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Ecosystem Use by Indigenous People in an Oregon Coastal Landscape

Abstract

Data regarding probable uses of biological materials by the indigenous people of the Salmon River-Cascade Head area of the Oregon coast were used to estimate the people's use of various ecosystems near villages. Of 308 uses identified, 256 were attributable to a given species; 124 species were identified. All local ecosystems were important sources of organisms for the people, with no apparent concentration of highly used species in any particular ecosystem. One species was cultivated, one domesticated, and five acquired by trade. Four major plant resources, camas, yew, hazel, and beargrass, are not known from the Cascade Head landscape, but may have been available from elsewhere in village territory. House construction without use of cedar planks, as indicated by ethnographic records, may have resulted from the paucity of western redcedar in the Salmon River lowlands. The scarcity of several widely used taxa near coastal village sites, especially western redcedar, may have limited the wealth of this indigenous population, even on the resource-rich Oregon coast.

Introduction

Indigenous people used resources primarily from the landscape in which they resided. The natural distribution of resources governed the pattern and richness of their lives. Determining where they obtained and how they used resources can help us understand where and how they lived, and how ecosystems have changed since Euro-American settlement.

Data about the use of plants and animals by indigenous Oregon coastal tribes are limited, but useful (Lyman 1991, Lindsay 1995). A few detailed interviews were recorded with persons born before Euro-American settlement. Archeological study has been rewarding, as bone, shell, and antler are preserved well within the shell-dominated middens (Lyman 1991, Hall 2001). Detailed study, however, is of limited extent even at the best-known Oregon sites. Beckham et al. (1982), Lyman (1991), Lindsay (1995), and Erlandson et al. (1998) have summarized information for numerous sites and tribes along the Oregon coast.

Understanding how a single local population used resources requires detail beyond that provided by the summaries, as differences in usage among tribes, villages, households, and times have been described (Barnett 1937, Newman 1959, Lyman 1991, Connolly 1992, Lindsay 1995). For this study, I combined information from anthropologists with local, detailed ecological data. I developed a list of organisms used by one subtribal group, the Salmon River people of the Tillamook, who resided near Cascade Head on the north-central Oregon Coast, in an area where information about historic and modern plant and animal species distribution is unusually complete. The list of taxa used was compared to historic and current species distribution in local and regional ecosystems. An estimate was made of the origin of each plant and animal used, based on ecosystem location relative to village sites and species' importance in each ecosystem. Thus, the relative usefulness to indigenous people of each ecosystem could be estimated. Local scarcity was identified for some widely used species. I suggest effects of and compensations for local scarcity of these important resource organisms.

Study Area

The region of study is in and near the Salmon River drainage, on the north central Oregon coast between Lincoln City and Neskowin, just north of 45°N latitude. It includes primarily the Cascade Head Scenic-Research Area and Cascade Head Experimental Forest of the USDA Forest Service, Siuslaw National Forest. I refer to this area as the Cascade Head landscape, named for the prominent headland bordering the Salmon River to the north. Forests, marshes, and grasslands in this area have been studied scientifically and distributions of vascular plants and vertebrates recorded in detail (Greene and Blinn 1991; unpublished species lists on file, Forestry Sciences Laboratory, USDA Forest Service, Corvallis, Oregon). The Salmon River estuary is less disturbed

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than most others in Oregon (Murray and Marrant 1983). The territory controlled by the Salmon River villages extended south several kilometers into the current location of Lincoln City and inland to the crest of the Coast Range (Beckham et al. 1982).

The Salmon River is small, draining 210 km^2. The Salmon River has 306 ha of estuarine habitat, including 223 ha salt marsh, 51 ha tideland, and 32 ha submerged land (Thompson and Snow 1974). There is evidence in the estuary of earthquake-induced subsidence and tsunami deposition, which covered Indian hearth areas about A.D. 1700 (Minor and Grant 1996). A sand spit blocking most of the estuary mouth supports dune forest and grassland, although there was probably less stable vegetation there before the introduction of European beachgrass (*Ammophila arenaria*) (Wiedemann 1984). A 69 ha grassland dominates the southwestern promontory of Cascade Head, just uphill from major village sites. Cascade Head also supports smaller grasslands above the ocean cliffs farther north. Little rocky shore can be reached on foot, but much is accessible by water. Steller's and California sea lions (*Eumetopias jubatus, Zalophus californianus*) haul out on small rocky islands <0.25 km offshore (Lyman 1991). The rocks provide roosting and nesting sites for thousands of sea birds of several species (Murray and Marrant 1983). The beach, rocky shore, rocky islands, estuary, dune, salt marsh, and upland grassland are within minutes by foot or canoe travel of major village sites.

The Salmon River estuary is the smallest of seven major estuaries and bays used by the Tillamook tribe; others are 1.6-12 times its size (Thompson and Snow 1974). The Salmon River estuary has the lowest proportion of submerged and tideland of any of them, and a limited invertebrate fauna. It supports 4 of 16 estuarine invertebrates listed by Thompson and Snow (1974) and Emmett et al. (1991), compared to 5 for the Siletz, 7 for the Nehalem, 11 for Tillamook Bay, and 16 for Netarts Bay. Sand Lake and the Nestucca estuary support fewer of these species than the Salmon River, although they are larger. The estuarine fish fauna is relatively richer (Cornwell et al. 2001). Of 22 major fish species (Emmett et al. 1991), the Salmon River estuary supports 14, compared to 15 in the Siletz estuary, 18 in Netarts Bay, 19 in the Nehalem estuary, and all 22 in Tillamook Bay. Pre-hatchery runs of salmon and steelhead in the Salmon River totaled 4000-5000 fish (Oregon Department of Fish and Wildlife 1997). In 1923-1927, before a major decline, commercial catch of salmon and steelhead from the Salmon River was much less than that in larger systems, 1% that in Tillamook Bay, 2% of the Nehalem, and 4% of the Nestucca and Siletz estuaries (Cleaver 1951).

Extensive red alder (*Alnus rubra*) and conifer forests dominate slopes above the Salmon River valley. The conifers are primarily Sitka spruce (*Picea sitchensis*) near the shoreline, with western hemlock (*Tsuga heterophylla*) becoming important a short distance inland. Several kilometers farther inland, Douglas-fir (*Pseudotsuga menziesii*) becomes abundant and often dominant, and abundance of spruce declines. This forest pattern is not an artifact of logging; it existed in the uncut forests near the time of Euro-American settlement, according to timber cruise records for Tillamook County (Anonymous 1908). Most of the forested area burned in the 1840s (Munger 1944), although areas of old-growth and isolated old trees survived (Greene 1982). The conifer forests are productive and dense, especially when young (Harcombe et al. 1990).

Village sites near the mouth of the Salmon River have been dated to as early as A.D. 1020 (Ross 1990). In 1854, Tillamook people, the southernmost Salish-language group, occupied the area (Beckham et al. 1982). Other Salish-speaking groups lived north of the Columbia River. The Salmon River people, referred to as the Nechesne (also an early name for the Salmon River), Kowai, or Salmon River Indians, continued to live there well into historic time (Beckham 1975, Beckham et al. 1982). Their population was about 10 in 1854 (Beckham et al. 1982), but had probably been reduced by disease before 1840, as had other coastal groups (Seaburg and Miller 1990). The Salmon River people lived primarily by fishing and gathering shellfish, although hunting and use of marshlands and forest were also critical to their survival (Murray and Marrant 1983), like other Oregon coastal groups (Lyman 1991, Connolly 1992, Erlandson et al. 1998). They apparently did not hunt in the open ocean.

The Cascade Head landscape was included in the Siletz Indian Reservation, established in 1855, although the life of the local people probably remained unchanged. Most of the landscape was excluded from the reduced reservation in 1875, although the Salmon River itself remained in the

reservation until 1894 (Beckham 1975). The area appears to have been used as pasture by settlers from the Willamette Valley by 1851. Although early squatters of European lineage settled the north bank of the Salmon River in the 1870s, most settlement occurred in the 1890s, primarily along the lowlands near the Salmon River and Neskowin Creek.

Methods

The primary record about the Salmon River people came from informants for two anthropological studies (Boas 1923, Barnett 1937). Local archeological studies are described by Murray and Marrant (1983) and Beckham et al. (1982). I developed a list of plant and animal species collected, and of their probable uses, by the Salmon River people. I based the list primarily on Barnett's detailed questionnaire (1937), and summaries of local history by Beckham (1975) and Beckham et al. (1982). Secondary sources were Boas' (1923) interview, Murray and Marrant's (1983) excavation, Seaburg and Miller's (1990) tribal summary, and information about other Tillamook villages: Newman's (1959) excavations at Netarts Bay, Sauter and Johnson's (1974) book about people in the Tillamook Bay region, and Zontek's (1978) excavations at Oceanside. Because data about use of plants by the Tillamook were limited, I also included plants for which Salish-speaking groups in southwestern Washington had a distinct name and use (Gunther 1973). Information from Salish language groups in northern Washington and Canada was not used, as they lived in a region culturally different from the Oregon coast (Erlandson et al. 1998).

Species mentioned in works from outside the Cascade Head landscape were counted only if I could confirm their presence in the landscape, either from observation or species lists. In some cases, the exact species identity is uncertain (e.g., several species of bird eggs), but a reasonable estimate of the number could be made. Scientific nomenclature (Tables 1, 2) follows Hitchcock and Cronquist (1973) for plants, Verts and Carraway (1998) for most mammals, Csuti et al. (1997) for birds and amphibians, Maser et al. (1981) for mammals not included in Verts and Carraway, Emmett et al. (1991) for fish and most invertebrates, and Hafele and Hinton (1996) for other invertebrates. I counted uses as in the following example: eating elk meat is one use of elk; wearing elk skins is a second use; fashioning a wood-splitting wedge from elk antler is a third use.

Each species of use was assigned to its most likely origin. For most species, the origin was the type of local ecosystem from which it was easiest to collect, based on ecosystem accessibility to the village sites and species' importance in the ecosystems. Other possible origins were cultivation and trade. Some important fiber plants from freshwater marshes were grouped with salt marsh; they grow on the upper fringes of salt marsh vegetation (Frenkel and Morlan 1990). Elk (*Cervus elaphus*), deer (*Odocoileus hemionis*), bear (*Ursus americanus*), mountain lion (*Puma concolor*), bobcat (*Lynx rufus*), and raccoon (*Procyon lotor*) occur in many habitats, and thus were assigned to a separate category. Similarity of distribution among origins of species and uses (Table 3) was tested using Spearman's rank correlation and the Kolgomorov-Smirnov test.

Other Oregon coastal peoples used many species that occur at Cascade Head but were not counted here (Lindsay 1995), as they were not referred to in literature about the Tillamook. Many useful species undoubtedly went unrecorded, especially those limited to medicinal, ceremonial, or emergency use.

For six widely-used plant species absent or rare in the Cascade Head landscape, I checked distributions of herbarium specimens (ORE, OSC, WILLU) and used the preliminary version of the Oregon Plant Atlas data base (Scott Sundberg, Oregon State University, personal communication) to locate sightings of species.

Results

At least 68 plant and 56 animal species were used by the Salmon River people (Tables 1, 2), with 308 recorded uses, counting multiple uses of a single type (e.g., use of spruce roots in several kinds of baskets). Fifty-two of the 308 uses were associated with a resource, such as wood or bone, without identification of a specific organism, and thus could not be assigned to an origin. To gather the species associated with the 256 uses of an identifiable species, the people used all the major ecosystems in their landscape (Table 3). The most species and uses came from the forests, estuary, and ocean, and many uses from animals that occupy several ecosystems. A few resources

TABLE 1. List of plant species report
use and most likely ecosys

Type	Common name
Fern	Maidenhair fern
	Lady-fern
	Deer-fern
	Horsetail
	Licorice-fern
	Sword-fern
	Bracken
Tree	Red alder
	Big-leaf maple
	Sitka spruce
	Shore pine
	Douglas-fir
	Cascara
	Western yew
	Western redcedar
	Western hemlock
Shrub	Vine maple
	Serviceberry
	Kinnikinnick
	Hairy manzanita
	Hazelnut
	Salal
	Oceanspray
	Twin-berry
	Currant
	Rose
	Thimbleberry
	Salmonberry
	Willow
	Red elderberry
	Evergreen huckleber
	Huckleberry
	Red huckleberry
Forb	Yellow sandverbena
	Yarrow
	Wild onion
	Angelica
	Camas
	Coast strawberry
	Cow parsnip
	Waterleaf
	Seashore lupine
	False lily-of-the-vall
	Water-parsley
	Oregon oxalis
	Wild tobacco
	Pacific silverweed
	Wapato
	Goldenrod
	Stinging nettle
	Edible thistle
Grass-like	Bentgrass
	Brome

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TABLE 1. List of plant species reportedly used by Tillamook people and present in the Cascade Head landscape, with types of use and most likely ecosystem or other origin from which it was obtained.

Type	Common name	Species	Uses[1]	Origin[2]
Fern	Maidenhair fern	*Adiantum pedatum*	BF	A
	Lady-fern	*Athyrium filix-femina*	F	A
	Deer-fern	*Blechnum spicant*	M	S
	Horsetail	*Equisetum* spp.	FI	A
	Licorice-fern	*Polypodium glycyrrhiza*	IM	A
	Sword-fern	*Polystichum munitum*	BFHM	S
	Bracken	*Pteridium aquilinum*	F	G
Tree	Red alder	*Alnus rubra*	BIW	A
	Big-leaf maple	*Acer macrophyllum*	BCI	A
	Sitka spruce	*Picea sitchensis*	BISW	S
	Shore pine	*Pinus contorta*	FIR	D
	Douglas-fir	*Pseudotsuga menziesii*	BW	S
	Cascara	*Rhamnus purshiana*	M	A
	Western yew	*Taxus brevifolia*	IRS	S[3]
	Western redcedar	*Thuja plicata*	BHIS	S
	Western hemlock	*Tsuga heterophylla*	BIW	S
Shrub	Vine maple	*Acer circinatum*	BIS	A
	Serviceberry	*Amelanchier alnifolia*	F	G
	Kinnikinnick	*Arctostaphylos uva-ursi*	FRS	D
	Hairy manzanita	*A. columbiana*	F	D[3]
	Hazelnut	*Corylus cornuta*	BI	S[3]
	Salal	*Gaultheria shallon*	FM	S
	Oceanspray	*Holodiscus discolor*	IM	D
	Twin-berry	*Lonicera involucrata*	FM	D
	Currant	*Ribes* spp. *(3)*	F	S,A
	Rose	*Rosa nutkana*	F	A
	Thimbleberry	*Rubus parviflorus*	BF	S
	Salmonberry	*R. spectabilis*	F	A
	Willow	*Salix hookeriana*	CIS	D
	Red elderberry	*Sambucus racemosa*	FM	A
	Evergreen huckleberry	*Vaccinium ovatum*	F	D
	Huckleberry	*V. ovalifolium*	F	S
	Red huckleberry	*V. parvifolium*	FR	A
Forb	Yellow sandverbena	*Abronia latifolia*	F	D
	Yarrow	*Achillea millefolium*	MR	G
	Wild onion	*Allium* sp.	F	G
	Angelica	*Angelica hendersonii*	FS	M
	Camas	*Camassia quamash*	F	G[3]
	Coast strawberry	*Fragaria chiloensis*	F	D
	Cow parsnip	*Heracleum lanatum*	FM	G
	Waterleaf	*Hydrophyllum tenuipes*	F	A
	Seashore lupine	*Lupinus littoralis*	F	D
	False lily-of-the-valley	*Maianthemum dilitatum*	F	S
	Water-parsley	*Oenanthe sarmentosa*	F	M
	Oregon oxalis	*Oxalis oregana*	FM	S
	Wild tobacco	*Nicotiana quadrivalvis*	RS	C
	Pacific silverweed	*Potentilla pacifica*	F	M
	Wapato	*Sagittaria latifolia*	F	T
	Goldenrod	*Solidago spathulata*	F	D[3]
	Stinging nettle	*Urtica dioica*	FS	A
	Edible thistle	*Cirsium edule*	F	G
Grass-like	Bentgrass	*Agrostis* sp.	F	D
	Brome	*Bromus carinatus*	F	G

Continued, next page

TABLE 1. Continued.

Type	Common name	Species	Uses[1]	Origin[2]
	Slough sedge	*Carex obnupta*	F	M
	Red fescue	*Festuca rubra*	F	D
	Baltic rush	*Juncus balticus*	H	M
	Salt rush	*J. lesueurii*	H	M
	Coastline bluegrass	*Poa confinis*	F	D
	Small-fruited bulrush	*Scirpus microcarpus*	BCF	M
	Seaside arrow-grass	*Triglochin maritimum*	F	M
	Tall trisetum	*Trisetum canescens*	F	G
	Beargrass	*Xerophyllum tenax*	BC	S[3]
	"Reeds"	-	BCH	M
Algae	"Kelp"	-	I	O
	"Seaweeds"	-	FI	E
Moss	"Moss"	-	H	S

[1]Types of usage: B = containers, such as baskets, boxes, or liners for them; C = clothing; F = food; H = housing or bedding, including mats; I = implements, including canoe, bow, wiper, needle, rope, fish club...; M = medicinal use; R = recreational use, including ornaments, games, or smoking; S = ceremonial use by the shaman or in dances or other ceremonies; W = firewood. Other uses of plants not identified to species: wood, 28; grass, 3; fiber, 2; rotten wood, 1.
[2]Origin: T = probably by trade; C = cultivated; other letters indicate the ecosystem from which the species was most likely to be collected—A = alder forest, D = dune grassland or dune forest, E = estuary, G = headland grassland, M = marsh, both salt marsh and bordering freshwater marsh, O = ocean and its shores, S = spruce-hemlock forest.
[3]indicates that the species is not listed for the landscape, but may have been collected elsewhere within territory controlled by the group.

TABLE 2. List of animal species noted in lists of uses by Tillamook people, with types of use and most likely ecosystems or other origins from which they were obtained.

Type	Common name	Scientific name	Uses[1,2]	Origin[3]
Mollusc	Chiton	—	F	O
	Clam	*Tresus nuttalli*	BFI$	O[4]
	Cockle	*Clinocardium nutallii*	F	O
	Dentalium	*Dentalium pretiosum*	S$	T
	Mussel	*Mytilus* sp.	FI	O
	Octopus	*Octopus dofleini*	F	O
	Olivella shell	*Oliviella biplicata*	S	O
	Red abalone	*Haliotis rufescens*	S	T
	River clam	—	F	E
	Snail	—	F	O
Crustacean	Barnacle	—	F	O
	Crab	*Cancer magister*	F	E
	Crawfish	*Pacifastacus* sp.	I	A
Fish	Chinook salmon	*Oncorhynchus tshawytscha*	FI	E
	Chum salmon	*Oncorhynchus keta*	FI	E
	Coho salmon	*Oncorhynchus kisutch*	FI	E
	Herring or smelt	—	F	E
	Lamprey	*Entosphenus tridentatus*	F	E
	"Mudcat"	—	I	E
	Starry flounder	*Platichthys stellatus*	F	E
Amphibian	Rough-skin newt	*Taricha granulosa*	S	A
Bird	Duck (5 spp.)	—	FI	E
	Eagle	*Haliaeetus leucocephalus*	S	S
	Goose	*Branta canadensis*	FI	E
	Hummingbird	—	S	A

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TABLE 2. Continued.

Type	Common na
	Seagull (>1 s
	Woodpecker
	Unspecified
	(>1 spp.) egg
Mammal, marine	California se
	Harbor seal
	Porpoise
	Sea otter
	Steller's sea
	Gray whale
Mammal, terrestrial	Black bear
	Beaver
	Chipmunk
	Deer
	Dog
	Elk
	Mink
	Mole
	Mountain lio
	Rabbits
	Raccoon
	River otter
	"Sheep" (mo
	Douglas' squ
	Long-tailed
	Wildcat (bob

[1]Types of usage: B = containers such implements, including canoe, bow, w ments, games, or smoking; S = cerem
[2]Uses of animals not identified as to s
[3]Origin: C = domesticated animal, T = to be collected—A = alder forest, D = bordering freshwater marsh, O = ocea
[4] indicates that the species is not listed group.

must have come from trade. T tivated tobacco, as did other wes apparently their only attempt a ticated dog bones occur in Saln food seems their most likely Marrant 1983).

The proportions of species among ecosystems were signi (Spearman's rank correlation c $p = 0.015$); i.e., there were mor were more species. The distribu origins did not differ from th statistic = 0.447); i.e., there wa concentration of highly used sp systems.

There were many documer mammals and some trees, inclu lion, whale, western redcedar (

TABLE 2. Continued.

Type	Common name	Scientific name	Uses[1,2]	Origin[3]
	Seagull (>1 spp.) eggs	—	F	O
	Woodpecker	—	S$	A
	Unspecified sea bird (>1 spp.) eggs and young	—	F	O
Mammal, marine	California sea lion	*Zalophus californianus*	BCF	O
	Harbor seal	*Phoca vitulina*	BCF	O
	Porpoise	*Phocoena phocoena*	F	O
	Sea otter	*Enhydra lutris*	CH	O
	Steller's sea lion	*Eumetopias jubatus*	BCF	O
	Gray whale	*Eschrichtius robustus*	BFI	O
Mammal, terrestrial	Black bear	*Ursus americanus*	CFS	W
	Beaver	*Castor canadensis*	FHIR	A
	Chipmunk	*Tamias townsendii*	CF	S
	Deer	*Odocoileus hemionus*	BCFHIS	W
	Dog	*Canis familiaris*	FR	C
	Elk	*Cervus elaphus*	BCFHIM	W
	Mink	*Mustela vison*	RS	M
	Mole	*Scapanus* sp.	B	G
	Mountain lion	*Puma concolor*	C	W
	Rabbits	*Sylvilagus bachmani, Lepus americanus*	FCIR	S
	Raccoon	*Procyon lotor*	CF	W
	River otter	*Lutra canadensis*	CS	E
	"Sheep" (mountain goat)	*Oreamnos americanus*	H	T
	Douglas' squirrel	*Tamiasciurus douglasii*	CF	S
	Long-tailed weasel	*Mustela frenata*	B	S
	Wildcat (bobcat)	*Lynx rufus*	C	W

[1]Types of usage: B = containers such as bags, or liners for containers; C = clothing; F = food; H = housing or bedding; I = implements, including canoe, bow, wiper, needle, rope, fish club...; M = medicinal use; R = recreational use, including ornaments, games, or smoking; S = ceremonial use by the shaman or in dances or other ceremonies; $ = currency.
[2]Uses of animals not identified as to species: bird bone, I, R; bone, IS; skin, BHI; antler, CI; feathers, IS.
[3]Origin: C = domesticated animal, T = probably by trade; other letters indicate the ecosystem from which the species was most likely to be collected—A = alder forest, D = dune grassland or dune forest, E = estuary, G = grassland, M = marsh, both salt marsh and bordering freshwater marsh, O = ocean and its shores, S = spruce-hemlock forest, W = moved widely through several ecosystems.
[4] indicates that the species is not listed for the landscape, but may have been collected elsewhere within territory controlled by the group.

must have come from trade. The Tillamook cultivated tobacco, as did other western Oregon tribes, apparently their only attempt at farming. Domesticated dog bones occur in Salmon River middens; food seems their most likely use (Murray and Marrant 1983).

The proportions of species and uses (Table 3) among ecosystems were significantly correlated (Spearman's rank correlation coefficient r = 0.81, $p = 0.015$); i.e., there were more uses where there were more species. The distribution of uses among origins did not differ from that of species (K-S statistic = 0.447); i.e., there was not a significant concentration of highly used species in a few ecosystems.

There were many documented uses for large mammals and some trees, including elk, deer, sea lion, whale, western redcedar (*Thuja plicata*), and

TABLE 3. Percentages of species and recorded or probable uses of biological materials for the indigenous peoples in the Cascade Head landscape, by their most likely ecosystem of origin or other origin. Percentages are for 124 species and 256 uses attributable to an origin. See text for basis of assignment to ecosystems.

Ecosystem or other origin	Percentage of species	Percentage of uses
Ocean	11	11
Estuary	14	11
Dune/beach	10	10
Salt marsh	10	7
Alder forest	15	17
Conifer forest	20	24
Headland grassland	8	6
Roam through several	6	14
Cultivated	2	1
Acquired by trade	5	4

red alder. Uses were best documented for antler, shell, and bone implements. Multiple uses of wood, many recorded or inferred to be western redcedar, are indicated by Barnett's (1937) informant and for other Tillamook areas (Newman 1959, Sauter and Johnson 1974, Beckham et al. 1982).

Some important plant resources for coastal tribes were rare or absent from the Cascade Head landscape. Western redcedar was not recorded in the Tillamook County portion of the landscape in 1908 (Anonymous 1908). In the 1934 timber cruise of the Cascade Head Experimental Forest, this species made up only 0.26% of timber volume (USDA Forest Service 1938) and was recorded no closer than 2.6 km to the estuary. It grew 9 km south, also, probably within territory of the villages. Yew (*Taxus brevifolia*), preferred for bows and arrows by the Salmon River people (Barnett 1937), is absent from the study area. Although yew grows in many Coast Range forest types, including two with Sitka spruce (Hemstrom and Logan 1986), the nearest record is from 92 km NNE. Hazel (*Corylus cornuta*), a major material for baskets and rope, is widespread in inland Coast Range forests, but almost absent where spruce dominates (Hemstrom and Logan 1986); it has been collected on the coast at Sand Lake, 25 km N of the Salmon River and near the coast 36 km S. Camas (*Camassia* spp.), widely reported as a staple food plant, has not been collected in the Cascade Head landscape, but herbarium specimens show that it grew at Devil's Lake, at least 4 km S and probably within the territory of the Salmon River villages. Otherwise, camas is rare on the central and north-central coast, but does occur in meadows near and east of the crest of the Coast Range. The current herbaceous vegetation in the Salmon River valley, where one might expect camas to have grown, was probably riparian forest before it was converted to pasture (USDA Forest Service 1999). Big-leaf maple (*Acer macrophyllum*), an important source of fiber and wood, is uncommon in the landscape, in forests with spruce (Hemstrom and Logan 1986), and in this region in general (Hines 1971). Maple grows abundantly in the Coast Range, probably within territory controlled by the Salmon River people. Beargrass (*Xerophyllum tenax*) is absent from the landscape, but is reported from forest types that grow on the eastern fringe of the watershed. The nearest specific record is from 92 km NNE.

Some commonly used animals also are apparently absent from the landscape. The soft-shelled clam (*Mya arenaria*), probably introduced, is the only clam reported from the Salmon River (Thompson and Snow 1974), although shell from gaper clam (*Tresus* sp.) is present in local shell middens (Beckham et al. 1982). Of seven invertebrates found in middens farther north in Tillamook territory (Barner 1982), only three grow or were found in middens at the Salmon River (Beckham et al. 1982). Mussels (*Mytilus* sp.) were the most commonly used invertebrates (Murray and Marrant 1983), as elsewhere on the Oregon coast (Lindsay 1995). More fish than named in Table 2 were probably used: Oregon coastal peoples appear to have eaten most that were available and collected them year-round (Erlandson et al. 1998), and 24 species have been identified from middens at Seaside (Connolly 1992), on the northern fringe of Tillamook occupancy during the historic period.

Discussion

Data from studies of ethnography, archeology, and distribution of organisms share some problems of interpretation. Sampling is sparse compared to the time and territory it is usually used to represent. Absence of an item from the record cannot assure its absence from indigenous use or the landscape. In this study, most data about plant usage are recent, from interviews of tribal members who survived until at least 1890 (Boas 1923). Many data about animal use, in contrast, came from excavation of earlier middens deposits, AD 900-1675 (Newman 1959, Ross 1990, Erlandson and Moss 1995). Data for organism distribution date from 1908 to (usually) after 1970.

Two major changes in vegetation occurred near the time of contact with Europeans. About AD 1700, subsidence during an earthquake and burial by a tsunami deposit modified estuarine habitats (Minor and Grant 1996); marsh vegetation in the estuary probably recovered within several decades. In the 1840s, a large, intense fire killed most forest in the landscape (Munger 1944). Informants for ethnographic studies grew up amidst young forest that developed after fire. Their statements to anthropologists may have differed from those appropriate for preceding generations. Old-growth forest that survived the fire is of similar composition to forest that developed after the fire (Greene

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1982); thus, it seems unlikely that the 1840s fire caused the local scarcity of western redcedar. Effects of management with fire, used by the Tillamook to make berries, game animals, and perhaps camas more available (Sauter and Johnson 1974, Boyd 1999), would have disappeared. Although the comparisons of resource usage and availability in this study seem reasonable, many data for usage of resources, and all data for organism distribution and abundance, may include changes after the time of European contact.

Except for materials that survived burial, data about usage depend on the sparse records of early Euro-American explorers and residents, and experience and memory of a few informants. Usefulness of many species may not have been recorded for the Tillamook. For example, 17 grassland plant species present at Cascade Head but absent from Table 1 were used or possibly used by the indigenous peoples of the prairies of western Washington (Norton 1979), and an additional six were famine foods of northwestern coastal tribes (Turner and Davis 1993). Detailed analysis of faunal remains at Seaside, Oregon, just north of Tillamook territory, identified at least 24 fish taxa and 30 bird taxa (Connolly 1992), many more than listed in Table 2.

Obtaining appropriate distribution data for this type of study is also difficult. Published range maps (Little 1971, Csuti et al. 1997) show general aspects of organism distribution, but abundance and even presence vary within the ranges shown on maps. Data from detailed vegetation survey plots and specimen collections illustrate the maps' failure to display the details of distribution required for a study of this type (Anonymous 1908, Hemstrom and Logan 1986, Emmett et al. 1991).

Table 3 probably underestimates the importance of some of the lesser-used ecosystems. For example, grasslands are represented in Tables 1 and 2 only by food plants and moles, but were managed by Tillamook people to improve hunting of elk and deer (Sauter and Johnson 1974), which are assigned to no specific ecosystem and could be captured in a variety of ways in several ecosystems (Barnett 1937). The Salmon River people had easy access to a large grassland where elk and deer graze, which has cliffs along much of its perimeter. Elk bones were common in middens at the mouth of the river (Beckham et al. 1982, Murray and Marrant 1983).

Not all resources for which use is claimed by or attributed to the Salmon River people grow in the vicinity of known villages. Four important materials probably came from trade: the dentalium (*Dentalium pretiosum*) and red abalone (*Haliotis rufescens*) shells, widely used for currency and decoration throughout the northwest coast; mountain goat (*Oreamnos americanus*) hair for blankets; and wapato tubers (*Saggitaria latifolia*) for food. Wapato may have been traded from east of the Coast Range (Beckham et al. 1982), because access through the mountains was relatively easy. Woven blankets in coastal Oregon probably came from imported mountain goat wool, rather than mountain sheep; in contrast, coast Salish farther north used hair of domesticated dogs (Howay 1918). In addition, it is unclear whether beargrass leaves, used to decorate woven items, and camas, as food, were available to the Salmon River people. Where camas was absent, people traded for it (Gunther 1973).

Some resources absent from the landscape may have been available in the inland territory controlled by the village, which extended to the crest of the Coast Range (Beckham et al. 1982), including beargrass (Hines 1971), camas, yew, and hazel. These resources are easily transported. There is evidence that residence at the Salmon River estuary was seasonal, during fall and winter (Murray and Marrant 1983), presumably with residence farther inland in other seasons. Big-leaf maple is present at Cascade Head in small numbers, but abundant inland within territory controlled by the village.

The most important scarcity in the Cascade Head landscape was western redcedar. Availability of large western redcedar trees revolutionized the culture of coastal peoples in British Columbia as cedar migrated into their territory during post-glacial warming (Hebda and Mathewes 1984). Local spatial variation in its importance on the Oregon coast seems likely to have affected culture, also. According to Barnett's (1937) informant, a Salmon River native, houses had mat-lined dirt walls, and walls and roof were not made of planks or bark. Wood (type unspecified) was used for beams, posts, and the sweathouse roof. House construction without cedar planks differs from the standard Tillamook and coastal practice. Beckham (1975) cites Barnett (1937) but also states that Salmon River people built plank houses. Newman (1959) explicitly dismisses Barnett's

informant's statement, citing the planked houses he had excavated at Netarts Bay and Boas (1923) as his reasons. On the other hand, one of Newman's houses apparently had not been of planks, and Boas (1923) noted that poor people sometimes lived in grass houses both in winter and summer. It seems likely that building houses without cedar was necessary, due to its scarcity near the Salmon River villages. Cedar was used for canoes (Barnett 1937), the usual regional custom. Canoes were an important item of trade (Seaburg and Miller 1990), whereas moving house planks many meters long (Newman 1959) for kilometer distances may not have been feasible.

The scarcity of several plants considered standard resources for Oregon coastal peoples, especially cedar and camas, may have limited the population and wealth of the Salmon River people. In addition, they lived near a small, primarily marshy estuary (with limited invertebrate diversity) of a small river (with relatively small fish runs). Access to extensive rocky coastline required ocean travel, not feasible during stormy weather. There are no estimates of population before the introduction of disease that accompanied contact with European traders. These villages, although located optimally amidst river, estuary, sandy and rocky shore, ocean (Erlandson et al. 1998), upland grassland, and forest, appear to have less potential for wealth than situations usually described for Tillamook and other coastal Oregon tribes. Previously unrecognized differences in resource availability may have caused unrecognized variation in size, wealth, and trade of different villages.

In conclusion, all local ecosystems were important sources of organisms for Salmon River people. Even so, the Cascade Head region could not supply all important species used by the Tillamook tribe. Trade supplied some needs. Collecting throughout their extensive territory away from coastal villages probably supplied others. In the case of cedar for houses, however, the people apparently had to do without.

Acknowledgements

This research was supported by a residency at the Sitka Center for Art and Ecology, Otis, Oregon, provided by the Neskowin Coast Foundation, and by sabbatical support from Oregon State University. I appreciate the comments on a draft of this paper by Roberta Hall, Sarah Greene, Kenneth Ames, Jon Erlandson, and Mark Merlin. Thanks to Richard Halse and Scott Sundberg for help determining plant distributions.

Literature Cited

Anonymous. 1908. Timber cruise, Tillamook County, Volume 2. Unpublished report, on file at the Pioneer's Museum, Tillamook, Oregon.

Barner, D. C. 1982. Shell and archaeology: an analysis of shellfish procurement and utilization on the central Oregon coast. M. S. Thesis, Oregon State University, Corvallis, Oregon.

Barnett, H. G. 1937. Culture element distributions. VII. Oregon coast. Anthropological Records, University of California Berkeley 1:155-204

Beckham, S. D. 1975. Cascade Head and the Salmon River estuary: A history of Indian and white settlement. Unpublished report to USDA Forest Service, Siuslaw National Forest, Corvallis, Oregon.

Beckham, S. D., K. A. Toepel, and R. Minor. 1982. Cultural resource overview of the Siuslaw National Forest, western Oregon. Heritage Research Associates Report 7. Lake Oswego, Oregon.

Boas, F. 1923. Notes on the Tillamook. University of California Publications in American Archaeology and Ethnology 20:3-16.

Boyd, R. 1999. Introduction. Pages 1-30 *In* R. Boyd (editor), Indians, Fire, and the Land in the Pacific Northwest. Oregon State University Press, Corvallis, Oregon.

Cleaver, F. C. (editor). 1951. Fisheries statistics of Oregon. Contribution 16, Oregon Fish Commission, Portland, Oregon.

Connolly, T. J. 1992. Human responses to change in coastal geomorphology and fauna on the southern Northwest Coast: Archaeological investigations at Seaside, Oregon. University of Oregon Anthropological Papers 45, Eugene, Oregon.

Cornwell, T. J., D. L. Bottom, and K. K. Jones. 2001. Rearing of juvenile salmon in recovering wetlands of the Salmon River Estuary. Oregon Department of Fish and Wildlife, Information Reports 2001-05, Portland, Oregon.

Csuti, B, A. J. Kimerling, T. A. O'Neil, M. M. Shaughnessy, E. P. Gaines, and M. M. P. Huso. 1997. Atlas of Oregon Wildlife. Distribution, Habitat, and Natural History. Oregon State University Press, Corvallis, Oregon.

Emmett, R. L., S. L. Stone, S. A. Hinton, and M. E. Monaco. 1991. Distribution and Abundance of Fishes and Invertebrates in West Coast Estuaries, Volume II. Species Life History Summaries. Estuarine Living Marine Resources Report 8. National Oceanic and Atmospheric Administration, National Ocean Service, Strategic Environmental Assessments Division, Rockville, Maryland.

Erlandson, J. M., and M. L. Moss. subsistence change at the Oc Tillamook County, Oregon. No Research Notes 29:221-228.

Erlandson, J. M., M. A. Tveskov, a The development of maritime ern Northwest Coast of Nor thropology 35:6-22.

Frenkel, R. E., and J. C. Morlan. 1 Salmon River salt marshes: Unpublished Final Report to tection Agency, Region 10, S

Greene, S. E. 1982. Neskowin Crest Supplement 13. *In* J. F. Fra Dyrness, and C. Maser (edit search Natural Areas in Ore guide for scientists and educa vice, Pacific Northwest Fores Station, Portland, Oregon.

Greene, S. E., and T. Blinn. 1991. R the Cascade Head Experim Research Area, Oregon Coa USDA Forest Service Genera GTR-268. Pacific Northwes periment Station, Portland,

Gunther, E. 1973. Ethnobotany of W Knowledge and Use of Indi Americans. Revised edition. ton Press, Seattle, Washingt

Hafele, R., and S. Hinton. 1996. Gu Aquatic Invertebrates. Aquat 1. Oregon Trout, Portland, C

Hall, R. L. 2001. Nah-so-mah village, Unpublished Report to Sea State University, and the C file at Department of Anth University, Corvallis, Orego

Harcombe, P. A., M. E. Harmon, Changes in biomass and pro a coastal *Picea sitchensis-T* approaching maturity. Can Research 20:1602-1610.

Hebda, R. J., and R. W. Mathewes. of cedar and native Indian cul can Pacific coast. Science 2

Hemstrom, M. A., and S. E. Logan and management guide, Si USDA Forest Service, Pacifi Ecol 220-1986a, Portland, C

Hines, W. W. 1971. Plant communiti ests of north coastal Oregon State University, Corvallis,

Hitchcock, C. L., and A. Cronquist cific Northwest. University attle, Washington.

Howay, F.W. 1918. The dog's hair bla The Washington Historical

Lindsay, L. W., Jr. 1995. Native use egon coast. Pages 191-210 *In* of the Coquille Estuary: Nat

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Halse and Scott Sundberg for
ant distributions.

951. Fisheries statistics of Oregon.
Oregon Fish Commission, Portland,

nan responses to change in coastal
nd fauna on the southern Northwest
gical investigations at Seaside, Or-
of Oregon Anthropological Papers
on.
ttom, and K. K. Jones. 2001. Rear-
mon in recovering wetlands of the
ary. Oregon Department of Fish and
ion Reports 2001-05, Portland, Or-

T. A. O'Neil, M. M. Shaughnessy,
M. M. P. Huso. 1997. Atlas of Or-
tribution, Habitat, and Natural His-
University Press, Corvallis, Oregon.
, S. A. Hinton, and M. E. Monaco.
and Abundance of Fishes and In-
t Coast Estuaries, Volume II. Spe-
Summaries. Estuarine Living Ma-
Report 8. National Oceanic and
nistration, National Ocean Service,
nmental Assessments Division,
nd.

Erlandson, J. M., and M. L. Moss. 1995. Chronology and subsistence change at the Oceanside site (35-TI-47), Tillamook County, Oregon. Northwest Anthropological Research Notes 29:221-228.

Erlandson, J. M., M. A. Tveskov, and R. S. Byram. 1998. The development of maritime adaptations on the southern Northwest Coast of North America. Arctic Anthropology 35:6-22.

Frenkel, R. E., and J. C. Morlan. 1990. Restoration of the Salmon River salt marshes: retrospect and prospect. Unpublished Final Report to US Environmental Protection Agency, Region 10, Seattle, Washington.

Greene, S. E. 1982. Neskowin Crest Research Natural Area. Supplement 13. *In* J. F. Franklin, F. C. Hall, C. T. Dyrness, and C. Maser (editors). 1972. Federal Research Natural Areas in Oregon and Washington: a guide for scientists and educators. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Greene, S. E., and T. Blinn. 1991. Research publications of the Cascade Head Experimental Forest and Scenic Research Area, Oregon Coast Range, 1934 to 1990. USDA Forest Service General Technical Report PNW-GTR-268. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Gunther, E. 1973. Ethnobotany of Western Washington: The Knowledge and Use of Indigenous Plants by Native Americans. Revised edition. University of Washington Press, Seattle, Washington.

Hafele, R., and S. Hinton. 1996. Guide to Pacific Northwest Aquatic Invertebrates. Aquatic Biology Series: Book 1. Oregon Trout, Portland, Oregon.

Hall, R. L. 2001. Nah-so-mah village, viewed through its fauna. Unpublished Report to Sea Grant Program, Oregon State University, and the Coquille Indian Tribe, on file at Department of Anthropology, Oregon State University, Corvallis, Oregon.

Harcombe, P. A., M. E. Harmon, and S. E. Greene. 1990. Changes in biomass and production over 53 years in a coastal *Picea sitchensis-Tsuga heterophylla* forest approaching maturity. Canadian Journal of Forest Research 20:1602-1610.

Hebda, R. J., and R. W. Mathewes. 1984. Holocene history of cedar and native Indian cultures of the North American Pacific coast. Science 225:711-713.

Hemstrom, M. A., and S. E. Logan. 1986. Plant association and management guide, Siuslaw National Forest. USDA Forest Service, Pacific Northwest Region R6-Ecol 220-1986a, Portland, Oregon.

Hines, W. W. 1971. Plant communities in the old-growth forests of north coastal Oregon. M. S. Thesis, Oregon State University, Corvallis, Oregon.

Hitchcock, C. L., and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press, Seattle, Washington.

Howay, F.W. 1918. The dog's hair blankets of the Coast Salish. The Washington Historical Quarterly 9:83-92.

Lindsay, L. W., Jr. 1995. Native use of resources on the Oregon coast. Pages 191-210 *In* R. L. Hall (editor), People of the Coquille Estuary: Native Use of Resources on the Oregon Coast. Words and Pictures Unlimited, Corvallis, Oregon.

Little, E. L., Jr. 1971. Atlas of United States Trees. Vol. 1. Conifers and Important Hardwoods. US Department of Agriculture Miscellaneous Publication 1146. U. S. Government Printing Office, Washington, D. C.

Lyman, R. L. 1991. Prehistory of the Oregon Coast: The Effects of Excavation Strategies and Assemblage Size on Archaeological Inquiry. Academic Press, San Diego, California.

Maser, C., B. R. Mate, J. F. Franklin, and C. T. Dyrness. 1981. Natural history of Oregon coast mammals. USDA Forest Service General Technical Report PNW- 133. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Minor, R., and W. C. Grant. 1996. Earthquake-induced subsidence and burial of late Holocene archaeological sites, northern Oregon coast. American Antiquity 61:772-781.

Munger, T. T. 1944. Out of the ashes of Nestucca. American Forests 50:342-345, 367- 368.

Murray, T. A., and J. Marrant. 1983. Preliminary sampling of the Three Rox site, 35- LNC-33, on the Oregon coast. Pages 47-55 *In* D. E. Dumond (editor), Contributions to the Archaeology of Oregon 1981-1982. Association of Oregon Archaeologists Occasional Papers 2, Portland, Oregon.

Newman, T. M. 1959. Tillamook prehistory and its relation to the Northwest Coast culture area. Ph. D. Dissertation, University of Oregon, Eugene, Oregon.

Norton, H. H. 1979. The association between anthropogenic prairies and important food plants in western Washington. Northwest Anthropological Research Notes 13:175-200.

Oregon Department of Fish and Wildlife. 1997. Salmon River Basin fish management plan. Salem, Oregon.

Ross, R. E. 1990. Prehistory of the Oregon coast. Pages 554-559 *In* W. Suttles (editor), Handbook of North American Indians Vol. 7: Northwest Coast. Smithsonian Institution, Washington, D. C.

Sauter, J., and B. Johnson. 1974. Tillamook Indians of the Oregon Coast. Binfords & Mort, Portland, Oregon.

Seaburg, W. R., and J. Miller. 1990. Tillamook. Pages 560-567 *In* W. Suttles (editor), Handbook of North American Indians Vol. 7: Northwest Coast. Smithsonian Institution, Washington, D. C.

Thompson, K., and D. Snow. 1974. Fish and Wildlife Resources, Oregon Coastal Zone. Oregon Coastal Conservation and Development Commission, Portland, Oregon.

Turner, N. J., and A. Davis. 1993. "When everything was scarce": The role of plants as famine foods in northwestern North America. Journal of Ethnobiology 13:171- 201.

USDA Forest Service. 1938. A guide to the Cascade Head Experimental Forest. Pacific Northwest Forest Experiment Station, Portland, Oregon.

USDA Forest Service. 1999. Salmon River Estuary restoration. Cascade Head Scenic- Research Area. Unpublished feasibility study, Siuslaw National Forest, Corvallis, Oregon.

Verts, B.J., and L.N. Carraway. 1998. Land Mammals of Oregon. University of California Press, Berkeley, California.

Wiedemann, A. M. 1984. The ecology of Pacific Northwest coastal sand dunes: a community profile. USDI Fish and Wildlife Service Publication FWS/OBS- 84/04. Washington, D. C.

Zontek, T. 1978. Test excavations and cultural resource evaluation of the Oceanside site (35-TI-47). Unpublished manuscript, Department of Anthropology, Oregon State University, Corvallis, Oregon.

Received 5 December 2001
Accepted for publication 16 May 2002

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Folivory of Vine Map Forest

Abstract

Folivory of vine maple was docun consumption by lepidopteran larva the period from bud break to leaf rearing to adult. Weekly folivory p seasonal herbivory was 9.9% of lea represented by eight taxa in the G served, suggesting that the folivor was a significant component of sta vine maple is a regionally widespr communities and leaf-based food

Introduction

Herbivory in forested ecosy consumption of foliage, pl woody tissue by animals. Ty herbivory levels of 7.1% for 11.1% for shade-tolerant s tropics have been reported, b (Coley and Barone 1996). In folivore outbreaks of the worm (*Choristoneura occi* (Brookes, 1987) or the wes (*Lambdina fiscellaria lugul* (Harris et al. 1982) in tem can produce defoliation app bivory also varies spatially, to 54% along an elevation (Lowman 1995). Studies ar measuring holes produce arthropods, and therefore de

Old-growth conifer fores west west of the Cascade R have defoliator outbreaks (P Exceptions are outbreaks o the western hemlock looper ally produces patches of inte growth stands dominated (*Tsuga heterophylla*) (Harr

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