positive response is due to a combination of increased light, water, nutrient

availability, and soil temperatures associated with disturbance events. This matches well with the traditional ecological knowledge of Native peoples including the CTUIR, who have used fire to promote huckleberry production across western North America (Trusler and Johnson 2008, Hunn et al. 2015). Therefore, fire suppression efforts which have altered biotic integrity attributes and increased tree density and overstory canopy closure are likely to reduce fruit availability. While big huckleberry may respond positively to opening of the canopy, it remains unclear how different management actions will affect rates of recovery. For example, research in the Catherine Creek watershed in Union County found that huckleberry abundance and fruit production in forest stands that were thinned and burned nearly 30 years ago were highly variable and recovery may depend on fire intensity and environmental factors: the best predictors of huckleberry abundance and fruit density following timber harvest and prescribed fire were elevation and aspect (Holloway and Endress, 2017). How the canopy was opened may also affect berry production, and no research has explored how huckleberry responds to different disturbances (e.g. timber harvest, wildfire, fuels reduction treatments, prescribed fire), though Minore (1984) noted that for a different species of huckleberry, berry production increased when disturbance events had minimal impact on understory species.

While many unanswered questions remain regarding how alterations to touchstones affect the availability and production of berries in moist conifer forests, it is clear that it is essential to ensure ecological patterns and processes that result in a dynamic mosaic of forest patches of varied ages



and stand structures are needed to support the continued production of berries and other First Foods.

### Implementing the Upland Vision

To be successful, the upland vision must be clearly connected to use, management, and restoration actions. Figure 19, presents a flowchart connecting the overarching CTUIR First Foods-based mission to the upland vision and management actions. Here, we present an approach that links ecological touchstones and their component attributes to use, management and restoration of upland landscapes. This a general template that can be utilized and modified to develop management and restoration actions across upland ecosystems.

To successfully develop, plan, design and implement projects that support the upland vision and the CTUIR DNR mission, it is important to first: (1) develop a reference ecosystem model based on available knowledge, and (2) assess the current condition of touchstone attributes including the importance of the site for upland First Foods. A reference ecosystem model will contain and describe key attributes of soil stability, hydrologic function, biotic integrity and landscape pattern, and serve as the foundation with which to develop management priorities. Information from a range of sources can help develop a reference ecosystem model including field

indicators, monitoring data, scientific reports, reference sites, historical records, and oral histories. A number of guides and reports are also useful. For example, for dry conifer forests (as well as for some mixed-moist conifer forests), Franklin et al. (2013) and Powell (2017) can help in reference ecosystem model development. In shrub-steppe and other rangeland ecosystems, resources such as the Rangeland Health Assessment (Pellant et al. 2005), Ecological Site Description (NRCS 2018) and the State and Transition Model concept (Bestelmeyer et al. 2017) assist in reference ecosystem development and also help evaluate and identify alterations to touchstone attributes and what that may mean for ecosystem health. Oral histories, site surveys and references such as Hunn et al. (2015) can help provide valuable information on what First Foods are (or should be) explicitly considered for a given location.

Two hypothetic examples of how project actions can connect to and support the upland vision are found in Table 4. Not only is it important to directly identify how management decisions are related to supporting or improvement touchstone attributes, it is also critically important to consider and mitigate for any potential negative consequence management actions may have on First Foods directly or indirectly.

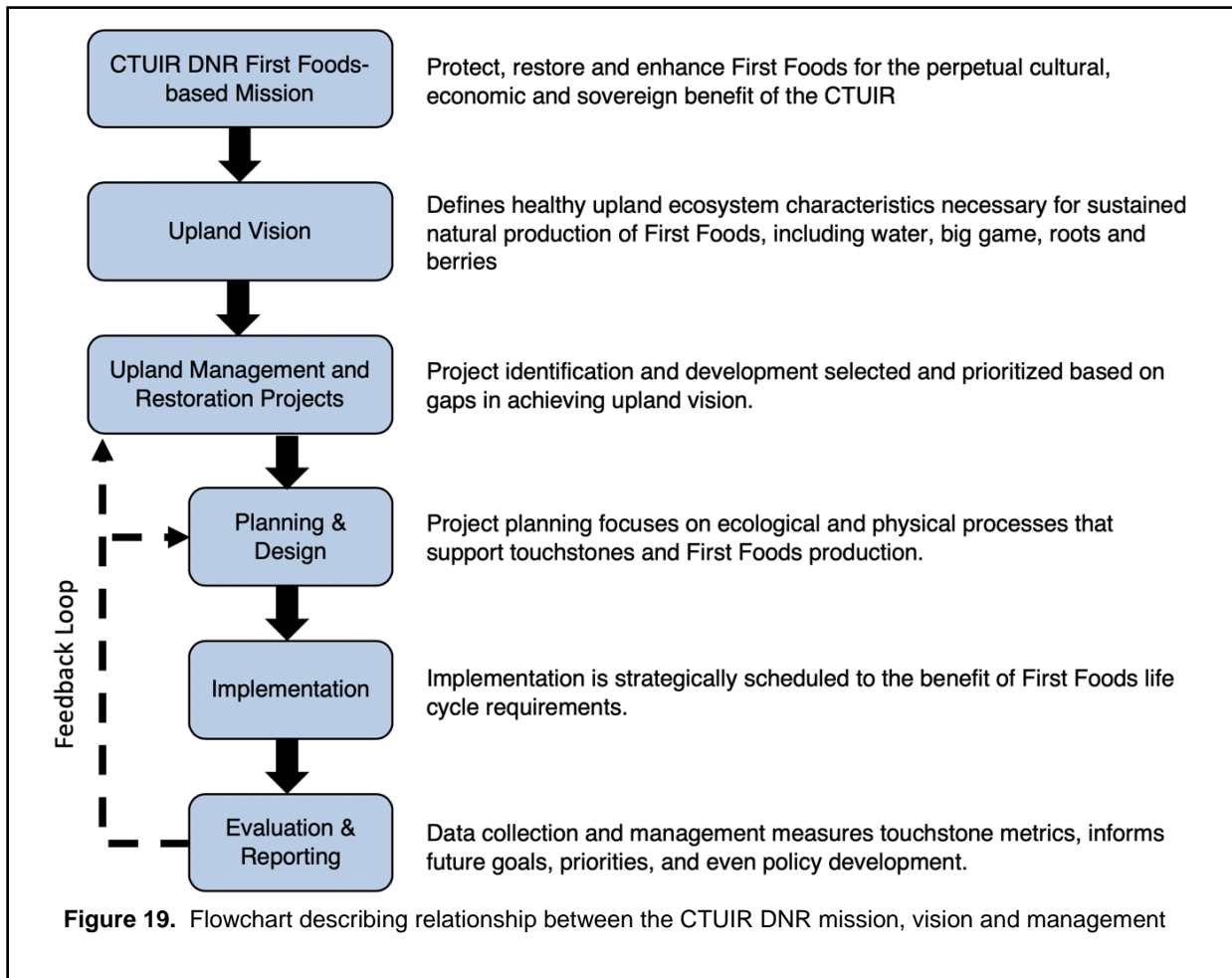


Table 4. Two hypothetical examples of projects, one in a shrub-steppe ecosystem (above) and the other in moist conifer forest (below), that link management activity, the relevant site-specific First Foods affected, and the touchstones to be addressed. The blue boxes with the “X” indicates touchstones addressed in the example management actions. The white indicates touchstones that are not addressed by project design, and the yellow boxes indicate touchstones that may be negatively impacted by management activities, which in turn may negatively impact First Foods, and therefore require specific consideration, scheduling requirements and/or mitigation action.

	Project Description	First Food Group	Principal First Food Species	CTUIR Upland Vision Touchstones and Attributes			
				Soil Stability Physical Chemical Biological	Hydrologic Function Capture Storage Release Quality	Landscape Pattern Patch size & extent Spatial arrangement Connectivity Heterogeneity	Biotic Integrity Composition Structure Species interactions First Foods
Shrub-Steppe	Shrub-steppe restoration including invasive plant control, seeding with native perennial grasses, rest from livestock grazing, protection of existing suppressed shrubs	Big Game	Mule Deer Elk	X	X	X	X
		Roots	Cous Bitterroot Wild Hyacinth	X	X		X
		Berries	Serviceberry				X
<p><i>Invasive plant control and seeding with native perennial grasses will primarily improve biotic integrity, with subsequent positive impacts on soil stability and hydrologic function. This benefits Big Game by improving winter range (increased forage quality and increase in spatial extent of improved winter range) and Roots by reducing/eliminating potential non-native competitors. Resting the site from livestock will directly improve soil stability, hydrologic function and biotic integrity by increasing vegetative cover, reducing soil compaction, increasing organic matter input into the soil, and promoting establishment of biological soil crust. This benefits both Big Game and Roots, and may also reduce browse pressure on serviceberry.</i></p>							
	Project Description	First Food Group	Principal First Food Species	CTUIR Upland Vision Touchstones and Attributes			
				Soil Stability Physical Chemical Biological	Hydrologic Function Capture Storage Release Quality	Landscape Pattern Patch size & extent Spatial arrangement Connectivity Heterogeneity	Biotic Integrity Composition Structure Species interactions First Foods
Moist Conifer Forest	Fuels reduction treatment (mechanical and prescribed fire) including reduction of surface fuels, a decrease in crown density, and retaining large fire-resistant species. Implemented in a way that increases stand heterogeneity.	Big Game	Mule Deer Elk			X	X
		Berries	Huckleberry			X	X
<p><i>Fuels reduction treatments implemented in order to reduce high fuel loads as a result of decades of fire suppression will support ecosystem health and function. This management action supports Big Game by altering stand structure and composition (Biotic Integrity) which should improve summer range by increasing understory forage quantity and quality. Potential negative impacts which must be mediated include damage to soil stability and hydrological function during treatment which can ultimately affect biotic integrity and the availability of forage resources. Additionally it is important to ensure security cover for Big Game, and consider how stand management supports overall landscape pattern attributes that promote Big Game abundance and health. Management action also supports huckleberry by reintroducing fire to the stand and increasing light in the understory. It is important to recognize in the short term, huckleberry production may decline as a result of stand treatment, and this may inform the timing, extent and spatial configuration of fuels reduction across the landscape to ensure huckleberry availability. Minimizing damage to soil structure and stability during fuels treatments should promote huckleberry recovery.</i></p>							

## Implications of the First Foods Management Framework

The ultimate goal of this First Foods-focused management approach is to ensure the sustainable stewardship of natural ecosystems within CTUIR ceded lands. Using the long-term production and harvest of the full First Foods order as a benchmark for success helps ensure natural resource management and restoration priorities, plans, and actions support the continuity of Tribal cultural traditions, First Foods and the ecosystems in which they are found. Achieving this goal requires the proper functioning of ecological touchstones (soil stability, hydrologic function, landscape pattern, biotic integrity) across a large, diverse, dynamic and heterogeneous landscape. This has several management implications:

**1. Management and restoration priorities should be based upon a thorough understanding of the touchstone attributes of an appropriate reference system.** Reference ecosystems, which are assembled from available knowledge, represent a site's characteristics as they would have been prior to

degradation (McDonald et al. 2016). This includes an understanding of a site's historic disturbance regimes and touchstone attributes, the degree to which these ecological attributes, patterns, and processes have deviated from reference conditions, and the underlying factors driving observed alterations. It is important to note that use of a reference ecosystem is not an attempt to immobilize or fix ecosystem characteristics, but rather to serve as a starting point to understand ecosystem structure and dynamics and identify restoration targets that incorporate natural variation as well as current and future environmental and/or land use changes (McDonald et al. 2016). This understanding provides an appropriate foundation with which to develop site-appropriate short and long-term management targets and goals.

**2. Upland ecosystems are dynamic, and their structure, composition, and function are a product of a variety of interacting ecological processes, management activities and land use legacies. Therefore, long-term stewardship of First Foods requires management actions that address the underlying factors and processes that affect First Foods**



**Figure 20.** Mule deer (*O. hemionus*) in a stand of bluebunch wheatgrass, a key forage species for many big game species. Deer numbers have declined across many areas of the CTUIR ceded-lands over the past several decades. Management efforts to support healthy and abundant mule deer populations should focus on repairing damaged touchstone attributes, some of which (e.g. connectivity) many cross ownership and management boundaries. Photo by E.J. Quaempts.

**availability and production.** For example, many areas of shrub-steppe are highly invaded by non-native annual grasses, reducing forage quality and quantity for elk, deer and other wildlife. Management actions that solely focus on eliminating the invasive annual grasses (e.g. herbicide application), do little to address the underlying ecological factors that caused the high abundances to begin with (James et al. 2010), which may be the result of a number of factors such as altered disturbance regimes that promote annual grasses, limited availability (sources) of native species to establish, or other ecological processes. Therefore, if one goal of the site is to increase winter forage for Big Game, then simply trying to control invasive annual grasses is unlikely to be successful in reaching the goal in the long-term; management actions need to focus on the underlying cause of invasive plant dominance at the site. The ability to identify the driving factors that underlie the functioning (or lack thereof) of touchstone attributes is important to develop appropriate management goals and identify the methods by which to achieve those goals.

**3. Key touchstone attributes vary across upland ecosystems, as does the distribution and abundance of First Foods. Therefore, management and restoration targets and goals will vary from site to site depending on the ecosystem, the degree to which touchstone attributes have been altered, the primary First Foods and their status, and the landscape context.** Upland ecosystems of the CTUIR ceded-lands are incredibly diverse, and the distribution and abundance of First Foods as well as the factors influencing their productivity vary greatly. Additionally, alterations to touchstone attributes and their effects on First Foods range in scale, scope, and intensity. Therefore, appropriate site-specific targets and goals, as well as the methods and approaches to reach these goals will vary depending on these factors. Management and restoration goals must be site and context specific in order to have the highest chance of success.

**4. Upland ecosystems within CTUIR-ceded lands are owned and managed by a diverse mix of individuals, communities, government and Tribal agencies. Many critical ecological processes necessary for the sustained production of First Foods cross ownership and management boundaries, and some managers may be unaware of the importance of First Foods to CTUIR culture or their goals do not explicitly include stewardship of First Foods. Therefore, achieving the goal of sustained production of First Foods by natural ecosystems and the ability of Tribal members to harvest requires communication and close collaboration across land ownership and management boundaries.** Large changes in land use, management and ownership have occurred since the Treaty of 1855. Many ecological processes operate at scales beyond the any particular site (e.g. wildfires, seasonal migration of elk, invasive species). Therefore, understanding and incorporating landscape context and connections between and among areas may be critical to successful stewardships at a local site. Engaging and when possible



**Figure 21.** Roots (*L. cous*) and cupin. Photo by E.J. Quaempts.

developing a shared vision for ecosystem and landscape attributes that support First Foods production should increase management and restoration success.

## Conclusion

First Foods have sustained tribal people since time immemorial and the relationship between First Foods and the Tribes is essential to the ongoing culture of the CTUIR. In recognition of this relationship, the CTUIR DNR adopted a First Foods-based mission focused on the protection, restoration and enhancement of First Foods. The targeted vision for healthy, resilient and dynamic upland ecosystems able to support the continued natural production of First Foods provides a framework to guide assessment, planning, management and restoration efforts and helps to ensure current and future management activities are aligned with and account for the protection and enhancement of First Foods.

Working towards this vision requires an understanding of the attributes that are vital to ecosystem health and First Foods production. These attributes, or touchstones, are central to the proper function of upland ecosystems and their ability to

provide a range of ecosystem services, including First Foods. These include: 1) Soil Stability, 2) Hydrological Function, 3) Landscape Pattern, and 4) Biotic Integrity. Assessment and monitoring of the touchstones and their attributes provides a direct link between on-the-ground management, decision making, and the mission and vision of the CTUIR DNR. This framework may also be of use to non-Tribal land owners and managers within the CTUIR-ceded lands.

The First Foods-focused mission and upland vision highlight direct connections between the ecological health of upland ecosystems and the health and well-being of Tribal members. Focusing the CTUIR DNR's mission and upland vision on the management, protection and restoration of touchstone attributes that affect upland ecosystem health, supports the continued availability of First Foods now and into the future and strengthens the relationship between Tribal members and First Foods—a fundamental relationship that underlies the health, well-being and cultural identity of the Tribes.

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