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TRADITIONAL PHENOLOGICAL KNOWLEDGE OF ABORIGINAL PEOPLES IN BRITISH COLUMBIA

TREVOR C. LANTZ[a] and NANCY J. TURNER[b]
[a]*Department of Biology, University of Victoria, P.O. Box 3020, STN CSC, Victoria, B.C., Canada. V8W 3N5*
<tlantz@cablelan.net>
[b]*School of Environmental Studies, University of Victoria, P.O. Box 1700 STN CSC, Victoria, B.C., Canada. V8W 2Y2*
<nturner@uvic.ca>

ABSTRACT.—The seasonal timing of life cycle events (phenology) of organisms in temperate regions is relatively predictable, occurring primarily in response to accumulated heat and photoperiod. Aboriginal peoples have long recognized these phenological indicators and traditional phenological knowledge (TPK) is evident throughout traditional ecological knowledge and wisdom (TEKW). We assess the nature and significance of TPK in British Columbia and neighboring areas with a survey of the ethnographic literature. Over 140 traditional phenological indicators among more than 20 linguistic groups were identified. These peoples use TPK to predict the timing of plant and animal resource availability and abundance, to assess and predict changes in weather and the seasons, and to mark points in their seasonal rounds. Approximately half of these indicators directly involve using the phenology of one species, typically a flowering plant, to signal the onset of a prominent stage in the life cycle (phenophase) of a second species, typically an important resource. The remainder of the TPK described here is less direct, often embedded in language, and closely linked with traditional conceptions of time and the seasonal round. Consequently TPK cannot be considered a discrete subset of TEKW, but is interwoven in a larger framework of cultural knowledge and represents a broad yet significant domain of TEKW.

Key words: Phenology, traditional ecological knowledge and wisdom, traditional phenological knowledge, indicators, British Columbia.

RESUMEN.—La sucesión estacional de los fenómenos del ciclo vital (fenología) de los organismos de las regiones templadas es relativamente predecible, ya que ocurre primariamente en respuesta al calor acumulado y al fotoperiodo. La fenología se puede utilizar para temporizar las actividades relacionadas con la extracción de recursos. Los pueblos indígenas han reconocido desde tiempos remotos estos indicadores fenológicos y el Conocimiento Fenológico Tradicional (CFT) es evidente dentro de la Sabiduría y Conocimiento Ecológico Tradicional (SCET). El propósito de este artículo es estudiar la naturaleza e importancia del CFT en la Columbia Británica y territorios cercanos a través de una revisión de la bibliografía etnográfica. Se identificaron más de 140 indicadores fenológicos entre más de 20 grupos lingüísticos. Estos pueblos utilizan el CFT para indicar la disponibilidad y abundancia de recursos vegetales y animales a lo largo del año, para comprobar y predecir cambios en el tiempo y las estaciones, y para marcar hitos en los ciclos estacionales de los pueblos. Aproximadamente la mitad de los indicadores son directos: tienen en cuenta la fenología de una especie, típicamente una fanerógama, para indicar el comienzo de un paso clave en el ciclo vital (fenofase) de una segunda especie, típicamente un recurso importante. El resto del CFT que se describe aquí es menos directo, a menudo integrado en el lenguaje, y estrechamente relacionado con las concepciones tradicionales del tiempo y el cambio estacional. Consecuentemente, el CFT no se puede considerar un subapartado discreto dentro de la SCET, sino que se encuentra entretejido dentro de un marco más amplio de conocimientos culturales y representa un dominio amplio e importante de la SCET.

RÉSUMÉ.—Le calendrier saisonnier des stades de développement des organismes (phénologie) dans les régions tempérées est relativement prévisible. Elle se produit principalement en réponse à la chaleur accumulée et à la photopériode. Les peuples indigènes savent reconnaître ces indicateurs phénologiques depuis longtemps et la connaissance phénologique traditionnelle (CPT) est évidente dans toute la connaissance et la sagesse écologiques traditionnelles (CSET). Nous évaluons la nature et le sens de la CPT en Colombie Britannique et dans les régions avoisinantes à travers une revue de la littérature ethnographique. Plus de 140 indicateurs phénologiques anciens ont été identifies dans plus de 20 groupes linguistiques. Ces peuples utilisent la CPT pour prédire le calendrier et l'abondance des ressources animales et végétales, évaluer et anticiper les changements de temps et de saisons, et établir des points de repère dans les routines saisonnières des personnes. Environ la moitié de ces indicateurs concernent directement la phénologie d'une espèce, typiquement une plante à fleurs, signalant le commencement d'une étape majeure du développement (phénophase) d'une deuxième espèce qui est en général une ressource importante. Le reste de la CPT décrite dans cet article est moins direct. Elle est souvent enfouie dans le langage et étroitement liée aux anciens concepts du temps et du cycle des saisons. En conséquence la CPT ne peut être considérée comme un sous-ensemble discontinu de la CSET, mais elle est mêlée étroitement à un cadre plus large de connaissance culturelle et représente un domaine général et néanmoins important de la CSET.

INTRODUCTION

In temperate regions, the triggering of plant and animal development depends on the passing of certain temperature thresholds and changes in photoperiod (Larcher 1983). In the spring most woody plant species (e.g., shrubs and trees) and perennial herbs (wildflowers) flower primarily in response to accumulated heat, often measured using growing degree summation (Rathcke and Lacey 1985). Phenology is the formalized study of seasonal biological changes. Phenological indicators can be thought of as stable biological timepieces that respond to seasonal variation between years (Molitor 1987). One application of phenology is to use organisms that respond predictably to heat as indicator species. Such indicators have become very important proxies to monitor the biological impact of accelerated global warming. In Europe, researchers have used records kept at a network of phenological gardens to demonstrate that the length of the growing season has increased by approximately 11 days in the last 30 years (Menzel and Fabijan 1999). Similarly, long-term phenological data reveal a 26-day shift to the earlier onset of spring in Western Canada (Beaubien and Freeland 2000).

Phenological events generally occur in consistent order, with the arrival of one event predicting the imminence of another, so phenological data can also be used as a valuable predictive tool in forestry, agriculture, and fisheries (Caprio 1966; Lieth 1974). For over a century phenological data have been used by the German Meteorological Service to predict the best times to plant, fertilize, apply pesticides, and harvest (Hopp 1974). Fishermen in western Canada have long recognized that pickerel (*Esox lucius* L.) run when the southern cottonwood (*Populus balsamifera* L.) releases seed, and, on the east coast of Canada, fishermen would not fish for shad (*Alosa sapisissima* Wilson) until the saskatoon, or shadbush (*Amelanchier* spp.), had flowered (Beaubien 1991).

The use of plant and animal development to predict seasonal events is by no means a new practice. When Samuel de Champlain arrived at Cape Cod in 1605, the Wampanoag people informed him that the best time to plant corn was when the white oak (*Quercus alba* L.) leaf was the same size as the footprint of a red squirrel (*Tamiasciurus hudsonicus* Erxleben) (Molitor 1987). To the Blackfoot peoples of southern Alberta and Montana, the flowering of the buffalo bean (*Thermopsis rhombifolia*) was considered to be an indicator that bison bulls (*Bison bison*) had eaten enough spring browse and marbled enough fat that they were ready to be hunted (Johnston 1982; Peacock 1992). On the west coast of Canada, the Nuu-Chah-Nulth peoples of Vancouver Island recognize the correspondence between the ripening of the salmonberries (*Rubus spectabilis*) and the return of adult sockeye salmon (*Oncorhynchus keta*) to freshwater (Bouchard and Kennedy 1990). Phenological knowledge is also significant in the subsistence activities of the Ka'apor peoples of the Amazon (Balée 1993), Pomo and Tubatulabal peoples in California,[1] and the Yanyuwa peoples of Northern Australia (Baker 1993).

Although there are numerous references to phenological indicators in North American ethnographic and ethnobotanical records, this type of knowledge has not been treated systematically, and its occurrence in the literature is somewhat sporadic. Recently, the use of phenological indicators by North American aboriginal peoples has received some attention, and has been recognized as an important component of traditional ecological knowledge and wisdom (TEKW) (Berkes 1999; Turner 1997b; Turner et al. 2000). However, to date there has been no detailed examination of the scope and overall importance of this type of knowledge for North American aboriginal peoples.

This paper is a preliminary effort to assess TEKW that relates to seasonality and phenology in British Columbia, Canada and surrounding regions, and to assess the significance of traditional phenological knowledge (TPK) to the aboriginal peoples in this region. Because many phenological indicators are intimately associated with language, cultural beliefs, and traditional conceptions of time, in order to consider all possible sources of knowledge, we define TPK in a broad sense here. TPK encompasses all knowledge of biological seasonality, including the observation of life cycle changes in specific plant or animal species to indicate the timing of the onset of growth stages in other species, linguistic references to phenological events, traditional conceptions of time as they relate to seasonal change, and spiritual beliefs about cause and effect relationships of seasonal change.

METHODS

To summarize and assess the use and significance of phenological indicators by the aboriginal peoples of British Columbia, we reviewed published and unpublished literature, noting direct and indirect references to plant and animal phenology. Traditional Phenological Knowledge was categorized as direct or indirect. Direct TPK includes the observation of specific phenological changes in indicator species to signal the seasonal timing of secondary species; indirect TPK includes knowledge embedded in language (lexically marked seasonal indicators) and knowledge associated with the seasonal round, traditional conceptions of time and the seasons, and associated beliefs and rituals. Sources included ethnobotanical monographs, ethnographies, technical reports, and plant-use handbooks. In general, this literature pertained to British Columbia, but published sources from surrounding regions (Alaska, Washington, Montana and Alberta) were also examined. Information on TPK was grouped using a linguistic/cultural classification (Figure 1) and is presented and discussed by subcategories of plant and animal resources. More than 20 languages were encountered in the literature consulted, so no attempt has been made to standardize orthographies, and the orthography used for those languages follows that of the source publications.

PLANT AND ANIMAL RESOURCES

Berries.—Indicators of the imminence of berry ripening, 15 of which are documented here (Table 1), are among the most common phenological indicators used by aboriginal peoples in British Columbia. Phenological events used to signal the onset of berry ripening include life cycle changes in invertebrates, vertebrates, and plants, but predominantly incorporate the flowering or fruiting phenology of a second plant species. Indicators of berry availability include the Okanagan use of prickly pear (*Opuntia fragilis*) flowering as a sign that the saskatoon (*Amelanchier alnifolia*) berries are ripe (Turner et al. 1980), and the Nlaka'pamux use of the blooming of wild rose (*Rosa* spp.) as an indication that the soapberries (*Shepherdia canadensis*) are ready to harvest.[2] One of the most interesting examples of phenological knowledge that relates to berry ripening is indirectly encoded in the belief that the singing of the Swainson's thrush (*Hylocichla ustulata*) is responsible for ripening the salmonberries. The Tlingit, Haida, Haisla, Oweekeno, Squamish, Nuu-chah-nulth, Ditidaht, and Straits Salish all associate the singing of this bird causally with the ripening of salmonberries. This belief is also reflected in the names for the Swainson's thrush and the song of the Swainson's thrush in at least four languages (Haida, Oweekeno, Ditidaht, and Squamish: Table 1), and encodes the direct TPK that in Coastal British Columbia salmonberry flowers mature and the fruits begin to ripen at approximately the same time (Pojar and MacKinnon 1994) that the Swainson's thrush returns to this part of its breeding range (Campbell et al. 1997).

The prevalence of indicators used to determine when a particular edible berry is ready to harvest underscores the importance of these resources to the aboriginal peoples of British Columbia. Traditionally, berries were one of the most important food resources, and served as an essential winter foodstuff (Thornton 1999; Turn-

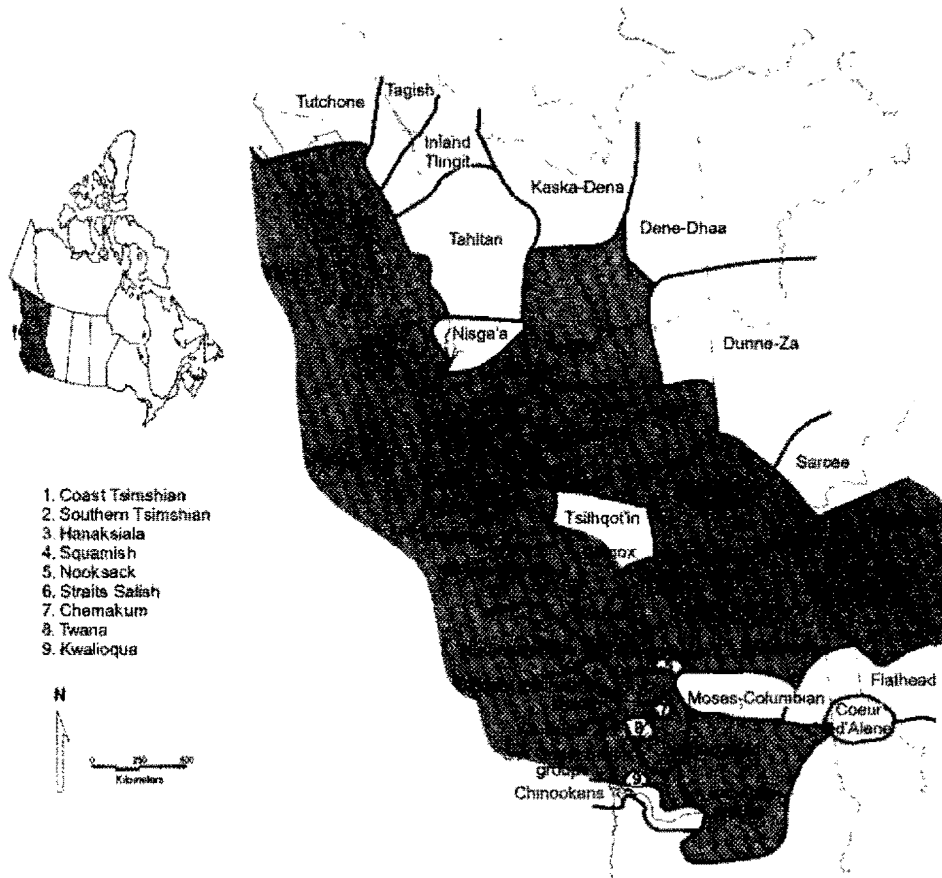

FIGURE 1.—Cultural linguistic classification of the aboriginal peoples of British Columbia. Cultural groups included in this review are shaded in gray. Figure modified from Turner and Loewen (1998).

er 1995, 1997a). Berries were also extremely important in trade and as a food gift item in potlatch ceremonies (Thornton 1999; Turner 1995, 1997a). However, edible berries, often called the "quintessential patchy resource" (Thornton 1999:31; cf. Winterhalder and Smith 1981), are prime for extremely short time periods and must be collected, processed, and stored rapidly. Acquiring large enough quantities of berries for food and ceremony requires familiarity with habitat and the coordinated organization of harvesting and processing (Thornton 1999). Consequently, berry harvesting must be effectively and efficiently planned and regulated so that harvesting yields sufficient quantity to return the energy invested (Gottesfeld 1993). Different berries occur in different ecosystems across the landscape, often far from where other resources are harvested. Therefore, in addition to knowledge of berry distribution and abundance across a given territory, a prerequisite to such planning is precise knowledge of the temporal availability of the berries, which would ensure that harvesting effort is not wasted. Indicator species that signaled the beginning of the availability of a particular berry crop may have

TABLE 1.—Traditional phenological knowledge associated with plants.

Plant resource (berries)	Indicator	Lexically marked seasonal indicator
Amelanchier alnifolia Nutt. (saskatoon)—berries ripening	*Opuntia fragilis* (Nutt.) Haw. (prickly pear cactus)—blooming: Okanagan	***Ókonokistsi otsitsi'tssp***: Blackfoot ~ July = 'when the saskatoons are ripe' ***Pellqwelq'wel't***: Secwepemc[2] ~ June = 'saskatoons getting ripe'
Fragaria spp. (wild strawberry)—berries ripening	*Rosa* spp. (wild roses)—blooming: Stl'atl'imx	***Plltqaitq'atan***: Secwepemc[2] ~ June = 'the time of strawberries'
Gaultheria shallon Pursh (salal)—berries ripening		***Temt'áka7***: Squamish ~ August = 'when the salal berries ripen' ***Kiamgam lax tsa'wast***: Tsimshian ~ September = 'when some kind of late (salal) berries ripen' ***Tem taka***: Sechelt ~ August = 'salal berry time'
Prunus virginiana L. (chokecherry)—berries ripening		***Pákipistsi otsítai'tssp***: Blackfoot ~ August = 'when chokecherries are ripe' ***Iitáipa'ksiksini'kayi pákki'pistsi***: Blackfoot ~ September = 'when the chokecherries are mushy from being overripe'
Ribes oxyacanthoides L. (currant)—berries ripening	*Heracleum lanatum* Michx. (cow parsnip)—before blooming (prior to harvest): Blackfoot	***Kachich***: Tlingit[1] ~ September < ***kaxʷéx*** = 'cranberries'—(*Viburnum edule* (Michx) Raf.)
Rubus spectabilis Pursh (salmonberry)—berries ripening	*Hylocichla ustulata* Nutt. (Swainson's thrush)—singing ripens berries: Haida, Haisla, Oweekeno, Ditidaht,[1,2] Squamish, nuu-chah-nulth,[1] Tlingit,[2] Straits Salish[1]	***Tŭmtsewŭk***: Squamish ~ April = 'the time of salmonberries' ***wiid***: Haida; ***h'xʷ :h'xʷ ni***: Oweekeno; ***qaqawašł y'k***: Ditidaht[1]; ***xwet*** Squamish ~ Swainson's thrush = 'salmonberry bird' ***Ğŭlanx***: ~ July: Oweekeno = 'time for picking salmonberries' ***Tem kweekwel***: Sechelt ~ June = 'salmonberry time' ***Temtsá7tskay***: Squamish ~ April = 'when the salmonberry shoots ripen'
—shoots ready to harvest	*Elasmostethus cruciatus* Say. (stink bug)—presence: Squamish	

TABLE 1—(continued)

Plant resource (berries)	Indicator	Lexically marked seasonal indicator
Rubus ursinus Cham and Schlecht (trailing blackberry)—berries ripening		***Tŭmtsewŭk***: Squamish ~ July = 'the time of blackberry'
Shepherdia canadensis (L.) Nutt. (soapberry)—berries ripening	*Rosa* spp. (wild roses)—blooming: Stl'atl'imx	
Sambucus racemosa L. (red elderberry)—berries ripening		***Tŭmtsewŭk***: Squamish ~ April = 'the time of red elderberries'
Vaccinium ovalifolium Bong. (oval-leaved blueberry)—berries ripening	*Rubus spectabilis* Pursh (salmonberry)—berries ripe: Ditidaht[1]	
Vaccinium ovatum Pursh (evergreen huckleberry)—berries ripening	*Oncorhynchus keta* (dog salmon): running: Nuu-chah-nulth[2]	
Vaccinium membranaceum Dougl. ex Hook (black mountain huckleberry)—berries ripening	*Crataegus douglasii* Lindl. (black hawthorn)—berries ripe: Okanagan	
Vaccinium parviflorum Smith (red huckleberry)—berries ripening		***Tl'ihapaXpl***: Ditidaht[1] ~ June = 'the time of the red huckleberry'
Unspecified berries ripening	Cicada—song awakens the berries and makes them ripen faster: Secwepemc[1,2]	***Kiamgam laxmai***: Tsimshian ~ June = 'moon when they pick berries' ***TsakulstaAm***: Oweekeno ~ September = 'moon when there are no more berries' ***Tem saiuq***: Sechelt ~ July = 'red cap time' (*Rubus parviflorus* Nutt.) ***Kakit***: Tlingit[1] ~ August = 'berry picking time' ***Hloxsa Maa'y***: Gitxsan ~ June = 'time for berry picking' ***Lasa maa'y***: Gitxsan ~ June = 'the first berries of the season'

TABLE 1—(continued)

Plant resource ('roots' and other)	Indicator	Lexically marked seasonal indicator
Camassia quamash (Pursh) Greene (blue camas)—bulbs ready to harvest		***Penáwen***: Straits Salish ~ May = 'moon of the camas harvest'
Dryopteris expansa (Presl.) Fraser-Jenkins & Jermy (wood fern)—rootstalks ready to harvest		***Sik̲aalx̲m***: Nuxalk ~ October = 'the time for gathering the rootstalks of spiny wood fern'
Erythronium grandiflorum Pursh (yellow avalanche lily)—bulbs ready to harvest	*Catharus guttatus* Pallas (hermit thrush) or *Catharus fuscescens* Stephens (veery) = (nightingale)–song: Stl'atl'imx *Odocoileus hemionus* Rafinesque (mule deer)—fawns born: Stl'atl'imx	***Pllscwicwm***: Stl'atl'imx ~ April = 'when the avalanche lilies start to grow' ***Pell7e7llqten/Scwicw***: Secwepemc[2] ~ May = 'digging month'/'time to dig avalanche lily bulbs'
Fritillaria pudica (Pursh) Spreng (yellowbells)—bulbs ready to harvest	*Nereocystis luetkeana* (Mert.) Posr. And Rupr.—bulbs ready: Stl'atl'imx	
Lewisia rediviva Pursh (bitter root)—roots ready to harvest	*Amelanchier alnifolia* Nutt. (saskatoon)—flowering: Nlaka'pamux[1] *Prunus virginiana* L. (choke cherry)—leafing: Nlaka'pamux[1]	***Sp'itl'mtn***: Okanagan ~ April < ***sp'itl'm*** = bitter root (Okanagan first roots ceremony held when the bitter root flower starts to bend over. Ktunaxa root digging season also begins with this plant)
Lomatium macrocarpum (Nutt.) Coult. & Rose (biscuit root)—roots ready to harvest	*Turdus migratorius* L. (robin)—song: Secwepemc[2]; *Sturnella neglecta* Audubon (meadowlark)—song: Secwepemc[2]	
Phalaris arundinacea L. (basket grass)—ready to harvest	*Rosa* spp. (wild roses)—blooming: Nlaka'pamux[3]	
Pinus contorta Dougl. ex Loud. (lodgepole pine)—cambium ready to harvest	*Astralagus miser* Dougl. ex. Hook. (locoweed)—blooming: Okanagan	

TABLE 1—(continued)

Plant resource ('roots' and other)	Indicator	Lexically marked seasonal indicator
Pinus ponderosa Dougl. ex Loud. (Ponderosa pine)—cambium ready to harvest	*Pseudotsuga menziesii* (Mirbel.) Franco. (Douglas-fir)—cones shedding pollen Okanagan	***skam'álekw***: Okanagan = 'trees that have ripe pollen cones'
Porphyra spp. (red laver—edible alga)—ready to harvest	*Rubus parviflorus* Nutt. (thimbleberry)—shoots ready: Nuxalk *Urtica dioica* L. (stinging nettle)—growth parallels growth of seaweed: Tsimshian*	***Hà7li7xłà7ask^{h}***: Tsimshian ~ May > ***łá7ask^{h}*** = edible seaweed (*Porphyra abbottiae* V. Krishnamurthy)
Psoralea esculenta Nutt. (bread-root)—roots ready to harvest	*Thermopsis rhombifolia* R.Br. (buffalo bean)—flowering: Blackfoot	
Thuja plicata Donn. (western red cedar)—roots ready to harvest	*Rosa* spp. (wild roses)—blooming: Stl'atl'imx[2]	
Tricholoma spp. (edible mushrooms)—will be abundant	*Monotropa uniflora* L. (Indian pipe)—blooming: Nlaka'pamux[2]	
Sap from various trees—ready to harvest	*Acer macrophyllum* Pursh (big-leaf maple)—sap running: Kwakwaka'wakw	***Sakw'a***: Kwakwaka'wakw = 'the time when the sap is flowing' < ***Sakwa'7ems*** = broad-leaf maple (*Acer macrophyllum*)

Sources: Blackfoot (Peacock 1992); Ditidaht[1] (Turner et al. 1983); Ditidaht[2] (Turner et al. 1997b); Gitxsan (Sim'algax Working Group 1996); Haida (N.J. Turner, unpublished notes, see note 4 of text); Haisla (Davis et al. 1995); Ktunaxa (Hart 1974); Kwakwaka'wakw (Turner and Bell 1973); Nlaka'pamux[1] (Bandringa 1999); Nlaka'pamux[2] (Turner et al. 1990); Nlaka'pamux[3] (Turner 1992a); Nuu-chah-nulth[1] (Clayoquot Scientific Panel 1995); Nuu-chah-nulth[2] (Turner and Efrat 1982); Nuxalk (Turner 1973); Okanagan (Turner et al. 1980); Oweekeno (Compton 1993); Sechelt (Hill-Tout 1978); Secwepemc[1] (Turner 1997b); Secwepemc[2] (N.J. Turner et al., unpublished manuscript, see note 6 of text); Squamish (Bouchard and Turner 1976); Stl'atl'imx (Turner et al. 1998); Straits Salish[1] (Turner 1997b); Straits Salish[2] (Claxton and Elliott 1993); Tsimshian (Compton 1993); Tlingit[1] (Emmons 1916); Tlingit[2] (De Laguna 1972).

* Helen Clifton, pers. comm. to N. Turner, 2002.

also provided human gatherers with an important competitive advantage over other animals consuming the same resource.

In Nuxalk villages McIlwraith (1948:265) describes how "one woman had the prerogative of picking the first berries of a particular kind." When these berries were ready for picking "she paraded up and down the village with a special decorated picking basket, calling 'Get ready to pick red elderberries (or whatever kind was ripe) tomorrow!'" The use of phenological indicators represents an important tool for determining when a given berry is ready to be collected. Additionally, the ripening of a particular berry may have itself been used as an indicator of an important life cycle change in another species (Tables 1, 2).

'Roots', Cambium, Shoots, and Other Plant Parts.—In addition to berry resources, there are 16 phenological indicators of the availability of other plant foods and materials that are documented here (Table 1). These consist of indicators of the availability of a diverse range of resources; they include eight 'roots' (rhizomes, bulbs, swollen roots, and other edible underground plant parts), five other plant foods (cambium, shoots, mushrooms, tree sap, and seaweed), and two kinds of plant materials. Like the seasonal markers that signal the availability of berries, these indicators mainly involve the flowering or fruiting phenology of a second plant species, but also include several animal indicator species. Examples include Okanagan use of the ripening of Douglas-fir (*Pseudotsuga menziesii*) pollen cones to signal that ponderosa pine (*Pinus ponderosa*) cambium was ready to be harvested (Turner et al. 1980); Stl'atl'imx use of the blooming of wild rose to indicate the best time to collect cedar roots (*Thuja plicata*) and basket grass (*Phalaris arundinacea* L.) (Turner 1992); and Blackfoot use of the blooming of buffalo bean as a sign that it was time to harvest the roots of Indian breadroot (*Psoralea esculenta*) (Peacock 1992).

For many of the aboriginal peoples of British Columbia, edible underground plant parts, which were gathered and stored in extremely large quantities, served as an important winter resource (Turner 1995, 1997a). Like berries, the developmental timing, and consequently the availability, of many of these 'roots' varies greatly between years. The use of indicators as a cue for the best time to harvest would have allowed for the effective coordination of efficient harvesting activities. Indicators of underground plant part availability appear to have been particularly important to the aboriginal peoples of interior British Columbia, where 'root' crops were among the first plant foods harvested in the spring, and first roots ceremonies celebrating the availability of these foods were an important sociocultural recognition of the arrival of spring (Bandringa 1999; Hart 1974; Turner et al. 1990). The comparatively smaller number of indicators of 'root' food phenology relative to the number of indicators for berries may be attributed in part to the greater relative importance of these 'root' staples to the aboriginal peoples of the interior, compared with the uniform importance of berry resources to aboriginal peoples across the province.

Fish.—The bulk of all of the phenological signals of animal resource availability detailed here relate to the seasonal appearance of fish resources (Table 2). These include 18 indicators of life cycle timing in fish, more than half of which relate to the phenology and availability of salmon. Most of these involve the use of plant

TABLE 2.—Traditional phenological knowledge associated with animals.

Animal resource (fish)	Indicator	Lexically marked seasonal indicator
Clupea harengus pallasi Valenciennes (Pacific herring)		***T'híqalaxsǧam***: Oweekeno ~ February = 'when the water turns milky with herring spawn' ***Watsum***: Oweekwno ~ March < ***wasila*** = 'to place boughs for herring spawn'
Hippoglossus stenolepis Schmidt (Pacific halibut)—availability: beginning of spawning migration	*Sambucus racemosa* L. (red elderberry)—blooming: Nuu-chah-nulth[1] *Urtica dioica* L. (stinging nettle)—size of shoots: Nuu-chah-nulth[2,3]	
Ictalus nebulosus Lesueur (brown bullhead)		***Sx̱ánel***: Straits Salish ~ April = bullhead moon
Oncorhynchus gorbuscha Walbaum (pink or humpback salmon)		***Ćenhenen***: Straits Salish ~ July = 'the humpback returns to earth'
Oncorhynchus keta Walbaum (dog or chum salmon)—beginning of spawning migration	*Spirogyra* spp. (green pond slime) and *Fontinalis antipyretica* Hedw. (common water moss) washed out to sea with first heavy rains: Nuu-chah-nulth[2,3] *Vaccinium ovatum* Pursh (evergreen huckleberry)—ripening: Nuu-chah-nulth[2]	***sk'ági chay***: Haida ~ *Vaccinium vitis-idaea* L. (low-bush cranberry) = 'dog salmon eggs' ***Ǧvàxsəm***: Oweekeno ~ September = 'dog salmon arrive' ***Ćenqolew***: Straits Salish ~ September = 'the dog salmon returns to earth' ***Tem kwaloq***: Halkomelem ~ September = 'dog salmon spawning season' ***t'eda'xwdi***: Makah ~ *Symphoricarpos albus* (L.) Blake (common snowberry) = 'eye of the dog salmon'
—abundant	*Symphoricarpos albus* (L.) Blake (common snowberry)—large fruit set: Makah	

TABLE 2—(continued)

Animal resource (fish)	Indicator	Lexically marked seasonal indicator
Oncorhynchus kisutch Walbaum (coho salmon)—beginning of run	*Spirogyra* spp. (green pond slime) and *Fontinalis antipyretica* Hedw. (common water moss)—washed out to sea with first heavy rains: Nuu-chah-nulth[2,3] *Tabanus* spp. (horsefly)/*Chrysops* spp. (deer-fly)—presence: Tsimshian*	***Zuwànsǧam***: Oweekeno ~ August = 'time when the coho salmon arrive' ***Ćentáwen***: Straits Salish ~ August = 'coho salmon returns to earth' ***KwísuT/Kēkaitka'in***: Nlaka'pamux[2] ~ September = 'poor fish'/'they reach the source' (the cohoes and the silver salmon come, and the salmon begin to get poor)
Oncorhynchus mykiss Walbaum (steelhead trout)–beginning of spawning migration	*Ribes cereum* Dougl. (desert currant)—leafing: Nlaka'pamux[1] *Turdus migratorius* L. (American robin)—singing: Gitksan[1]	
Oncorhynchus nerka Walbaum (sockeye salmon)—beginning of spawning migration	*Rubus spectabilis* Pursh (salmonberry) ripening: Ditidaht *Shepherdia canadensis* (L.) Nutt. (soapberry)—ripening: Secwepemc *Holodiscus discolor* (oceanspray)—flowering: Straits Salish** Unidentified mushroom—presence: Stl'atl'imx[1]	***sqlélten re ckwetkwtút'stens***: Secwepemc ~ *Gaillardia aristata* Pursh. (brown-eyed susan) = 'sockeye salmon eyes' ***skts'unús***: Okanagan[1] ~ *Phlox longifolia* Nutt. (phlox) = 'early sockeye salmon eye' ***MAłtsum***: Oweekeno ~ June–August = 'sockeye moon' ***Ćenteki***: Straits Salish ~ June = sockeye moon: ***Laxa'ks***: Nlaka'pamux[2] ~ August = 'first (or nose) of returning sockeye run' ***nláw7e̱kw***: Stl'atl'imx[2] ~ unidentified mushroom = 'sockeye head'
—smolt no longer good to eat	*Shepherdia canadensis* (L.) Nutt. (soapberry) ripening: Stl'atl'imx[2]	

TABLE 2—(continued)

Animal resource (fish)	Indicator	Lexically marked seasonal indicator
Oncorhynchus tshawytscha Walbaum (spring or chinook salmon)—beginning of spawning migration	*Ranunculus glaberrimus* Hook. (sagebrush buttercup)—blooming: Stl'atl'imx[1] *Rosa* spp. (wild rose)—blooming: Stl'atl'imx[1,2]	***ntitixwu's***: Okanagan[1] ~ *Erigeron filifolius* Nutt. (fleabane) = 'spring salmon eye' ***kntitixwús***: Okanagan[1] ~ *Gaillardia aristata* Pursh. (brown-eyed susan) = 'spring salmon eye' ***n/k'ʷl'=ús-tn-s e s/c'wén'***: Nlaka'pamux[1] ~ *Gaillardia aristata* Pursh. (brown-eyed susan) = 'spring salmon eye' ***(s-)kwex̱málus/kwex̱m'álus***: Stl'atl'imx[1] ~ *Ranunculus glaberrimus* Hook. (sagebrush buttercup) = 'spring salmon eye' ***Sken'írmn'***: Okanagan[1] ~ February < ***sken'Rrmn'*** = *Ranunculus glaberrimus* Hook. (sagebrush buttercup) ***sk'elu7sálhk̲***: Okanagan[1] ~ *Prunus virginiana* L. (chokecherry) = 'old spring salmon fruit' ***SastsAm***: Oweekeno ~ June = 'spring salmon moon'
—beginning of spawning migration		***Tem paku***: Halkomelem ~ October = 'spring salmon spawning' ***Hlox̱sa ya'/Lasa ya'a***: Gitxsan[2] ~ April = 'time for spring salmon'
Oncorhynchus spp. (Pacific salmon)—abundant	*Prunus virginiana* L. (chokecherry)—filled with worms: Nlaka'pamux[1]	***Mia'sğam/Hâyànx***: Oweekeno ~ June = 'fish moon'/ 'arrival of salmon' ***Pesqelqleten***: Secwepemc ~ August = 'many salmon month' ***Pelltemllik't***: Secwepemc ~ September = 'salmon spawned out month' ***Tem okwalenuh***: Sechelt ~ September = 'when the fish stop running' ***Tem qasetcin***: Sechelt ~ November = 'time when the fish leave the streams'

TABLE 2—(continued)

Animal resource (fish)	Indicator	Lexically marked seasonal indicator
Thaleichtys pacificus Richardson (eulachon)		***zawas***: Haisla and Hanaksiala ~ *Salix lasiandra* Bentham (pacific willow) = 'eulachon tree' ***TcaHam***: Oweekeno ~ April = 'eulachon moon' ***Zàx^{w}ilaqus***: Haisla and Hanaksiala ~ March = 'the month when the eulachon came' ***Kauhkish***: Tlingit[1] ~ April = eulachon spawn
Fish (freshwater)—general presence	*Ribes hudsonianum* Richards (northern black currant)—presence: Nlaka'pamux[1]	

Animal resource (other)	Indicator	Lexically marked seasonal indicator
Larus spp. (seagull)—eggs no longer good to eat	*Heracleum lanatum* Michx. (cow parsnip)—blooming: Haida[2]	***Hlk'iid kaajénjes dlaan***: Haida = of time before blooming of (prior to harvest) *Heracleum lanatum* Michx. (cow parsnip)
Phoca vitulina L. (harbor or hair seal)—time to hunt	*Sambucus racemosa* L. (red elderberry)—blooming: Nuu-chah-nulth[1]	***Shanagh disee***: Tlingit[1] ~ December = 'hair shows on the baby seals in the womb'
—baby seals born	*Urtica dioica* L. (stinging nettle)—size of shoots: Squamish	
Eschrichtius robustus Lilljeborg (gray whale)—time to hunt	*Sambucus racemosa* L. (red elderberry)—blooming: Nuu-chah-nulth[1]	
Bison bison L. (bison)—bulls, time to hunt	*Thermopsis rhombifolia* R.Br. (golden or buffalo bean)—blooming: Blackfoot[1,2], Flathead	***wudzi-eh-kay***: Blackfoot[2] ~ *Thermopsis rhombifolia* R.Br. (buffalo bean) = 'buffalo flower'
—cows, time to hunt	*Stipa comata* Trin. And Rpr (spear grass)—spread out: Blackfoot[1]	
Odocoileus hemionus Rafinesque (mule deer)—time to hunt	*Epilobium angustifolium* L. (fireweed)—blooming: Nlaka'pamux[1]	
—fawns born	*Catharus guttatus* Pallas (hermit thrush) or *Catharus fuscescens* Stephens (veery) = (nightingale)—song: Stl'atl'imx[1]	

TABLE 2—(continued)

Animal resource (other)	Indicator	Lexically marked seasonal indicator
Marmota spp. (marmot)—time to hunt	*Philadelphus lewisii* Pursh (mockorange)—blooming: Okanagan[1]	
Marmota spp. (marmot/groundhog)—time to hunt	*Lupinus sericeus* Pursh—blooming: Okanagan[2]	***Lasa sgangwiikw***: Gitxsan ~ September = 'the groundhog getting fat and the Gitxsan go and hunt them' ***Hloxsa genmu gwiikw***: Gitxsan ~ September = 'the groundhogs are getting ready for winter'
Ursus arctos horriblus Ord (grizzly bear)		***Hloxsa Lak'insxw***: Gitxsan ~ August = 'the grizzly bears are out in numbers' ***Lasa lik'i'insxw***: Gitxsan ~ August 'when the girzzly bears are eating fish'
Ursus americanus Pallas (black bear)—females denning	*Larix occidentalis* Nutt. (western larch)—change color, if they do this when the needles are senescing they will miscarry: Okanagan[2,3]	***Ko-ko-ha dis***: Tlingit[1] ~ November = 'when bear digs winter holes' ***Wihlax-s or 'Wiihloxs***: Gitxsan ~ March = 'the bears sit around their den before they come out in spring'
Saxidomus giganteus Deshayes (butter clams)—ready to harvest	*Holodiscus discolor* (Pursh) Maxim (oceanspray)—blooming: Comox	
Tresus capax Gould (horse clams)—ready to harvest	*Alnus viridis* (Chaix) Candolle (sitka alder)—catkin growth: Heiltsuk	
—no longer good to eat	Unidentified seaweed—growth: Tlingit[2]	

Sources: Blackfoot[1] (Johnson 1982); Blackfoot[2] (Peacock 1992); Comox (Turner 1997b); Ditidaht (Turner et al. 1983); Flathead (Johnston 1982); Gitksan (Jensen and Powell 1979); Gitxsan (Sim'algax Working Group 1996); Haida (N.J. Turner, unpublished notes, see note 4 of text); Haisla (Compton 1993); Halkomelem (Hill-Tout 1978); Hanaksiala (Compton 1993); Heiltsuk (Compton 1993); Makah (Gunther 1973); Nlaka'pamux[1] (Turner et al. 1990); Nlaka'pamux[2] (Teit 1900); Nuu-chah-nulth[1] (Bouchard and Kennedy 1990); Nuu-chah-nulth[2] (Turner and Efrat 1982); Nuu-chah-nulth[3] (Clayoquot Scientific Panel 1995); Okanagan[1] (Turner et al. 1980); Okanagan[2] (Turner 1997b); Okanagan[3] (Ray 1932); Oweekeno (Compton 1993); Secwepemc (N.J. Turner et al., unpublished manuscript, see note 6 of text); Sechelt (Hill-Tout 1978); Squamish (Bouchard and Turner 1976); Stl'atl'imx[1] (N.J. Turner, ed., unpublished notes, see note 2 of text); Stl'atl'imx[2] (Turner 1997b); Straits Salish (Claxton and Elliott 1993); Tlingit[1] (Emmons 1916); Tlingit[2] (De Laguna 1972).

* Helen Clifton pers. comm. to N. Turner, 2002.

** Belinda Claxton pers. comm. to N. Turner, 2001.

phenology to signal the timing of a particular spawning migration. Examples include Nlaka'pamux use of the leafing of desert currant (*Ribes cereum*) as a sign that the steelhead trout (*Oncorhynchus mykiss*) are running in the Stein River (Turner et al. 1990); Stl'atl'imx observation that the blooming of sagebrush buttercup (*Ranunculus glaberrimus*) corresponds to the first peak in the spawning migration of the spring (chinook) salmon (*Oncorhynchus tshawytscha*) up the Fraser River[3]; and Nuu-chah-nulth use of red elderberry (*Sambucus racemosa*) blooming as a sign that it is time to fish for halibut (*Hippoglossus stenolepis*) (Bouchard and Kennedy 1990).

As with edible underground plant parts and berries, the high number of direct phenological indicators that relate to fish availability highlights the importance of these resources to the aboriginal peoples of British Columbia. Historically, these peoples consumed large quantities of animal protein throughout both the winter and summer months (Chisholm et al. 1983). Fish were also an important item in trade and ceremony (Turner 1995, 1997a). As with plant foods, the acquisition of animal foods for sustenance and ceremony necessitated the quick, efficient collection and storage of sufficient quantities when they became available. The use of phenological indicators would have provided an effective means of ensuring that harvesting effort was efficiently directed. Furthermore, a mistimed harvest, in addition to reduced yields, could also potentially jeopardize the long-term availability of the resource. For example, harvesting migrating adult salmon too early could preclude adequate escapement for spawning.

Like the phenology and abundance of berry-producing shrubs, fish reproductive phenology, and thus availability, also varies considerably between years. For example, the timing of the chinook and coho salmon (*Oncorhynchus kisutch*) adult spawning migration into the Big Qualicum River varied by as much as five weeks between 1959 and 1972 (Fraser et al. 1983). Indicator species, particularly plants that are widespread and thus easily observable, would have provided an important cue to the availability of fish, which are inherently more difficult to monitor than plants. Predicting when to harvest an important resource such as salmon would have been particularly important because in many cases, a decision to begin harvesting would have involved traveling long distances away from areas where other foods were being collected.

Mammals, Birds, and Shellfish.—In addition to indicators signaling the onset of fish abundance, there are also a number of phenological indicators which are used to predict the availability of other animal resources (Table 2). These include twelve indicators of vertebrate resources (e.g., mule deer [*Odocoileus hemionus*], bison, marmot [*Marmota* spp.], harbor seal [*Phoca vitulina*], gray whale [*Eschrichtius robustus*], and seagull eggs [*Larus* spp.]) and two indicators of invertebrate resources (horse clams [*Tresus capax*] and butter clams [*Saxidomus giganteus*]). Indicators of the timing of these resources also generally involve the use of plant flowering phenology to signal the best time to gather or hunt. Examples of these indicators include Haida utilization of the blooming of cow parsnip (*Heracleum lanatum*) as a sign that seagull eggs were no longer good to harvest[4]; Comox use of oceanspray (*Holodiscus discolor*) flowering as an indicator of the best time to dig for butter clams (Turner 1997b); and Okanagan use of mock-orange (*Philadelphus lew-*

isii) blooming as an indicator that the marmots were fat and ready to be hunted (Turner et al. 1980). Like indicators of fish availability and abundance, this phenological knowledge represents an important tool that would have aided in the efficient collection of animal resources.

Several other indicators signal the onset of various animal phenophases that do not directly relate to the availability of a specific resource, but undoubtedly represent knowledge that contributes to an understanding of the availability and abundance of the harvestable phenophase of that resource. Examples of these include the Squamish association of the time when the stinging nettle shoots (*Urtica dioica*) were several centimeters high with the time when harbor seals were born (Bouchard and Turner 1976); the Okanagan association of the yellowing and senescence of western larch (*Larix occidentalis*) with the timing of female black bear (*Ursus americanus*) denning (Turner et al. 1980, 1997b); and the Stl'atl'imx association of 'nightingale' (*Catharus* sp.?) singing with the time when the mule deer fawns were born.[5]

Generally, most of the phenological indicators described here seem to correspond roughly with the timing of the plant and animal life cycle events that they predict. However, we have made no effort to examine the temporal precision or predictive rigor of these indicators in any detail. For species where phenological data are readily available, an analysis of this kind would certainly be an interesting extension of this paper.

PHENOLOGY IN RELATION TO TIME AND THE SEASONAL ROUND

In addition to what can be called direct indicators, where the phenology of one species is used to signal the onset of another phenophase in a second species (typically an important resource), there is also extensive traditional phenological knowledge encoded in language and words with etymological reference to phenological events. Most of these lexically marked seasonal indicators are inextricably linked with traditional conceptions of time and the seasonal round. Eighty-four words in 21 languages that make reference to a range of phenological events and discrete time periods are described here. Of these, 35 are related to the phenology of plant resources, 26 of which relate to berries (Table 1); 49 are associated with animal phenology, 39 of which relate to fish (Table 2). Examples include the Squamish name for the time period corresponding to August (***temt'áka7***), which is derived from the name for salal (*Gaultheria shallon*) (***t'áka7ay***) and is glossed as 'when the salal berries ripen' (Bouchard and Turner 1976); the Ditidaht name for the time period corresponding to the month of June (***tl'ihapaXpł***), which is derived from the word for red huckleberry (*Vaccinium parvifiorum*) and is glossed as 'the time of the red huckleberry' (Turner et al. 1983); the Oweekeno name for the time period corresponding to April (***tcaHsAm***), which is derived from the word for eulachon (*Thaleichtys pacificus*) (***tcaHan***), and literally means 'eulachon moon' (Compton 1993); and the Secwepemc name for the time period corresponding to August (***pesqelqleten***), which is glossed as 'many salmon month' (Turner et al. 1998).

Although this form of TPK is not as direct as that involving the use of specific indicator species, it nonetheless encodes a profound knowledge of the phenology of many organisms, which perhaps cannot be expressed in isolation from traditional conceptions of time and the seasonal round itself. The recognition of the passage of time in the recurring phenological cycles of plants and animals, which were often associated with, and named after, recurring lunar cycles (Claxton and Elliott 1993; Compton 1993; De Laguna 1972)[6], reflects a holistic understanding of phenology and the seasonal round. Presumably a number of specific phenological events, in conjunction with lunar cycles, would have been used to signal the arrival of a given time period. Amongst the Yakutat Tlingit, the Chief observed these cycles and would inform others that the time to harvest a particular resource had arrived. According to a Tlingit informant, this chief would say, "this time we have hooligans [eulachon] in Dry Bay or Situk [and] when geese or swans going to come, he mentions the day. No mistake. He would say: 'Tomorrow you will see the geese,' and they would come" (De Laguna 1972:801). Because the temporal availability of many plant and animal resources varies considerably between years, the fixed demarcation of time (e.g., the Gregorian or Julian calendar) cannot be used to reliably predict the times to gather important foods. Conversely, a calendar based on lunar cycles, continuously recalibrated through the observation of plant and animal phenology, represents an effective means of determining resource availability.

The First Foods ceremonies of many aboriginal peoples of British Columbia, in which harvesting and food use prescriptions were ritually enacted and the availability of a particular food was recognized and celebrated, similarly exemplify an understanding of plant and animal development that is encoded in spiritual beliefs and ritual (Compton 1993; Johnson 1997; Thornton 1999; Turner 1995, 1997a; Turner et al. 2000). The Hanaksiala of the Northwest Coast of British Columbia celebrated the New Year (***h'isƛàm hs‿h'snx***) when the riceroot (*Fritillaria camschatcensis* (L.) Ker-Gawl) flowered (around the end of March), and performed a ceremonial flower dance in which "costumes were covered with flowers of the Nootka rose, salmonberry, blueberries, riceroot and any other plants that were blooming then" (Compton 1993:197). This time of year was alternately known as ***q'ʷàxilaqus*** 'growing month', and was associated both with the flower dance and the time of the eulachon harvest, ***zàxʷilaqus*** 'eulachon month'.

For other cultural groups, accounts of the seasons and their associated activities are incomplete or absent from the literature. Consequently, phenological knowledge associated with the seasonal round, and knowledge of direct indicators linked to first foods ceremonies and other rituals associated with the annual round may exist but be undocumented.

TRADITIONAL PHENOLOGICAL KNOWLEDGE

The TPK described here consists of a variety of types of knowledge of annual seasonal change and recognition of contemporaneous phenological events. Approximately half of this knowledge can be considered direct phenological knowledge, where one seasonally mediated life cycle stage predicts the onset or end of another, and the remainder is borne out of a broader cultural knowledge, including phenological knowledge, that is embedded in linguistic classification and description of the natural world; in ceremonies, customs, ritual and spiritual beliefs that are intimately linked to the relationship between time and the seasonal round; and in an ecological knowledge of the landscape.

As noted previously, one of the most geographically widespread examples of TPK in British Columbia is the belief that the breeding call of the Swainson's thrush is responsible for the ripening of the salmonberry. In most areas of coastal British Columbia, the salmonberry does flower and begin to ripen (Pojar and MacKinnon 1994) at approximately the same time as the Swainson's thrush begins breeding activity (Campbell et al. 1997), so this phenological knowledge can be viewed as both direct, with the song of the thrush indicating that salmonberries will soon be ripe, and indirect, both in the belief that the song of this bird causes the berry ripening, and in the names for the Swainson's thrush (in four different languages, across three language families), typically glossed as 'the salmonberry bird'. For the Ditidaht, the ripening of the salmonberry in turn functions as a direct indicator, signaling the beginning of the sockeye salmon adult migration (Turner et al. 1983). Thus, while many indicators are expressed directly, and can be seen as a discrete and specific subset of traditional ecological knowledge and wisdom, others are interwoven in a much broader philosophical and cultural framework. Another example of this latter category of TPK is evidenced in the Gitksan belief that several weeks after arriving, American robins (*Turdus migratorius*) sing a special song, ***gii gyooks milit, milit,*** which means "the steelhead are swimming" (Jensen and Powell 1979). Since this type of phenological knowledge cannot be separated from the cultural context of TEKW, TPK is perhaps better described, not as a subset of TEKW, but as a domain of TEKW that is interwoven throughout cultural knowledge (Figure 2).

This less direct phenological knowledge is much more difficult to document because it is easily excluded from many of the analytical categories often used in ethnobiology. Additionally, without the cultural context often critical to the understanding of TPK, it may simply get overlooked. Thus the data presented here probably vastly underestimate the historical importance of TPK. This also partly explains some of the variability in the amount of TPK documented in the publications reviewed here. Some of this discrepancy can be attributed to the varying scope of the publications consulted; some are comprehensive, and report a strikingly large amount of TPK, and others derive from a restricted number of sources and report a correspondingly small amount of TPK. There are also a number of examples of a relatively rich ethnobotanical literature that has few references to TPK; in these cases it seems unlikely that TPK was unimportant to the peoples whose knowledge is being described, but rather that ethnographers, using analytical categories focusing primarily on utilitarian aspects of cultural knowledge, did not record information relating to TPK. Additionally, a great deal of TPK may also have been lost through acculturation, the disruption of traditional life ways, and historical events that have imperiled the link between people and the natural world. However, evidence for the importance of seasonality in discussions of subsistence patterns and the seasonal round for groups where there is no direct evidence of TPK suggest that phenological indicators were indeed significant.

Importance of Traditional Phenological Knowledge.—The large number of phenological indicators used by many cultural groups, as documented in literature sources,

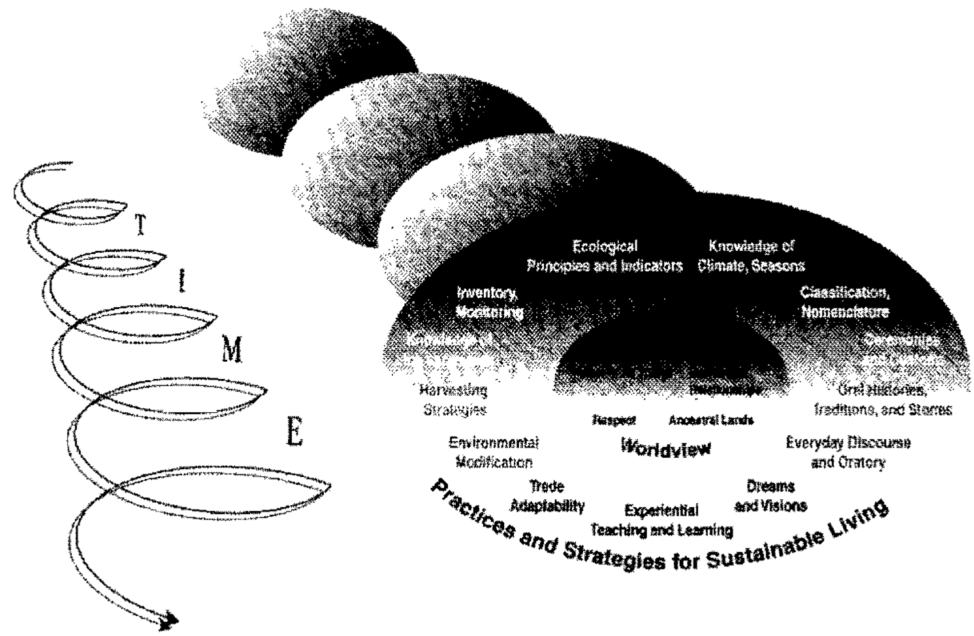

FIGURE 2.—Domain of traditional ecological knowledge and wisdom (TEKW) occupied by traditional phenological knowledge (TPK). Areas of this domain that include direct TPK are represented by categories in white text, and the continuum of less direct TPK is shown by categories in gray moving to black text. Figure modified from Turner et al. (2000).

highlights the overall importance of TPK to the aboriginal peoples of British Columbia and the surrounding regions. Even so, the over 140 examples of phenological knowledge described here undoubtedly represent only a small subset of the TPK that was used by over 20 linguistic/cultural groups. In British Columbia and the surrounding regions TPK was used as a means to ensure that adequate plant and animal resources were collected from across a large landscape, in which annual variability in phenology would have had a considerable impact on the availability and abundance of these organisms. In British Columbia, TPK may have been particularly important because the traditional homelands of many cultural groups are extremely heterogeneous, and plant and animal resources were separated by great distances and/or elevations. For example, by knowing that ripe black hawthorn (*Crataegus douglasii*) berries at low elevations signal that the black mountain huckleberries (*Vaccinium membranaceum*) at higher elevations are starting to ripen, Okanagan peoples would have saved the time and energy it took to travel to the mountains to observe these huckleberries directly (Turner et al. 1980). Similarly, the Tubatulabal people of California, by observing that the coffeeberry (*Rhamnus californica* ssp. *cuspidata* (Greene) C.B. Wolf) fruit was ripe at low elevations, knew that the pinyon pine (*Pinus monophylla* Torr. & Frémont) seeds in the mountains were ready to harvest.[7] TPK proxies that allowed indigenous peoples to accurately predict when a given resource was available without observing it directly would have increased the overall efficiency and effectiveness of subsistence activities. Additionally, if a given indicator event corresponded to the very beginning of the availability of a particular resource, careful observation would have extended the window of harvest considerably.

TPK is also an important means of delineating time periods within the seasonal round, and consequently affected the many cultural activities, rituals, and beliefs associated with the seasonal round. Phenological events that signaled the arrival of the time to harvest plant resources or the time for a First Foods ceremony in the spring would have had an enormous social and cultural impact. As Davis (1993:35) has described, "the use of plants as environmental indicators greatly influenced both the Sekani's movement as well as their emotions."

Traditional phenological knowledge (TPK) is an extremely important component of the traditional ecological knowledge and wisdom (TEKW) of the aboriginal peoples of British Columbia. Phenological knowledge in British Columbia represents a significant domain of TEKW that shaped seasonal movements, subsistence activities, ritual, ceremony, language, and cultural beliefs. Intimately linked with traditional conceptions of time and the seasonal round, TPK was also affected by a much broader framework of cultural knowledge.

This type of TEKW represents another layer of the sophisticated understanding of the natural world that was required of indigenous peoples living within their traditional territories. TPK is particularly significant because it underscores the complexity and depth of traditional knowledge of the environment, which in the case of TPK integrates detailed information from a number of "disciplines," such as ornithology, meteorology, ecology, botany, and ichthyology and links them together with human activities in a complex ethnoecological web.

NOTES

[1] M. Kat Anderson, University of California, Davis, personal communication to N. Turner, 2002.

[2] N. J. Turrner, editor. Draft, unpublished notes (Stl'atl'imx). School of Environmental Studies, University of Victoria, Victoria, B.C. (1998).

[3] See note 2.

[4] N. J. Turner. Unpublished notes (Haida). School of Environmental Studies, University of Victoria, Victoria, B.C. (1998).

[5] See note 2.

[6] N.J. Turner, M.B. Ignace, and D. Loewen, editors. Draft, unpublished manuscript, "Plants of the Secwepemc People" (1998).

[7] M. Kat Anderson, University of California, Davis, personal communication, 2002.

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