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PLANT FOOD RESOURCE RANKING ON THE UPPER KLAMATH RIVER OF OREGON AND CALIFORNIA: A METHODOLOGY WITH ARCHAEOLOGICAL APPLICATIONS

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ABSTRACT. — Ethnographic, biogeographic, nutritional and experimental data are used to rank the relative value of plant food resources available in the precontact period to indigenous peoples of the Upper Klamath River. The regional ethnographic record identifies more than 60 food plants which grow within the study area, located in the western United States, along the Oregon-California border. Analysis indicates that only a modest number are ranked highly enough to have appreciably influenced food procurement strategies. The most important of these are *Quercus garryana*, *Q. kelloggii*, *Perideridia* spp., *Pinus lambertiana*, *Madia* spp., *Pinus ponderosa* and several Rosaceae species. The plants which would have been most amenable to intensification are in the *Quercus* and *Perideridia* genera. Many of the remaining plants tend to be erratic producers, have restricted range distributions, have low caloric return rates or evidence some combination of these factors. This information supplements the archaeological record, suggests archaeological applications, and helps clarify the relationship between indigenous peoples and food resources along the Upper Klamath River. While this study focuses on a particular location, the methodology used for this analysis may have a broader utility in the evaluation of the role of plant foods in hunter-gatherer diets.

RESUMEN. — Datos etnográficos, biogeográficos, nutricionales y experimentales son usados para categorizar el valor relativo de los recursos alimenticios de las plantas disponibles en el periodo de pre-contacto a la gente indígena del "Upper Klamath River." El récord etnográfico regional identifica más de 60 plantas alimenticias las cuales crecen dentro del area de estudio, localizada en el oeste de los Estados Unidos, y a lo largo de la frontera de Oregon y California. Los análisis indican que solamente un modesto número de plantas tienen un grado suficientemente alto de valor relativo para ser consideradas como estratégicas para su obtención. Las más importantes de éstas son: *Quercus garryana*, *Q. kelloggii*, *Perideridia* spp., *Pinus lambertiana*, *Madia* spp., *Pinus ponderosa* y varias especies de la Rosaceae. Las plantas más sensibles a la intensificación pudieron haber sido la *Quercus* y la *Perideridia*. Muchas de las otras plantas restantes tienden a ser erráticas productoras, tienen rangos restringidos de producción, producen bajos niveles de calorias o muestran la combinación de alguno de estos factores. Esta información de ambos suplementos el récord arqueológicas sugeridas puede ser usada para tener un mejor conocimiento de las relaciones entre los indígenas y los recursos del "Upper Klamath River." Mientras este estudio se enfoca en una zona particular, la metología usada por este análisis podría tener una utilizacíon más amplia en la evaluación del papel de la comida de plantas para la dieta de los cazadores/ recogedores.

RÉSUMÉ. — Les données ethnographiques, biogéographiques, alimentaires et expérimentales sont utilisées pour classer la valeur relative des resources des plantes alimentaires disponibles aux les peuples autochtones qui habitaient près du haut Fleuve Klamath avant 1827 (date du premier contact avec les Européens). Les données régionales ethnographique relèvent plus de soixante plantes alimentaires qui poussent dans la région où l'étude prend place à l'ouest des Etats-Unis à la frontière entre l'Oregon et la Californie. Les analyses indiquent que seulement un nombre très modeste de ces plantes sont classées suffisamment hautes pour avoir exercé d'une façon importante une influence sur les stratégies d'obtention alimentaire. Parmi les plus importantes sont *Quercus garryana, Q. kelloggii*, les espèces *Perideridia*, les espèces *Madia, Pinus ponderosa*, et plusiers espèces Rosaceae. Les plantes qui auraient été les mieux disposées á une intensification sont parmi les genres *Quercus* et *Perideridia*. Beaucoup des plantes qui restent ont tendance à se reproudire d'une façon irrégulière et capricieuse, ont également une distribution de portée limitée, possèdent une quantité insuffisante d'energie thermique où bien font preuve de combinaison des facteurs. Ces renseignements s'ajoutent aux données archéologiques, suggèrent des applications archéologiques, et aident à mettre au point le rapport qui existe entre les peuples indigènes et les resources alimentaires du haut Klamath. Tandis que cette étude se concentre sur un endroit précis, la méthodologie utilisées pour cette analyse aurait peut-être des applications plus larges dans l'évaluation du rôle des plantes alimentaires dans le régime des peuples chasseurs-cuilleurs.

What we know suggests that analysis of landscapes in terms of the distribution and abundance of food...will lead directly to the elucidation of archaeological site distribution...

C. Melvin Aikens (1982:152)

INTRODUCTION

Plant food resource ranking provides a research methodology which may prove particularly useful where traditional food procurement practices are no longer in place. It is a theoretically motivated method of ordering the ethnobotanically relevant elements of a regional or local flora into a hierarchy which suggests both predictive and retrodictive applications. Its deductive approach yields hypotheses which may be incorporated into archaeological research designs and tested against the independent archaeological record. While this assessment focuses on a particular region, the methodology may be more broadly applicable and have particular value for archaeobotanical evaluations and diet reconstruction.

The archaeological evidence for resource use in the Far West is strongly weighted toward the recognition and evaluation of animal rather than plant food resources. However, plant food gathering constitutes an important component of the subsistence strategies of many hunting-gathering peoples, influencing the locations of living sites, task sites, and patterns of seasonal movement. Nutritional data strongly suggest that plant-derived carbohydrates are an essential part of most diets, especially of diets having a high proportion of lean animal foods (Speth and Spielmann 1983; King 1994:197). Researchers in various locations are developing methods to evaluate the role of plant foods in hunter-gatherer diets. Using ethnographic information, Hunn (1981) has reassessed the role of carbohydrate foods and concomitantly the economic contribution of women on the Columbia Plateau. Turner (1988) used data from two Interior Salish groups in British Columbia to develop a methodology for the evaluation of the relative importance of plants within traditional cultures. Recent archaeological work in the Fort Rock, Oregon, vicinity addresses the context of plant food use among the early inhabitants of that region (Aikens and Jenkins 1994; Prouty 1995). While description has been the foundation of ethnobotany, description may be enhanced through the quantification of measurable values (Prance *et al* 1987; Phillips and Gentry 1993). This paper outlines an approach to the quantification of the relative dietary value of specific plants available to the indigenous people who lived along the Upper Klamath River in the vicinity of the Oregon-California border. In the proto-historic period, the Shasta people were most closely associated with the study area, although the Klamath and Modoc peoples may have used portions of the area for resource procurement (Figure 1).

Anthropological literature pertaining to this region is sparse, and with a few exceptions, obscure. Ethnographic material pertaining to the Upper Klamath River region has been summarized by Theodoratus (1991:9-17). A range of perspectives

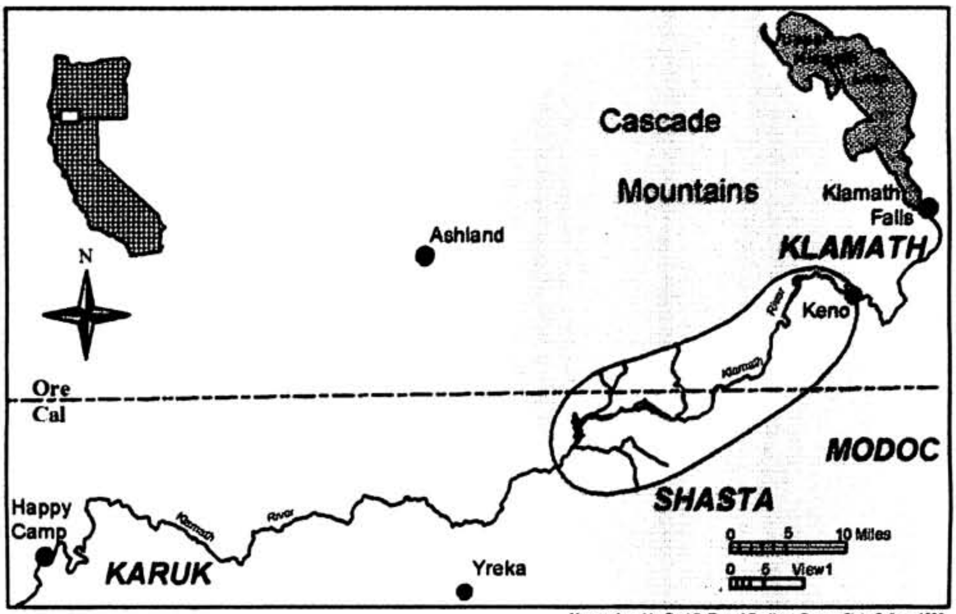

FIGURE 1. — Map of study area showing general locations of ethnographic groups discussed in the text. Map by Paul Caffrey, Department of Geography, Southern Oregon University.

on the prehistory of the region may be found in Hannon and Olmo (1990). Archaeological research in the area was sporadic until the mid-1980s (Newman and Cressman 1959; Cressman and Wells 1962; Leonhardy 1961; Anderson and Cole 1964; Cole 1965; Mack 1979, 1983; Jensen and Farber 1982; Gehr 1985, 1986a, 1986b; Jensen 1987). Mack (1991) recently synthesized this research. Archaeological investigation has identified numerous small temporary camps, large temporary camps, and more permanent habitation sites within the project area. Mack (1991:42) suggests that people continuously used the upper Klamath River vicinity from approximately 7500 years ago through the proto-historic period. Ethnobotanical research for the study reported here is being conducted in conjunction with archaeological investigations which began during the 1992 field season, in which Mack serves as principal investigator.

The working plant list for the project area includes more than 60 species identified as food resources in the regional ethnographic record.[1] During the precontact period, these plants exhibited a range of significance for the people who inhabited the area; some likely drove resource procurement strategies while others were harvested infrequently and opportunistically. Ideally, evaluations of the importance of food resources should be accomplished by Native People living within the context of traditional cultures (Turner 1988:274). However, in the Upper Klamath River region, traditional food procurement systems have not been in place since the late 19th century and a limited body of ethnographic data exists pertaining to resource procurement. In the absence of robust and site specific ethnographic data, this paper uses biogeographic, regional ethnographic, and nutritional data to estimate the relative dietary value of plant food resources for indigenous peoples. The goal is to retrodict the multi-component environmental information system that may have guided plant food procurement behaviors. Plant food resource ranking may have heuristic value in supplementing and helping to interpret the archaeological and archaeobotanical record, leading to a better understanding of the relationship between prehistoric peoples and resources along the Upper Klamath River.

The specific applicability of these data are limited in space and time. Spatially they apply only to the Cascade Mountain portion of the upper Klamath River and its adjacent uplands. Chronologically they apply to that period of time during which the present general climatic regime has been in effect, approximately the past 4000 years. Climate-mediated discontinuities in plant distributions, abundance and productivity prior to 4000 B.P. make observations based on present vegetation patterns much less applicable.

Physiographic setting. — The Klamath River drains the shallow lakes and marshes of the Klamath Basin along the southern Oregon-northern California border. As the river drops toward the south and west, entering the Cascade Mountains, it forms a steep canyon within a wider trough comprised of a series of terraces (Figure 2). The Upper Klamath River is that portion of the river above the Cascade Mountain-Klamath Mountain contact. For the purpose of this paper, the study area extends along the Cascade portion of the Upper Klamath River and includes the terraces and adjacent uplands above the river between 640 and 1370 meters (2100 and 4500 feet) (Figure 1).

FIGURE 2. — Upper Klamath River Canyon with Oregon white oaks in foreground.

Climate. — The climate of the Upper Klamath River country is transitional between a continental climate and one strongly modified by the presence of the Pacific Ocean. Since the Upper Klamath River falls within the rain shadow of the Klamath Range to the west, the incoming Pacific storms are usually diminished and precipitation is comparatively low, particularly for a Cascade Range location, averaging between 31.2 - 48.5 cm (12.3 -16.1 in). [2] The most important characteristic of the climate is its unpredictability. A wet year may be followed by a year so dry that it would fit the pattern of the Great Basin. Unusually warm weather in late spring, summer, or early fall may be followed by a hard freeze. The average year in this locale is a summation of mean climatic values around which the actual weather and year-to-year climate oscillates wildly (Figure 3). This intrinsic climatic variability profoundly affects the year-to-year availability of many of the plant food resources found within the study area.

Plant biogeography. — The Klamath River is one of only three rivers which cut entirely through the Cascade-Sierra uplift. The upper reach of the Klamath River, as it flows through the Cascade Mountains, is the most botanically heterogeneous landscape along its entire course. The Cascade Range serves as a semi-permeable biogeographic boundary between the Great Basin Floristic Province and the California Floristic Province. The trough created by the river functions as a corridor connecting portions of the two provinces. The ranges of plants characteristic of

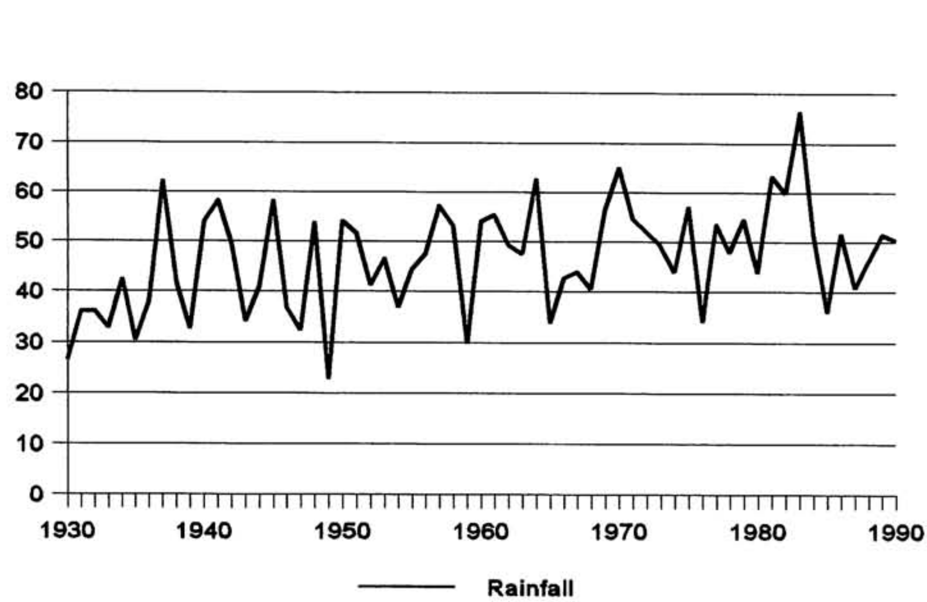

FIGURE 3. — Yearly rainfall in study area (in centimeters).[3]

each region interdigitate throughout the study area, resulting in a large number of species with the potential for ethnobotanical importance. The biogeography of ethnobotanically important species probably had strong cultural implications, influencing the location of resource collection areas, the plant materials chosen for the manufacture of artifacts such as baskets and nets, as well as the primary plants available for sustenance. Trade relationships likely derived from the unequal distribution of culturally important plant resources.

Two ethnobotanically important habitat types, the upland alluvial meadow and the lithosol meadow, are found above the Cascade section of the river, though not commonly within the Klamath Mountain section to the west of the study area. Both of these habitat types form in areas of gentle topography and poor local drainage associated with basalt/andesite rock types weathering into soils with a high proportion of clay particles. These locations are associated with concentrations of ethnobotanically important geophyte species in genera including *Allium, Brodiaea, Camassia, Dichelostema, Lomatium, Perideridia,* and *Triteleia.*

Oak woodlands, which characterize large portions of the California Floristic Province, extend well up the Klamath River. The two oak species which are found along the upper river are California black oak (*Quercus kelloggii* Newb.) and Oregon white oak (*Q. garryana* Hook.), also known as Garry oak. Both species reach their primary upriver range limits on south-facing slopes only a few miles below the point where the river enters the Cascades from the Klamath Basin. Within the California Floristic Province, wherever oak trees are common, acorns have served as a dietary staple. In fact, the abundance of oak trees has been one of the factors used to attempt to retrodict aboriginal population densities within California (Baumhoff 1963:223). Shrubs, which have an especially large number of ethnobotanical uses, are particularly well-represented in the mix. Along and above the rather short stretch of river within the Cascades there are more than 70 shrub species, more than are found within the entire hydrographic Great Basin (Mozingo 1987).

The context of plant food resources. — Plant food resource ranking information is most useful when it is integrated with and contextualized by information about other available resources (Simms 1984:75). Deer (*Odocoileus hemionus hemionus* Rafinesque, *O. hemionus columbianus* Rafinesque) and fish were staple foods on the Upper Klamath River, and are ethnographically regarded as having relatively equal value as resources (Voegelin 1942:58). Although deer are resident year-round, the local dispersed population is supplemented in late fall and winter by a much larger population which migrates into the relatively snow-free elevations of the study area from the surrounding high country (BLM 1990:2-28; map 2-5). Deer are most concentrated and would have been accessible from former village sites during the colder months when caloric demand would have been high and unstored plant food resources would have been generally scarce (Table 1). In winter and spring, deer provide lean meat, with most of their caloric value derived from protein. In May, 1828, as explorer Jedediah Smith worked his way down the Klamath River to the west of the study area, he commented on the poor quality of the spring venison (Morgan 1953:262).

Prehistorically, anadromous fish were the most abundant of the aquatic resources available in the upper Klamath River. While many species of anadromous fish migrated through the upper river, the most important runs were of the spring and fall Chinook salmon (*Onchorynchus tshawytscha* [Walbaum]). The spring Chinook run was the larger and began in April (Holt 1946:310). The spring salmon had a relatively high fat content and so dried and stored poorly. The run of fall Chinook usually began in late September, peaked in October, and was over by early November (Klamath River Basin Fisheries Task Force 1991:4-8). The fall salmon were relatively low in fat content and thus dried and preserved well.

Hunting, fishing, gathering, processing, and storage were coordinated strategies. However, among the Shasta, Modoc, and Klamath peoples, these interdependent strategies were highly gender-specific; the men concentrated on anadromous fish and large game while the women procured plant food resources (Voegelin 1942:62-3). King (1994:197) has suggested that, for nutritional reasons, most prehistoric societies in the temperate zone obtained at least half of their calories from plants. During winter, the period of highest caloric demand, both deer and stored fish furnished low-fat, high-protein diets. Carbohydrates and fats, derived from plants provided by women, supplied nutritional benefits well beyond their caloric value by buffering the deleterious effects of a high protein diet and by increasing the efficiency with which lean animal foods were metabolized (Speth and Spielmann 1983; Leiberman 1987:231-235). There is, therefore, a functional consistency in analyzing plant food resources, even in the absence of particular estimates of nutritional and caloric return values derived from fish and game.

METHODOLOGY

The methodology employed in resource ranking is synthetic, incorporating ethnographic, biogeographic and nutritional data to rank the relative value of plant food resources. Regarding the biogeographic data, it is assumed that the present distribution of species and the availabilities and predictability of harvestable portions reflects characteristics of precontact conditions. Regarding the ethnographic

TABLE 1 — Comparative Importance Ratings and Estimated Caloric Return Rates For Plant Food Resources Found Along the Upper Klamath River.

Species	Part Used	1	2	3	4	5
Staples						
Quercus garryana	acorn	33	11	11	11	8400
Quercus kelloggii	acorn	33	10	11	12	5000
Perideridia oregana	root	32	11	13	8	650
Perideridia bolanderi	root	32	11	13	8	<250
Perideridia gairdneri	root	30	10	13	7	<250
Pinus lambertiana	seeds	30	9	10	11	500
Important						
Madia spp.	seeds	27	9	9	9	350
Sambucus mexicana	fruit	27	8	9	10	2000
Amelanchier utahensis	fruit	27	9	10	8	>250
Perideridia erythrorhiza	root	25	9	8	8	250
Camassia quamash	bulb	25	9	8	8	850
Pinus ponderosa	cambium	25	13	4	8	400
Rhus trilobata	fruit	24	10	6	8	700
Arctostaphylos patula	fruit	24	9	7	8	400
Pinus ponderosa	seeds	24	12	5	7	400
Prunus subcordata	fruit	23	8	6	9	1000
Brodiaea coronaria	corm	23	12	4	7	<250
Sometimes important						
Ribes velutinum	fruit	22	8	6	8	<250
Typha latifolia	rhizome	21	12	2	7	400
Rumex spp.	seeds	21	13	2	6	<250
Prunus virginiana	fruit	21	5	10	6	<250
Vitis californica	fruit	21	9	7	5	<250
Sometimes used						
Cornus glabrata	fruit	20	10	3	7	500
Bryoria sp.	thallus	20	13	2	5	400
Lomatium piperi	tuber	20	8	5	7	>250
Lomatium nudicaule	stem	20	7	6	7	<250
Scirpus acutus	seeds	19	10	1	8	900
Pinus lambertiana	sap	19	9	4	6	<250
Rubus ursinus	fruit	19	4	9	6	<250
Lilium pardalinum	rhizome	18	8	4	6	>250
Darmera peltata	greens	18	7	4	7	<250
Dichelostema capitatum	corm	18	10	4	4	<250
Rosa spp.	fruit	18	10	2	6	<250
Fritillaria recurva	bulb	17	4	6	7	<250
Carex spp.	stem	17	9	3	5	500
Scirpus acutus	rhizome	17	11	1	5	<250
Sparganium sp.	root/stem	17	10	2	5	<250
Balsamorhiza sagittata	seeds	17	9	2	6	<250
Eriogonum spp.	seeds	16	9	1	6	<250
Calochortus macrocarpus	bulb	16	9	2	5	400
Eriogonum nudum	stem	16	7	1	8	<250
Rubus leucodermis	fruit	16	7	3	6	<250

TABLE 1 — (continued)

Species	Part Used	1	2	3	4	5
Sometimes used						
Rubus parviflorus	fruit	16	6	4	6	<250
Descurainia pinnata	seeds	15	7	1	7	350
Mentzelia laevicaulis	seeds	15	7	2	6	400
Pinus contorta	cambium	15	6	2	7	400
Allium spp.	bulb	15	10	1	4	<250
Chrysolepis sempervirens	seeds	15	6	3	6	<250
Leymus cinereus	seeds	15	7	2	6	550
Elymus glaucus	seeds	14	7	1	6	550
Arctostaphylos nevadensis	fruit	14	6	4	4	<250
Fragaria vesca	fruit	14	7	2	5	<250
Heracleum lanatum	stalks	14	7	2	5	<250
Low or infrequent use						
Helianthus bolanderi	seeds	13	6	1	6	300
Grindelia sp.	foliage	13	6	1	6	<250
Phragmites australis	seeds	13	6	2	5	300
Pinus contorta	seeds	13	7	1	5	<250
Prunus emarginata	fruit	12	7	1	4	<250

1 Rating. 2 Availability rating. 3 Ethnographic rating. 4 Nutritional rating. 5 Return rate, cal / hr.

data, it is assumed that the ethnographic record accurately, although incompletely, documents actual resource use. It is further assumed that the Shasta people were the long-term occupants of much of the study area, and that Shasta data should therefore carry the greatest weight. Regarding the nutritional data, it is assumed that optimal foraging models predict and retrodict actual human behavior.

Each plant food species found within the study area and identified within the regional ethnographic record is ranked according to attributes which may have affected its utility (see Appendix 1). These attributes may be divided into three broad categories reflecting the plant's ecological salience, perceptual salience, and potential utility (Turner 1988:272-278). The attributes combine and interact to affect the projected cultural importance of particular species. This projected importance is quantified by assigning numerical values to biogeographic, ethnographic, and nutritional characteristics (Table 1). Numerical values are assigned on the basis of theoretical assumptions pertaining to each of the data categories.

The broad categories of ecological salience, cultural salience, and potential utility are further divided into subcategories. Each broad category has an equal weight, facilitating comparisons between the categorical values. Sub-categories are weighted according to degrees of importance attached to each value. For example, the geographic abundance of a species (eight possible points) is deemed of greater importance than the seasonal availability of a species (four possible points). The weighting of the various categories and sub-categories, while certainly subjective, is based upon extensive fieldwork in the Upper Klamath River region. In other regions, common sense, ground-truthing, desired grain size, and refinement of the rating system method might well dictate different categorical and sub-categorical values and weightings. The categories and their sub-categories are further explained below (and Appendix 1).

Ecological salience (biogeographic and temporal availability rating). — An availability rating should include both the geographic distribution and abundance of the species as well as variations in the abundance of the food product over the course of a year and from year to year. The abundance rating categories are relatively fine-tuned, ranging from "locally rare" to "regionally abundant" and are weighted toward plants which are both abundant and located near known concentrations of Native American occupation sites. The temporal availability rating specifies the window during which a particular food product is both available and palatable. For instance, while some greens are available over most of the growing season, they are only palatable during a short period of time in the early spring. The year-to-year variability is particularly important for highly ranked resources. Oaks, for example, may produce an abundance of acorns one year, while having little or no production the next.

Changes in the plant communities along the Upper Klamath River since the early contact period have resulted in modifications of the distribution and abundance of ethnobotanically important species. Decreased fire frequency, the introduction of non-native plant species, logging, and the establishment of domestic stock grazing initiated most of the changes. Although we will never know all of the details relating to the nature of the precontact environment, we can factor many of the changes into an ethnobotanical analysis. In the Upper Klamath River area, we are relatively close in time and condition to the precontact environment, which remained largely intact until the 1850s. Relevant historic, ethnographic, and ecological clues may be found which pertain to changes in the distribution and abundance of many species. Modifications of biogeographic and availability ratings based on changes since the precontact period are specified in the rating document (Appendix 2) for that particular species.

Perceptual salience (ethnographic ratings). — Ethnographic rating subcategories are based primarily on published ethnographies or ethnobotanical works pertaining to the cultures which inhabited the region at the beginning of Euroamerican occupation. Tribes located within and immediately adjacent to the study area are the Penutian-speaking Klamath and Modoc and the Hokan-speaking Shasta (Theodoratus 1991:9-11; Silver 1978:211). Two primary sources of ethnobotanical information pertaining to the Klamath and Modoc tribes, Coville (1898) and Ray (1963), are used to structure the data for these tribes. There is a paucity of ethnobotanical information in the primary ethnographies pertaining to the Shasta (Dixon 1907; Holt 1946; Silver 1978); consequently, data from these sources have been supplemented by information from additional ethnographic and ethnohistoric sources (Merriam MS; Curtis 1924; Kroeber 1925; Voegelin 1942; Olson 1960; LaLande 1981; Mary Carpelan, personal communication, 1998[4]). Ethnobotanical information regarding the Hokan-speaking Karuk (Schenck and Gifford 1952) are included in the analysis since the data are particularly detailed and were obtained from a river-oriented people located along the Klamath River, albeit a distance downstream.

Food resources within the study area not mentioned by the preceding sources were probably culturally or nutritionally insignificant. The numerical ratings are weighted toward Shasta data as the environment of the study area most closely approximates that of traditional Shasta territory, as a portion of the study area contains village sites reported to have been occupied by Shasta people, and as the Shasta maintain strong cultural ties to the region (Figure 4) (Theodoratus 1991:9-13; Betty Hall and Mary Carpelan, Shasta Nation, personal communications, 1993-1998). Processing and storage are cultural practices which extend resource availability and thus increase the plant food's importance. These data are drawn, in most cases, from the ethnographic record, which reflect actual cultural practices rather than potential applications.

Potential utility (nutritional and energetic rating). — The nutritional and energetic ratings complement the ethnographic ratings by providing dietary and economic information pertaining to why particular resources may have been used to a greater or lesser extent. The caloric value of a plant food shows the relative concentration of energy units available per unit of weight from each resource. While plant food resources provide nutritional benefits in addition to calories, the caloric value provides a readily comparable currency for ranking various resources (Smith and Winterhalder 1981:20-21; Simms 1984:46; Kelly 1995:101-102). Most of the nutritional information was obtained from Kuhnlein and Turner (1991), since their coverage includes a large number of species or closely related species found within the study area. Sources of nutritional information for plants more proximate to the study area include Benson *et al* (1973); Farris (1982); Norton *et al* (1984); Simms (1984); and Couture *et al* (1986).[5] In some cases, approximate caloric values were calculated by averaging the values of related species.

Caloric values are useful in rating plants as energy sources. However, they can be misleading when applied to the actual economics of resource use. For instance, very small seeds may have a high caloric value per unit weight but they are often inefficient to gather. Experimental work conducted in the Great Basin by Simms (1984) and Jones and Madsen (1991) clarifies some of the relationships between base caloric values and the caloric return rates which may be expected from particular plant resources. The rating system for the energetic sub-categories described here relies heavily upon these published works as well as upon new experimental data obtained as part of this study.

Plants which contribute important nutrients in addition to calories are given added value. Plants which have more than one food use are given a separate rating for each use. For example, sugar pine (*Pinus lambertiana* Douglas) has edible seeds as well as edible sap crystals. Since each product is obtained by different methods, at different times of year, and each has different caloric values and processing methods, they are rated separately.

While some plant foods such as fresh fruits and greens may be eaten with little or no modification, most plants require varying degrees of processing in order to yield a digestible,

nutritious, and/or storable product. Energy expended in processing these foods may greatly reduce their net caloric value. Simms' experimental data on 24 plant food resources show that on average, about 40% of the value of the hourly caloric

FIGURE 4. — Members of the Shasta Tribe still use the study area for plant gathering and ceremonial purposes. Betty Hall is shown in an *ipos* meadow. Photo courtesy of Mary Carpelan.

return rate was lost in processing (1984:86-87, Table 2). Although it is recognized that many resource-specific variables influence the "cost" of processing, the rating system developed here is based simply upon the type of plant food. Most fresh fruits and greens are considered to have no processing requirements. Fruits which are dried; and large, non-toxic nuts such as sugar pine nuts, are considered to have low processing requirements. Geophytes and medium-to-large seeds such as those of tarweed (*Madia* spp.) are rated as having moderate processing requirements, while acorns and small, chaffy seeds are considered to have high processing requirements. These assignations, while somewhat arbitrary, are generally supported by data in O'Connell and Hawkes (1981:118-119), Simms (1984:86-87, Table 2), Thoms (1989:237-238), Basgall (1987:24), Cane (1987:430), and Wright (1994:244-245). Deviations from these general categories are occasionally made where more applicable processing requirements are documented.

The diet-breadth model simulatess practical economic decisions made by people attempting to maximize energy intake while minimizing energy expenditures. The model, as used by Winterhalder (1981) and Simms (1984), specifies that the resource rendering the greatest caloric return rate per unit of energy expended will be the one preferentially harvested if higher ranked resources become unavailable. The ranking of plant food resources in terms of net caloric values (i.e., return rates) helps to clarify the relative value of a suite of plants within a particular region. The ranking system developed here is area-specific for the Upper Klamath River, relying upon the geographical distribution and abundance of the various species as well as upon potential caloric return rates. For example, although blue elderberries (*Sambucus mexicana* C. Presl (*S. caerulea* Raf.)) have a potentially high caloric return rate (2,500 cal/hr), they are sparsely distributed within this specific geographical area and so would be relatively inefficient to harvest in quantity. *Ipos* (*Perideridia* spp.),[6] on the other hand, have a lower caloric return rate but are much more widely distributed and available over a longer period of time. Thus they achieve a higher overall importance rating.

The implementation of the rating system is illustrated below, first for a highly rated resource, Oregon white oak, then for the much lower ranked Bolander's sunflower (*Helianthus bolanderi* A. Gray). An understanding of how the rating system operates may be facilitated by referring to the Resource Ranking Criteria (Appendix 1). Documentation of the ratings may be found in Appendix 2.

The biogeographic and temporal availability rating for Oregon white oak acorns is 11 out of a possible 16 points. This rating is obtained by combining the geographic abundance rating (7) with the seasonal availability rating (2) and the variability rating (2). The ethnographic rating (11 out of a possible 16 points) is derived by adding the use rating (4), the importance rating (3), and the processing and storage rating (4). Finally, the nutritional and energetic rating (11 of a possible 16 points) is calculated by combining the caloric value rating (2) with the value for the caloric return rate (4), the processing value (1), the additional food value rating (2), and the economy of scale rating (2). Adding the three larger categories together (11+11+11) yields an overall importance rating of 33 which is the highest numerical value given to a species and equals that of California black oak, which has a slightly different rating profile (see Table 1).

The majority of food plants found within the study area, and identified within the regional ethnographic record, are ranked much lower than the oak species. An example would be Bolander's sunflower, ranked 54th out of ca. 60 species. The biogeographic and temporal availability rating of this sunflower is rated as six of a possible 16 points. Fieldwork indicates that it is uncommon, with very localized populations (2), it is available over a moderate period of time (2), and, since it is an annual, there are frequent fluctuations in its abundance (2). The ethnographic rating is low as well, since closely related species were recorded as having been used only by the Modoc (1). It is not recorded as important or a staple by any of the ethnobotanical works used in this study (0), and it was not recorded as having been dried or stored (0). The total ethnographic rating, then, is only one. The potential utility rating total is seven of a possible 16 points. The caloric value, ca. 365 cal/100g, is fairly high (3), but the caloric return rate is estimated at only ca. 300 cal/hr since local plant populations are scattered and sparse (2). Processing requirements are high (1) since the seeds are small and the heads are very chaffy. The seeds are given an additional food value of (2) due to the presence of fats in addition to carbohydrates and the Economy of Scale rating is (-2). The three larger categories are added together (6+1+6), yielding an importance value of 13. See Table 1 for comparative ranking profiles and estimated return rates.

DISCUSSION

The Upper Klamath River exhibits a great degree of vegetational diversity reflected in a correspondingly large number of plants having the potential for ethnobotanical importance. The great number of ethnobotanically relevant food plants growing within a small geographic area is due, in part, to the transitional nature and biogeographic complexity of the region. Many plants found within the study area are near the limits of their ranges. Thus they are subject to climatic extremes not experienced by populations located in less peripheral locations. Many species within the study area tend to exhibit small populations, disjunct patterns of distribution, and frequent failures in the production of fruit/seeds. Of the 22 species rated most important in the study area, ten, including the two most highly rated species, *Quercus garryana* and *Q. kelloggii*, exhibit frequent crop failures. If resource predictability strongly mediates a culture's adaptation to an environment (Yellen 1976:265), then the Upper Klamath River area was challenging to its Native inhabitants. Procurement strategies must have been modified frequently in the face of a highly unpredictable and variable resource base, or cultural buffers must have been in place to mediate the effects of the unpredictability of plant food resources.

By far the most important plant food resources, when they were available, were the acorns from two species of oaks. Acorns potentially provided a much higher caloric return rate per unit of energy invested than any other species. Their large component of carbohydrates and fats had the greatest capacity to offset the potential deleterious effects of a diet which would otherwise have been high in animal protein and seasonally low in fat. When acorns are abundant, they may be gathered in quantity and stored at little energetic expense. Although processing costs for acorns are high, an appreciable portion of these costs may be delayed until shortly before they are used and until there is little conflict with the gathering and processing of other plant food resources. The gathering and storage of a large volume of acorns may have been a low investment "insurance policy" against the possibility of a food shortage later in the year.

Variation in acorn availability would have affected the overall plant resource procurement strategy. If acorns were abundant, procurement would have been coordinated with the harvest of many other resources available in the early autumn. If acorns were scarc and thus energetically expensive to gather, scheduling conflicts would likely have occurred between acorn harvest and the harvest of other available plant food resources. Shrewd decisions were probably made regarding the energetic cost effectiveness of focusing on acorns *vis-à-vis* gathering other combinations of resources. Decisions might have been influenced by such factors as resource storability, delayed processing costs, and the "marketability" of resources to be used in trade for acorns as well as upon the energetic logic modeled by optimal foraging theory.

If current observations accurately reflect the precontact situation, there were frequently years in which, for all practical purposes, there was no crop of acorns to be harvested. The situation would be comparable to that further south, near the Cascade - Sierra Nevada border, where people relying on only one oak species (California black oak) recognized the real danger of starvation if that crop failed (Voegelin 1942:177). Options under the circumstance of a small or non-existent acorn crop may have included: 1) accumulation of resources with trade value, such as deer products or obsidian, to facilitate importation of acorns from downriver, 2) intensification of the harvest of other plant food resources, 3) temporary abandonment of the area, or 4) some combination of these responses. There is also the possibility that population levels were maintained below the level at which the availability of acorns became a nutritionally-limiting factor.

In the event of a shortfall or absence of an acorn crop, the plant food resource within the study area which had the greatest potential for intensification is ***ipos***. This resource, comprised of several species within the study area, meets most of the criteria for an optimal food source. It is consistently available from year to year, it is available during much of the year, it is storable, it was a valued trade commodity, and extensive processing is not essential in order to obtain good nutrition or palatability. *Ipos* was harvested by all cultures within the vicinity of the Upper Klamath River (Voegelin 1942.:177).

Ipos, in this region, was generally gathered in the spring, although there is a record of its having been gathered in late summer or fall as well (Coville 1897:101; Ray 1963:198; Holt 1946:308). The Modoc, lacking access to a large and consistent supply of acorns, devoted approximately one month in the spring to the gathering of *ipos*. Most were processed and stored for use during the coming winter (Ray 1963:198). While the Modoc had a single First Fruit Rite associated with *ipos*, the nearby Atsugewi had three rites associated with this root (Voegelin 1942:57, 176). An indication of how important *ipos* was to the Shasta may be found in the context of a 1960 interview with a Shasta elder, Sargent Sambo, who was at least in his mid-90s at the time. When asked about food, *ipos* was the only plant food which he described in detail:

> "*Epos* are kind of sweet, and we dug them for the winter. You could get lots of them, but they are no more...All those herbs are gone now. The cows have eaten off the tops and the roots have died." (Olson 1960:Appendix B).

The primary limitation to the intensification of this resource would have been its relatively modest initial caloric return rate, at best, one-tenth the return rate from gathering a fair crop of acorns (see Table 1). By way of comparison, much higher return rates are estimated for important geophytes on the nearby Columbia Plateau (Hunn 1981:130-131; Hunn and French 1981:92; Hunn 1990:176). While the estimated high-end caloric return rate for *ipos* in the Upper Klamath River region is 600-800 cal/hr, this rate may be appreciably lowered when *ipos* is dug from dry soil. During years in which autumn rains did not come until September, October, or even November, *ipos* may have been effectively unavailable for harvest. Dry, clay-hardened lithosols effectively thwart efficient procurement efforts. Even today, *ipos* is widely distributed in the alluvial meadows above the Upper Klamath River. Given the likelihood of an even greater abundance of this resource in the past, the limits on procurement would have had more to do with "costs" associated with digging, transporting, and processing these roots than with the species' physical abundance.

With the exception of ***ipos***, few other plant species within the study area have the capacity to support sustained harvest for a long period of time, resulting in the accumulation of a large volume of a storable food product. Those resources which may have supported some intensification include sugar pine, tarweed, elderberry, serviceberry, and, to a lesser extent, camas, three-leaf sumac, and manzanita. None of these, even in combination, has the capacity to equal the calories provided by a modest crop of acorns.

Probably the majority of the remaining plant food species were used occasionally when encountered and might have been nutritionally important at times, but they would not driven the resource procurement strategy. Nevertheless, plants having greens with a high vitamin content such as pestle lomatium (*Lomatium nudicaule* (Pursh) J. Coulter & Rose) or naked-stem eriogonum (*Eriogonum nudum* Benth.) probably were sought out, especially in spring (Holt 1946:309; Schenck and Gifford 1952:385). During times of food shortage, especially in early spring, such resources as the inner bark of ponderosa pine and the thalli of black lichen (*Bryoria* sp.) may have served an important function in providing short-term sustenance until other resources became available. The occasional large crop of Klamath plums (*Prunus subcordata*), grapes (*Vitis californica* Benth.), or chokecherries (*Prunus virginiana* L. var. *demissa* (Nutt.) Torrey) would likely have been factored into the resource procurement strategies for particular years as well. Geophytes such as camas, brodiaeas, and onions (*Allium* spp.) may well have been harvested in conjunction with *ipos*. Most of the remaining food plants either tend to be erratic producers, have restricted distributions, have low caloric return rates, or evidence some combination of these factors (see Appendix 2).

CONCLUSIONS

For a total of more than sixty food plant species reported in regional ethnographic sources and growing in the Upper Klamath River area, resource ranking predicts that only a small number would actually drive the resource procurement behaviors of indigenous peoples. One might suppose that a large number of plant species would comprise a stable resource base upon which indigenous cultures might have depended. In fact, the opposite may be true. Plants near the limits of their ranges often have low population densities, exhibit a high degree of patchiness and have inconsistent fruit production, characteristics which greatly diminish their usefulness and dependability. The generally low caloric return rates matched by low ethnographic ratings for the majority of species probably reflect their minimal contribution to the overall diets of peoples who lived in the vicinity of the Upper Klamath River. For example, resources which would tend to yield less than 250 cal/hr (30 of 58 resources, see Table 1) would have little potential for intensification since effort expended in gathering and processing would not compensate for calories lost in the effort. Nevertheless, enhanced storability may have made resources such as some ***ipos*** species, tarweed, and other small seed-bearing plants important components of the diet in spite of low return rates (Simms 1984:153-154).

The following resources are those most highly ranked according to the criteria of this study. They are listed in a descending order of importance. Acorns from two species of oaks: Oregon white oak and California black oak, the roots of three species of *ipos* (*Perideridia oregana, P. bolanderi,* and *P. gairdneri*) and the seeds of sugar pine. These species, listed as "staples" in Table 1, are hypothesized to have driven resource procurement behaviors on the Upper Klamath River. The interaction between human nutritional requirements and the plants upon which precontact peoples most depended, those most highly ranked in this study, should be manifested in the archaeological record.

Archaeological applications. — In her synthesis of Upper Klamath River archaeology, Mack (1991:44) called for "an inventory and study of plant resources...in order to understand the potential role of plants within the subsistence pattern of the canyon's past inhabitants." The current study, using biogeographic, ethnographic, and nutritional data, both supplements the archaeological record and suggests archaeological applications. The applicability of resource ranking to the archaeological record depends upon the identification of plants which would have most greatly influenced the location of living sites, task sites, and resource collection areas; and the identification of archaeological signatures for the use of these plants. The following are examples of explanations and testable predictions regarding the local archaeological record, based upon the resource ranking data:

1) While acorns are the most highly ranked plant food resource within the study area, retrodiction from present observations suggests that they were frequently unavailable. Therefore, artifacts associated with acorn processing should not be as strongly represented in the archaeological record of the Upper Klamath area as in regions where the acorn crop is more reliable. Within the California Floristic Province, it is assumed that mortars, pestles and hopper mortar bases are generally associated with acorn processing and that their abundance and relative proportions in a ground stone assemblage can be used as a measure of relative reliance on acorns (Basgall 1987:30). The paucity of mortars and pestles and hopper mortar bases (Mack 1991:10, Table 1, 11) along the Upper Klamath River may be related to the unreliability of the acorn crop reported in this study.

2) A prediction may be made regarding the relative abundance of ground stone tools associated with acorn processing within the study area. The upriver sites, surrounded by oak trees on the very margins of their range, should evidence fewer ground stone tools associated with acorn processing, while the downriver sites, closer to the climatic optimum for the two indigenous species of oaks, should evidence a greater quantity.

3) Resource ranking criteria predict that evidence of acorn procurement activities should be weighted toward locations having an abundance of California black oaks. Black oak acorns, because of their exceptional nutritional value, should have been preferentially harvested when available. The discrete, localized patches of these trees should have been visited more intensively than the more abundant and widespread locations supporting stands of Oregon white oak.

4) Resource ranking retrodicts that geophytes and some seeds would have been dietary staples. Mullers and millingstones are the tools usually associated with the processing of seeds and geophytes. Within the study area, mullers are the most common ground stone tool recovered and both mullers and millingstones are frequently found on the ground surface (Mack 1991:9). The abundance of these artifacts supports the importance attached to these resources by the ranking system. This hypothesis might be further tested by comparing the relative abundance of mullers and millingstones along the Upper Klamath River with their abundance along the middle portion of the Klamath River, where small geophyte and seed resources are far less abundant. Analysis of organic residues on mortars, pestles and other ground stone tools would give a stronger indication of the correspondence between the form and function of these artifacts.

5) The regional ethnographic record indicates that storage pits were used for vegetal foods (Merriam 1905-1929 film 1022: reels 15, 138; Barrett 1910:243; Spier 1930:167). Acorns and geophytes, the predominant foods recorded as being stored underground, are the highest ranked resources in this study. Resource ranking criteria thus predict that evidence of underground food caches should be common in the study area.

6) Within the northern California - southern Oregon region earth ovens were used for both flesh and vegetal foods (Voegelin 1942:61). However, in the Far West generally, the predominant use of earth ovens was for geophyte processing. Although earth ovens are recorded from the nearby Rogue Valley (Prouty 1989), they have not been identified along the Upper Klamath River. In this vicinity, the most highly ranked geophyte, *ipos*, appears to have been processed without the use of earth ovens (1873 interview with Calvin Hall quoted in Neasham 1974:12; Howe 1968:184). Camas and balsamroot (*Balsamorhiza sagittata* (Pursh) Nutt.), which are usually processed in earth ovens, are not abundant and are comparatively low-ranked within the study area. Resource ranking thus predicts that earth ovens used for vegetal food processing would be much less common along the Upper Klamath River than in regions where the predominant geophytes were usually oven-processed, such as in the Pacific Northwest.

7) A general conclusion from the resource ranking data is that plant foods on the Upper Klamath River are patchy, dispersed, and in many cases, unpredictable. Ray, in his description of the neighboring Modoc environment, states that, "The total number of species utilized was impressively large but the physical character of the Modoc habitat was such that many kinds of plants were found only in limited numbers and in widely distributed patches" (1963:197). The Upper Klamath River is of similar character. Patchy, dispersed, and unpredictable resources should foster the mobility characteristic of peoples practicing broad-spectrum resource use. Mobile groups should tend to occupy small settlements, build temporary dwellings requiring minimal energy investment, and construct small storage caches. The archaeological record along the Upper Klamath River tends to validate these hypotheses, although small occupation sites with semi-subterranean houses appeared by at least 1100 B.P. (Mack 1991:39). One factor which may have made this semi-sedentism possible was the amenability of the most highly ranked plant resources to some degree of intensification.

8) According to optimal foraging theory, a relationship exists between the distance people are willing to travel to procure a resource and its caloric return rate (Kelly 1995:133-135). This model predicts that with increasing sedentism, calorically low-ranked plant food resources located at a distance from living sites would be eliminated from the diet. Increased trade associated with semi-sedentism, as evidenced in the archaeological record (Mack 1991:23), might have been one response to the energetic inefficiency of gathering lower-ranked plant foods. Readily obtainable goods such as obsidian and deer hides (Mack, personal communication, 1997)[7] may have been traded for foods more efficiently imported than gathered. Thus, during the late prehistoric period, the evidence of increased trade in the archaeological record may be evidence of the general tenuousness of the region's plant food resource base.

Additional archaeological and ethnobotanical analysis and paleobotanical analysis should help to clarify the roles of plants in the economy of the past inhabitants of this region. While the present study has relied upon biogeographical data most applicable to the recent past, paleoenvironmental reconstructions should serve to more closely coordinate the earlier archaeological record with the long-term interactions of plants and people along the Upper Klamath River.

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NOTES

[1] Voucher specimens from this ethnobotanical study on the Upper Klamath River are in Donn Todt's possession. A duplicate set of voucher specimens is curated by the Department of Biology Herbarium at Southern Oregon University, Ashland, Oregon. Botanical nomenclature is according to The Jepson Manual: Higher Plants of California, 1993, Hickman (editor). *Perideridia erythrorhiza* follows Chuang and Constance (1969). Because the Jepson Manual is parsimonious in its use of common names, these are derived from Munz and Keck (1968), Hitchcock and Cronquist (1973), Niehaus and Ripper (1976), as well as Hickman (1993).

[2] The lesser precipitation figure, characterizing the southwestern, low elevation section of the study area, is from Montague, California, located approximately 15 km. south of the river. The greater precipitation figure, characterizing the northwestern, higher elevation portion of the study area, is from Keno, Oregon, located adjacent to the river on the eastern side of the Cascade Range.

[3] Precipitation figures are derived from the vicinity of COPCO Reservoir, in the southwestern portion of the study area. Data courtesy of PacifiCorp, COPCO Division.

[4] Mary Carpelan (Shasta Nation, Quartz Valley Indian Reservation) P.O. Box 773, Yreka CA, 96097.

[5] In Appendix 2, when sources using "dry weight" calculations of calories were referenced, these figures were converted to approximate "fresh weight" values for ease of comparison.

[6] *Ipos* (also spelled *epos, apos, epa, apaws* in the ethnohistoric literature), is both a Native American and an English colloquial name applied to some species within the genus *Perideridia*. *Yampa*, also having many spellings, is the term used in the Great Basin and Rocky Mountain region for a number of species within this same genus (Todt 1997:252-255).

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APPENDIX 1

Resource Ranking Criteria

I. Ecological Salience (Biogeographic and Temporal Availability Rating)

- A. Geographic Abundance
  - +1 Isolated individuals or isolated small stands
  - +2 Uncommon and localized populations
  - +3 Small populations within restricted environments
  - +4 Scattered individuals or stands throughout a significant portion of the study area
  - +5 Common within localized portions of the study area, usually well removed from the river
  - +6 Common within localized portions of the study area near river
  - +7 Common within a significantly large portion of the study area
  - +8 Abundant throughout much of the study area
- B. Seasonal Availability (by month)
  - +1 Available over a short period of time (< 1 month)
  - +2 Available over a moderate period of time (1-3 months)
  - +3 Available over a long period of time (3-6 months)
  - +4 Available over a good portion of the year (>6 months)
- C. Year-to-year Variability (Predictability)
  - +1 Plant seldom bears harvestable portions
  - +2 Frequent fluctuations in the abundance of harvestable portions
  - +3 Occasional fluctuations in the abundance of harvestable portions
  - +4 Consistently bears harvestable portions

II. Perceptual Salience (Ethnographic Rating)
- A. Use by tribes recorded in indexed sources
  - +0 Not reported as used in the indexed sources
  - +1 Use by one tribe exclusive of Shasta
  - +2 Use by two to three tribes exclusive of Shasta
  - +3 Use by Shasta but not other indexed tribes
  - +4 Use by Shasta plus one other tribe
  - +5 Use by Shasta plus two other tribes
  - +6 Use by Shasta plus three other tribes
- B. Rated as Important or a Staple by Tribes in Vicinity
  - +0 Not important to the indexed tribes
  - +1 Important or staple by one tribe exclusive of Shasta
  - +2 Important or staple by two-three tribes exclusive of Shasta
  - +3 Important or staple by Shasta but not other tribes
  - +4 Important or staple by Shasta plus one other tribe
  - +5 Important or staple by Shasta plus two other tribes
  - +6 Important or staple by Shasta plus three other tribes
- C. Processing and Storage
  - +0 Not recorded as being dried/stored by the indexed tribes
  - +1 Recorded as being dried/stored by at least one tribe exclusive of Shasta
  - +2 Recorded as being dried/stored by at least two tribes exclusive of Shasta
  - +3 Recorded as being dried/stored by Shasta
  - +4 Recorded as being dried/stored by Shasta and at least one other tribe

III. Potential Utility (Nutritional and Energetic Rating)
- A. Caloric value per 100 grams
  - +1 <100 cal/100 grams
  - +2 100-300 cal/100 grams
  - +3 300-500 cal/100 grams
  - +4 500+ cal/100 grams
- B. Caloric return rate in calories per hour
  - +1 <250 cal/hr
  - +2 250-1000 cal/hr
  - +3 1000-5000 cal/hr
  - +4 5000+ cal/hr
- C. Processing requirements
  - +1 High processing requirements (acorns and small, chaffy seeds)
  - +2 Moderate processing requirements (roots, seeds)
  - +3 Low processing requirements (dried fruit)
  - +4 No processing requirements (fresh fruit, greens)
- D. Additional Food Value
  - +1 Provides primarily carbohydrates
  - +2 Provides carbohydrates plus a significant portion of at least one other nutrient in short supply
- E. Economy of Scale
  - -2 Usually gathered/consumed in very small portions (most foliage)
  - -1 Usually gathered/consumed in small portions (uncommon fruit, etc.)
  - 0 Quantity not known or not available
  - +1 Usually gathered/consumed in moderate portions when available
  - +2 Usually gathered/consumed in large portions when available

APPENDIX 2. — Plant Food Resource Evaluation and Documentation (use in conjunction with Appendix 1)

Quercus garryana (Oregon white oak: acorns) Total = 33

Biogeographic and Temporal Availability Rating: A (+7), **B** (+2) Sept.- Oct., **C** (+2)

Ethnographic Rating: A (+4) Shasta: (Dixon 1907:243); (Holt 1946:308). Karuk: (Schenck and Gifford 1952:382). **B** (+3) Shasta: (LaLande 1987:40). **C** (+4) Shasta: (LaLande 1987:40). Note: Ethnohistoric sources often don't differentiate between oak species. It is assumed that white oak acorns were stored.

Nutritional and Energetic Rating: A (+2) 270 cal / 100 g. Based on an average of four oak spp. (Kuhnlein and Turner 1991:435-436, Table 5A). **B** (+4) 8,370 cal / hr. (Hannon 1991:93). **C** (+1) **D** (+2), **E** (+2) Note: The actual economy of scale would be a multiple of this figure.

Quercus kelloggii (California black oak: acorns) Total = 33

Biogeographic and Temporal Availability Rating: A (+6), **B** (+2) Sept.- Oct., **C** (+2)

Ethnographic Rating: A (+4) Shasta: (Holt 1946:308). Karuk: (Schenck and Gifford 1958:382). Note: Not used by Klamath or Modoc (Voegelin 1942:177). **B** (+3) Shasta: (LaLande 1987:40) **C** (+4) Shasta: (Kroeber 1926:293; LaLande 1987:40). Karuk: (Schenck and Gifford 1958:382). Note: Storage of black oak acorns not specifically mentioned for the Karuk but they were likely stored in the same fashion as other acorns.

Nutritional and Energetic Rating: A (+3) 400 cal / 100 g. Based on an average of four oak spp. (Kuhnlein and Turner 1991: 435-435, Table 5A), but given added value because of the particularly high fat content of *Q. kelloggii* acorns. **B** (+4) Assigned a lower return rate than *Q. garryana*, since they don't mast as heavily in this area. **C** (+1), **D** (+2), **E** (+2)

Perideridia oregana (*ipos, yampa*: root) Total = 32

Biogeographic and Temporal Availability Rating: A (+5) Note: Increased from +4 to +5 due to a likely decrease in abundance since the contact period. **B** (+3) April-June, Sept.-Nov., **C** (+3)

Ethnographic Rating: A (+5) Shasta: (Dixon 1907:424; Holt 1946:308). Modoc: (Ray 1963:213). Klamath: (Coville 1897:101). **B** (+4) Shasta: Several lines of evidence point to *ipos* being regarded as a staple (Voegelin 1942:58; Holt 1946:308; Olson 1960:Appendix B). Modoc: (Ray 1963:197). **C** (+4) Shasta: (Holt 1946:308). Modoc: (Ray 1963:198). Klamath: (Coville 1897:101). Note: *Perideridia* spp. lumped together in Ethnographic Ratings.

Nutritional and Energetic Rating: A (+2) 117 cal / 100 g. (Norton *et al* 1984:223-4 Table I). **B** (+2) 650 cal / hr. Based on harvest data in Ray (1963:198). **C** (+2) **D** (+1) **E** (+1)

Perideridia bolanderi (*ipos, yampa:* root) Total = 32

Biogeographic and Temporal Availability Rating: A (+5) Adjusted for likely decrease in abundance since contact. **B** (+3) April- June, Sept.- Nov. **C** (+3)

Ethnographic Rating: A (+5) Shasta: (Dixon 1907:424; Holt 1946:308). Modoc: (Ray 1963:198). Klamath: (Coville 1897:101). Note: *Perideridia* spp. lumped together in Ethnographic Ratings. **B** (+4) Shasta: (Voegelin 1942:58; Holt 1946:308: Olson 1960: Appendix B). See *P. oregana*. **C** (+4) See *P. oregana*.

Nutritional and Energetic Rating: A (+2) 117 cal / 100 g. (Based on *P. gairdneri*. Norton *et al* 1984:223-4 Table I) **B** (+1) < 250 cal / hr. Based on harvest trials within study area 1994-95. **C** (+2) **D** (+2) **E** (+1)

Perideridia gairdneri (*ipos, yampa*: root) Total = 30

Biogeographic and Temporal Availability rating: A (+4) Rating increased from +3 to +4 due to the likelihood of its decreased abundance since contact. **B** (+3) April- June, Sept.-Nov. **C** (+3)

Ethnographic Rating: A (+6) Shasta, Modoc, Klamath: See *P. oregana*. Karuk: (Schenck and Gifford 1952:387). **B** (+3) Shasta: Several lines of evidence point to *ipos* of various spp. being regarded as a staple (Voegelin, 1942:58; Holt 1946 1946:308; Olson 1960: Appendix B). Modoc, Klamath, Karuk: Not common enough to be considered a staple. **C** (+4) Shasta: (Holt 1946:308). Modoc: (Ray 1963:198). Klamath: (Coville 1897:101). Karuk: Storage not indicated (Schenck and Gifford, 1952:387).

Nutritional and Energetic Rating: A (+2) 117 cal / 100 g (Norton *et al* 1984:223-4) **B** (+1) <250 cal / hr. Based upon harvest trials within the study area 1994-95. **C** (+2) **D** (+1) **E** (+1)

Pinus lambertiana (sugar pine: seeds) Total=30

Biogeographic and Temporal Availability Rating: A (+5) Based on historic evidence (LaLande 1987:35; Klamath Echoes 1966:45). **B** (+1) Sept. **C** (+3)

Ethnographic Rating: A (+6) Shasta: (Dixon 1907:424-427; Kroeber 1926:294; Holt 1946:308). Modoc: (Ray 1963:218). Klamath: Coville (1897:88). Karuk: (Schenck and Gifford 1952:378). **B** (+0) **C** (+4) Shasta: (Krober 1926:294; Holt 1946:308). Karuk: (Schenck and Gifford 1952:378).

Nutritional and Energetic Rating: A (+4) 594 cal / 100 g. (Farris 1982:119 Table II). **B** (+2) Based on an estimate of 500 cal / hr. **C** (+2) Karuk: (Schenck and Giffford 1952:378). **D** (+2) fat **E** (+1)

Madia spp. (tarweed: seeds) Total=27

Biogeographic and Temporal Availability Rating: A (+4) **B** (+2) Sept.- Oct. **C** (+3) An annual subject to population fluctuations.

Ethnographic Rating: A (+5) Shasta: (Curtis 1924:lll). Modoc: (Ray 1963:199). Klamath: (Coville 1897:106). Karuk: Recognized as a food plant (Schenck and Gifford 1952:387). **B** (+0) **C** (+4) Extrapolating from the ethnographic record for western North America, it is suggested that intensively harvested small seeds were stored by the people who gathered them.

Nutritional and Energetic Rating: A (+4) 580 cal / 100 g. Derived from the value of *Helianthus annuus* L. (Kuhnlein and Turner 1991 428, Table 5A). **B** (+2) 350 cal / hr. Derived from limited gathering trials by Todt in the nearby Rogue Valley, Oregon. **C** (+2) **D** (+1) **E** (+0)

Sambucus mexicana (blue elderberry: fruit) Total=27

Biogeographic and Temporal Availability Rating: A (+3) **B** (+2) Aug.- Oct. **C** (+3) Fairly consistent at higher elevations; frequent fluctuations at lower elevations.

Ethnographic Rating: A (+6) Shasta: (Dixon 1907:424; Holt 1946:308). Modoc: (Ray 1963:199-200). Klamath: (Coville 1897:104). Karuk: (Schenck and Gifford 1952:389). **B** (+0) **C** (+3) Shasta: (Dixon 1907:424).

Nutritional and Energetic Rating: A (+1) 52 cal / 100 g. (Norton *et al* 1984:223-4 Table I) **B** (+3) 2000 cal / hr. Based on an average of four gathering trials conducted by Todt in the Keno, OR vicinity, 1992-1995. **C** (+4) For fresh fruit. **D** (+2) Vitamin C (Kuhnlein and Turner 1991:460 Table 6A). **E** (+0)

Amelanchier utahensis (Utah serviceberry: fruit) Total=27

Biogeographic and Temporal Availability Rating: A (+5) **B** (+2) Aug.- Oct) **C** (+2) A fungus affects serviceberries in this vicinity, often rendering a large proportion of the fruit unpalatable. Value increased from +1 to +2 since the fungus may have been less common in the precontact period.

Ethnographic Rating A (+6) Shasta: (Dixon 1907:424; Holt 1946:308). Modoc: (Ray 1963:200). Klamath: (Coville 1897:97). Karuk: (Schenck and Gifford 1952:385). **B** (+0) Culturally important to Shasta, who served them to guests (Holt 1946:308). (+4) Shasta: (Dixon 1907:424; Holt 1946:308). Klamath: (Coville 1891:97). Karuk: (Schenck and Gifford 1952:385).

Nutritional and Energetic Rating: A (+1) 90 cal / 100 g. (Kuhnlein and Turner, l991:442 Table 6A). **B** (+2) >250 cal / hr. Derived from gathering trials conducted by Todt near Keno, OR 1992-1995. Fungus affected a large portion of the fruit in all years. Value increased from +1 to +2. See above. **C** (+3) For dried fruit. **D** (+2) vitamin A (*Ibid.*) **E** (+0)

Perideridia erythrorhiza (*ipos, yampa*: roots) Total=25

Biogeographic and Temporal Availability Rating: A (+3) Biogeographic abundance increased from +2 to +3 due to the likelihood of decreased abundance through the historic period. **B** (+3) April- June, Sept.- Nov. **C** (+3) Fluctuations probably due to weather and predation by burrowing rodents.

Ethnographic Rating: A (+5) Probably occasionally used by the Shasta, Modoc and Klamath. *Perideridia* spp. not differentiated. **B** (+0) Due to restricted habitat. **C** (+3) Shasta: (Holt 1946:308) For *ipos* generally. Species perhaps more common in this area than elsewhere.

Nutritional and Energetic Rating: A (+2) 117 cal/ 100 g. Based upon *P. gairdneri* (Norton *et al* 1984:223-4 Table I) **B** (+2) Estimated. **C** (+3) < 250 cal / hr. Estimated. **D** (+1) **E** (+0)

Camassia quamash (camas: bulb) Total=25

Biogeographic and Temporal Availability Rating: A (+3) **B** (+3) Mar.- June, Sept.- Nov. **C** (+3)

Ethnographic Rating: A (+5) Shasta: (Dixon 1907:424) Modoc: (Ray 1963:198) Klamath: (Coville 1897:93). **B** (+1)? Possibly Modoc: (Ray 1963:198). **C** (+2) Modoc: (*Ibid.*) Klamath: (Coville 1897:93).

Nutritional and Energetic Rating: A (+2) 150 cal / 100 g. (Couture et. al. 1986:158 Table 3) 113 cal / 100 g (Benson *et al* 1973:143). **B** (+2) 850 cal / hr. An estimate based on observed low population densities and small sizes of bulbs. **C** (+2) Cooking required for good nutritional value. **D** (+1) **E** (+1)

Pinus ponderosa (ponderosa pine: inner bark) Total=25

Biogeographic and Temporal Availability Rating: A (+8) **B** (+1) May (Coville 1897:89) Probably earlier at lower elevations along the river. **C** (+4)

Ethnographic Rating: A (+4) Shasta: (Dixon 1907:424; Curtis 1924:111). Modoc: Not specifically mentioned in Ray (1963), but likely used. Klamath: (Coville 1891:89). **B** (+0) Though may have been important during times of food scarcity. **C** (+0)

Nutritional Rating: A (+2) 100 cal / 100 g. From data pertaining to *Tsuga heterophylla* (Raf.) Sarg. (Kuhnlein and Turner 1994:346 Table 1A). **B** (+2) 400 cal / hr. Estimated. **C** (+4) Eaten uncooked (Curtis 1924:111). **D** (+1)? **E** (-1)

Rhus trilobata (three-leaf sumac: fruit/seeds) Total=24

Biogeographic and Temporal Availability Rating: A (+4) Western section of study area at low elevations. **B** (+3) Aug.- Nov. **C** (+3)

Ethnographic Rating: A (+3) Shasta: (Dixon 1907:424; Holt 1946:308). **B** (+0) **C** (+3) (Dixon 1907:424).

Nutritional and Energetic Rating: A (+1) 100 cal / 100 g. Value assigned according to *Rhus glabra* L. (Kuhnlein and Turner 1991:452 Table 6A). **B** (+2) <1000 cal / hr. Based upon gathering trials conducted by Todt in 1996. **C** (+2) For dried, pounded. **D** (+2) vitamin A (*Ibid.*) **E** (+1)

Arctostaphylos patula (greenleaf manzanita: fruit/seed) Total=24

Biogeographic and Temporal Availability Rating: A (+5) **B** (+2) Sept.-Oct. **C** (+2)

Ethnographic Rating: A (+5) Shasta: (Dixon 1907:243-244). Modoc: (Ray 1963:212, 218 Appendix II). Klamath: (Coville l897:102). Karuk: (Schenck and Gifford 1952:388) Note: Dixon (1907) and Ray (1963) reference species other than *A. patula*. **B** (+1) Karuk: (Davis and Hendryx 1991:149). **C** (+1) Karuk: (Schenck and Gifford 1952:388).

Nutritional and Energetic Rating: **A** (+1) 90 cal / 100 g. Data from *A. uva-ursi* (L.) Sprengel (Kuhnlein and Turner 1991:442 Table XX) **B** (+2) 400 cal / hr. Estimated. **C** (+2) Processing involved pounding and winnowing. **D** (+2) Vit. A (*Ibid.*) **E** (+1)

Pinus ponderosa (ponderosa pine: seeds) Total=24

Biogeographic and Temporal Availability Rating: **A** (+8) **B** (+2) Sept.- Oct. **C** (+2) (Oliver and Ryker 1990-91:416).

Ethnographic Rating: **A** (+4) Shasta: (Holt 1946:308) Modoc: (Ray 1963:199) Possibly a reference to *P. lambertiana*. **B** (+0) **C** (+1)? Modoc: (Ray 1963:199).

Nutritional and Energetic Rating: **A** (+3) 450 cal / 100 g. Estimated from data pertaining to *P. edulus* Engelm.(Kuhnlein and Turner 1991:434 Table 5A). **B** (+2) 400 cal / hr. Estimated. **C** (+2) **D** (+1) **E** (-1)

Prunus subcordata (Klamath plum: fruit) Total=23

Biogeographic and Temporal Availability Rating: **A** (+5) **B** (+1) Sept. **C** (+2) Fruit often affected by pathogens in Upper Klamath River vicinity.

Ethnographic Rating: **A** (+5) Shasta: (Holt 1946:308). Modoc: (Ray 1963:200). Klamath: (Coville 1897:99). **B** (+0) **C** (+1) Karuk: (Schenck and Gifford 1952:384-385).

Nutritional and Energetic Rating: **A** (+1) 47 cal / 100 g. Based upon data from "Damson" plum (Kuhnlein and Turner 1991:450 Table 6A). **B** (+2) 1000 cal / hr. Based on gathering trials conducted by Todt in the Keno, OR vicinity, 1992-1995. **C** (+4) For fresh fruit. However Shasta cooked fruit as well (Holt 1946:308). **D** (+1)? Possibly vitamin A and C (Kuhnlein and Turner 1991:450 Table 6. **A**) **E** (+1)

Brodiaea coronaria (harvest brodiaea: corm) Total=23

Biogeographic and Temporal Availability Rating: **A** (+5) **B** (+3) April- June, Sept.- Nov. **C** (+4)

Ethnographic Rating: **A** (+4) Shasta: (Holt 1907:308). Karuk: (Schenck and Gifford 1952:380). Plants not identified to species in the Shasta ethnographic record. **B** (+0) **C** (+0) Note: *Triteleia hyacinthina* (Lindley) E. Green (white brodiaea) is fairly common within the study area and may have been used as well.

Nutritional and Energetic Rating: **A** (+2) 100 cal / 100 g. is an average value for starchy geophytes. **B** (+1) <250 cal / hr. Estimated. Populations often sparse. **C** (+2) (Schenck and Gifford 1952:380). **D** (+1) **E** (+1)

Ribes velutinum E. Greene (plateau gooseberry: fruit) Total=22

Biogeographic and Temporal Availability Rating: **A** (+4) This is the most common of eight *Ribes* spp. growing within the study area. **B** (+2) July-Aug. **C** (+2) Years of low productivity show a correlation with drought years.

Ethnographic Rating: **A** (+5) *Ribes* spp. often not well differentiated in the ethnographic record.

Shasta: (Holt 1946:308). Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:97). Karuk: Beyond expected range of *R. velutinum*. **B** (+0) **C** (+1) Generally not preserved (Holt 1946:308; Coville 1897:97; Schenck and Gifford 1952:389).

Nutritional and Energetic Rating: **A** (+1) 52 cal / 100 g. Based upon *Ribes* spp. (gooseberries) (Norton *et al* 1984:223-4 Table I) **B** (+1) 110 cal / hr. An average from three years of gathering trials conducted by Todt near Keno, Oregon. **C** (+4) **D** (+2) vitamin C for some *Ribes* spp. (Kuhnlein and Turner 1991:452-454 Table 6A) **E** (+0)

Typha latifolia L. (cattail: rhizome) Total=21

Biogeographic and Temporal Availability Rating: **A** (+6) **B** (+2) Aug., Sept., Oct. (Simms 1984:257 Appendix) **C** (+4)

Ethnographic Rating: **A** (+2) Modoc: (Voegelin 1942:78; Ray 1963:218). Klamath: (Coville 1897:90). **B** (+0) **C** (+0)

Nutritional and Energetic Rating: A (+3) 334 cal / 100 g. (Simms 1984:146) **B** (+2) 374 cal / hr. (Simms 1984:257 Appendix). **C** (+1) (*Ibid.*:255-257) **D** (+1) **E** (+0) Note: Although *Typha latifolia* pollen has a potentially high rate of return, it is not mentioned in the ethnographic sources used in this study.

Rumex spp. (dock: seed) Total=21

Biogeographic and Temporal Availability Rating: A (+6) **B** (+3) Aug., Sept., Oct., Nov. **C** (+4) Note: *R. salicifolius* J.A. Weinm is the sp. mentioned in the ethnographic record and found within the study area.

Ethnographic Rating: A (+2) Modoc: Ray 1963:215 Appendix II). Klamath: (Coville 1897:95). **B** (+0) **C** (+0)

Nutritional and Energetic Rating: A (+2) 240 cal / 100 g. Estimated **B** (+2) 300 cal / hr. Estimated. Stands are patchy and seldom densely populated. **C** (+2) **D** (+1) **E** (-1)

Prunus virginiana L. (chokecherry: fruit, seed) Total=21

Biogeographic and Temporal Availability Rating: A (+3) **B** (+1) Sept. **C** (+1) Little fruit production within the study area 1992-1995.

Ethnographic Rating: A (+6) Shasta: (Holt 1946:308,341). Modoc: (Voegelin 1942:60; Ray 1963:200). Klamath: (Coville 1897:98). Karuk: (Schenck and Gifford 1952:384). **B** (+0) **C** (+4) Shasta: (Holt 1946:308). Modoc: (Voegelin 1942:60). Karuk: Noted as "not preserved" (Schenck and Gifford 1952:384).

Nutritional and Energetic Rating: A (+1) 48 cal / 100 g. Based on data from *Prunus avium* L. (Kuhnlein and Turner 1991:450 Table 6A). Undoubtedly higher when processed with seeds. **B** (+1) <250 cal / hr. Based on gathering trials by Todt near Keno, OR, 1992-1995. Significantly higher return rates obtained from nearby Rogue Valley, OR. **C** (+3) +2 if seeds are processed as well. **D** (+2) Vitamin C if eaten fresh (Kuhnlein and Turner 1991:450 Table 6A). **E** (-1)

Vitis californica Benth. (western wild grape: fruit) Total=21

Biogeographic and Temporal Availability Rating: A (+6) **B** (+2) Sept., Oct. **C** (+1)

Ethnographic Rating: A (+4) Shasta: (Holt 1946:308). Karuk: (Schenck and Gifford 1952:386). **B** (+0) **C** (+3) Shasta: (Holt 1946:308).

Nutritional and Energetic Rating: A (+1) 63 cal / 100 g. Based on data from *V. vinifera* L. (Kuhnlein and Turner 1991:468 Table 6A). **B** (+1) <250 cal / hr. within study area. **C** (+3) **D** (+2) Some *Vitis* spp. have a high vitamin C content (Kuhnlein and Turner 1991:468 Table 6A). **E** (-2) Note: *V. californica* seldom bears fruit within the study area.

Cornus glabrata Benth. (smooth dogwood: fruit) Total=20

Biogeographic and Temporal Availability Rating: A (+6) **B** (+1) Oct. **C** (+3)

Ethnographic Rating: A (+3) Shasta: (Merriam 1907:20) **B** (+1) **C** (+0)

Nutritional and Energetic Rating: A (+1) 52 cal/100g. From data pertaining to *Cornus canadensis* (Kuhnlein and Turner 1991:444 Table 6A). **B** (+2) 500 cal / hr. Estimated. **C** (+3) Cooked (Merriam 1907:20). **D** (+1) **E** (+0)? Note: The fruit of *Cornus sericea* L., a much less abundant species, was probably used as well.

Bryoria sp. (black lichen: foliage) Total=20

Biogeographic and Temporal Availability Rating: A (+5) **B** (+4) Mar.- Dec. **C** (+4)

Ethnographic Rating: A (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:87). **B** (+0) **C** (+0)

Nutritional and Energetic Rating: A (+1) Estimated **B** (+2) Estimated **C** (+1) High processing requirements to remove toxic vulpic acid. Processing usually involves pounding, soaking and pit-cooking (Kuhnlein and Turner 1991:34). **D** (+1)? **E** (+0)

Lomatium piperi J. Coulter & Rose (desert parsley, wild parsnip: tuber) Total=20

Biogeographic and Temporal Availability Rating: A (+2) **B** (+3) April, May (Ray 1963:198) **C** (+3)

Ethnographic Rating: A (+2) Shasta: *Lomatium* spp. not specifically mentioned but the term "turnip" as used in deAngulo (1950:323-377) likely refers to this genus. Modoc: (Ray 1963:198). Reference is to *L. canbyi*. (J. Coulter & Rose) J. Coulter & Rose. Klamath: "used comparatively little" (Coville 1897:102). Reference is to *L. canbyi*. **B** (+1) (*Ibid*.). Reference is to *L. canbyi*. **C** (+2) Modoc: (Ray 1963:198). Klamath: (Coville 1897:102).

Nutritional and Energetic Rating: A (+2) 119 cal / 100 g. (Norton *et al* 1984:223-4 Table I) **B** (+2) >250 cal / hr. Tubers are quite small. **C** (+3)? **D** (+1) **E** (-1) Small disjunct stands. Note: This species is highly regarded on the Columbia Plateau (Hunn 1990:102 Table 6) so it is unlikely that it would have been ignored in the Upper Klamath area. Another, more common species which may have been used is *L. macrocarpum* (Nutt.) Coult. & Rose.

Lomatium nudicaule (pestle lomatium: stem) Total=20

Biogeographic and Temporal Availability Rating: A (+3) **B** (+1) May **C** (+3)

Ethnographic Rating: A (+3) Shasta: (Holt 1946:309) "Wild parsley" probably *L. nudicaule*. Also used by Klamath, but not in Coville (1897); referenced in Gatschet (1890). **B** (+0) **C** (+3) Shasta: (Holt 1946:309).

Nutritional and Energetic Rating: A (+1) <100 cal / 100 g. Greens generally low in calories. **B** (+1) <250 cal / hr. Greens have a low return rate. **C** (+4) if eaten raw, (+3) if steamed and dried. **D** (+2) vitamin C (Norton *et al* 1984:225 Table III) **E** (-1)

Scirpus acutus Bigelow (tule, hardstem bulrush: seed) Total=19

Biogeographic and Temporal Availability Rating: A (+4) **B** (+2) Aug., Sept., Oct. (Simms 1984:248). **C** (+4)

Ethnographic Rating: A (+1) Klamath: (Coville 1897:92). **B** (+0) **C** (+0)

Nutritional and Energetic Rating: A (+3) 305 cal / 100 g. (Simms 1984:207 Appendix, Table II). **B** (+2) 800-1000 cal / hr. for average situation (*Ibid*.:248 Appendix, Table II). **C** (+2) (*Ibid*.) **D** (+1) **E** (+0)

Pinus lambertiana (sugar pine: sap crystals) Total = 19

Biogeographic and Temporal Availability Rating: A (+5) Historic evidence (Klamath Echoes 1966:45; LaLande 1987:35) indicates there were a large number of trees located in the northern portion of the study area. Presently scarce. **B** (+2) Aug., Sept., Oct. During and after the burning season. **C** (+2) Depending upon geography of fire occurrence.

Ethnographic Rating: A (+4) Shasta: (Dixon 1904: 424). Karuk: (Schenck and Gifford 1952:377). **B** (+0) **C** (+0)

Nutritional and Energetic Rating: A (+2) 200- 300 cal / 100 g. Estimated. **B** (+1) <250 cal / hr. Usually gathered and eaten in small quantities (Dixon 1904:424). **C** (+4) (Schenck and Gifford 1952:377). **D** (+1) ? **E** (-2)

Rubus ursinus Cham. & Schldl. (Pacific blackberry: fruit) Total=19

Biogeographic and Temporal Availability Rating: A (+2) **B** (+1) June **C** (+1)

Ethnographic Rating: A (+6) Shasta: (Dixon 1907:424; Holt 1946:308). Modoc: (Ray 1963:215 Appendix II). Klamath: (Coville 1897:99). Karuk: (Schenck and Gifford 1952:384). **B** (+0) **C** (+3) Shasta: (Dixon 1907:424; Holt 1946:308). Karuk: "not preserved" (Schenck and Gifford 1952:384).

Nutritional and Energetic Rating: A (+1) 56 cal / 100 g. (Norton *et al* 1984:223-4 Table I) **B** (+1) <250 cal / 100 g. Stands small and scattered. **C** (+4) For fresh rather than dried fruit. **D** (+2) Vitamin C (Kuhnlein and Turner 1991:458 Table 6A) **E** (-2)

Lilium pardalinum Kellogg ssp. *vollmeri* (Eastw.) M. Skinner (tiger lily: rhizome) Total=18
Biogeographic and Temporal Availability Rating: A (+2) **B** (+2) April- Oct.? **C** (+4)
Ethnographic Rating: A (+4) Shasta: (Holt 1946:308). Karuk: (Schenck and Gifford 1952:381). Reference is to *Lilium pardalinum*. **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+2) 100 cal/ 100 g. based on an average value for geophytes. **B** (+2) >250 cal/ hr. Estimated. **C** (+2) **D** (+1) **E** (-1)

Darmera peltata (Torrey) Voss (Indian rhubarb, umbrella plant: greens) Total=18
Biogeographic and Temporal Availability Rating: A (+2) **B** (+1) May **C** (+4)
Ethnographic Rating: A (+4) Shasta (Gamutwa): (Holt 1946:309). Karuk: (Schenck and Gifford 1952:384). **B:** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) <250 cal / hr. Foliage has a low caloric return rate. **B** (+1) <250 cal / hr. **C** (+4) **D** (+2) ? No nutritional information on this species, but greens often have high vitamin content. **E** (-1) Note: Found in one location only. Possibly introduced.

Dichelostema capitatum Alph. Wood (blue dicks, brodiaea, snake-heads- corm) Total=18
Biogeographic and Temporal Availability Rating: A (+4) **B** (+3) May-June, Sept.-Nov **C** (+3)
Ethnographic Rating: A (+4) Shasta: M. Carpelan (personal communication, 1998). Karuk: (Schenck and Gifford 1952:380) but not given a use. It might be supposed that use is similar to the species listed previously in Schenck and Gifford 1952: *Brodiaea laxa* (= *Triteleia laxa* Benth.) **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+2) 100 cal/100 g. Based on a standard caloric value for geophytes. **B** (+1) <250 cal/hr. Estimated. Deep-rooted and difficult to dig in rocky soil. **C** (+2) Processing probably similar to that described for *Triteleia laxa* (*Ibid.*) **D** (+1) **E** (-2)

Rosa spp. (wild rose: fruit) Total=18
Biogeographic and Temporal Availability Rating: A (+4) **B** (+3) Aug., Sept., Oct., Nov. **C** (+3)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:214, 218 Appendix II). Klamath: (Coville 1897:99). **B** (+0) **C** (+0) Note: Roses are treated generically within the Ethnographic Rating. *Rosa* spp. found within the study area include: *R. californica* Cham & Schldl., *R. gymnocarpa* Nutt., *R. woodsii* Lindley and *R. pisocarpa* A. Gray.
Nutritional and Energetic Rating: A (+1) 74 cal / 100 g. Data derived from *R. nutkana* Presl (Kuhnlein and Turner 1991:456 Table 6A). **B** (+1) <250 cal / hr. **C** (+4) **D** (+2) Vitamin C and A (*Ibid.*). **E** (-2)

Fritillaria recurva Benth. (scarlet fritillary, red-bells: bulb) Total=17
Biogeographic and Temporal Availability Rating: A (+3) Biogeographic abundance increased from +2 to +3 based on the likelihood of decreased abundance during the historic period. **B** (+3) March- April, July- Nov.? **C** (+3) Perhaps due to fluctuations in the populations of burrowing rodents.
Ethnographic Rating: A (+3) Shasta: (Holt 1946:308). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) 98 cal / 100 g. From *F. camschatcensis* (L.) Ker-Gawl (Kuhnlein and Turner 1991:354 Table 3A). **B** (+2) 500 cal / hr. Estimated. **C** (+2) **D** (+1) **E** (-1)

Carex spp. (sedge: stems) Total=17
Biogeographic and Temporal Availability Rating: A (+3) **B** (+2) March- June? **C** (+4)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:92). **B** (+0) **C** (+0)

Nutritional and Energetic Rating: **A** (+1) <100 cal / 100 g. Most stem and leaf tissues have low caloric values. **B** (+1) <250 cal / hr. Estimated. **C** (+3) Peeling. **D** (+1)? **E** (+0)

Scirpus acutus Bigelow (tule, hardstem bulrush: rhizome) Total=17
Biogeographic and Temporal Availability Rating: **A** (+4) **B** (+3) July: Nov. + (?) See discussion in Simms (1984:252). **C** (+4)
Ethnographic Rating: **A** (+1) Modoc: (Ray 1963:218 Appendix II). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: **A** (+1) 63 cal / 100 g. (Simms 1984:251 Appendix). **B** (+1) <250 cal / hr. (*Ibid*.:249-251). **C** (+2) **D** (+1) **E** (+0)

Sparganium sp. (bur-reed: rootstock and base of stem) Total=17
Biogeographic and Temporal Availability Rating: **A** (+3) **B** (+3) ? July-Oct.? **C** (+4)
Ethnographic Rating: **A** (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:90). Karuk: "The Karuk do not use this" (Schenck and Gifford 1952:379). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: **A** (+2) 100 cal / 100 g. An average for starchy roots, tubers, etc. **B** (+1) <250 cal / hr. Populations not concentrated. **C** (+3)? **D** (+1) **E** (-2)

Balsamorhiza sagittata (arrow-leaf balsamroot: seeds) Total=17
Biogeographic and Temporal Availability Rating: **A** (+4) **B** (+2) July, Aug. **C** (+3)
Ethnographic Rating: **A** (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:106). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: **A** (+2) 300 cal / 100 g. Estimated. **B** (+1) <250 cal / 100 g. Estimated. *Balsamorhiza* spp. seeds are small and chaffy. **C** (+1) **D** (+2) *Helianthus annuus*, within the same family, has high values for P, K and Mg (Kuhnlein and Turner 1991:429 Table 5B). **E** (-2)

Eriogonum spp. (Eriogonum, wild buckwheat: seeds) Total=16
Biogeographic and Temporal Availability Rating: **A** (+4) **B** (+2) Sept., Oct. **C** (+3)
Ethnographic Rating: **A** (+1) Modoc: (Ray 1963:218 Appendix II). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: **A** (+3) 425 cal/100g. Data derived from *Polygonum convolvulus* L., a plant within the same family (Kuhnlein and Turner 1991:434 Table 5A). **B** (+2) 500 cal / hr. 500-600 cal / hr. is a typical return rate for small seeds (Simms 1984:86 Table 2). **C** (+1) **D** (+1) **E** (-1)

Calochortus macrocarpus Douglas (mariposa lily: bulb) Total=16
Biogeographic and Temporal Availability Rating: **A** (+3) Geographic abundance rating increased from +2 to +3 due to the likelihood of decreased abundance during the historic period. **B** (+3) April- May, Sept.- Nov. **C** (+3)
Ethnographic Rating: **A** (+2) Shasta: Within the Shasta ethnographic record, the genus *Calochortus* is often misapplied (Todt 1997:253-255). Modoc: Ray (1963: 218 Appendix II). Klamath: (Coville 1897:93). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: **A** (+1) 67 cal / 100 g. Based on an average of three Liliaceous spp. (Kuhnlein and Turner 1991:352 Table 3A). **B** (+2) 400 cal / hr. Estimated. **C** (+2) **D** (+1) **D** (-1)

Eriogonum nudum Benth (naked-stem eriogonum: stem) Total=16
Biogeographic and Temporal Availability Rating: **A** (+3) **B** (+1) May **C** (+3)
Ethnographic Rating: **A** (+1) Karuk: (Schenck and Gifford 1952:383). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: **A** (+1) <100 cal / 100 g. **B** (+1) <250 cal / hr. Estimated. **C** (+4) **D** (+2)? Probably vitamin C. **E** (+0)

Rubus leucodermis Torry & A. Gray (black raspberry, blackcap: fruit) Total=16
Biogeographic and Temporal Availability Rating: **A** (+3) **B** (+1) Aug. **C** (+3)
Ethnographic Rating: **A** (+2) Modoc: (Ray 1963:215 Appendix II). Klamath: (Coville 1897:99). Karuk: (Schenck and Gifford 1952:384). **B** (+0) **C** (+1) Klamath: (Coville 1897:99).

Nutritional and Energetic Rating: **A** (+1) 65 cal / 100 g. Derived from data pertaining to *R. idaeus* (Kuhnlein and Turner 1991:456 Table 6A). **B** (+1) <250 cal / hr. Stands small and scattered. **C** (+4) For fresh rather than dried fruit. **D** (+2) vitamin C. Three *Rubus* spp. yielded an average of 63.7 mg / 100 g. of vitamin C (Kuhnlein and Turner 1991:456 Table 6A). **E** (-2)

Rubus parviflorus Nutt. (thimbleberry: fruit) Total=16
Biogeographic and Temporal Availability Rating: **A** (+2) **B** (+1) Late July, early Aug. **C** (+3)
Ethnographic Rating: **A** (+4) Shasta: (Holt 1946:308). Karuk: (Schenck and Gifford 1952:384). **B** (+0) **C** (+0)
Nutritional and Energetic rating: **A**(+1) 54 cal / 100 g. (Norton *et al* 1984:223-4 Table I) **B** (+1) <250 cal / hr. Stands small and scattered. **C** (+4) **D** (+2) Vit. A. An average of three *Rubus* spp. yielded 63.7 mg of vit. C / 100 g. (Kuhnlein and Turner 1991:456 Table 6A). **E** (-2)

Descurainia pinnata (Walter) Britton (tansy mustard: seeds) Total=15
Biogeographic and Temporal Availability Rating: **A** (+3) **B** (+1) Lt. June, early July. **C** (+3)
Ethnographic Rating: **A** (+1) Modoc: (Ray 1963:218 Appendix II). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: **A** (+3) 350 cal / 100 g. (Simms 1984:144 Table 8). **B** (+2) 500 cal / hr. Derived from figures in Simms (1984:215 Appendix) but downgraded since stands within the study area are small and often not well stocked. **C** (+2) **D** (+1) **E** (-1)

Mentzelia laevicaulis (Hook.) Torrey & A. Gray (blazing star: seeds) Total=15
Biogeographic and Temporal Availability Rating: **A** (+2) **B** (+2) Sept., Oct., Nov. **C** (+3)
Ethnographic Rating: **A** (+2) Modoc: (Ray 1963:218 Appendix II: reference is actually to the related *M. albicaulis* Hook). Klamath: (Coville 1897:100). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: **A** (+2) 460 cal / 100 g. Assigned a value slightly below an average value for seeds (Kuhnlein and Turner 1991:422-428 Table 5A). **B** (+2) 400 cal / hr. Estimated. **C** (+2) **D** (+1) **E** (-1)

Pinus contorta Loudon (lodgepole pine: inner bark) Total=15
Biogeographic and Temporal Availability Rating: **A** (+1) **B** (+1) April (Coville 1897:89). **C** (+4)
Ethnographic Rating: **A** (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:89). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: **A** (+2) 103 cal / 100 g. Data from *Tsuga heterophylla* (Kuhnlein and Turner 1991:346 Table 1A). **B** (+2) 400 cal / hr. Estimated. **C** (+4) **D** (+1) **E** (-2)

Allium spp. (wild onion: bulb) Total=15
Biogeographic and Temporal Availability Rating: **A** (+3) **B** (+3) Mar.: Nov. **C** (+4)
Ethnographic Rating: **A**(+1) Karuk: (Schenck and Gifford 1952:380). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: **A** (+1) 61 cal / 100 g. Data derived from the related Liliaceous bulb of *Camassia quamash* (Couture *et al.* 1965:58). **B** (+1) <250 cal / hr. Onions have patchy distributions, are usually located in lithosols and the bulbs are of small size. More than 5 species are located within the study area. **C** (+2) **D** (+1) **E** (-1)

Chrysolepis sempervirens (Kellogg) Hjelmq. (shrub chinquapin: seed) Total=15
Biogeographic and Temporal Availability Rating: **A** (+2) **B** (+2) Sept., Oct., Nov. **C** (+2)
Ethnographic Rating: **A** (+2) Klamath: (Coville 1897:94). Karuk: (Schenck and Gifford 1952:383). **B** (+0) **C** (+1) Karuk: (Schenck and Gifford 1952:383).

Nutritional and Energetic Rating: A (+2) 213 cal / 100 g. for a related *Castanea* sp. (Kuhnlein and Turner 1991:426 Table 5A). **B (+1)** <250 cal / hr.: a low estimate due to high percentage of insect infestation. **C** (+3) **D** (+1) **E** (-1)

Leymus cinereus (Scribner and Merr.) A. Love (giant wild rye: seeds) Total=15
Biogeographical and Temporal Availability Rating: A (+3) **B** (+1) Sept. **C** (+3)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:218, Appendix II). Klamath: (Coville 1897:91). **B** (+0) **C** (+0)
Nutritional and Energetic Raing: A (+2) 280 cal / 100 g. (Simms 1984:206, Appendix, Table II) **B** (+2) 550 cal / hr. (Simms 1984:86 Table II) **C** (+2) **D** (+1) **E** (-1)

Elymus glaucus Buckl. (blue wild rye: seeds) Total=14
Biogeographic and Temporal Availability Rating: A (+3) Abundance rating increased from +2 to +3 since it was likely more abundant before contact. **B** (+1) late August-early Sept. **C** (+3)
Ethnographic Rating: A (+1) Karuk: (Schenck and Gifford 1952:380). **B** (+0) **C** (+0) ?
Nutritional and Energetic Rating A (+2) 280 cal / 100 g. (Simms: 1984: 206 Appendix, Table II: data for *Leymus cinereus). **B** (+2) 550 cal / hr. Data derived from *Leymus cinereus* (Simms 1984: 86 Table 2). **C** (+2) **D** (+1) **E** (-1)

Arctostaphylos nevadensis A. Gray (pine-mat manzanita: fruit) Total=14
Biogeographic and Temporal Availability Rating: A (+2) **B** (+2) Aug.- Sept. **C** (+2)
Ethnographic Rating A: (+2) Modoc: (Ray 1963: 219 Appendix II). Karuk: (Schenck and Gifford 1952:388). **B** (+0) **C** (+2) In this case use probably implies processing, drying and storage.
Nutritional and Energetic Rating: A (+1) 90 cal / 100 g. data derived from *A. uva-ursi* (Kuhnlein and Turner 1991:442 Table 6A). **B** (+1) < 250 cal / hr. Estimated. **C** (+2) **D** (+2) High vitamin C content listed for two other *Arctostaphylos* spp. (Kuhnlein and Turner 1991:442 Table 6A).E (-2) Note: Diseased and low fruit production in Upper Klamath River vicinity.

Fragaria vesca L. (wild strawberry: fruit) Total=14
Biogeographic and Temporal Availability Rating: A (+4) **B** (+1) July **C** (+2)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:98). Species listed as *F. virginiana* Duchesne. Karuk: (Schenck and Gifford 1952:384). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) 54 cal / 100 g. for *F. vesca* (Kuhnlein and Turner 1991:446 Table 6A). **B** (+1) <250 cal / hr. Fruit seldom abundant or ripe at same time. **C** (+4) **D** (+1) **E** (-2)

Heracleum lanatum Michaux (cow parsnip: stalks) Total=14
Biogeographic and Temporal Availability Rating: A (+1) **B** (+2) April, May **C** (+4)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:102). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) 20 cal / 100 g. peeled shoots (Kuhnlein and Turner 1991:390 Table 4A). **B** (+1) <250 cal / hr. Low population densities. **C** (+3) **D** (+2) (Norton *et al* 1984:225 Table III). **E** (-2)

Helianthus bolanderi A. Gray (sunflower, Bolander's sunflower: seeds) Total=13
Biogeographic and Temporal Availability: **Rating A** (+2) **B** (+2) Sept., Oct. **C** (+2)
Ethnographic Rating: A (+1) Modoc: (Ray 1963: 218 Appendix II) reference is to *H. cusickii* A. Gray, *H. nuttallii* Torrey & A. Gray. **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+3) 365 cal / 100 g. (Simms 1984:206 Table II: reference to *H. annuus*) . **B** (+2) 300 cal / hr. based on Simms (1984:206 Appendix) data but decreased since local populations are scattered and sparse. **C** (+2) **D** (+1) **E** (-2)

Grindelia sp. (gumweed: foliage) Total=13
Biogeographic and Temporal Availability Rating: A (+2) **B** (+1) May **C** (+3)
Ethnographic Rating: A (+1) Karuk: (Schenck and Gifford 1952:389). Species listed as *G. robusta* (= *G. camporum* E. Greene). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) 45 cal / 100 g. Average caloric value for four Asteraceae spp. (Kuhnlein and Turner 1991:370, 382, 392, 416 Table 4A). **B** (+1) < 250 cal / hr. Stands small and very scattered. **C** (+4) **D** (+2) vitamin C (*Ibid.*). **E** (-2)

Phragmites australis (Cav.) Steudel (giant reed grass: seeds) Total=13
Biogeographic and Temporal Availability Rating: A (+2) Geographic abundance increased from +1 to +2 since it may have been more abundant prehistorically. **B** (+1) Sept. **C** (+3)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:91). **B** (+0) **C** (+0) ?, though probably stored when a sufficient quantity was harvested.
Nutritional and Energetic Rating: A (+2) 261 cal / 100 g. (Simms 1984:206 Appendix II) for *Phalaris arundinacea* L. **B** (+2) 300 cal / hr. based on small, scattered stands. **C** (+2) **D** (+1) **E** (-2)

Pinus contorta (lodgepole pine: seeds) Total=13
Biogeographical and Temporal Availability Rating: A (+1) **B**(+2) Sept., Oct. **C** (+4)
Ethnographic Rating: A (+1) Modoc: (Ray 1963:218 Appendix II). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+3) 400 cal / 100 g. **B** (+1) ? <250 cal / hr. Cones small, seeds small. **C** (+2) **D** (+1) **E** (-2) Note: Rare within study area.

Prunus emarginata (Hook.) Walp. (bittercherry: fruit) Total=12
Biogeographic and Temporal Availability: A (+2) **B** (+2) Sept. **C** (+3)
Ethnographic Rating: A (+1) Modoc: (Ray 1963:218 Appendix II). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) 48 cal / 100 g. Based on data from *Prunus avium* (Kuhnlein and Turner 1991:450 Table 6A). **B** (+1) <250 cal / hr. Fruits usually sparsely distributed on plants; stands discontinuous. **C** (+3) ? **D** (+1) **E** (-2)