Reinhabitation is an approach to building local cultures and economies within industrial society. The food system is a vital starting point. What are the principles of reinhabitory food systems? What are the possibilities for a locally adapted food system in the Marys River region of western Oregon? I describe past and present food systems in the region and give recommendations for building a reinhabitory food system.

Native people established locally adapted food systems in the Marys River region and maintained them for thousands of years, culminating in the Kalapuyan food system that existed at Euroamerican contact. Euroamericans began to settle in the region in 1845, and immediately began to domesticate the landscape, replacing native ecosystems with cropland and pasture. By 1900, a diversified food system had emerged with several locally adapted characteristics. The industrial food system replaced the diversified food system during World War II, and has dominated since then. Locally adapted elements of food systems were rapidly abandoned. Industrialism emphasized mass production of export crops using fossil fuels, heavy machinery, and agrichemicals. A large variety of cultural, economic, and ecological problems emerged, and the health of natural and human communities was diminished.

Reinhabitation is a positive response to the problems of industrial food systems. A locally adapted food system in the Marys River region is possible. There is enough agricultural land to feed the population. A small but growing segment of the local population has established alternative food systems, and initiated the process of building a regional food system.

Reviewing the history of the Marys River region helps clarify how to apply principles of reinhabitation in the region.
Food Systems In The Marys River Region And Reinhabitation

by

Erik P. Burke

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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Erik P. Burke, Author
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FOOD SYSTEMS IN THE MARYS RIVER REGION AND REINHABITATION

CHAPTER 1: BACKGROUND AND PRINCIPLES OF REINHABITATION

REINHABITATION

Reinhabitation is an approach to building local cultures and economies within industrial society. The food system is a vital starting point. What are the principles of reinhabitory food systems? What are the possibilities for a locally adapted food system in the Marys River region (figure 1) of western Oregon? Describing the environmental setting and past food systems in the study area provides context for making recommendations to build a locally adapted food system.

The term reinhabitation originated within the bioregionalism movement from biologist Raymond Dasmann's terms “ecosystem people” and “biosphere people” (Dasmann 1981:21-22; orig. 1964). Ecosystem people are “inhabitory,” that is their economy, technology, and culture is adapted to specific watersheds or ecosystems. Nabhan (1997:321) describes ecosystem people as “cultures of habitat,” societies tightly linked with local ecosystems. In contrast, biosphere people live in state societies or civilizations with national or global economies. Berg and Dasmann (1978:217-218) define reinhabitation as:

learning to live-in-place in an area that has been disrupted and injured through past exploitation. It involves becoming native to a place through becoming aware of the particular ecological relationships that operate within and around it. It means . . . evolving societies and behavior that will enrich the life of that place, restore its life-supporting systems, and establish an ecologically and socially sustainable pattern of existence within it.

In the Marys River region, Native American food systems were locally adapted or inhabitory. Industrial food systems globalized, abandoning locally adapted practices, and damaged natural and human communities in many ways. Reinhabitation is a process of moving from industrial to more locally adapted food systems.
Figure 1. Marys River Region
Sustainability has been the central paradigm in the movement to build local food systems, but industrial agriculture also uses the term. Kloppenburg et al. (2000) point out that sustainability has “achieved canonization as a kind of cultural shorthand” for goodness or greenness. For example, Monsanto portrays itself as “committed to sustainable food production” (Kloppenburg et al. 2000). The term agrarianism is increasingly replacing sustainability as a guiding concept (Kimbrell 2002; Berry 2002; The Land Report 1999). Berry (2002:10, 8) defines agrarianism broadly as an approach of preserving, improving, or establishing local economies and cultures, focusing on food systems. He argues that agrarianism is the major “countervailing economic idea” to industrialism. I chose to use reinhabitation instead of agrarianism because agrarianism is typically associated with Euroamerican mixed farming, and to emphasize a response to industrialism that fits with regional history.

Aldo Leopold’s writings on the land ethic and agriculture guide reinhabitation. Leopold’s efforts to develop a locally adapted agriculture in Wisconsin were an attempt at “reinhabitation of the Midwest” (Callicott and Freyfogle 1999:18). Leopold describes a “land ethic” that “enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land” (Leopold 1949:204). Later authors more explicitly expanded the boundaries of community to include landforms and ecological processes such as nutrient cycles (Snyder 1977:188). The terms biocentrism or ecocentrism have come to replace the term land ethic. The land ethic implies a need for a different relationship between culture and nature than the dominance of industrial agriculture. Leopold (1949:204) summarizes this new role for humanity: “a land ethic changes the role of Homo sapiens from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow-members, and also respect for the community as such.”

The long-term goal of reinhabitation in a given region is vibrant local communities and regional culture coexisting with healthy ecosystems. Building a “local food economy” is a practical first step in building “a decentralized system of durable local economies” (Berry 1995:21). Kirschenmann (1996:9) poses an important question for food systems:
What would our food system look like... if we produced and procured our food from local foodsheds? If the first priority of agriculture were to supply all the nutrient requirements in the USDA food pyramid from within the foodshed, by and for people in the foodshed, exporting only surplus production and importing only exotic foods to satisfy superfluous tastes--how would that change the food system?

TWO FOOD STREAMS

Anthropologists refer to two main food systems or “food streams” in the United States, the industrial and the alternative, which interweave, but at root are “two fundamentally different systems” (Grey 2000). The industrial food system is international, rational, centralized, efficient, and dominated by vertically integrated, transnational corporations that try to control global production, market share, and profit (Grey 2000). These corporations have billions of dollars in annual sales and work within the regulatory framework of the World Trade Organization (WTO) and the North American Free Trade Agreement.

Many people are worried about the effects of the “transnational vending machine,” and the millennium signaled the “equivalent of a Boston Tea Party” in concern about food (Nabhan 2002:14). People troubled by industrial food systems destroyed experimental crops in labs and fields and attacked McDonald’s franchises. Farmers refused to grow patented seeds controlled by transnational corporations (Nabhan 2002:14). Consumers increasingly demanded local organic food, with labeled contents, and boycotted foods perceived as harmfully produced. Many countries around the world banned food products from the United States perceived to be harmful. The protests at the WTO meetings in Seattle made it clear that millions of people were concerned about how “globalization trends were wreaking havoc on family farms, migrant farmworkers, fishermen, and consumer food choices” (Nabhan 2002:262).

The alternative agriculture movement is growing rapidly (Grey 2000). This broad movement includes sustainable agriculture, organic farming and gardening, agrarianism, French intensive gardening, permaculture, wild farming, the Slow Food movement, the seed and livestock breeds’ conservation movement, food coops, farmers’ markets, and community supported agriculture (CSA) programs. Many Native American groups working to revitalize their traditional subsistence practices fit within this movement. Alternative food systems are a mix of smaller-scale, more decentralized operations that emphasize direct marketing and production for local markets (Grey 2000). The alternative paradigm emphasizes local control,
decentralization, and independence from purchased inputs, community, local knowledge and skill, harmony with nature, diversity, and restraint (Kloppenburg et al. 2000; Stauber et al. 1995:11). Alternative food systems are morally-driven, guided by ethics of concern for natural and human communities (Kloppenburg et al. 2000). They are “a value-based reaction to industrialized food” (Grey 2000).

There is significant and growing demand for locally and organically produced foods. Organic farmland in the United States reached 2.3 million acres in 2001, only 0.3% of total farmland, but acreage has more than tripled since 1992 (Economic Research Service 2002). Organic food sales have grown by more than 15.0% a year for a decade, although organic foods account for less than 2.0% of the food supply (Cowley 2002:51). The natural food market also expanded by more than 15.0% a year for more than a decade, and is projected to account for 10.0% of all food sales by 2008 (Grey 2000).

Nationwide farmers’ markets expanded from less than 100 in 1960, to over 2,400 in 1996 (Grey 2000). The CSA movement began in Europe and Japan and spread to the United States by 1985. By 1999, there were 1,000 CSA projects nationally, including several near Corvallis (Cone and Myhre 2000). Local data supports the idea that there is untapped demand for regionally produced food products. Two extension agents conducted a survey on the Corvallis and Albany food markets (Lev and Stephenson 1998). They found that there is strong demand for locally grown foods. In the 1998 survey, 72.0% preferred locally grown to other Oregon products. Local outlets that sell foods produced regionally are thriving. The alternative food stream represents the beginning of reinhabitation.

PRINCIPLES OF REINHABITATION

Principles of reinhabitation guide proposals to build a locally adapted food system in the Marys River region. Such principles derive from natural ecosystems, the examples of hunter-gatherers such as the Kalapuya in the Marys River region, and small-scale food systems throughout the world. What are the principles of reinhabitation for food systems?

Reinhabitory food systems provide for human needs while preserving biodiversity. Food production exists within a larger matrix of preserved land and wildlife corridors as part of a conservation plan for the overall landscape. The presence of agriculture on the land is limited. Extensive wildlands protect native biological diversity and provide wild foods such as fish,
game, roots, berries, and mushrooms. Rehabilitation of ecosystems damaged by agriculture takes place. Farms are adapted to local ecological processes such as the natural flood pulses of major streams. Farming and ranching coexist with native animals, including large predators. The intensity of land use decreases on a continuum from human settlements to wildlands. People integrate use of plants and animals for food with use for fibers, medicines, fuels, and other uses. Food processing and manufacturing of agricultural tools and supplies is local.

Locally adapted food systems rely primarily on solar energy, using few fossil fuels and agrichemicals. Farmers rigorously maintain soil fertility as the “foundation of good health” (Leopold 1999:173). Food producers maintain respected conservation farming traditions. The use of legumes, crop rotations, manure, additions of organic material, and other practices help maintain fertility. Many crops are perennials. Waste is recycled through the system. Pollution of soil, air, and water is minimal. Cultural, mechanical, and biological methods control pests, diseases, and weeds.

Locally adapted food systems produce and process most of their own food. Much of the population takes part in gardening, farming, gathering, hunting, or fishing. Imports and exports are low. Consumers are knowledgeable, have close relations with producers, and maintain regional food traditions. Food is sold in association with verifiable information about production, processing, transportation, and distribution that appeals to local ethics. Local people maintain and celebrate regional food traditions. Ownership of land is widespread. Food systems provide safe, abundant, rewarding work, and food security.

To better understand the process of reinhabitation and apply it locally, it is necessary to understand the history of regional food systems. The major types of food systems that have characterized the region are Native American, diversified, industrial, and alternative. Native American food systems were inhabitory. Euroamerican food systems became less locally adapted as they industrialized. The current industrial food system has few locally adapted characteristics and is the baseline for change. Alternative food systems are a response to problems of the industrial food system, and a base from which to build reinhabitory food systems. Reviewing the history of the Marys River region helps clarify how to apply principles of reinhabitation in the region.
CHAPTER 2: DEFINITION OF STUDY AREA AND ENVIRONMENTAL SETTING

I chose the Marys River region (figure 1) as the study area for reinhabitation planning because it more effectively integrates cultural and ecological considerations than Benton County or the Marys River watershed. The region is representative of cultural ecological areas in the inland valleys of western Oregon. It borders on the Willamette River and contains a major urban center as well as rural areas dominated by agriculture in the lowlands and forestry in the uplands. The study area has excellent potential for food system reinhabitation. It has relatively well-developed alternative food systems and an agricultural research university. The area has a consistently strong economy and a highly educated population. The region has some of the best potential conservation areas and remaining relics of native ecosystems in the Willamette Valley (Oregon Biodiversity Project 1998:203).

Recent land-use planning emphasizes watersheds as units of analysis rather than political boundaries such as counties. For example, starting in 1993, the state of Oregon initiated the Watershed Health Program to manage natural resources (Soscia 1997:304). The Marys River region improves upon the Marys River watershed as a land-use planning area by including the local section of the Willamette River floodplain as well as the entire city of Corvallis as a core cultural and economic center. The study area includes a section of the Willamette River and one of its tributaries and the major natural features of Willamette Valley landscapes.

The Willamette River marks the eastern boundary of the Marys River region, from Spring Hill in the north, to the confluence of the Long Tom and Willamette Rivers in the south. The southern boundary is the watershed boundary between the Marys River and Long Tom watersheds. The western boundary is the watershed divide between the Marys River watershed and the watersheds of the Siuslaw, Alsea, Yaquina, and Siletz Rivers. The north boundary of the region breaks from the watershed boundary at the northeast edge of the Oak Creek drainage, and follows the ridgeline in the McDonald-Dunn forest to the northeast to the Willamette River at the base of Spring Hill. Most of the region is in Benton County, but less than 5.0% of the land area, is in Lincoln, Polk, and Lane counties.
WILLAMETTE BASIN, MARYS RIVER

The Marys River region is part of the Willamette River Basin, which is part of the massive Columbia River Basin system. The Willamette River drains the western Cascade Range and the eastern Coast Range. The total watershed area of the Willamette Basin is 11,200 square miles or 7,168,000 acres (Orr et al. 1992:203). The Willamette Basin is about 40 miles east of the Pacific Ocean, centered at 45 degrees north latitude. The basin floor is an alluvial plain, 20 to 40 miles wide, about 120 miles long, oriented north-south, separated in places by low hills. The basin floor drops from 641 feet in Cottage Grove, to 419 feet at Eugene, 225 feet at Corvallis, to near sea level in Portland. The river flows northward 295 river miles from its headwaters in the Calapooya Mountains of southwestern Oregon through the Willamette Valley to its confluence with the Columbia River.

The Marys River originates in western Oregon’s central Coast Range and flows into the Willamette River at Corvallis. Marys Peak, at 4,200 feet in elevation, is the highest point in the region and the Oregon Coast Range. The Marys River Watershed is 198,400 acres, compared to 236,138 acres for the Marys River region and 432,961 acres for Benton County (appendix 1; Brooks and Buckley 2002; Ecosystems Northwest 1999:2). The “westslope” or westside tributaries of the Willamette River that originate in the Coast Range, like the Marys River, are significantly different from eastside tributaries originating in the Cascades (Ecosystems Northwest 1999:2). Westside tributaries are not glacier-fed, and their extremely low summer flows limit agriculture. Adult salmon and steelhead prefer eastside tributaries.

SOILS, STREAM FLOW, CLIMATE

Sedimentary rocks underlie much of the Coast Range, but volcanic and intrusive rocks also appear (Ecosystems Northwest 1999:7). Alluvial terraces rise in steps from the Willamette River floodplain to the foothills (Ecosystems Northwest 1999:7). The geological history of flooding strongly shaped the agricultural possibilities of the Marys River region. Towards the end of the Wisconsin Glaciation, about 18,000-12,000 years ago, the Missoula floods swept down the Columbia River system and up the Willamette Valley, filling the valley with water to a depth of 400 feet or more (Loy et al. 2001:122,133). This series of enormous floods originated in western Montana when ice dams that impounded huge lakes collapsed. As the floods moved up the Willamette Valley, heavier gravel and sand settled out at lower
elevations in the northern valley. Thick deposits of fine silt and clay particles occurred at higher elevations in the upper Willamette Valley. The poorly drained soils of the region are a result of these deposits, as well as the area’s winter-wet climate, parent material, and lack of relief. The best soils for agriculture in the area are alluvium deposited near the Willamette and Marys Rivers. Floodplain soils are level, well drained, and are capable of growing many crops (Ecosystems Northwest 1999).

The Marys River follows a rainfall pattern rather than an extended snowmelt pattern (U.S. Army Corps of Engineers 1971). The low elevation of the Coast Range and lack of permanent snowpack lead to low base flow in westside compared to eastside tributaries. The characteristic stream-flow pattern is for peak flows to occur during the winter and baseflow extending from late spring into fall (Ecosystems Northwest 1999:8). Average peak discharge occurs in January, following the peak precipitation of December. Saturated soils are common during the winter. Base flow begins between April and June and continues into October. From May through October, the mean discharge of the Marys River is lower than 250 cfs (cubic feet per second) (Ecosystems Northwest 1999:9). The peak discharge in the period of record between 1940 and 1985 at the Marys River gauging station located between Corvallis and Philomath was over 11,000 cfs in 1964 (Ecosystems Northwest 1999:10). Flood events are flows exceeding 5485 cfs at the Marys River gauging station. In the 45 years of record, Marys River discharge reached flood stage 22 years, indicating how common flooding is in the region.

Cool, wet winters, and warm, dry summers distinguish the regional. The climate is similar to the Mediterranean climates of California but it is cooler and wetter (Oregon Climate Service 2000). The marine influence of the Pacific Ocean and the protection from continental climate extremes provided by the Cascade Range moderate the region’s climate. The Willamette Valley rarely receives severe weather events (Oregon Climate Service 2000). The agricultural lowlands of the area have a long frost-free season, and moderate precipitation. A high-pressure area called the North Pacific High typically builds over the Pacific Ocean in the summer, causing low summer rainfall in much of the west coast of the United States.

Elevation is an important determinant of precipitation in western Oregon (Oregon Climate Service 2000). Much higher precipitation occurs in the Coast Range than on the valley floor (Franklin and Dyrness 1988). Winter precipitation falls mainly as rain, and the small amount of snowfall the region receives usually melts away quickly. Corvallis receives
42.7 inches of annual precipitation, using a period of record from 1961-1990 (Oregon Climate Service 2000). Rainfall is greatest during the coolest months and lowest during the warmest. The area receives 0.6 inches of rain in July and 0.9 in August. For July and August, open pan evaporation near Corvallis averages 6.8 and 6.0 inches, making a major summer precipitation deficit, severely limiting agriculture (Moir and Mika 1972:5).

The coldest month of the year in Corvallis is January, with a monthly mean temperature of 39.3 deg. F., a mean maximum temperature of 45.4, and mean minimum temperature of 32.9 (Oregon Climate Service 2000). August is the warmest month, with a mean maximum temperature of 81.1 deg. F., a mean minimum of 51.2, and a monthly mean of 66.2. Summer nights are cool, limiting warm season crop potential. Extreme hot or cold temperatures are rare in the Willamette Valley. Maximum temperatures above 90 deg. F. occur an average of 5-15 times per year and temperatures below zero occur only about once every 25 years. The average growing season (between temperatures of 32 deg. F.) is 150-180 days for the Willamette Valley lowlands and 110-130 days above about 800 feet in the foothills (Oregon Climate Service 2000). Winters are very cloudy and during the coldest months, average cloud cover exceeds 80% (Oregon Climate Service 2000). Cloud cover during the summer decreases to less than 40%, and over 50% of July days are clear.

NATIVE ECOSYSTEMS

The ecosystems of the region formed a mosaic of riparian forests, wet and dry prairies, oak savanna, woodlands, stream and wetlands, as well as open and closed forests. The ecosystems coevolved with Native American land use. Habeck (1961:69) was the first to systematically reconstruct historic vegetation from government land surveys conducted in the 1850s. He defined five habitat types for the Willamette Valley, oak opening, oak forest, Douglas-fir (*Pseudotsuga menziesii*) forest, bottomland forest, and prairie. Recent studies replace the term oak openings with oak savanna, oak forest with oak woodlands, and bottomland forest with riparian forest. Habeck and other researchers found that most of the Willamette Valley was grassland (prairie and oak savanna) before Euroamerican settlement. Dense forests existed primarily along the Willamette and tributary floodplains and in the Coast Range and Cascades (Franklin and Dyrness 1988:126). Figure 2 shows data from government surveys in the 1850s (Brooks and Buckley 2002).
Historic Vegetation in the Marys River Region

Source: Oregon GAP Analysis Project

Figure 2. Historic Vegetation in the Marys River Region
In the 1850s, grasslands, including Oregon white oak savanna and perennial bunchgrass, made up 61.5% of the Marys River region. The most common element in the historical acreage was Oregon white oak savanna, at 34.4% of the total acreage, followed by Douglas-fir at 32.0%, perennial bunchgrass at 27.1%, riparian at 5.9%, and open water at 0.7% of the total land area (appendix 1). Grasslands existed in every part of the region. Indigenous burning and ponded water maintained sites in an open, early successional condition (Wilson et al. 1994).

The regular and immense flooding of the Willamette and Marys Rivers was a core determinant of the lowland landscape. The largest flood event recorded since Euroamerican settlement was the 1861 flood, which covered much of the floor of the Willamette Valley (Miller 1999:204; Benner 1997). Characteristics of historic stream ecosystems include wide bands of riparian forest, terrace deposits, numerous islands, oxbow lakes, sloughs, and snags. Riparian forests along the Willamette River averaged 0.9-2.2 miles on each side of the river (Towle 1974). The Willamette River had multiple, braided, meandering channels, which shifted position annually (Sedell and Froggatt 1984). Water ponded in blocked-off channels and depressions, making extensive permanent and seasonal wetlands that were productive habitat for wildlife. Some creeks that entered the lowland prairies lost their channels entirely and spread out as shallow seasonal wetlands or moved as groundwater (Benner 1997).

Flooding is an important process for the ecological health of river and floodplain systems.

CONCLUSIONS

The major ecological limits on food production in the Marys River region are the annual summer drought, poorly drained soils in the lowlands away from the Willamette River, cool night temperatures during the summer, and seasonal flooding. Agricultural water needs are highest during the summer when streams in the Marys River and its tributaries are at base flow, making irrigation from streams more damaging to stream ecosystems. A locally adapted food system would focus on cool season and winter crops that can be grow without irrigation. There is a small area of high-quality, well-drained agricultural soils along the Willamette and Marys Rivers, but most of the lowland soils in the region are poorly-drained soils, limiting the growing season and crops that can be grown. These heavy soils are challenging to use and easily compacted by tilling when wet. A reinhabitory food system would adapt to these regional limiting factors.
CHAPTER 3: INDIGENOUS FOOD SYSTEMS

Indigenous hunting and gathering food systems in the Marys River region were locally adapted and inhabitory. A reinhabitory food system is not a return to a hunting and gathering lifeway, however. Indigenous food systems are examples from which to draw specific practices and principles of reinhabitation. The application of characteristics and principles takes place in a contemporary context. Just as agroecologists use prairies and forests as models for agroecosystems, indigenous food systems are models for reinhabitory food systems. Characteristics of Native American food systems in the region such as relying on solar energy, obtaining most food locally, and preserving biological diversity and ecological integrity are principles of reinhabitory food systems. Hunting, fishing, and gathering using indigenous technology can provide a small amount of food for the local population. More importantly, participation in traditional practices can be an educational tool to increase knowledge of natural and cultural history, and give people positive physical experiences that connect them to the region and inspire involvement in food systems.

ARCHAEOLOGICAL RECORD

Scholars conventionally divide Oregon archaeology into the Paleo-Indian period, followed by the early, middle, and late Archaic (Aikens 1993). The Paleo-Indian period begins with the arrival of the first human pioneers prior to 11,000 years before present (B.P.), and continues to the beginning of the Archaic around 8,000 B.P. The Archaic divisions are early Archaic (8,000-6,000 B.P.), middle Archaic (6,000-2,000 B.P.), and late Archaic (2,000-150 B.P.). Archaic people developed locally adapted food systems by about 8,000 years ago. The Kalapuya culture inhabited the Willamette Valley at the time of Euroamerican contact.

Researchers can document human use of the Willamette Valley for 11,000 or more years and consistent human inhabitation for more than 8,000 years (Aikens 1993:184). The oldest well-documented human culture in North America is the Clovis culture which dates from approximately 11,200-10,900 years ago at the end of the Wisconsin glaciation (Suttles and Ames 1997:265). Clovis artifacts appear throughout North America, including spear or dart points in the Willamette Valley. Distinctive artifacts of the Clovis culture are large fluted
spear or atlatl dart points. Aikens (1993:269) points out that “the Clovis horizon marks the only time in North American prehistory when a single diagnostic artifact style spread over the entire continent.” The Marys River region has no documented Clovis points. Clovis points found nearby in the Willamette Valley, however, suggest that Clovis people used the area. Researchers generally assume that the Clovis lifeway emphasized hunting large animals.

Recovered fossils from the Pleistocene Epoch (1.6 million to 10,000 years ago) show that a variety of large mammals inhabited western Oregon during this period. These megafauna include Columbian mammoth, *Mammuthus columbi*, mastodon *Mammut americanum*, sloth *Nototheriops shastensis, Megalonyx jeffersonii, Mylodon spp.*, horse *Equus spp.*, bison *Bison spp.*, and tapir *Tapirus californicus* (Hay 1927; Orr et al. 1992). The ground sloth in the Willamette Valley was the size of an ox, walked bipedally like humans, stood up to ten feet tall, and weighed nearly a ton. It browsed forage and used large claws to dig roots (Orr et al. 1992:7-8). These animals all became extinct approximately 11,000 years ago, shortly after humans arrived in the region. A problem for Oregon ecological history is why many Pleistocene mammals disappeared about 11,000 years ago (Orr et al. 1992:8). There is little or no evidence to indicate whether Paleo-Indians contributed to these local extinctions. The loss of these animals changed the development of ecosystems by eliminating their considerable effects on plant communities.

The period following the last glaciation in North America was a time of climatic, ecological, and cultural transition. Across the continent, Paleo-Indians “became Archaic foragers and collectors, hunting and gathering a wide variety of plant and animal foods” (Aikens 1993:270). The Archaic peoples who evolved into the Kalapuyans were part of this continental pattern of the development of locally adapted food systems out of the more generalized Paleo-Indian adaptations. Local Archaic people adapted technologies such as the earth ovens used to cook camas (*Camassia spp.*) and the leaching process for acorns. Major foods of the historically known lifeway of the Kalapuya such as camas, hazelnuts (*Corylus cornuta*), as well as deer (*Odocoileus spp.*) and elk (*Cervus elaphus*) hunting, can be traced archaeologically for at least 8,000 years (Aikens 1993:185, 219).

The Archaic begins in the Willamette Valley with the appearance of more varied toolkits in the archaeological record and represents locally adapted Indian cultures, extending from roughly 8,000 to 150 years ago (Aikens 1993). In the Marys River area, indigenous people established a broad-spectrum gathering, fishing, and hunting economy. At least 4 major
culture divisions existed in aboriginal Oregon, the Great Basin, Columbia Plateau, Interior Valley, and Coastal culture areas (Aikens 1993:270; Buan and Lewis 1991:20). Each of these distinctive cultural adaptations to native regions can be traced from postglacial to historic times (Buan and Lewis 1991; Aikens 1993).

Important sites documenting Archaic use of camas exist in the Luckiamute and Long Tom watersheds. According to state archaeologist Tom Connolly (1999), camas ovens first appear in the Willamette Valley 8,000-9,000 years ago and sites with earth ovens and camas remains are common after about 4,000 years ago. Other edible plant remains often found with camas include hazelnuts, acorns, onions (*Allium* spp), chokecherries (*Prunus virginiana*), berries, and several kinds of seeds. Artifacts used for camas harvest and processing found in the archaeological record includes pestles, mortars, digging sticks, and earth ovens.

The Hannavan Creek Site has some of the earliest and best-documented archaeological evidence of camas use. The site is located near Fern Ridge Lake in the Long Tom drainage of the southern Willamette Valley. Clusters of fire-cracked rocks at the site indicate old fire hearths and roasting pits (Aikens 1993:194). One rock cluster contained 350 charred camas bulbs that have been Carbon 14 dated between 7,750 and 6,830 B.P. Other tools found at the same site include ground stone fragments indicating pounding and grinding plant foods, and stone tools suggesting the working of bone and wood. Projectile points found at the site suggest consistent use of the site for many thousands of years. Native people at the site consumed caterpillars, yellowjacket larvae, and grasshoppers (Hylton 1998:20).

Acorns were a part of the indigenous economy during the middle Archaic and probably earlier. Five charred acorns found at the Luckiamute Hearth site have radiocarbon dates of 5,300 B.P. (Pettigrew 1990). Earth ovens dating to 4,600 B.P. at the Oregon Country Fair site on the Long Tom River document remains of acorns, hazelnuts, and camas bulbs (Aikens 1993:196). The transition from the atlatl to use of the bow and arrow and small triangular and stemmed points marks the beginning of the Late Archaic period about 2,000 years ago.

The first major archaeological work on Kalapuya sites in the Marys River area took place on or around Finley Refuge (Havercroft 1986). The researchers report dates from 1,800-300 B.P. for the sites, and they found two camas ovens (Havercroft 1986:147). Research at these sites suggests that diversified hunting and historic seasonality in settlement and subsistence patterns extends back to the earliest dates. The Marys River Kalapuya apparently followed a similar subsistence pattern to Kalapuya elsewhere in the Willamette Valley. Hylton reports
three camas ovens and groundstone tools found at sites in Peavy Arboretum and the McDonald-Dunn Forest (Hylton 1998:63). Other camas ovens were located nearby. X-ray florescence analysis of artifacts from sites in Peavy Arboretum and McDonald-Dunn Forest indicate that human occupants were part of trade networks with people in the high Cascades and central Oregon (Hylton 1998:80). The earliest dated artifact from those sites is a Middle Archaic style projectile point. The available archaeological evidence indicates thousands of years of continuity in the development of locally adapted indigenous food systems.

THE KALAPUYA

Culture

Boyd (1990:136,147) estimates aboriginal Kalapuya populations before white diseases at 16,200. Connolly (1999) estimated the population of the Kalapuya in 1770 at 20,000 or higher. The ethnographic record for the Kalapuya culture is “dismal” (Connolly 1999). No serious study of the Kalapuya took place until a generation or more after whites forced them from their land and more than 90 percent of their population was lost to disease. Most ethnographic information is from Kalapuyan speakers on the Grand Ronde Reservation and at the Chemawa Indian Training School, but only a partial knowledge of indigenous lifeways remained by that time (Havercroft 1986:32-33). The earliest study of the Kalapuya took place on the Grand Ronde Reservation in 1877 and focused primarily on linguistics (Connolly 1999). Other ethnographic studies of the Kalapuya include Gatschet (1891), Frachtenberg (1916), Jacobs (1945), Mackey (1974), and Zenk (1990). Because of the weak ethnographic record on the Kalapuya, some of the background on their local adaptation has to be inferred from other sources and regions where similar cultures existed.

An important source of information on the Kalapuya is an interview with William Hartless, conducted by Frachtenberg on December 10, 1913 at Chemawa, Oregon (Mackey 1974:31-46). Hartless was a Marys River Indian born in Corvallis area around 1843. He called the Marys River Kalapuya “Pinafo,” and divided them into riverside, middle, and mountain bands. The Marys River Kalapuya’s range probably extended from the Willamette River westward into the Coast Range, to the border of coastal people’s territory. The northern boundary may have been the McDonald-Dunn ridge, and the southern boundary near Monroe.
Loy (1976:7) separated the Marys River Kalapuya (Chepenefa) from the Muddy Creek Kalapuya (Chemapho).

The Marys River Kalapuya lived in a center of linguistic diversity, indicating the extensive cultural diversity of locally adapted cultures. Within 100 miles of the Marys River were more than 20 active languages and many more dialects (Loy 1976:7). The 12 or more bands of Kalapuya spoke dialects of the Takelman-Kalapuyan Family. The native people of the Marys River spoke dialects of the Santiam language group, one of the 3 major groups within the Kalapuyan language (Buan and Lewis 1991:19; Havercroft 1986:24). The Penutian language phylum to which the Kalapuyan languages belong probably arrived in Oregon 5,000 or more years ago, and then split apart into sister languages (Aikens 1993:223,10). The many adjoining, closely linked Kalapuyan dialects suggest that, “Kalapuyan subgroups gradually drifted apart in their speech over some thousands of years of stable co-residence in the area” (Aikens 1993:10).

The range of the Kalapuya was the Willamette Valley south of Willamette Falls and the northern valleys of the Umpqua River. To the west in the Coast Range and on the Oregon coast were the coastal Alsea and Siuslawan cultures, and the Salish speaking Tillamooks. Chinookan people occupied the area below Willamette Falls on the Willamette and Lower Columbia. Up the Columbia Plateau were Sahaptian and Cayuse cultures. Across the Willamette to the east into the Cascades, Kalapuya territory bordered the Molalla. East of the Cascades was the Northern Paiute (Aikens 1993:10).

Indigenous language and cultural boundaries closely match ecoregion or watershed boundaries in Oregon, demonstrating how locally adapted indigenous cultures were (Buan and Lewis 1991:19). Larger culture areas tend to fit ecoregion boundaries, and band divisions tend to follow physical boundaries such as watersheds. For example, the Willamette Valley culture area or Kalapuya territory follows the boundaries of the Willamette Valley ecoregion (Aikens 1993:7, 10; Oregon Biodiversity Project 1998:68). The 12 or 13 major groups of the Kalapuya in the Willamette Valley occupied areas roughly similar to the 13 major tributaries of the Willamette River. This settlement pattern gave each tributary tribe or band access to all major land types in their region (Havercroft 1986:28; Aikens 1993:185). For the Marys River group this meant that they had access to the Willamette River, its riparian forests and associated wetlands, the Marys River, prairie, oak savanna, and the forests of the eastern Coast Range.
The Indian groups of Oregon were lumped into tribal groups for the benefit of white administrators, but the label tribe may not fit the Kalapuya. There probably was no elite class, head chiefs, or overarching authorities, although a small slave class may have existed, especially in the northern Willamette Valley (Zenk 1990; Aikens, 1993:187). The Kalapuya had a high level of political freedom (Mackey 1974:36). The Kalapuya lived in small, autonomous, patrilineal, extended family groups or bands (Loy 1976:6; Havercroft 1986:33). During the winter, several families lived together at village sites in partitioned houses up to sixty feet long that held up to ten families (Havercroft 1986:39). Winter villages were located in sheltered areas on higher ground along rivers or streams. Trade, marriage ties, and social gatherings tied together families, bands, and regions. Gifts connected people in relationships of obligation and mutuality.

To get a contemporary Kalapuyan perspective on their food systems, I spoke twice with Merle Holmes, the great-grandson of William Hartless, the Marys River Kalapuyan interviewed by Frachtenberg (Mackey 1974:31-46). I met with Holmes on 11/22/98 in Salem, and spoke with him over the phone on 12/14/98. I also participated in camas seed and bulb collection and replanting at a restoration project along the Marys River attended by a representative of the Grand Ronde tribe. I attended two talks by Carol Logan, a Kalapuya woman, three speeches by Carl Hecota, another living Kalapuyan, and spoke informally with other western Oregon Indians. Holmes said that regular burning of the landscape by the Kalapuya made the land fertile. He said that camas was the Kalapuya’s most important food source and that women were in charge of camas and still are today among Oregon Indians. Holmes reported that the main camas harvest occurred around berry picking time, and that camas would be dried and stored all year in hanging baskets. The Kalapuya leached acorns, ground them into flour, and mixed the flour with berries. They used winnow fans to clean the large tarweed (Madia spp.) harvests and then pulverized the seeds. Holmes had collected hazelnuts, blackberries (Rubus spp), and huckleberries (Vaccinium spp.) as a child. He did not know if the Kalapuya used mushrooms, but said Indians use them on the Warm Springs Reservation. Holmes contrasted the locally adapted seasonal Kalapuyan diet with modern eating by the clock. He said that neither hunger nor obesity was common among the Kalapuya. Soups were common meals, with seasonal foods added to bases made from staples like camas and dried meat. Large amounts of dried foods were stored.
Holmes said that not many salmon successfully ascended Willamette Falls but the Kalapuya traded extensively for salmon. Trout were an important part of the Kalapuya diet and Kalapuya fishermen speared and hooked them. Holmes said that lamprey (*Lampetra tridentata; L. richardsoni*) are still consumed and considered a delicacy by Kalapuyans, but they were much more common before pollution. The Kalapuya hunted grizzly bears (*Ursus arctos*), but they were difficult to kill. The bow and arrow was effective for hunting waterfowl. Holmes stated that crickets were an important food. They were stored inside elderberry (*Sambucus spp.*) stems after removing the pith. The information from Holmes is in agreement with the limited ethnographic information about the Kalapuya.

**Diet and Seasonal Round**

Little published ethnobiological research exists for western Oregon or the Willamette Valley. Suttles (1990) lists nearly 90 plants and animal species used in the subsistence economies of indigenous people in the Pacific Northwest. Gunther (1945) lists over 150 plant species used by native people, and most of these plants are present in the Marys River region. It is safe to assume that the Kalapuya used 150 or more native plant species in their food system and at least 30 animals. Native prairie, oak savanna, wetlands, and streams, are the habitat types where the Kalapuya collected the majority of their food.

The Kalapuya focused on collecting bulbs, seeds, and other plant parts, as well as fishing and hunting. Their main foods were camas, acorns, wapato, tarweed, hazelnuts, deer, elk, waterfowl, fish, and berries (Havercroft 1986:42). There was “no overriding focus on any one food source” (Aikens 1993:272). In 1814, Alexander Henry said of the Kalapuya diet, “Their principal food is roots, although they prefer deer flesh to any goods we have” (Mackey 1974:3). Camas was the most important plant food in much of the Pacific Northwest and was the most important plant food in the Willamette Valley (Thoms 1989:185). The Kalapuya reportedly propagated tobacco (*Nicotiana multivalvus; N. spp.*) by planting seeds into ashes following prairie fires (Mackey 1974:41-42; Zenk 1990).

Hunting, trapping, and fishing supplemented stored foods during winters. Overwintering waterfowl were valuable winter foods. In spring, fishing and waterfowl hunting continued, and plant collection began for the season. Fresh greens provided important nutrients after a long period of minimal availability. If food supplies were low, camas harvest could occur in late
January when its leaves first appear, or in marked patches. People left their winter houses during much of the drier season, from late March until October, and lived in the open in temporary camps, moving through the region to collect available foods (Buan and Lewis 1991:16). Summer was the time for harvesting and processing staple foods. Camas harvest continued from June to October (Buan and Lewis 1991:20). Hazelnuts and caterpillars began to be collected in July. Grasshopper collection coincided with the annual burning of the prairies which began in July and continued into early fall. Late summer and early fall was best for hunting deer, elk, and collecting acorns and tarweed. October was a major wapato harvest time (Buan and Lewis 1991:20). By November, the Kalapuya moved into their winter houses.

Camas

The most important plant foods in the Pacific Northwest were geophytes, often called root foods. The term geophyte signifies perennial plants whose overwintering buds are underground in the form of bulbs, tubers, rhizomes, corms, or taproots. Camas was the most important geophyte used by the Marys River Kalapuya (Zenk 1990). The most comprehensive reference on the use of camas is Thoms dissertation (1989). Over 60 tribes in the Pacific Northwest and Northern Rockies collected camas or obtained it through trade (Gritzner 1994:33). Camas thrived in the Pacific Northwest before humans arrived in the area. Palynological data show that camas persisted throughout the warmest, driest, coldest, and wettest periods of the last 70,000 years in the Pacific Northwest and probably for much longer (Thoms 1989:459). Pollen data indicate that Camassia is a resilient genus with wide ecological amplitude, appearing in all the major life zones in the Pacific Northwest. I describe camas use in depth to give an example of how locally adapted the Marys River Kalapuya food system was, and because growing, harvesting, processing, and consuming camas has the most potential of the Kalapuyan plant foods for using in public education.

The two species of camas in western Oregon are common camas (C. quamash), and great camas (C. leichtlinii). Some taxonomists lump the two forms as one species, with common camas a subspecies of great camas. Great camas and common camas differ in several ways. Common camas has bulbs 0.4-1.2 inches in diameter (Thoms 1989:132). Great camas generally has larger bulbs than common camas. Great camas is generally taller, has bracts shorter than its flower stalks, and when great camas flowers wither, they usually twist (Guard...
Common camas has longer bracts than flower stalks, and its flowers usually do not twist when they wither. In addition, the seedpods of common camas are larger than great camas, and press closer to the scape or main flower stalk than great camas. Alexander Henry describes camas already three inches high on January 24, 1814 (Thoms 1989:214). I found camas three inches high on January 30, 2001 on Jan 30, 2002, and on January 23, 2003 in the southern Willamette Valley. Camas blooms from mid-March to May in the Willamette Valley. In 2001, the earliest camas I saw blooming was March 21. The flowers normally have blue petals or tepals, but stands of pink, lavender, and white camas also appear.

Raw camas bulbs are “crisp, white, and mucilaginous, but virtually tasteless,” and when roasted, camas tastes like “a cross between brown and maple sugar” (Gritzner 1994:34). Indians used camas to sweeten meals and with meat or salmon dishes (Gritzner 1994:34). Camas is rich in inulin, a largely undigestible, non-reducing sugar (Turner et al. 1980:44). Kalapuyans and other Indians learned how to convert most inulin in camas to digestible fructose through hydrolysis by slowly cooking the bulbs. The concentration of fructose in cooked camas is as high as 32.9% of the wet weight or 43.0% of the dry weight. A study of hydrolysis in camas found that adequate hydrolysis of inulin for digestion occurred rapidly with incubation in dilute hydrochloric acid or by boiling for 80 minutes (Thoms 1989:55, 159). Complete hydrolysis required 24 hours of boiling.

The Marys River Kalapuya used digging sticks to harvest camas, according to Hartless (Mackey 1974:43). Few digging sticks appear in archaeological sites, but they probably used digging sticks similar to those used by other Pacific Northwest Indians that used camas as a staple food (Thoms 1989:258). Digging sticks use local hardwoods, and have wooden or antler handles. They are up to 47.2 inches long, but they are typically 29.5 inches long and slightly curved at the distal end. Digging stick handles typically are about 11.8 inches long with a tapered hole 0.5-1.0 inches in diameter (Thoms 1989:261).

Camas is harvestable all year, but the main period for harvesting camas was May through September (Turner 1997a: 66). Clark observed that only after the flowers faded were the bulbs “fit for use” (Thoms 1989:155). For the Okanagan the preferred harvest time was also just after the plants had flowered (Turner et al. 1980:44). Other Indians considered camas ready to harvest after the flowers on the bottom half of the raceme had started to fade (Gritzner 1994:40). The Kalapuya collected camas for fresh eating during the winter and spring but did
not begin to collect it for winter storage until June (Buan and Lewis 1991:16). According to Hartless, August was “camass [sic] time” (Mackey 1974:40).

Camas typically grows in fine-grained soils that stay moist until early summer. It is particularly difficult to dig in heavy soils both when they are dry and wet. The soils become impenetrable “concrete” by June or July due to the annual summer drought. From fall to late spring, many soils are too wet to dig easily. Digging the bulbs late in the season, after the plant life cycle is complete, maximized access to the energy reserves in the bulb, but by then the soil becomes more difficult to penetrate. Digging in the late spring may have been the best conditions for digging but the nutritional quality of the bulb would be lower. Digging bulbs for storage after the rainy season begins would require using fire to dry the bulbs and increases problems with rot. It would make the bulbs harder to locate precisely if not marked, and easier to confuse with death camas. It is not clear how the Kalapuya solved this problem. Regularly working and maintaining camas patches would lead to fewer weeds, easier to dig soil, and less confusion with death camas.

Camas harvests were 50.0-100.0 pounds per day (Thorns 1989:221; Gritzner 1994:42). Thoms (1989:233) estimated that camas consumption for a 5-person family in the Pacific Northwest interior using camas as a staple was about 1,653.5 pounds, including 661.4 pounds of fresh bulbs, 771.6 pounds of cooked and dried bulbs, and 220.5 pounds of camas cakes. Bulb cleaning and sorting by size followed harvest, with damaged bulbs separated for immediate consumption (Thoms 1989:223). Indians consumed some bulbs raw, but processed or bagged most for long-term storage (Gritzner 1994:42). Raw camas bulbs could be stored for several months. Camas processed into cakes could be stored through the winter (Thoms 1989:8). Some bulbs were cooked or stored mixed with black tree lichen (Alectorion fremontii) or other plant foods (Turner et al. 1980:44).

The Kalapuya used varied styles of earth ovens to bake and steam the camas harvest (Hall 1981; Smith 1978a). Building an oven required excavating a pit, inserting a stone heating element, and building a fire on the rocks to heat the element. When the stones became red hot, the fire was put out, and then grasses, sword fern (Polystichum munitum), skunk cabbage (Lysichitum americanum), bigleaf maple (Acer macrophyllum), or other plants were placed over the hot rocks in layers with the plant food to be cooked. Some oven designs layered rocks and plant materials. The pit was covered with more leaves and water poured on to make steam. A woven mat or soil covered the oven while it cooked for 1 to 3 days. Some
groups built additional fires on top of the mound. A camas processing site needed access to wood for fuel, rock to make a heating element, plants for layering materials, and water to soften the sacks that camas bulbs were cooked in, to clean bulbs and packing material, and for other purposes. Rocks were mostly river cobbles, averaging 5.0 inches in diameter.

The Kalapuya were renowned in the Pacific Northwest for their skill in preparing and preserving camas (Ratcliff 1973:29). Processed camas became flour, cakes, mush, and soups. A stone boiling process was used to cook raw bulbs and to pre-cook bulbs in bark-lined pits or baskets. Some Indian groups steamed camas in cast iron pots after contact with Euroamericans (Turner et al. 1982:84).

Cooked camas bulbs needed to begin drying immediately after removal from the oven or they could spoil within 24 hours. Indians dried the bulbs and other foods on racks, mats, or bark slabs in the sun or by fires (Thoms 1989:227). Most cooked bulbs were stored whole and sometimes rendered bear fat was poured on the bulbs before they were stored (Thoms 1989:226). The smaller bulbs not mixed with lichen sometimes were ground into coarse flour using a stone pestle on a heavy piece of rawhide. Camas processed into cakes or loaves required a double cooking process. The bulbs were ground to dough with stone tools after the first baking. They were then rolled into 8.0-10.0 pound cakes, baked again, made into cakes ½ to ¾ inches thick, and dried in the sun or by fires. Cooked and dried camas bulbs or camas cakes could be stored through the winter in cool, dry, environments (Thoms 1989:230). Much of the camas harvest was stored inside houses on hanging shelves and baskets to keep it dry.

Other Plant Foods

Wapato (Sagittaria latifolia) or Indian potato is a wetland plant that grows in dense colonies and produces starchy tubers. Wapato grew prolifically in wetlands in the Willamette Valley, and was an important food source (Smith 1978b). Darby’s thesis (1996) is the primary source on its use in western Oregon. The plant grows in water up to 4.0 feet deep, on the margins of lakes between high and low water levels, and along slow streams. By late August, tubers form on the ends of the rhizomes, thicken into starchy overwintering organs, and gain the ability to float (Darby 1996:31). Wapato can be harvested 250 days a year. Native women harvested it, wading through ponds, uprooting the tubers with their feet, and placing them into canoes. Darby (1996:88) estimated wapato harvests per acre at 5,313.8 pounds. Wapato
harvest was cost-effective, providing 3,240 calories for every hour harvested (Darby 1996:99). Wapato has greater quantities per gram of carbohydrates, protein, iron, and zinc than the potato (*Solanum tuberosa*), and the same amount of calcium per gram (Darby 1996:79). It can be solar dried and stores well. People typically baked wapato and ate it whole. Wapato is a food crop in Japan, where the tubers are steamed on wooden skewers, then dipped in a variety of sauces and eaten like edamame (Darby 1996:43).

Acorns probably were a significant food source in the Marys River area. They were a dietary staple in the California Floristic Province, and the availability of oaks predicted population densities of indigenous Californians (Todt and Hannon 1998). Acorns were collected in the early fall and could be stored through the winter. Native people had a variety of methods for leaching out the tannins in acorns to improve their edibility. The Kalapuya leached acorns with water in baskets and then roasted the acorns (Hylton 1998:53). Acorns were also commonly ground into a meal and cooked as mush with the stone boiling technique. Unlike California, with its great diversity of oak species, the Marys River area has only the Oregon White oak (*Q. garryana*). Oregon white oak is a slow growing tree that produces large seed crops every few years (Sprague and Hansen 1946). Hazelnuts were also a significant food source as well as a major source of materials for basketry (French 1965).

Tarweed is a plant with a weedy habit that grows in dense stands. The Kalapuya collected its edible seeds by placing a tightly woven basket part way around the plants and hitting the plants with a threshing stick or a seed berry comb (Hall 1981). They used loosely woven basketry winnowing trays to separate seeds from chaff (Zucker et al. 1983). Tarweed harvest occurred immediately after burning the prairies. The patches may have been the only resource owned by individuals, families, or villages in the Willamette Valley (Connolly 1999). Kalapuyans sometimes mixed the ground seeds with mashed cooked camas and hazelnuts (Buan and Lewis 1991:16).

Other Kalapuya plant foods included yampah or ipos (*Pteridium gairdneri*), sego lily or cat’s ears (*Calochortus spp.*), tule (*Scirpus validus*), cattail (*Typha latifolia*), and many berries (Buan and Lewis 1991:16). Many geophytes were secondary food sources. Edible bulbs native to the local area that are documented to have been consumed in other regions include chocolate lily (*Fritillaria lanceolata*), tiger lily, (*Lilium columbianum*), wild onions, fawn lilies (*Erythronium spp.*), and cluster lilies (*Brodiaea spp.*). Other secondary geophyte foods include the corm of the calypso orchid (*Calypso bulbosa*), cinquefoil (*Potentilla* spp.)
and lupines (*Lupinus* spp.) (Suttles 1990). Indians in Western Washington consumed the roots, rhizomes, shoots, and fiddleheads of 7 species of ferns (Gunther 1945). Bracken fern (*Pteridium aquilinum*), and sword fern are likely to have been the most heavily used ferns by local gatherers. The Kalapuya used Mule’s ears (*Wyethia angustifolia*), a native sunflower, as a food. Native Californians harvested grass seeds (Lewis 1993; Boyd 1999b:99), and Kalapuyans may have harvested grass seeds also (Connolly 1999).

More than 25 kinds of native edible berries and fruits were available in the Marys River area. The most important include cherry (*Prunus* spp.), salmonberry (*Rubus spectabilis*), thimbleberry (*R. parviflorus*), blackberry (*R. ursinus*), blackcap (*R. leucodermis*), wild strawberry (*Fragaria* spp.), serviceberry (*Amelanchier alnifolia*), huckleberries, and salal (*Gaultheria shallon*). Other useful berries include the elderberries, honeysuckles (*Lonicera* spp.), the currants and gooseberries (*Ribes* spp.), wild roses (*Rosa* spp.), kinnikinnick (*Arctostaphylos uva-ursi*), and other fruits. A witness described Kalapuyans processing berries in the Coast Range by drying them on a bark slab by a fire (Hylton 1998:39).

Tender greens that provided important nutrients include miner’s lettuce (*Claytonia* spp., *Montia* spp.), cow parsnip (*Heracleum lanatum*), stinging nettle (*Urtica dioica*), horsetails (*Equisetum* spp.), ferns, and the leaves of strawberries, blackberries, salmonberries, and thimbleberries, stonecrop (*Sedum* spp.), violets (*Viola* spp.), and some grasses. Consuming cow parsnip stems requires carefully removing the extremely irritating outer layer. The Kalapuya probably used stinging nettle for greens and for making rope, twine, and nets. This plant also has a irritant, necessitating hand protection during harvest, and cooking to neutralize the irritants. Native Americans throughout western North America have used the inner bark or cambium of many trees as a survival food, and the Kalapuya may have used it (Turner 1997a). They consumed some mosses and lichens. Northwest Indians ate some mushroom species such as oyster mushroom (*Pleurotus ostreatus*) (French 1965).

**Hunting, Trapping, and Fishing**

Hunter-gatherers valued animal foods highly for critically needed fats as well as materials for clothing, shelter, fuel, and tool manufacture. Hunters used clubs, bows, snares, traps, and decoys to catch a variety of large and small animals (Buan and Lewis 1991:19). Hulse et al. (1997) compiled a complete list of all vertebrate animals presumed to occur in the Muddy
Creek watershed of the Marys River region at the time of Euroamerican arrival, including 234 mammal, bird, amphibian, and reptile species. The most important native animal foods were probably deer, elk, fish, and waterfowl. Secondary animal foods included black bear (*Ursus americanus*), black-tailed jackrabbit (*Lepus californicus*), brush rabbit (*Sylvilagus bachmani*), birds, and insects. Grey wolf (*Canis lupus*) and cougar (*Felis concolor*) hunting was possible. Trapping of beaver (*Castor canadensis*), river otter (*Lutra canadensis*), the bushy-tailed wood rat (*Neotoma cinerea*), as well as squirrels and chipmunks (*Sciuridae*) provided food. The Kalapuya trapped raccoon (*Procyon lotor*) (Buan and Lewis 1991:19). Roasted grey squirrel (*Sciurus griseus*) was a Kalapuyan delicacy (Ratcliff 1973:29).

Elk as well as two species of deer were available locally, white-tailed deer (*O. virginianus leucurus*) and black-tailed deer (*O. hemionus*). During the Kalapuya era, white-tailed deer apparently were common along the riparian belt and brushy foothills in the Willamette Valley, and elk inhabited much of the valley floor. Douglas describes the black-tailed deer as less common than the white-tail (Storm 1941:25). White-tailed deer are now extinct in the Willamette Valley (a restoration attempt is in progress) but survive along the North Umpqua River and on Sauvie Island near Portland. The Oregon Department of Fish and Wildlife (ODFW) reports (1995) that white-tailed deer are typically associated with riparian areas in their remaining range in western Oregon. Connolly (1999) argues that deer were a systematically managed food source in the Willamette Valley. Men hunted deer with bow and arrows, fire drives, traps, and drove them into pre-set snares (Mackey 1974:26). The practice of battue was an indigenous “circle hunt” method (Zenk 1990; Ratcliff 1973:29). A wide circle of people surrounded an area, drove the game inward to a central site, where hunters killed them with arrows, spears, or clubs. Sometimes a ring of fire was set to drive the game inward. Villagers shared meat with all participants.

Reports vary about how rich the Willamette Valley was in game. Towle (1979:19) reports that the Willamette Valley was an “unusually productive game area.” Kay (1994:2) argues that the “Columbia Plateau and the Great Basin were particularly devoid of game at historical contact.” Alexander Henry reports large herds of deer in the Willamette Valley in 1813 and that deer were the most prized food of the Kalapuya (Havercroft 1986:38). The Kalapuya focused more on hunting than other tribes of the lower Columbia (Ratcliff 1973:29).

Birds were important food sources for the Marys River Kalapuya. The region is on the Pacific Migratory Flyway and its combination of rivers, wetlands, and prairie provided
excellent habitat for populations of swans (Cygnus spp.), geese (Branta spp.; Chen spp.), and small waterfowl (Aikens 1993:188-189). Geese were attracted to the new grass that appeared with the fall rains on freshly burned prairie and oak savanna and were abundant from late October until April (Towle 1979:17). Suttles (1990) reports that many Indian groups in the Pacific Northwest valued the Great Blue Heron (Ardea herodias) for winter food. Hunters pursued the Blue Grouse (Dendragapus obscurus), Ruffed Grouse (Bonasa umbellus), California Quail (Callipepla californica), Band-tailed Pigeon (Columba fasciata), and American Robin (Turdus migratorius) year round (Mackey 1974). Large flocks of Band-tailed Pigeon migrated into the region during the summer to feed on the seeds of prairie plants (Towle 1979:17).

Harvesting edible insects was part of the seasonal round among most Indian groups. Insect foods were important for hunter-gatherers nutritionally because they contain large amounts of high-quality fat, as well as protein, vitamins, and minerals (DeFoliart 1994:3). Evidence from the Hannavan Site indicates that native people ate caterpillars, yellowjacket larvae, and grasshoppers (Hylton 1998:20). Native people often used a “surround” technique with fire to capture grasshoppers (DeFoliart 1994:3). They could be cooked and eaten fresh or pounded in a mortar and mixed with acorns or other plant meal to make breads (Hylton 1998:36). The Kalapuya ate a caterpillar they collected from holes dug at the base of native ash trees (Fraxinus latifolia) (Ratcliff 1973:29). Many other insects were regularly consumed by Indians in the western United States, and may have contributed to the Kalapuyan diet, including ants, ant pupae, cicadas, wasp pupae and prepupae, beetle larvae, the Mormon cricket, Pandora moth caterpillars, and several other species of caterpillars (DeFoliart 1994:1,3). The honeydew secretions of the mealy plum aphid (Hyalopterus pruni) may have provided the Kalapuya with sugar (DeFoliart 1994:2). Reed grass (Phragmites communis), its host plant, is native to the Willamette Valley.

The Kalapuya collected many kinds of food from streams and riparian ecosystems, including crawfish, freshwater shellfish, turtles, and many kinds of fish (Buan and Lewis 1991:16; Mackey 1974:43). The western pond turtle (Clemmys marmorota) was an abundantly available food source, as were fresh water mussels (Anodonta spp.). The Kalapuya apparently also traveled to the coast to obtain mussels, clams, and whale meat, drying or smoking part of the catch for use in the winter. There are 20 native fish species in local streams (Ecosystems Northwest 1999:42). The major native fish species likely used for food by Marys River
Kalapuya were cutthroat trout \textit{(Oncorhynchus clarki)}, Chinook salmon \textit{(O. tshawytscha)}, Pacific lamprey \textit{(L. tridentata)}, brook lamprey \textit{(L. richardsoni)}, and mountain whitefish \textit{(Prosopium williamsoni)}. Indians probably harvested Chinook and steelhead mainly from the Willamette itself or its side channels since they prefer the higher-gradient tributaries draining from the Cascades (Ecosystems Northwest 1999:43).

Reports vary about the abundance of salmon and steelhead above Willamette Falls (i.e. Ratcliff 1973; Schalk 1977; McKinney 1984; Thoms 1989; Aikens 1993). Most authorities feel that Willamette Falls near Oregon City prevented the majority of salmon from ascending the river during the summer and early fall. According to this perspective, salmon and steelhead were available mainly in the late spring. The Kalapuya consumed most of the salmon they harvested fresh, since storage was poor during the summer, but they traded for substantial amounts of preserved salmon with other Indian groups.

Resident and fluvial cutthroat are native to the Marys River (Ecosystems Northwest 1999:44). Resident cutthroat live over the year in a single pool or group of pools and are widespread in the drainage. The larger fluvial cutthroat migrates between the Willamette River and tributaries like the Marys River where they spawn. The annual migration of cutthroat trout from the Willamette River up the Marys River was a significant food resource. Euroamericans writing about local history describe an abundance of “cut-throat” trout “in all our smaller streams,” some as large as eight pounds (Woodson 1905:47). An early resident of Monroe described huge harvests of “whitefish” that he said came “by the thousands and thousands” to the Long Tom in the fall following heavy rains (Barclay 1983:47).

**Technology**

Havercroft (1986:48-50) provides an extensive list of the basic elements of Kalapuya material culture including 6 items of technology for hunting, 7 for fishing, 5 for gathering, 22 items for food preparation and storage, and 34 utilitarian tools and weapons. Tools used in plant collection and processing included fire, knapped and ground stone tools, bone tools, woodworking tools, wooden utensils, basketry, seed beaters, antler for digging sticks, and pit ovens. Stone tools used by the Kalapuya included projectile points, flake tools for woodworking, cobble choppers, ground stone tools, and many others. The tools usually associated with the processing of geophytes and seeds are mullers and millingstones (Todt and
Hannon 1998). Flint Knives were common. The Marys River Kalapuya typically made bows from oak, backed them with sinew, and made bowstrings with deer or elk sinew (Mackey 1974:37). Quivers were made of coyote (Canis latrans) or wolf skin. Women preserved hides and furs, and converted other useful parts of the animals into bone tools, hide glue, sinew for bows and sewing, and other uses (Zenk 1990). The Kalapuya made needles from deer bones and thread from sinew (Mackey 1974).

Basketry was critical to native culture. Kalapuyans made baskets from western-red cedar (Thuja plicata) roots, spruce (Picea sitchensis) or other tree roots, willow (Salix spp.), and other plant fibers for collecting, transporting, processing, cooking, and storing food, water, and other materials (Mackey 1974:42). The amount of plant material needed to manufacture basketry, rope, bows, arrows, housing, and other tools and technologies was considerable (Anderson 1996:163). The Kalapuya cooked using the stone boiling method, using wooden tongs to transfer heated stones to watertight baskets to cook soups and gruels (Buan and Lewis 1991:16). Hartless describes cooking some meat over a fire using a split stick, and drying meat by hanging slices in the sun or by fires (Mackey 1974:43). Native people built wooden drying racks to dry fruits, meat, roots, bulbs, and fish (Hall 1981). Indians made spoons from wood, mussels, or other shells, and plates were often made of bull rushes. Canoes were made of western-red cedar, white-fir (Abies concolor), or cottonwood (Populus balsamifera) (Mackey 1974:38). Hartless describes the Kalapuya using hardwood sticks for igniters and dry moss or cedar bark as tinder to make fires (Mackey 1974:43).

Kalapuyan fishing technology included spears, detachable harpoon heads, clubs, lures and bait, hooks and line, basket traps, and rock dams (Buan and Lewis 1991:19). The Marys River Kalapuya used nets, wiers, and spears as their primary fishing technologies (Havercroft 1986:47). The Kalapuya also fished for trout and steelhead with lines of willow bark, with nets weighted with stone sinkers, and at Willamette Falls after giving tribute to the Chinook tribe (Ratcliff 1973:29). Hartless describes trapping and spearing fish with 8-10 foot long poles by torchlight (Mackey 1974). Indian weir technology probably was capable of fully blocking all streams in the region. Fishers essentially herded fish into pens and removed them with dip nets or spears. In the summer, people harvested lamprey from small streams (Ratcliff 1973:29).
Indigenous Landscape Management

The Marys River Kalapuya’s food system coevolved with native ecosystems, both adapting to and shaping them. The animals and plants used in Kalapuyan food systems were all native to the region. Fire, digging sticks, bows, traps, weirs, and nets were the main technologies used to influence the landscape. Early Euroamerican explorers and settlers’ descriptions give a feel for the Kalapuyan landscape.

In September of 1826, Douglas (1905:81) found the Willamette Valley almost entirely burned, except near streams. William Buchanan, born in the Marys River region in 1858, reports his father telling him that “the Indians used to burn off the old grass in the valley every year” (Phinney 1983:32). Wilkes (1845:222) also described widespread burning in the area. John Work traveled the Willamette Valley in 1834 and camped near Corvallis. North of the Marys River, Work described an “extensive plain” on both sides of the Willamette River, and the Coast Range to the west, “nearly without wood” (Scott 1923:249). South of the Marys River, Work described oxbow lakes near the channels of the Willamette, and “an extensive plain, very level . . . & averaging from 5 to 7 miles wide” (Scott 1923:250). He camped again along the Marys River on July 2, 1834. There he described aboriginal burning taking place on both sides of the Willamette River, notable for how early in the season it occurred (Scott 1923:264).

Douglas observed Indians digging camas October 1, indicating a long camas harvest. He (1905:91) saw a grizzly bear on the same day and encountered several other grizzlies on his trip, suggesting that the Kalapuya coexisted with large predators. Wilkes (1845:221-222) describes oaks of the southern Willamette Valley looking “more like orchards of fruit trees, planted by the hand of man, than groves of natural growth.” An early Willamette Valley settler, Quinn Thornton, described attractive oaks that gave the impression “that they were planted and tended by the hand of man” (Hylton 1998:94).

In general, native peoples of the Pacific Northwest “influenced but did not diminish their environment” (Marchak and Franklin 1997). The Kalapuya strongly influenced the landscape, manipulating and altering ecosystems to increase harvests of plants and animals useful as foods. Kalapuyan disturbances like burning or digging were regular and long-term, causing cumulative effects, altering plant associations, species composition and distributions (Anderson 1996:155).
As climate cooled over the last 4,000 years, conifer forests became the natural vegetation for much of the Willamette Valley. Conifer forests in general are “not notably rich in edible life forms” (Aikens 1993:189). The majority of foods valued by hunter-gatherers like the Kalapuya rely on disturbances like burning to maintain their early-successional communities (Anderson 1996:158). Franklin and Dyrness (1988:129) concluded that in the absence of fire or other disturbance most of the Willamette Valley would be initially dominated by Douglas-fir, and eventually by grand fir (*Abies grandis*). The Kalapuya’s land use limited the extent of conifer forests in the Willamette Valley. The argument that indigenous burning shaped the vegetation of the Willamette Valley is old and well accepted (i.e.: Kirkwood 1902; Morris 1934; Sprague and Hansen 1946; Habeck 1961; Thilenius 1964; Johannessen et al. 1971; Franklin and Dyrness 1988; Norton 1979; Towle 1974, 1982; Boyd 1986, 1999b). Evidence for indigenous prescribed burning includes ethnographic accounts, journals, and reports from early botanists, explorers, and settlers, and dendrochronological data. Lightning fires are rare in the Willamette Valley (Boyd 1999a:10). However, tree ring research by Sprague and Hansen (1946) conducted in the McDonald-Dunn Forest in the 1940s showed that fires were frequent since at least 1647. Field ecological observations, such as ground topography and the age of conifer forests, also support widespread indigenous burning.

Regular burning improved conditions for Kalapuyan foods such as camas and acorns (Alverson 1998). The use of fire prepared foods like tarweed, caterpillars, and grasshoppers for collection (Havercroft 1986:51). Regular burning kept brush away from the base of oaks, making acorn collection easier, and probably reducing disease in trees. Fires increased acorn production, providing food for humans as well as for game animals like squirrels, deer, and bear. Kalapuyans used fire in hunting and to improve habitat for game animals (Zenk 1990). Burning served as a renewal pruning for many food and fiber plants, rejuvenating them, and encouraging the growth of new, straight shoots useful in basketry (Anderson 1996:159).

Fire as a disturbance kills plants and animals and alters their abundance and distribution, but it also provides ecological benefits and can increase biodiversity. Low-intensity fires set by natives reduced fuel buildup and limited risk of catastrophic fires. For Kalapuyan people, fire was regenerative and their economy depended upon it. Some ecosystems that are managed heavily by indigenous people “can be labeled anthropogenic, in that they were shaped by human activities and are not self-sustaining” (Anderson 1996:155). Most of the prairies and
oak savannas of the Willamette Valley are anthropogenic systems, and they declined in tandem with Kalapuyan food systems.

Some tribes in the Pacific Northwest intensively managed camas patches, using horticultural practices to improve camas production and limiting access to camas patches (Gritzner 1994:33). Some camas harvesters deliberately buried mature seed capsules in the soil (Anderson 1996:159). Others burned camas beds after harvest as a cleanup process (Boyd 1999a:3). Camas harvest itself can increase camas production. Digging camas kills competing vegetation and makes an effective seed bed. Camas harvesting scatters seeds on to the surrounding soil and harvesters trample seeds into the soil. Burning reduced insect and disease outbreaks in camas plots (Thorns 1989:202). Camas management on southeastern Vancouver Island included marking patches with stones or stakes, reseeding, burning, and loosening soil. Patches were divided into individually owned plots. Every year workers cleared stones, weeds, and brush from the beds and burned them. Coastal groups often owned or inherited camas patches, but bands and tribes usually shared camas patches in the interior (Thorns 1989:215).

Death camas (Zigadenus venenosus), a poisonous native lily, is common to the same habitats as edible camas. The crowded inflorescences of death camas make it easy for an experienced observer to tell apart from camas when the plants are flowering or in seed, but the bulbs and leaves of death camas are similar to edible camas. Since the major camas harvest may have taken place after the plants went dormant, it would have been critical to know that patches were free of death camas. The shared habitat of camas and death camas supports the hypothesis that the Kalapuya weeded camas patches.

Turner (1997b:277) argues that native cultures in the Pacific Northwest encourage sustainability and have values that include strong allegiance to traditional land and respect for non-human entities and life forms. Turner (1997b:275) also identifies locally adapted practices including monitoring, inventory, adapting to ecological change, use of ecological indicators, and understanding ecological principles. Oregon Indians achieved connection with nature by using it carefully and attentively, as well as through ritual, ceremonies, songs, and offerings (Anderson 1996:156).

The Indian landscape was shaped by a people with limited populations and technology, a mainly subsistence economy, social limits on the economy, animistic religion, and a long-term connection to land (Bunting 1997:20). The Kalapuya shaped but did not tame the region. The available data indicates that the Kalapuya preserved all native species, ecosystems, and
ecosystem processes. No documentation exists of extinctions caused by hunter-gatherers in the Willamette Valley, and no scholars have suggested human-caused extinctions occurred during the last 8,000 years. The Kalapuyan food system coexisted with large predators like the grizzly bear and wolf. The major ecosystem they diminished, conifer forests, was still the most common ecosystem in the larger region. By maintaining large grasslands within a larger conifer forest region, the Kalapuya probably increased regional biodiversity. The Kalapuyan landscape is the primary standard for modern ecological restoration. The locally adapted Kalapuya food system appears to have enacted a cooperative, positive relationship with native ecosystems that is an example for reinhabitation food systems.

CONTACT PERIOD: 1778-1845

European visits to the Pacific Northwest were irregular until Cook entered the region in 1778 (Gibson 1985:1). Cook’s expedition traded with Pacific Northwest natives for sea otter furs and then traded the furs profitably in China (Bunting 1997:22). The publication of Cook’s journals in 1784 stimulated economic activity on the Pacific Northwest coast. Traders exchanged metals, blankets, guns, and alcohol for sea otter skins, and traded the skins at Canton for china, silk, and tea to sell in Europe and the United States (Gibson 1985:2). The sea otter trade initiated the Pacific Northwest into the global economy.

The first documented contact between the Kalapuya and Whites took place in 1812 when Pacific Fur Company traders entered the Willamette Valley (Zenk 1990). The Pacific Fur Company opened Wallace House in 1812-13 near Salem, and the North West Company opened its Willamette Post in 1813 near Champoeg (Gibson 1985:130). Trappers from these forts began exploring, trapping, hunting, and trading with natives. By 1821, a Hudson’s Bay Company fort was active in the Umpqua Valley (Gibson 1985:59). In 1821, the Hudson’s Bay Company took over the North West Company and monopolized trade and agricultural efforts in the region until the influx of Americans in the early 1840s and the territorial boundary decision of 1846.

The British Hudson’s Bay Company funded and directed the initial Euroamerican settlement and development of the Willamette Valley (Gibson 1985:145-146). Chief Factor McLoughlin directed French-Canadian settlers to French Prairie and American settlers to the Tualatin Plains. By 1837, the combined Canadian settlement had grown to about a hundred
people (Gibson 1985:131). Homesteaders established farms further south in the Willamette Valley, and released livestock south of settled areas. The year of 1843 was the turning point for settlement of the Willamette Valley by Euroamericans (Bowen 1978:12). In 1843, the “Great Migration” arrived, bringing approximately 800 new arrivals to the Willamette Valley, doubling the Euroamerican population.

Old World diseases decimated the Kalapuya, making it hard to fight the seizure of their land. Smallpox struck inland following contact with coastal European traders in the 1770s and probably killed more than 30 percent of Native Americans exposed to it (Boyd 1990:138). Cook’s expedition along the Oregon coast encountered people with smallpox scars (Suttles and Ames 1997:271). Smallpox appeared repeatedly, killing many more. Diphtheria, leprosy, cholera and other diseases entered the Willamette Valley after smallpox (Bowen 1978:59). Venereal disease spread from the mouth of the Columbia in the 1790s. Secondary sterility from venereal infections contributed to population declines (Boyd 1990:143). Farmers and missionaries also spread diseases among the Kalapuya by the 1830s. Settlers brought dysentery to the Willamette Valley in 1844 and measles shortly afterwards (Boyd 1990:141).

Malaria has caused more human casualties than any other disease (Cohen 1989:41). Malaria, or “fever and ague,” devastated the Kalapuya, striking the Willamette Valley between 1830 and 1833 (Cook 1956:303; Boyd 1990:139). Most of the white population in the lower Columbia River Valley had acute seasonal malaria in 1830, 1831, and 1832 (Cook 1956:310). The range of the malaria epidemic matched with the range of a native mosquito species (*Anopheles malcolipennis*) of western Oregon interior valleys, and the disease appeared in the summer during mosquito breeding season (Boyd 1990:139). By 1841, the Kalapuya population had fallen to approximately 600 (Boyd 1990:139). In the 1851 treaty negotiations, the Marys River Kalapuya may have been lumped with the 44 members of the Luckiamute groups (Mackey 1974:120). The diseases left Indians unable to provide much resistance to Euroamerican settlement (Cook 1956:316). In 1856, the United States government moved the native people of the Willamette, Umpqua, and Rogue watersheds to the Grand Ronde and Siletz reservations (Robbins 1997:85).
CONCLUSIONS

Reinhabitory food systems in the Marys River region can incorporate several important characteristics of Kalapuyan food systems. The Kalapuyan food system contributed to the preservation of biological diversity and ecological integrity and coexisted with large predators. It was adapted to native flood regimes, ecological processes, the summer drought, and the poorly drained soils of the region. The Kalapuyan could have devastated local species with fishing and hunting technologies such as weirs, yet there is evidence that they did not. The Kalapuyan food system did not excessively degrade or pollute soil, water, or air. The food system relied entirely on solar energy. Most food derived from the region and most people were involved in food collection, processing, or manufacture of tools. The Kalapuyan food system connected people to nature through land use, and knowledge and skills related to food systems were universal. Access to land was widespread and food security was high.

How can people begin to incorporate elements of Kalapuyan food systems in a reinhabitory food system in the Marys River region? People can restore native ecosystems and prescribed burning to some areas. Support could grow for the work of the Confederated Tribes of Grand Ronde to revive food system practices and traditions. Hobbyists can expand their work replicating, using, and teaching use of Kalapuyan food system technologies. Hunting, fishing, and gathering using indigenous technology can provide a small amount of food for the local population. Support could expand for people (i.e. Kallas 1998) investigating modern methods of propagation, processing, and preparation of native foods such as camas. Gardening of native food plants can develop as a regional cultural tradition. Camas can be a symbol of native food systems and reinhabitation, becoming a major landscape plant, initially for its floral display, and later for food. Camas patches and small replicas of native prairies can become a common part of urban yards and the landscaping of businesses and institutions. Local entrepreneurs can sell sustainably harvested native foods to local markets and to local restaurants that feature wild foods in meals. Perhaps most importantly, participation in traditional practices can be an educational tool to increase knowledge of natural and cultural history, give people positive physical experiences that connect them to the region, and inspire involvement in food systems.
CHAPTER 4: DIVERSIFIED FOOD SYSTEMS, 1845 TO 1940

I divide Euroamerican food systems in the Marys River region into diversified, industrial, and alternative to contrast different approaches. Separating the diversified and industrial periods at the end of the 1930s is a convention of anthropology for describing significantly different food streams (Grey 2000). The first 40 years of the diversified food system was a settlement period of farm and infrastructure development, ending in 1884 when the region was connected to national rail systems. The first Euroamerican agricultural pioneers began to establish farms in 1845, introducing a food system based on exotic plants and animals like wheat, oats, cattle, and hogs. Farmers began converting native ecosystems to cropland, and released livestock onto the landscape. A regional agriculture began to take shape by the 1880s. Farmers replaced continual cropping of wheat and oats with crop rotations and integrated crops and livestock. Many farms produced a variety of crops for local and export markets, combining cash cropping with partial self-sufficiency. The dairy, livestock, and fruit and vegetable industries grew and supplied local markets. Corvallis and Philomath developed food-processing industries. Home food production was common in Corvallis, Philomath, and in rural areas. By the end of the diversified agricultural period in 1939, elements of farming systems had become more inhabitory.

Diversified food systems were less locally adapted than Kalapuyan food systems and did not preserve biological diversity and ecological processes. Farmers replaced native with exotic species and exterminated predators and crop pests. The use of inanimate sources of energy and machinery increased during the diversified period. Marketers imported a significant amount of food into the region and many cash crops were grown for export markets. In contrast, diversified food systems followed reinhabitory principles in several ways. They relied considerably on solar energy. Horses provided power on farms. Local production supplied a significant amount of food for local consumption. Most families participated in food production. Local food processing was diverse and well developed. Farmers used primarily cultural and biological practices to manage weeds and pests and experimented with crops and practices for the region. An inhabitory food system could have evolved from the diversified food system.
SETTLEMENT PERIOD: 1845-1884

Settlers made the first land claims in the Marys River region in late 1845 and planted the first crops in 1846 (Fagan 1885:323; Bowen 1978:63). Most migration ended temporarily in 1849 because of the discovery of gold in California (Longwood 1940:34). Settlers claimed most of the attractive land in the region by 1865, although much was not cultivated (Speulda 1989:10). The Willamette Valley is a desirable place to grow food. The region’s weather and climate is mild and relatively predictable. The marine influence, ample winter rainfall, and protection provided by the Cascades from continental air limited risk, and led to stable grain yields. The lack of hard winters reduced stress on livestock and required limited supplemental feed or shelter. Wilkes (1845:361) reported that life was easier for settlers in the Willamette valley than for settlers in other parts of the United States. The major limits to agricultural development were limited capital, transportation, and distance from markets. Early land claimants were able to get desirable land claims with water from springs and creeks, open grasslands for farming and pasture, and forests for fuel and construction materials.

Early settlers mainly selected claims in foothill areas or on elevated terraces along the Willamette and Marys Rivers (Bowen 1978:61; Hylton 1998:115; Longwood 1940:35; Boag 1992). The initial settlement pattern of selecting land in the foothills was locally adapted. Some settlers chose upland claims based on experience with flooding and disease in the Mississippi River Valley. Many settlers who tried to settle on the floodplain were flooded out. The flood of 1861 caused extensive damage to buildings and farms and killed livestock (Miller 1999:204; Benner 1997; Russell 1998:238). Farmers’ initially used regularly flooded land or wetlands only for seasonal pasture or hay.

The foothill region also had better access to water and wood (Longwood 1940:36). Frosts were more frequent, but there were fewer temperature inversions in the foothills than in the lowlands. Another benefit of foothill claims was access to the major north-south trail in the region that followed the base of hills south from Philomath for driving stock in and out of the area. In 1860, about half of Benton County’s 365 farms were located in the foothills (Longwood 1940:37). Repeated settlement, farming, and abandonment of land occurred in the foothill area. The large Belknap clan that began settling the Bellfountain area to the northwest of Monroe beginning in the late 1840s followed the typical settlement pattern. They spent their
first winter near Marysville exploring the area, then moved south and laid claims in the spring. More related groups settled near them in subsequent years.

Transportation was a major problem during the settlement period. During the rainy season, "transportation and commerce were practically at a standstill" (Phinney 1983:1). One of the first actions of the Benton County government was to improve the infrastructure for moving farm crops. The county constructed roads, licensed ferries crossing the Willamette River, and by 1856 had built bridges over the Marys River (Phinney 1983:1). In the early settlement period, Corvallis was the community farthest upriver with regular water transportation. Local farmers shipped goods from Corvallis north to Portland and south to the mining districts. Farmers sold animal products, mainly cattle and salted pork, to bring to the gold country on pack trains and drives.

William Bowen’s study of Willamette Valley settlement argues that the kin/neighbor clan was the basic unit of pioneer migration and settlement (Bowen 1978:50, 52). Many early settlers established relatively self-sufficient communities. Many farmers also practiced skilled trades on the side to make extra money. Some homesteaders also exchanged goods and labor with each other (May 1994:238). Farmers generally exchanged work for work rather than for money (Bowen 1978:77). Labor pools helped complete large agricultural projects and connected communities. Exchange was not free or unconditional, and settlers kept records of their labor exchanges (Bowen 1978:77; Bunting 1997:94). A local reinhibitory food system could use these practices.

Boiled wheat, coarse breads, salted pork, beef, and potatoes dominated the diet of the early settlers, and became the primary commodities in the local economy (Bowen 1978:68; Phinney 1983:86). Many settlers hunted, fished, and harvested wild plants to supplement their diet. Gardens provided important nutrition and variation in the diet. Sugar was an expensive imported luxury used minimally (Phinney 1983:86). In addition to common garden crops, settlers grew tobacco for personal use and chicory for a coffee substitute (Bowen 1978:74).

Early farmers typically mixed partial self-sufficiency with market crops. Many pioneer farms produced most of their own food (Blok 1973:8). Most farms raised grain and livestock for cash and home use, managed woodlots, established orchards and gardens, kept horses, and raised cows, pigs, sheep, and chickens for meat, dairy, hides, and eggs. After establishing the farm, participation in commerce increased (Bowen 1978:69). The main early cash crops were wheat, cattle, salted pork, and potatoes. Livestock products typically sold locally and wheat
was an export crop. Money from the sale of grain and livestock products combined with limited wage labor and trades to pay for purchases necessary for the household and farm. Local farmers experimented during this period with producing orchard crops, tobacco, hemp, flax, hops, sweet potatoes, sorghum, peanuts, alfalfa, maple sugar, sorghum molasses, and other crops (Speulda 1989:6). Early pioneer farms typically tilled 20-40 acres of land, mostly wheat for sale, with some oats for feed, and a garden (Longwood 1940:38). Farmers slowly increased their improved acreage and built fences, barns, and other outbuildings. Fencing gardens and cropland to protect them from livestock and game was extremely time consuming, but sturdy fencing was required to be eligible for legal recourse against neighbor’s livestock (Bowen 1978:74).

Livestock

Euroamerican settlers quickly took advantage of the excellent grazing possibilities of the region (Gibson 1985:143). Livestock was the most important part of agriculture in Benton County during the early settlement period (Longwood 1940:44). Many early settlers let their stock range freely (Bowen 1978:76). Pigs and cattle multiplied rapidly with little supplemental feeding or care. Most early cattle were Spanish longhorns, independent and capable of fending off predators. Etna Burchard, the child of early settlers in Benton County, recalled that there were so many feral cattle that it was dangerous to be far from home (Phinney 1983:8). The open range ranching period ended in much of the region within less than 20 years (Bowen 1978:80). The yields of early dairy herds were extremely low (Bowen 1978:81). Dairying became much more productive after production-bred cattle were introduced into the Willamette Valley in the 1870s (Hylton 1998:137). The native prairies provided good forage for light grazing regimes but were not resilient to heavy use. Overgrazing was an immediate problem, contributing to the loss of native species and the spread of exotic plants like Scotch broom (Cytisus scoparius) and wild rose (Rosa spp.) (Storm 1941:4). Farmers advocated replacement of native grasslands with “improved” forage crops like orchard grass and red clover (Newsom 1972:96).

Within a few decades of settlement, most farms had a flock of sheep that provided wool for households, cottage industry, and market (Barclay 1986:7). One of the first local carding mills was built south of the current railroad tracks on the west side of Oak Creek between
1850 and 1869 (Benner 1984:8). Farmers allowed hogs to range freely much of the year to subsist off wild foods. Bands of feral hogs became common in the Willamette Valley by the late 1830s (Bowen 1978:87). Hogs thrived in the native prairies, wetlands, and forests, especially on Kalapuyan foods such as acorns, wapato, and camas. The semi-wild hogs created problems of tracking ownership, and they destroyed crops. Neighbors sometimes formed groups to hunt and process the pigs (Barclay 1986:7). Community hog processing groups might share ownership of processing equipment including meat grinders, sausage stuffers, and lard presses (Barclay 1983:52). Hogs were important to settlers for food and market income. Smoked ham, bacon, and salted pork stored well and were staples of home and local market (Bowen 1978:87).

Crops

Wheat was the single most important cash crop throughout the Willamette Valley during the settlement period (Bowen 1978:68; Longwood 1940:39). By 1880, the Marys River region was “principally a wheat growing area” (Longwood 1940:42). The area between the Willamette River and Muddy Creek was described in 1883 as “devoted almost entirely to wheat growing” (Woodcock 1883:31). Most farms also produced a large amount of oats for livestock feed. In 1879, farmers harvested 31,115 acres of wheat and 9,063 acres of oats in Benton County (Longwood 1940:42). I describe wheat production in more depth to give an example of early settlement farming. Wheat became the dominant crop in the local area for several reasons. It thrived in the area’s climate and tolerated many local soils. Farmers knew how to grow, harvest, process, and store wheat, and it could be grown with minimal time, technology, and capital (Bunting 1997:105). It was possible to grow the crop with little manure or other fertilizers and little care for months after planting. Many farmers cropped the same fields every year for decades. Yields were low but reliable. Wheat was a good cash export crop because markets were available, prices were relatively stable, it was easily measurable, provided many calories for its weight and bulk, and it stored and shipped well.

Farmers prepared to plant wheat by surrounding their fields with a rail fence, then broke the soil and planted in spring or fall (Gibson 1985:141). They initially used oxen and wooden implements to till fields, and seeded by hand. In succeeding years, growers often produced volunteer crops by simply harrowing old fields. Woodcock (1883:31) reports local slash and
burn practices in the foothill areas to prepare land for wheat farming. The wheat harvest began in July or August. Farmers harvested wheat with scythes and cradles and bundled it in fields (Gibson 1985:142). Two workers could scythe and bundle 3 or 4 acres a day using such technology (Bowen 1978:89). Wheat yields during this period were typically 15-20 bushels an acre, but yields on well-managed farms could be 40-50 bushels per acre (Longwood 1940:38; Hylton 1998:135; Bowen 1978:88). Grain processing took place on ground compacted by livestock or built “floors.” Horses or cattle threshed the crop on the compacted ground or platform. Farmers removed the straw with forks, and winnowed grain in the wind (Robbins 1997:98). Early farmers in the region also used horse-powered treadmill thrashing machines (Phinney 1983:86,89). Keturah Belknap (1993:72) described a local wheat harvest in her journal of 1852:

What little grain there is has to be cut with the cradle. There has not been much farming done this year so many went to the mines to make their fortunes faster than raising wheat. We went twenty miles to get some lumber sawed out with a whip saw to make a floor to thrash out our crop of about eight acres on. Most everyone thrashed on the ground this fall. Seed wheat is selling at one dollar and fifty cents per bushel (1993:72).

The Herbert gristmill is the first gristmill documented in Benton County (Gallagher 1986). It was located on Beaver Creek, near the current junction of Greenberry and Bellfountain roads and erected in approximately 1850. The Herbert’s milled locally grown wheat, sold flour and other supplies, and provided blacksmithing services to miners traveling south. Warehouses along the Willamette River stored wheat for shipping by steamboat. One farmer reported that teams carrying wheat to warehouses along the Willamette River “would extend in an unbroken line for half a mile, all waiting their turn to unload” (Phinney 1983:80).

For decades local farmers planted wheat on the same ground year after year, with no fallowing, manure, fertilizer, or crop rotation, causing declining yields and soil depletion (Longwood 1940:43; Williams 1914:4; Woodson 1905:5; Hylton 1998:136). Local farmer Virgil Carter reports that farmers had high initial wheat yields, but the soil became “worn out with years of continuous cropping with no fertilizing” (Phinney 1983:37). Wheat yields were stagnant or declined during this period (Goetze 1984:1).

Farmers used the Marys River for transportation during the settlement period. Ben Bratton, an early settler, hauled his wheat to the gristmill on Beaver Creek in a canoe pulled
by oxen (Ecosystems Northwest 1999:16). By 1851, steamboats traveled between Willamette Falls and Corvallis (Robbins 1997:92). Corvallis, Albany, and Harrisburg were wheat growing areas and important stops for steamboats (Robbins 1997:104). Industrialization in farming was most prevalent in export and cash crops, particularly grain crops. By the end of the 1850s, farmers in the Willamette Valley were purchasing machines such as mowers, threshers, and wheat separators (Robbins 1997:91). Mowing machines became common by the early 1860s (Hylton 1998:130). Threshing machines appeared by 1860 (Longwood 1940:41). Horses replaced oxen for traction by this time also.

Small local and regional urban populations and transportation limited local market development during the settlement period (Bunting 1997:91). The population of Benton County in 1880 was 6,403 (Longwood 1940:65). The amount of farms in Benton County grew from 110 in 1850, to 701 in 1880 (U.S. Department of the Interior 1853, 1883). Acreage in farms in Benton County expanded from 5,589 acres in 1850, to 138,464 acres in 1880 (U.S. Department of the Interior 1853, 1883). During the settlement period farmers established farms and infrastructure for agricultural development. By the 1880s, an agricultural landscape existed in the Marys River region.

DIVERSIFIED PERIOD: 1884-1940

A regional food system began to take shape in the 1880s. The growing Corvallis and Philomath urban areas provided markets for local producers, and local food processing expanded. Mixed farming became the prevalent practice, and most farms produced livestock and grains in rotation with legumes and pasture. Farmers replaced the continuous cropping of the settlement period with locally adapted crop rotations. Local farmers diversified their operations and expanded production of dairy products, fruits and nuts, vegetables, and poultry and eggs (Ecosystems Northwest 1999:16). The main components of the diet during the diversified food system era were potatoes, wheat, dairy, meat, and other animal products such as lard and eggs (Aitken 1910). Fruit and vegetable consumption was low during this period. Supermarkets did not exist until after WWII. Consumers produced their food at home or bought it at locally owned markets, food stands, or farmers' markets.

By the early 1900s, the region had significant local food processing capacity and manufacturing. Philomath had a creamery, and Corvallis had several flour mills, a creamery, a
fruit and vegetable cannery, a prune dryer, several sawmills, an ice factory, and many other local manufacturing operations (OSU Department of Anthropology 1980:32; Woodson 1905:25; Oregon State Immigration Commission 1915:92). The creamery of the Oregon Agricultural College was also in operation. Oregon State Agricultural College was located first at a temporary location in Corvallis in October of 1868 and in a permanent location in October of 1870 (Woodcock 1883:4). By 1914, county extension services were available (Blok 1973:42). The experiment stations of Oregon State Agricultural College implemented scientific programs to improve farming.

Farm writers, industry spokespersons, and university publications regularly advised farmers to be self-sufficient during the diversified period. The Horticultural Division of Oregon Agricultural College recommended in 1915 that every farm raise dairy cows, pigs, keep chickens, have a home garden and “endeavor to grow enough feed to maintain all the stock on his farm” (Blok 1973:97). Writers often argued that diversified farming furthered the independence of farmers. A variety of crops added security in case crops failed or prices fell.

Railroads were a technological force that worked against the development of locally adapted food systems. They entered the region in the 1870s and connected the area more effectively with external markets. The O & C Railroad traveled the east side of the Willamette River, bypassing Corvallis, but reaching Eugene in 1871. The West Side Railroad reached Corvallis from Portland in 1878 (Hylton 1998:130). In 1885, the Oregon and Pacific Railroad established railroad service between Corvallis and Yaquina Bay, and by 1887, connected Corvallis and Albany. The Union Pacific connected Oregon to the nation in 1884 (Bunting 1997:86). The introduction of railroads stimulated immigration and agricultural production (Robbins 1997:114). Railroads encouraged and facilitated cash cropping for export. They also helped increase urban power over rural areas (Bunting 1997:87). Railroads connected local areas “with the desires of people who lived outside the region” (Bunting 1997:87). People in other regions could obtain food without knowledge about the ecological and social consequences of the foods produced (Bunting 1997:88). People in the Marys River region bought products from other regions, affecting landscapes around the world.

In 1900, Benton County’s population was 6,706, with 37.3% of the population living in Corvallis. The county population more than doubled from 1900 to 1920, to 13,744 people (Longwood 1940:78). A significant movement to Corvallis and Philomath from rural areas began in the early 1900s. The number of farms rose from 110 farms in 1850 to a peak of 1,678
farms in 1935 (U.S. Department of the Interior 1853; U.S. Department of Commerce 1943). In
1900, there were 865 farms in Benton County, with 235,652 acres of farmland, and 85,823
improved acres (U.S. Department of the Interior 1902). From 1900 to 1950, land in farmland
was relatively stable. The average size of farms in Benton County declined from its peak of
273 acres in 1900 to its historic low of 166 in 1930 (U.S. Department of the Interior 1902;
U.S. Department of Commerce 1943).

The expansion of dairying, hay, grain production, ranching, poultry production, and
orcharding showed the local diversification in farming taking place (Phinney 1983:1). Grain
production shifted increasingly to the valley floor, and the foothills were more oriented to
livestock grazing (Longwood 1940:66). Local dairy production supplied most regional
demand for dairy products. In 1930, the most common kind of farm in Benton County was a
dairy farm, followed by general farms, self-sufficing farms, fruit farms, animal specialty
farms, and cash grain farms (Longwood 1940:85). The dairy industry became larger than the
beef cattle industry by 1920. Other crops that were experimented with on a small scale during
this period included grass seed, sweet potatoes, cowpeas, Canada peas, buckwheat, emmert,
spelt, soybeans, field peas, field beans, and root crops for storage.

Livestock

Local farmers managed large herds of cattle, sheep, and goats during the diversified
period. In addition to their cash value, livestock served as a reliable food bank and dairy
animals provided daily food. Most farms had milk cows during the diversified agriculture
period. In 1924, the Oregon State Agricultural College Extension Service recommended that a
commercially viable dairy herd have at least ten cows (Blok 1973:90). Farmers sold surplus
milk products or fed them to pigs or other livestock. In 1900, 741 Benton County farms
reported producing some dairy products (U.S. Department of Commerce 1931). In 1930,
78.9% of Benton County farms reported selling or trading livestock or livestock products, and
90.3% of farms used products from their own woodlands (U.S. Dept. of Commerce 1931).

The practice of grazing native or unplowed pastures was largely replaced with growing
hay and fodder crops, winter-feeding, and use of improved pastures. Regular use of manure
began in the early 1900s (Longwood 1940:66). Hay was often a mix of vetch and winter oats
or other tame species. Supplemental feeding typically took place in July through September,
and December into February. Farmers fed fodder corn in the fall, and roots, hay and silage in winter (Bloch 1973:89). Some farmers also fed clover, oats, and vetch silage during the summer (Corvallis Printing Company 1919:4). The importance of growing and storing feed in silos gradually increased.

Hog production was an integral part of mixed farming, and few if any farms specialized in raising hogs (Corvallis Printing Company 1919:7). Hogs were raised on clover or alfalfa pasture, then fattened on barley or wheat, and sold in local markets or to Portland (Corvallis Commercial Club 1912:29). Farmers fed swine waste products like skim milk and whey and turned them into harvested fields. Many farms had smokehouses to process meat for long-term storage for home and market. For example, T. W. B. Smith raised pigs south of Corvallis, in the area of the current Smith Loop road, and built one of the first smokehouses in the region, a structure about 20 by 20 (Russell 1998:195-196). Smith sold fresh and smoked meat in Corvallis from wagons. Another Smith family member constructed one of the last smokehouses in the area in the late 1940s or early 1950s (Russell 1998:197).

The mild regional climate was beneficial to poultry production. Egg yields were greater locally in November through January than in colder regions, allowing profitable export (Corvallis Printing Company 1919:7). Chicken houses could be open nearly all winter and green feeds produced year round to reduce costs. Farmers often planted kale in chicken yards in July, and turned chicken into the yards during winter. Farmers introduced Angora goats into the region to produce wool and control woody vegetation in pastures. The largest herd of goats in Oregon was southwest of Corvallis, a herd of about 1,000 animals (Woodson 1905).

Crops

Wheat acreage in Benton County increased until 1900, and then fell during the rest of the diversified agriculture period. Wheat became a much less important crop after 1920 except for years when it was an important replacement crop. Wheat yields per acre began to rise after their low of 17.3 bushels per acre in 1910, but yields did not increase much until after World War II. Farmers experimented with grass seed crops in Benton County as early as 1860 (U.S. Dept. of Interior 1864). In 1930, seed production included 1,208 acres of clover, 18 acres of timothy, 331 acres of vetch, and 1,122 acres of other grass seed, for a total of 2,679 acres.
Orchard crops were more oriented to export markets than most other crops, and they suffered from repeated and extreme boom and bust cycles. In the early 1900s, the most important orchard crops were plums, apples, pears, cherries, peaches, nectarines, apricots, and walnuts (U.S. Dept. of Commerce 1913, 1921). Strawberries, raspberries, loganberries, grapes, blackberries, and quinces led small fruit production (Oregon State Immigration Commission 1915:40). In 1905 in Benton County, there were 1,200 acres of bearing prune orchards as well as evaporating and packing plants (Woodson 1905:21). Nut production expanded in the 1920s and 1930s, but nuts never became a major crop in the region. From 1907 until the middle 1920s, Alpine experienced an economic boom due to the orchard industry (Gallagher 1986). After 1924, orchard production began a long decline due to chronically depressed prices.

Like orchard crops, specialty crops were oriented to export markets and prone to boom and bust cycles. Hop production in the local area increased slowly before 1910, peaked from 1910 until 1950, and then declined rapidly. In 1904, farmers worked 400 acres of hops locally (Woodson 1905:13). In 1912, a major hop yard was on the edge of the city of Corvallis (Corvallis Commercial Club 1912:31). Hops were a risky crop because of diseases and price fluctuation. The first commercial winery in Oregon, the Hugo L. Neuman Winery, operated locally from 1934-1960 (Gallagher 1986). The owners sold the wine regionally and nationally (Gallagher 1986). Farmers and the government tried to develop flax as a regional crop, but it never was consistently successful (Calvert and Marks 1995:16). A flax industry was active during World War II, and a processing plant was built about five miles north of Monroe (Barclay 1986:27), but the industry collapsed after the war (Calvert and Marks 1995:18).

CONCLUSIONS

The first Euroamerican agricultural pioneers began to develop farms in 1845. They immediately established a food system based on exotic crops and livestock. The diversified food systems were more mixed than the Kalapuyan or industrial food systems in terms of local adaptation. Diversified food systems had several locally adapted characteristics. Most households were involved to some extent in food production. Farmers sold products in markets, but markets did not control farms. Local production could supply local consumption
with the main staples of wheat, meat, and dairy products. Local facilities processed foods for local consumption and export. Fossil fuel use was relatively low and farmers used few agrichemicals (Longwood 1940:8 1). Horses provided traction and transportation, and consumed feed produced on farm. Diversified food systems used minimal energy for refrigeration. Irrigation was minimal. Farmers began to learn to adapt their practices to the region’s flooding, summer drought, and poorly drained soils.

Reinhabitory food systems encourage characteristics of diversified food systems such as integration of crops with livestock, crop rotations, use of legumes, self-sufficiency, community labor, labor trades, and shared ownership of tools. People had relatively high levels of skills and knowledge related to food systems compared to industrial food systems. Most local farms would have met current organic certification standards. Several native animal species appeared to prosper under diversified agriculture, including Douglas’ ground squirrel, the jackrabbit and brush rabbit, meadow mice (Microtus spp.), and red fox (Vulpes vulpes) (Storm 1941). Pastures and hayfields provided habitat for ground nesting birds such as Western Meadowlark (Sturnella neglecta) and Horned Lark (Eremophila alpestris). These birds appear to have had healthy populations in diversified agriculture (Storm 1941).

The diversified food systems were not locally adapted in other ways and caused significant damage to regional ecosystems. They failed to preserve regional biological diversity and ecological integrity or coexist with many native species. Farmers considerably transformed the region’s native ecosystems by 1939 (Ecosystems Northwest 1999:89). Prairies, oak savannas, wetlands, and riparian forests had been converted to grain fields or grazing land. The conversion of the native ecosystems of the Marys River region into neo-European landscapes featuring exotic plants and animals fits the global pattern described by Crosby (1986) as ecological imperialism (Robbins 1997:64). Fire suppression, grazing, and abandoning farmland allowed conifer forests to spread over the foothills and eastern Coast Range. Farmers used the Willamette River and other local streams as economic resources. Log drives, removal of woody debris, channelization, bank stabilization, and elimination of riparian vegetation significantly altered the Willamette and Marys Rivers. Farmers began to rapidly drain wetlands in the 1870s (Williams 1914; Bunting 1997:78). Aerial photos taken in 1937 give evidence of widespread channelization of seasonal streams and use of drain tile (Ecosystems Northwest 1999:56).
Hunters’ devastated deer, elk, gray fox (*Urocyon cinereoargeneus*), and black bear populations. Poison, as well as hunting and trapping quickly pushed the wolf, grizzly, and Canada lynx (*Lynx canadensis*) into extinction. Relentless trapping dramatically reduced weasel family (Mustelidae) animals. Farmers and their “boys with rifles” regularly killed animals and birds that they perceived as harmful to their operations, particularly hawks, owls, jays, woodpeckers, skunks (*Mephitis mephitis; Spilogale putorius*), and squirrels (Storm 1941). County agents contributed to local extermination efforts with the gray squirrel, Douglas’s ground squirrel (*Tamiasciurus douglasi*), and Townsend chipmunk (*Tamias townsendi*) (Storm 1941:57). Homeowners and gardeners systematically reduced pocket gopher (*Thomomys spp.*) populations.

Invasive plants and animals changed the landscape since the 1840s. Influential introduced animals in the region include carp (*Cyprinus carpio*) the house cat (*Felis catus*), house mouse (*Mus musculus*), black rat (*Rattus rattus*), Norway rat (*R. norvegicus*), eastern cottontail, opossum (*Didelphis virginiana*), Ring-necked Pheasant, House Sparrow (*Passer domesticus*), European Starling (*Sturnus vulgaris*), Wild Turkey (*Meleagris gallopavo*), Canadian thistle (*Cirsium arvense*), and purple loosestrife (*Lythrum salicaria*). By 1948, 215 exotic plants had established themselves in the Willamette Valley (Peck 1948).

During the 1930s, the balance began to tip between diversified and industrial farms. Many farmers saw industrialization as increasingly necessary for survival (Blok 1973:119). Tractors were quickly replacing horses as sources of power. A study of farms in the Willamette Valley in 1938 showed that within every farm type, the biggest farms were the most profitable (Blok 1973:196). Political and economic forces “favored production zones focused on one commodity” (Nabhan 1997:216). Diversified farms began to fail and World War II tipped the balance toward the industrial food system.
CHAPTER 5: THE INDUSTRIAL FOOD SYSTEM: 1940-2002

Industrial food systems are biosphere based rather than ecosystem based, the opposite of inhabitory systems. They maintain their dominance partly by being so complex that consumers, who primarily experience the retail end of the system, are uninformed of their disadvantages and costs. Berry (1992:36) points out that:

We are almost entirely dependent on an economy of which we are almost entirely ignorant. The provenance, for example, not only of the food we buy at the store but of the chemicals, fuels, metals, and other materials necessary to grow, harvest, transport, process, and package that food is almost necessarily a mystery to us... To know the full economic history of a head of supermarket cauliflower would require an immense job of research.

The industrial food system externalizes social and ecological costs. Increased knowledge about the industrial food system is likely to increase participation in alternative food systems. Understanding the current industrial food system is necessary to shift to a reinhabitory system. A description of the history of the industrial food system in the Marys River is useful for public education, to glean tools or practices to use in a locally adapted food system, and as a benchmark for reinhabitation of the food system.

INDUSTRIAL FOOD SYSTEMS

World War II was the turning point for food systems both locally and nationally (Grey 2000). It catalyzed the success of industrial food systems at the expense of diversified systems. Anthropologists typically mark the shift to a fully industrial food system by the nearly complete replacement of horses by tractors as a power source. World War II both stimulated the economy and developed infrastructure for producing machinery and chemicals that industry applied to agriculture. The population growth that occurred after the war expanded markets for agricultural products. Industrial farms became more specialized after the Great Depression and people increasingly abandoned self-sufficiency (Blok 1973:196).

Anthropologists define industrialism as a combination of extensive division of labor or specialization, and concentrated use of technology to mass-produce goods and services (Harris 1988:550). Machines replace most human and animal labor in industrial agriculture. Fields are
prepared, planted, weeded, sprayed, fertilized, and harvested using fossil fuel powered tractors. Industrial farmers in the region rarely enter fields apart from machines, although hired laborers sometimes enter fields on foot to spot spray or weed. Farmers typically examine fields from four-wheelers, pickup trucks, or hire people to identify weeds or bare patches from planes or helicopters. Manufactured fertilizers, pesticides, and hybrid seeds "were introduced to make farming more efficient," and they succeeded in increasing productivity (Grey 2000). These technologies required greater capital investment, and a larger scale of operations (Grey 2000). Farmers apply high-nitrogen fertilizers to crops. Natural gas powered machines draw nitrogen from the atmosphere to produce fertilizer (Bormann et al. 1993:93). Herbicides and mechanical cultivation control weeds. Insecticides and fungicides control pests and pathogens. Petroleum is necessary for mining, processing, and transporting agrichemicals to market. Industrial agriculture is dependent on large amounts of purchased inputs, primarily agrichemicals, energy, machinery, and seeds (Soule and Piper 1992:11-31). The demand for larger, more capitalized and specialized farms, led to a decline in family farms, and centralization of control of the food system (Grey 2000).

Industrial farmers plant large fields to monocultures of high yielding, often patented seeds. Scientific research develops crops and livestock that produce best under industrial conditions. Industrial food systems focus production on a few standardized crops or types of livestock, and largely replace diversified and decentralized production (Grey 2000). An important law passed to benefit industrial agriculture was the Plant Variety Protection Act, passed in 1970, allowing the patenting of seeds (Busch and Lacey 1990). After passage of this act, large agrochemical companies bought most of the major seed companies in the United States, leading to production of seeds and crops that are grown only as part of a monopolized product package. Agribusiness corporations influence much university research and often obtain the rights to products developed in government-funded research.

The importance of production as part of the food system declines in industrial agriculture relative to other elements of the system including processing, packaging, distribution, transportation, marketing, retail, preparation, waste processing, regulation, administration, research, and production of machinery, agrichemicals, and other agricultural products. All these other elements of the food system are industrialized. Farmers receive a continually decreasing share of the retail price of their agricultural products. The consumer branch of the food system rapidly industrialized after World War II. Supermarkets, prepared foods, frozen
foods, highly processed and packaged foods, and chain restaurants and convenience stores took over the consumer branch of the food system. Local processing facilities disappeared and consumption of locally produced foods declined. Home production of food became minimal.

Conventional agriculture is dependent on the use of fossil fuel for every aspect of production, processing, distribution, sale, and consumption. The food system currently accounts for 15.6% of total U.S. energy consumption, with processing using 28.1% of that total, home preparation 25.0%, agricultural production 17.5%, restaurants 15.8%, and transportation 11.0% (Pirog et al. 2001:26). Cargo ships, railroads, and the trucking industry move crops from fields to processors and distributors. A variety of studies examining food miles estimated that food products travel an average of 1,346-2,146 miles from farm to consumer (Pirog et al. 2001:9). The most energy efficient way to transport food is by water, followed by rail, truck, and air (Pirog et al. 2001:15). Trucking and air transport has accounted for more of the share of food transportation for decades (Pirog et al. 2001:12). Trucks ship harvested crops to large processing facilities, and from there, trucks carry goods to packagers, distributors, wholesalers, or retailers.

Industrial agriculture succeeded in its goal of producing food and fiber for domestic and export needs with a radically diminished labor force, freeing workers to pursue specialized or professional trades (Kirschenmann 2001b:1). National food systems have produced food rich in calories at the lowest cost per proportion of total income in the world. Industrialism succeeded in reducing the population of farmers from more than 30 million in the 1940s to less than 2 million farmers in 2001, while at the same time overproducing most food commodities (Kirschenmann 2001b:1).

During the industrial period, farm management became less land-related and influenced more by political and social factors, and there was an increase in the number and kinds of problems for producers. The need for secure access to capital to afford high operating expenses became critical (Blok 1973:152). Farmers faced increasing insurance costs. Government policy, environmental regulations, and social values became a major shaping factor. Federal, state, and local institutions became increasingly influential in agriculture, using regulatory power, land-use planning and zoning, taxation policies, environmental standards, and other methods to shape agriculture.

The switch from an economy based on manufacturing to a service and information processing economy is not post-industrial. Harris (1988:550) points out that the present
economy is shifting to a hyperindustrial rather than a post-industrial economy as mass production technology and detailed division of labor are applied with increasing intensity to the service and information economy. This process is represented in agriculture by the rise of "precision" or "digital" farming (Kimbrell 2002:261). Precision agriculture relies on high inputs of biotechnology, science, capital, and patented seeds, and has a high concentration of ownership of the means of production. Some examples in agriculture include growth regulators, cloning, genetic engineering, the use of bovine growth hormone (BGH), yield maps, grid maps, aerial photographs, satellite imagery, defense satellites, geographical information systems (GIS), and global positioning systems (GPS) (Webb-Bowen 1998). The dependence on highly specialized scientists in precision agriculture is an example of hyperindustrial division of labor. Airplanes and helicopters spray pesticides, knock nuts off hazelnut trees, and map patches of weeds or areas in need of more or less fertilizer. In digital agriculture, farmers map fields and control applications of fertilizers and pesticides with GPS devices. Farmers need computers and GIS because they “might find it hard to remember where weeds grew the previous year, but a computer can. When it’s time to apply herbicides, farmers can program locations to receive either a high or low dose” (Webb-Bowen 1998). As precision agriculture developed, unprecedented worries emerged, such as fear of ecotage, and the theft of agricultural chemicals to produce methamphetamines and bombs.

Biotechnology or genetic engineering is a key part of precision agriculture (Novak 2000). Cell and tissue culture, embryo transplanting, and gene splicing allegedly offer the best possibility of creating high yielding, drought-tolerant, and pest and disease resistant crop varieties. Private firms spend millions annually to research the development of biotechnologies. The federal government sponsors university research to benefit biotechnology corporations. Agribusiness conglomerates pursue genetic engineering because they can patent biotechnologies and control and sell all their required inputs. Multinational corporations continue to merge and concentrate elements of food systems. An example of the integration of chemical and seed companies was chemical giant, DuPont Company’s $7.7 billion dollar buyout of one of the nations largest seed companies, Pioneer Hi-Bred (Capital Press 1999). DuPont is expanding into agriculture, biotechnology, and pharmaceuticals.

Control of the food system in industrial food systems moved from farm owners to multinational corporations that seek control of global food production through vertical integration and concentration. For example, four companies now mill 62.0% of the world’s
flour, and 60.0% of hogs in the United States are slaughtered in plants owned by four corporations (Grey 2000). Multinational food system corporations have direct or indirect power over planting decisions on 80.0% of arable land internationally (Nabhan 2002:168). These corporations use a global work force of 27.0 million essentially enslaved bonded laborers and sharecroppers, and more than 100.0 million international migrant workers, “most of whom have been dispossessed of their own family farms over the last half century” (Nabhan 2002:168). The WTO has the authority to override any region or countries “health, safety, or environmental protection laws” that interfere with trade” (Nabhan 2002:264).

Values

The fundamental values associated with industrial food systems are production and profit. Stauber et al. (1995:5,13) summarize the key assumptions of conventional agriculture:

- Nature is a competitor to be overcome.
- Continued economic growth is necessary and desirable.
- Expanded productivity is essential to ensure abundant, cheap food.
- Profit and production maximization should be primary goals of farm operators.
- Larger farm units and improved labor efficiency are key to continued agricultural modernization and farm profitability.
- Technological innovation and increased material consumption are appropriate measures of agricultural progress.
- Progress requires unending evolution of larger farms and depopulation of farm communities.
- Efficiency is measured by looking at the bottom line.
- Science is an unbiased enterprise driven by natural forces to produce social good.

Stauber argues that the commodification and efficiency have been the “defining vision” of industrial food systems (Kirschenmann et al. 2000:2). Stauber points out that increasing commodity volume, expanding markets, and creating new food uses has been the pathway to pursue the industrial vision.

Farmers in industrial food systems are typically reduced to being suppliers of one or two commodities and farms have “become huge monoculture factories” (Kirschenmann 2001b:6). Many aspects of industrial farming are appropriately termed “food manufacturing” (Grey 2000). Steven Blank, an agricultural economist at the University of California-Davis, has followed the economic determinism of industrial agriculture to its logical conclusion, suggesting that the United States should abandon farming entirely and focus its labor force on higher value activities (Kirschenmann 2001b:6).
Industrial societies are capitalist, socialist, or communist. Regional and national food systems are capitalist. Everything is a commodity in capitalism. Local farmers compete with all regions on earth in a global economy to produce the cheapest agricultural products. The dominant values of capitalism are maximizing profit and productivity, as well as efficiency, rationality, competition, and acquisitiveness. Prestige in capitalism goes to “the person who has the most possessions and who consumes at the highest rate” (Harris 1988:297). A fundamental feature of industrial capitalism is emphasis on consumption as overriding value and practice (Bodley 1990:6). Worster (1979:6) argues that capitalist culture assumes that society should reward the personal maximization of financial gain in the use of nature. Goldschmidt (1947) states that, in addition to mass production and mechanization, the primary characteristic of industrialized farming is a “general acceptance of pecuniary standards of value and a social status system based upon money wealth.”

The conventional farm business seeks to achieve productivity and profitability through adaptation to complex and rapidly changing global markets. In an article in the Capital Press, an influential agricultural economist argues that the primary task for Oregon farmers is to adapt their “agricultural products to the changing needs of Chinese, Indonesians, Koreans and other populations in target markets” (O’Rourke 1996:11). In the same article, O’Rourke notes, “direct pressure by the United States has opened many markets,” and “the World Trade Organization will make regression into protectionism more difficult.” According to O’Rourke, “the challenge will be to hone Northwest agriculture into a progressive, competitive powerhouse. It will require unrelenting control of every cost of doing business in order to keep prices competitive” (O’Rourke 1996:11).

Farming Patterns

The major patterns of farming in the region during the industrial period include rapid declines in farm pasture, hayfields, farm woodlands, and pastured woodland (U.S. Department of Commerce 1943-1997; USDA 2000). Total farm woodlands declined from 101,100 acres in 1950 to 23,580 acres in 1997. Pastured woodland declined during the same period from 60,045 to 4,369 acres. Production practices on cropland heavily intensified. Cropland became more important and livestock less important in agriculture. The grass seed industry took over the heavy soils of the lowlands. Pasture and hay lands were eliminated. Farmers largely
phased swine out of agriculture, and moved dairy and beef cows from pasture to confined animal feedlot operations (CAFO's).

From World War II until about 1974, the number of farms and acreage in farms decreased, and the size of farms increased (U.S. Department of Commerce 1943-1981). Land in farms in Benton County fell dramatically, from 53.2% of county land or 230,452 acres in 1950, to 130,818 acres or 30.2% of county land in 1997 (U.S. Department of Commerce 1943-1997; USDA 2000). Most of the land abandoned by agriculture became forested timberland managed in plantations, an industrial silviculture not addressed by my thesis. The amount of farms steeply declined from the historic peak of 1,678 farms in 1935 to 527 farms in 1974 (U.S. Dept. Commerce 1943-1981). After 1974, the number of farms more gradually increased until the most recent census in 1997, when 726 farms exist in Benton County (USDA 2000). This increase is due to hobby farming and the farm exemption from property tax. Farm size rose to a peak of 247 acres in 1974 and started a slow decline that continued until 1997, when Benton County farms averaged 180 acres.

The prevalence of the tractor marks the transition from the diversified to the industrial period. Many farmers relied on horses until the 1940s. In 1930, the 1,340 Benton County farms had 213 trucks and 321 tractors, but by 1955, the 1,153 Benton County farms had 1,121 trucks and 1,589 tractors (U.S. Dept. of Commerce 1931-1961). The number of horses peaked at 4,497 animals in 1920, then steeply dropped to 2,643 in 1930, 1,052 in 1945, and hit bottom at 595 in 1960. After 1960, horse populations slowly increase as they become valued as pets. Total land in pasture declined dramatically during the industrial period, from 142,325 acres in 1929 at the end of the horse era, to 95,870 in 1950, and to 23,801 in 1997 (U.S. Dept. Commerce 1921, 1931, 1952; USDA 2000). Hay acreage declines by nearly half from 1930 to 1950, also reflecting the replacement of horses and the specialization of agriculture.

Farmers continued using horses on grass seed farms well into the 1950s in the southern Willamette Valley (Moser 1975:70). In this region, by the time soils dried out enough to support tractors it was too late to plant crops. Horses were able to maneuver over the heavy clay soils (Moser 1975:71). Farmers later engineered and built special vehicles with giant wide tires to get around on the wet, heavy soils. Moser (1975:76) reports that commercial fertilizers “sealed the doom” of horse farmers because the resulting plant growth, incidence of lodging, and volume of straw was more than their animals and technology could handle.
Small farmers owned the majority of Benton County farms in 1997, but large farms owned the majority of farmland (USDA 2000). The 517 farms under 70 acres, or 71.3% of farms, controlled 8.2% of county farmland in 1997. The 54 farms 500 acres or larger in 1997, accounted for only 7.4% of the total farms, but controlled 67.0% of farmland. The actual consolidation of farmland is even greater than it appears because these figures do not account for leased farmland. Farms with sales of less than $2,500 accounted for 320 farms, or 44.1% of all Benton County farms in 1997, and farms with less than $10,000 in sales made up 479 farms, or 68.5% of all farms. There were only 113 farms with sales of $50,000 or more, 15.6% of farms. The 53 largest grossing farms in the county accounted for 85.7% of the market value of agricultural products sold in 1997, while 68% of Benton County farms produced only 1.7% of agricultural sales for the county (USDA 2000). These data show that a small number of farmers and a small proportion of total farm owners control most farmland in Benton County. These figures suggest that only 50-150 farms in Benton County are full time commercial operations. The majority of local farms appear to be tax shelters or hobbies that lose money and require off farm work to support.

Two major achievements of industrial agriculture are dramatic increases in yield per unit area and per unit labor. Mechanization, fossil energy, crop breeding, synthetic nitrogen fertilizer, and pesticides caused these changes. Productivity increased rapidly despite losses in farmers, farms, and farmland. Crop breeding produced crops that responded to agrichemicals, and yields of many staple crops, such as wheat, more than tripled. For example, wheat yields in Benton County hovered around 20 bushels per acre from 1845 to 1950. Wheat yields increased in industrial agriculture from 23.4 bushels per acre in 1950, to 77.1 bushels per acre in 1997, and oats increased from 31.4 bushels per acre to 107.8.

Crops and Livestock

Grass seed became the major crop on poorly drained soils during the industrial farming era. Grass seed farming began expanding rapidly in the 1950s, and it became a dominant crop by 1960, when 15,756 acres of ryegrass seed were in production. In 1978, 27,379 acres of total field seeds were in production, increasing to 35,480 acres in 1997. The most important grass seed crops in Benton County are annual ryegrass, perennial ryegrass, fescue, orchardgrass, and bentgrass. In 1994, annual ryegrass was the most common crop, with 10,500 acres in
production, followed by perennial ryegrass with 8,400 acres, fescue with 7,800 acres, orchardgrass with 4,950 acres, bentgrass with 2,250 acres, 300 acres of clover, 200 acres in other seeds, and 150 acres in Kentucky bluegrass (USDA 2000).

Grass seed crops became the dominant crop in the entire central and southern Willamette Valley because they were the most profitable crops grown on the heavy soils of the area (Blok 1973:203). Research in the 1940s on local farm profitability showed that grass seed farms were the most profitable farms, averaging a 9.3% return, while general farms returned 3.9%, and dairies 2.7% (Blok 1973:170). Farmers mainly grow grass seed on contracts that have extreme purity requirements, sometimes nearly 100%. These purity requirements limit organic production, and are associated with increased application of pesticides, pest and pathogen problems, and removal of hedgerows and field border vegetation.

Grass seed is used for seeding pastures for livestock operations and lawn and golf course management. It is the most locally adapted major industrial crop in the region in the sense that it grows well in the poorly drained soils of the region without irrigation, the seeds develop well in the dry summer conditions, and some crops are perennial. However, producers export nearly all the harvest. Extension agent Mark Mellbye and leading local farmers report that it is “impossible” to grow the crop without extensive use of agrichemicals. Grass seed farming is heavily industrialized, with enormous tractors and combines making repeated passes over fields annually to prepare the crop, spray pesticides and harvest. Crop dusting airplanes are used to spray pesticides, and helicopters monitor crops for weeds and fungal infestations using GIS technology.

Moser (1975) produced a cultural ecological ethnography of grass seed farmers in the southern Willamette Valley. He (1975:95) observed that some grass seed farmers did little or no actual farming, and instead worked almost entirely on keeping machinery running, using hired labor to work fields. He also observed that farmers raised almost none of their own food, and their diets were identical to urban consumers (Moser 1975:109). In the early 1970s, he found no farmers left who practiced the diversified mixed farming common in the region 40 years previously (Moser 1975:74). Farmers told Moser (1975:94, 106) that they stayed in business largely from the tax benefits of depreciating farm equipment.

Benton County plummeted during the industrial period, with oats declining from 13,061 acres in 1950 to 1,584 in 1997, and barley declining from 9,462 acres in 1960 to none in 1997 (U.S. Department of Commerce 1952; USDA 2000). Wheat yields per acre rose dramatically after 1978, increasing from 34.5 bushels in 1978, to 65.8 bushels/acre in 1987 (U.S. Dept. of Commerce 1981, 1993). The white wheat typically grown in western Oregon is suitable for making pastries, biscuits, crackers, cookies, ramen, soft noodles, and other products (Goetze 1984:5). It is not as suited for making bread as the hard red wheat raised on the Great Plains. Farmers grow wheat and oats in a variety of cropping systems or rotations, usually in rotation with grass seed or row crops (Goetze 1984:5). After a sharp decline following the introduction of tractors, hay acreage was relatively stable during the industrial period, ranging from 8,000-14,000 acres (USDA 2000).

Wheat production in the Willamette Valley is a good example of the process of industrial intensification and the increased use of agrichemicals, capital, and management (Goetze 1984). The first major boost to wheat yields came with herbicide use to control broadleaf weeds. Effective control of broadleaf weeds allowed annual grass-family weeds like annual ryegrass, annual bluegrass, and brome grasses to build up. Then the herbicide diuron was applied to allow wheat to be grown more often in the rotation by selectively controlling some annual grasses. The continuous use of herbicides controlled most broadleaf plants and annual grasses but led to problems with weeds like speedwell and bedstraw. This problem stimulated the development of herbicides labeled for specific weeds and to the practice of herbicide rotation. The use of synthetic fertilizers, particularly nitrogen sources, significantly increased yields, but lodging (plants falling down) became a serious problem for the industry. Science then developed semi-dwarf varieties. Planting wheat continuously in dense monocultures led to increased problems with pathogens, such as the outbreak of stripe rust in 1961 and use of more pesticides (Goetze 1984:4).

Acreage in orchards and small fruit declined during the industrial era. Total Benton County orchard acreage declines from 2,367 acres in 1945, to 1,864 in 1950, and 891 acres in 1997 (U.S. Department of Commerce 1952, 1961; USDA 2000). Vegetable production increased during the industrial period from 1,489 total acres harvested for sale in Benton County in 1960, to 10,473 acres in 1997, with more than 85% of this acreage in corn and beans (U.S. Department of Commerce 1961; USDA 2000). In 1997, 58 Benton County farms produced vegetables on 10,473 irrigated acres (USDA 2000). Of this acreage, most was in
corn, snap beans, and squash, as well as a small amount of land farmed with beets, lettuce, cantaloupes, tomatoes, onions, and peas. Most of these vegetables were canned and shipped out of the area.

The nursery industry has surpassed cattle and calves as the segment in Oregon agriculture with the greatest annual sales. The industry uses the most inputs per unit area, produces the most money per unit area, and achieves the greatest control of nature. Census data lists 90 acres of nursery acreage for Benton County in 1950. In 1997, 147 Benton County farms were in the nursery and greenhouse crops, cut Christmas trees, mushrooms, and sod category (USDA 2000). These 147 Benton County farms had nearly 5 acres under glass, 6,212 acres in the open. Christmas trees are another important crop in the foothills of Benton County. The only year Christmas trees appear in the census records is 1997, with 1,983 acres.

The importance of livestock in agriculture declined during the industrial period. The amount of cattle in Benton County declined from 12,571 in 1950, to 8,764 in 1997 (U.S. Department of Commerce 1952; USDA 2000). Dairy cows declined during the same period from 4,580 to 2,103 cows, sheep declined from 22,722, to 3,378, swine declined from 2,787 to 881, and goats declined from 2,575 to 202. Farmers produce only a small amount of poultry in the region. Some landowners raise small amounts of livestock on rural residential properties in the region to obtain the farm exemption on property taxes. About 10 (CAFO’s) exist in Benton County, two swine operations with about 200 animals each, a 300 head beef operation, and seven dairies with 125-975 animals, with three of the dairies having more than 400 animals (Ecosystems Northwest 1999:73). Most of the region’s dairies lack adequate capacity for winter manure and liquid storage.

There are 92,314 acres in farmland in the Marys River region (Brooks and Buckley 2002; appendix 1). The two major agricultural land uses in the area currently are grass seed production and livestock, primarily cattle operations. Other major types of farmland include pasture, woodland, vegetable crops, hay and silage, grain crops, field crops, and specialty horticulture crops (USDA 2000). Field crops like vegetables, beetseed, and other crops are common on the better floodplain soils (USDA 2000).

Lawn and landscape plantings are another application of industrial agriculture. Urban agriculture is a significant land use and, after purchasing food, the primary way local citizens participate in food systems. Urban development accounts for approximately 11,221 acres, or 4.8% of the Marys River region (Brooks and Buckley 2002). If a third of this land is in urban
lawns and landscaping, then 3,740 acres or 1.6% of the region’s land area is in lawns and landscaping, 4 times the amount of land in orchards. Lawns, and exotic trees and shrubs dominate the urban landscape. People use fuel-powered machines, synthetic fertilizers, and pesticides to manage lawns and landscaping. Homeowners and landscapers typically are unskilled agriculturalists. This approach is expensive, noisy, and ecologically damaging.

Attractive lawns and home landscaping are possible without expensive and toxic agrichemicals and power equipment. One of the most damaging home landscape practices is the establishment and maintenance of the lawn (Bormann et al. 1993:84). In industrial urban lawn management, there is minimal floral diversity, applications of pesticides kill insects, fungi, and weeds, and organic matter removal and fertilizers replace natural nutrient cycling. Homeowners apply pesticides at rates up to 10 times rates of farmers (Bormann et al. 1993:97). Extensive irrigation with purified water takes place during the region’s annual summer drought to maintain continuously green lawns. Lawns are commonly overwatered or watered during the heat of the day using wasteful irrigation technology.

Industrial lawns and landscaping require high levels of inputs of capital, machinery, agrichemicals, and time or human management. Industry profits by encouraging homeowners to participate in a costly lawn management treadmill. The advantage of the conventional lawn ideal to industry is that continual expenditure is required to try to achieve an ideal that is unreachable and changing. New purchases are necessary to keep up with technical innovation, new product development, and marketing (Bormann et al. 1993:62). Unskilled and unnecessary management practices create problems that lead to more purchases. The management of urban landscapes changed to focus more on consumption than production. Raising livestock and crops in urban areas mostly ended.

Consumption, Retail, Diet, and Health

Regional diets are global rather than locally adapted and unnecessarily contribute to damage to natural and human communities around the world (Nabhan 2002). A small amount of food is produced in local farms or gardens. Consumers purchase most food from a few large retail conglomerates that import food from other regions of the United States and multiple countries. The industrial food system combines extreme sedentism with overconsumption of highly processed foods high in sweeteners, carbohydrates, trans-fats, and grain-fed meat. This
combination is associated with the major health problems of the wealthy countries: obesity, heart disease, stroke, high blood pressure, diabetes, hypertension, and cancer.

Industrial consumption patterns took shape after World War II. A relatively homogeneous diet was established. Then, as consumers became increasingly heterogeneous by the late 1960s, food markets split along regional, demographic, economic, value, ethnic, and other divisions. Food companies increasingly target products at specific groups of consumers, focusing on smaller market niches and differentiating products with extensive packaging and advertising (Senauer et al. 1991:3-4). Corporations now rely on scientists to track sales data to inform product design, categorize consumers, and target marketing (Senauer et al. 1991:4). Consumers are frequent recipients of increasingly intense advertising campaigns.

The industrial diet is primarily wheat, other cereals, sweeteners, meat, dairy, and vegetable fat. Per-capita annual consumption for Americans in 1996 was 198.4 pounds of flour and cereal products, 150.7 pounds of sweeteners, 65.8 pounds of fats and oils, 163.3 pounds of red meat, 100.5 pounds of poultry, 14.7 pounds of fish and shellfish, 237 eggs, and 575.5 pounds of dairy products (appendix 3; National Agricultural Statistics Service 1999). The diet also includes annual per capita consumption of 416.2 pounds of vegetables, 289.8 pounds of fruits, and 5.7 pounds of nuts and legumes, mostly peanuts. The vegetable figure does not include the limited amount of home production. Major changes that occurred in the last 50 years include replacing red meat with poultry, animal fats with vegetable oils, fresh fruit with processed fruit juice, fresh potatoes with processed, high-fat milk with low-fat milk, and substituting soft drinks for most other drinks (Senauer et al. 1991:31).

Before World War II, American fat consumption was stable at about 40.0 pounds per person per year, with about 75.0% of the fat from animal sources (Senauer et al. 1991:20) Fat consumption increased dramatically after the war, and vegetable fats rapidly replaced animal fats in the diet. Consumption of total fats and oils peaked at a per capita rate of 68.3 pounds annually in 1993 (U.S. Dept. of Commerce 1997:148). Per-capita consumption of vegetable fat increased from about 10.0 pounds in 1910, to about 50.0 pounds in 1990. Vegetable fat consumption surpassed animal fat consumption around 1950 (Senauer et al. 1991:20). Trans-fats, or fats with added hydrogen molecules, are now the dominant fat in the diet.

Heavy consumption of sweeteners is a modern phenomenon. National per capita annual consumption was about 4.0 pounds a year in 1750, 20.0 in 1850, and 150.7 in 1996 (Gedgaudas 2002:6; National Agricultural Statistics Service 1999). Around 1970, the
composition of sugars consumed changed dramatically. Cane and beet sugar per capita annual consumption dropped from 100.0 pounds per capita annually in 1970, to 60.0 pounds in 1990. At the same time, per capita annual corn sugar consumption more than tripled from less than 20.0 pounds in 1970 to about 70.0 pounds in 1990, becoming the dominant sugar consumed (Senauer et al. 1991:29). Soft drink consumption has boomed, growing from less than 30.0 gallons per capita in 1973, to 53.0 gallons per person in 1996 (Liebman 1998:4).

The industrial period saw the end of widespread consumption of homegrown fruit, but overall increases in consumption of fruits and vegetables. Since the mid 1960s, per capita fruit consumption has steadily increased to over 150.0 pounds (Senauer et al. 1991:25). Vegetable consumption rose for most of the industrial period. Health and nutrition concerns largely account for a 42.0% increase in fresh vegetable consumption from 1970 to 1989 (Senauer et al. 1991:26). Potato consumption declined from 73.0% of all vegetables in 1909 to 30.0% in 1987 (Senauer et al. 1991:27). A large increase in consumption of French fries slowed the fall in potato consumption. Lettuce, onions, and tomatoes account for greater than 64.0% of all fresh vegetable consumption excluding potatoes (Senauer et al. 1991:28).

In 1995, American consumers spent a per capita average of $4,505 dollars a year on food, or 14.0% of their annual consumer expenditures on food (U.S. Department of Commerce 1997: charts 702, 712). Of the $4,505 spent on food in 1998, $2,803, or 62.25% of the total was for food at home, and $1,702, or 37.8% of the total for food away from home. Including the $546 spent on alcohol and tobacco brings the annual per capita total in 1995 to $5,051. Multiplying this total by the 73,087 residents of the Marys River region gives a total regional food, alcohol, and tobacco expenditure of $369,162,430. Local food purchases could help keep most of the money in the local economy.

Americans have been increasing overall caloric intake every decade since 1970 and becoming more overweight. In 1970-1979, daily per capita caloric consumption averaged 3,300 calories, increasing to 3,400 in 1980-1989, to 3,600 in 1990, and 3,800 in 1994 (U.S. Dept. of Commerce 1997:149). Examining the 20-74 year old population, researchers found that in 1976-1980, 25.4 percent of the population was overweight (U.S. Dept. Commerce 1997:147). In 1988 to 1991, the percentage had increased to 33.0 percent. The definition of overweight in this study was men having a body mass index greater than or equal to 27.8 kilograms/meter squared, and 27.3 for women, representing the 85th percentiles for those 20-29 years of age (U.S. Dept. Commerce 1997:147).
Consequences of Loss of Local Adaptation and Industrial Food Systems

The industrial food system causes an extensive array of local and global social and ecological problems. The industrial food system disregards both people and nature, using them largely as resources to exploit to expand production or increase profit. These problems reflect a noninhabitory culture. I describe some of the major problems caused by the industrial food system for use in public education.

Euroamerican food systems eliminated most of the region’s native ecosystems. Figure 3 contrasts vegetation from the 1850s with contemporary vegetation (Brooks and Buckley 2002). In the early 1850s, grasslands, including perennial bunchgrass and white oak savanna made up 61.5% of the region, Douglas-fir forest 32.0%, and riparian forest 5.9%. Currently, Douglas-fir, western hemlock, and western red cedar forests account for 45.3% of the region’s total land area, agriculture 39.1%, urban areas 4.8%, and the remaining land is in a variety of small categories (Brooks and Buckley 2002; appendix 1). Forests grew over most of the land in the foothills and Coast Range abandoned by agriculture and moved into management for industrial forestry. Loggers have harvested nearly all of these forests at least once since 1900 (Noss et al. 1995:47).

The majority of the Marys River region was grassland in the 1850s. Farmers converted nearly all the grasslands to agriculture. In the Willamette Valley as a whole, the prairie and oak savanna ecosystems are almost entirely gone. The Willamette Valley’s grassland ecosystems are “critically endangered,” with less than 0.2% remaining (Noss et al. 1995:50; Guard 1995:93). Substantial populations of native plants survived on much of the lowlands and poorly drained soil areas until the 1940s and 1950s, their soils too wet and heavy for most field crops. During the 1950s and 1960s, the expansion of the grass seed industry eliminated most remaining unplowed native grasslands (Guard 1995:94). The diversified food system maintained most of its farmland in pasture, hayfields, and grazed woodlots, providing significant wildlife habitat. Industrial food systems focus on intensively managed cropland. Pasture, woodland, and hayfields declined rapidly in the transition to industrial agriculture.
Figure 3. Historic and Current Vegetation in the Marys River Region

Source: Oregon GAP Analysis Project
By 1970, the riparian forests of the Willamette River were a thin, discontinuous strip of forest directly adjoining the Willamette and its tributaries and small, isolated relics on the floodplain (Sedell and Froggatt 1984). Agricultural land is required to have little or no riparian forest buffers (Ecosystems Northwest 1999:69). In the understory of many riparian forests, and along unforested streams and wetlands, the aggressive exotic reed canary-grass (Phalaris arundinacea) now dominates large areas, forming monocultural patches (Guard 1995:194). Livestock graze riparian vegetation in much of the region. Agriculture or urban and industrial development has altered all the wetlands in the region. Exotic plant invasion, flood control projects, siltation, and draining land for farming eliminated wapato from much of its previous habitat (Guard 1995:58). The introduction of nutria (Myocastor coypus) and carp further limits the success of wapato (Wentz 1971; Darby 1996:41).

Euroamericans radically altered the Willamette River and its floodplain. Much of the development was to benefit industrial food systems. Urban development, revetments, diking, channelization, damming, removal of snags, side channels, riparian forests, and drainage for agriculture radically altered the Willamette River system (Sedell and Froggatt 1984). According to OSU fisheries biologist Stan Gregory, "we took what was a complex, braided system and turned it into a pipe" (Ketchum 1999).

Industrial farming is not adapted to the annual low base flows of the Marys River and its tributaries. The streams of the region are diminished by water withdrawals for agriculture that peak when flows are at their lowest. The Marys River, Muddy Creek, and Blakeslee Creek are over-allocated streams, that is, the combined water rights exceeds summer stream flows (Ecosystems Northwest 1999:37). Agriculture controls 87.0% of the permitted water withdrawals in the Marys River Watershed, compared to 12% for municipal, and less than 1% each for industry and domestic uses (Ecosystems Northwest 1999:20). There are illegal water withdrawals on many streams. No tracking system for water withdrawals is in place for the region (Ecosystems Northwest 1999:90). A locally adapted food system would rely on rainfall for irrigation or water pumped from wells at rates that do not exceed their recharge rates.

The rise of the industrial food system is a primary cause of the loss of native habitats and species. At least 14 species are extinct in the region (Hulse et al. 1997). Many others are endangered, threatened, functionally extinct, economically extinct as resources, or greatly diminished. Every major native ecosystem type in the region has species on state or federal endangered, threatened, and sensitive species lists (Oregon Natural Heritage Program 1998).
Currently 97 species in the area have some kind of sensitive status recognized by government organizations (Ecosystems Northwest 1999:90). Locally adapted food systems preserve regional biological diversity.

Industrial agriculture diminished many local bird populations, especially ground nesting birds associated with grasslands. Many species continued to have sizeable populations after diversified farming converted native prairies to hayfields and pastures but became rare as agriculture industrialized, including Western Meadowlark, Oregon Vesper Sparrow, Horned Lark, Grasshopper Sparrow (Ammodramus savannarum), and Common Nighthawk (Chordeiles minor) (Avifauna Northwest 1999:1; Ecosystems Northwest 1999:143; ODFW 2000:1). As the tractor replaced horses in the 1930s and feedlot production replaced pastured dairy and beef cows, the amount of pasture in the region declined rapidly. Producers needed less land to pasture horses and produce hay to feed them. Other agricultural activities damaging native birds include tilling, mowing, spraying, pruning, and harvesting crops during the breeding period (ODFW 2000:2). Bird eggs and chicks are particularly vulnerable to people, pets, livestock, predators, and machinery (ODFW 2000:1).

Several species that may be markers of ecological health declined as industrial farming replaced diversified farming. Ed Alverson (1998), Willamette Valley stewardship ecologist for The Nature Conservancy, feels that the Vesper Sparrow indicates the health of native prairies, Western Bluebird (Sialia currucoides) for oak savanna, and the western pond turtle for the mosaic of lowland habitats, including streams, wetlands, prairies, and oak savanna. All these species declined sharply as the industrial food system expanded.

Soil erosion occurs both locally and on the fields that produce the crops imported to supply local demand. The regional food system causes more erosion on cropland outside the region than on local cropland. The average loss per acre in U.S. croplands in the early 1990s was 8 tons per acre per year (Soule and Piper 1992:12). Local soil erosion is worst in association with farming practices and roads that leave soils bare during the rainy season (Ecosystems Northwest 1999:91). Current practices that can cause high rates of erosion are fall-plowed cropland that is not seeded and has inadequate crop residues; conventionally-seeded fall small grains, grasses, and legumes; clean tilled orchards; and Christmas tree farms clean tilled without cover crops (Ecosystems Northwest 1999:64).

The loss of agricultural biodiversity due to industrial farming is enormous and limits future possibilities. Studies indicate that greater than 75.0% of global agricultural genetic
biodiversity was lost in the last century (Kimbrell 2002:59). Industrial agriculture has contributed to the dramatic loss of varieties of crop plants. For example, from 1903 to 1983, 80.6% of tomato varieties were lost, 92.8% of lettuce varieties, 96.1% of sweet corn varieties, and 86.2% of apple varieties (Kimbrell 2002). Industrial farms typically use minimal crop diversity. Only 167 large industrial farms control nearly 80.0% of all national carrot acreage (Kimbrell 2002:112). Out of more than 5,000 varieties of potatoes worldwide, large commercial farms in the United States grow only four varieties (Kimbrell 2002:81). Cloning of livestock is a new intensification of this process of loss of genetic diversity. The high-yield varieties of wheat and other crops that are central to industrial agriculture have increased susceptibility to insects, pathogens, and weeds. Industrial varieties displaced traditional genotypes, which harbored alleles for resistance to pests and pathogens and competition with weeds. Planting monocultures of identical genotypes over wide areas provides an ideal setting for pests and pathogens to evolve to successfully attack such crops (Soule and Piper 1992:19). Reinhabitory food systems increase agricultural biodiversity, raising diverse crops and breeding locally adapted varieties.

The application of agrichemicals by farmers, gardeners, and households poisons farm workers, rural residents, consumers, soil, water, and air, and kills large numbers of beneficial organisms. Benton County farmers reported spending $11,247,000 on agrichemicals and energy in 1997 (USDA 2000). Of this total, the largest amount was spent on commercial fertilizer ($4,735,000), followed by pesticides ($4,038,000), with the remainder petroleum products and electricity. Buying agrichemicals supports the operation of mining operations and agrichemical plants where workers are regularly injured, poisoned, and killed in explosions and spills. Locally adapted food systems avoid agrichemicals by using a variety of cultural and biological practices.

The many social, physical, political, and economic problems of industrial food systems include diminished food security, the loss of farmers, low wages, poor working conditions, loss of skills and knowledge, alienation from nature, and physical and mental health problems. A major sociopolitical concern about the industrial food system is the issue of “relying on a few hegemonic systems to feed the world’s growing population” (Grey 2000). Anthropologists began to describe the negative effects of industrial agriculture on rural communities as early as 1947 (Goldschmidt 1947).
Industrial agriculture "stood an ancient pyramid on its tip. We now have an enormous population of urban consumers dependent on a tiny population of rural producers . . . That a small number of farmers can feed millions is not a sign of success. Rather, it is a sign of insecurity, and vulnerability" (Berry 1995:52). Hunter-gatherers, gardeners, or farmers were the vast majority of the population for most of human history. At the time of national independence, 97.0% of the population lived on farms, producing much of their own food (Nabhan 2002:70). In 1900, 42.0% of Americans worked on farms, falling to less than 2.0% in 1990 (Grey 2000). The majority of people in the Marys River region lived on farms until approximately 1920.

Overproduction of food is one of the most overlooked and damaging problems of industrial farming. Overproduction lowers price, drives farmers out of business, and makes it hard for alternative food systems to compete with industrial systems. A study undertaken by the Leopold Center for Sustainable Agriculture at Iowa State University found that net income from 1950 to 1998 was flat among Iowa farmers despite large increases in production (Kirschenmann 2001a). Gross income and total expenses both increased by a factor of 13 during the same period.

Pyle (1993:145) describes "the extinction of experience," the loss of direct experience of people and wildlife that grows in industrial systems. Particularly damaging is the loss of hands-on contact between children and wildlife. The ways of talking about plants and animals are themselves disappearing, the oral traditions of local nature, subsistence, and topography (Nabhan 1997:71). The extinction of experience leads to a "cycle of disaffection" where meaningful concern for nature diminishes as alienation from nature increases and intimacy and connection declines (Pyle 1993:146). Industrial agriculture severed most of the linkage of work and life with direct experience with plants and animals, leading to the modern desire to reconnect with nature by experiencing "pristine" wilderness. Participants in industrial food systems have lost experience and knowledge of gardening, farming, animal husbandry, and natural history. People graduate from schools with little knowledge of local cultural or ecological history, natural history, subsistence skills, ethnobiological knowledge or skills, and little or no commitment to the Marys River region. A greater number of people than at any time in history have "absolutely no involvement in producing the foods that sustain them" (Nabhan 2002:26). This loss of skills and knowledge is the loss of inhabitory characteristics in the general population, and the loss is largely mediated by the food system. Participants in
reinhabitory food systems have high levels of experience and knowledge in regional ecosystems and food production.

The industrial food system diminishes human physical and mental health. It is associated with extreme sedentism, unparalleled rates of obesity, dental caries, hypertension, heart disease, diabetes, and other diseases. The industrial food system is also associated with mental health issues such as anorexia, bulimia, guilt, shame, depression, and anxiety over food and the body. Fear and shame about pesticide use, environmental degradation, and exploitation of farmworkers, also became part of the industrial food system (Nabhan 2002:27). Levenstein (1991) calls the association of abundant and varied food with obesity, disease, fear, guilt, shame, and generalized anxiety about food, the “paradox of plenty.” Americans “no longer fear God or communists, but we fear fat,” says David Kritchevsky, author of the first textbook on cholesterol in 1958 (Taubes 2001:2536). Locally adapted food systems mitigate some of these problems by providing healthy food and exercise as part of involvement in the food system, and by building food systems that do not exploit workers or excessively pollute.

Work in industrial food systems is generally low quality, with low pay, few benefits, little security, and in some cases, dangerous conditions. Nationally, the lowest pay in any industry in 1996 was to workers in the service sector of the food system, followed closely by agricultural workers (U.S. Dept. of Commerce 1997: chart 666). Most agricultural workers have high injury rates. Workers in meat packing plants had the highest incidence rates of nonfatal injuries and illnesses per 100 workers in the United States in 1995, with 36.6 injuries or illnesses per 100 workers (U.S. Dept. of Commerce 1997: chart 683).

Local agriculture produces little food for local consumption. Purchasing imported foods supports damaging agricultural practices in other regions and uses fuels to transport foods from around the world. Most food system consumers do not understand the contemporary complex global food system (Pirog et al. 2001:1). Much of the production and processing of food takes place far from where consumers reside and purchase their food supplies. The external costs to human and natural communities in the production, processing, packaging, storage, transportation, marketing, and other segments of the food system are typically not seen by the consumer nor generally accounted for in the price of food (Pirog et al. 2001:1; Nabhan 2002).
CONCLUSIONS

Industrial food systems are not locally adapted and are inherently damaging to ecosystems and human communities. They failed to preserve the biological diversity, ecological integrity, or ecological processes of ecosystems in the Marys River region. Local farmers produce most of their crops for export markets. Most of the food consumed locally is imported. Most local food processors went bankrupt during the industrial era. The industrial food system is unparalleled in its use of fossil fuels. Industrial farming pollutes soils, air, and water. Farmers use agrichemicals for fertility and weed and pest control rather than cultural or biological practices. Regional residents participate minimally in food production, and most have little knowledge of food systems, gardening skills, or knowledge of local plants and animals. Industrial food systems provide low quality work that is dangerous and low paid. Ownership of the means of production is concentrated and food security is low. Producing food at farms around the world to supply local consumption is associated with numerous social and ecological costs.

Industrialism’s primary characteristics of mass production and division of labor make industrial farming inherently noninhabitory. Local adaptation requires individual attention and care on a small scale at a site-specific level. The large-scale approach of industrial food systems makes it impossible to pay attention and adjust to subtle characteristics of gardens, fields, and pastures. The biocentric ethics that guide reinhabitation consider all things as part of a community and try to treat them with respect, even if it is necessary to kill and eat them. This is only possible on a small scale. The industrial division of labor separates people from production and obscures knowledge of the sources of foods, making responsibility difficult if not impossible. Regional food systems became progressively less locally adapted. A process of reinhabitation is required to change course from industrial food systems. Alternative agricultural practices that are more inhabitory need to be applied in the Marys River region to build locally adapted food systems.
Examining alternative approaches to food production can reveal approaches and practices to use to make food systems more inhabitory. Workers in alternative food systems have initiated the process of building a locally adapted food system in the Marys River region. A reinhabitory food system will encourage the growth of alternative food systems and build on their strengths. Some of the alternative approaches that offer possibilities for a reinhabitory food systems include traditional agriculture, organic gardening, organic farming, agrarianism, the CSA movement, agroecology, and permaculture. Alternative food systems vigorously distinguish themselves from industrial food systems (Grey 2000). Most alternative agriculture strategies build on concepts such as intercropping practiced for centuries by indigenous farmers (Nabhan 1997:222). I describe the alternative systems to glean practices and approaches for the reinhabitation of industrial agriculture. Industrial agriculture moved food systems far from local adaptation and change is necessary to restore inhabitory food systems.

Most modern alternative approaches use industrial technology like conventional food systems, but they are typically smaller-scale and less capital, energy, and chemical intensive. A report from the National Research Council (1989) found that many alternative farms are more profitable and productive per unit area and per farm than conventional farms. The report also found that alternative agriculture could decrease environmental costs, increase employment, land ownership, and wages, and help revitalize rural communities. A more recent study reported that organic farms were more profitable than conventional farms, more energy efficient, more environmentally and economically sustainable, and had significantly higher soil quality ratings (Kirschenmann 2001a).

Alternative approaches like CSA’s and farmers’ markets follow the principle of reinhabitation of producing food for local consumption. Research in Iowa has shown that transportation costs are much lower in some alternative food systems than in conventional industrial food systems (Pirog et al. 2001:1). The study found that comparable foods traveled from producer to consumer an average of 21.2 miles in the CSA farm and farmers’ market vendors studied, 44.6 miles in a local food system serving institutional markets, and 1,546 miles in conventional food systems (Pirog et al. 2001:14). The study also found that the trucks
in industrial food systems consumed nearly 7.5 times more fuel and released more than 8.5 times the CO2 than the trucks in local food systems (Pirog et al. 2001:18).

Like reinhabitation, alternative food systems are value driven (Grey 2000). These food systems promote the process of local adaptation. Concern for healthy ecosystems, farmland, and social justice is strong. Alternative farmers typically report a stronger “environmental ethic” (Stauber et al. 1995:11). Stauber et al. (1995:13) described the main values of alternative agriculture:

- Integrating agriculture and nature.
- Local food systems to provide greater community autonomy and accommodate environmental constraints.
- Less centralized control of agriculture and farm resources.
- Greater self-sufficiency of farm operators.
- Independence of farm operators from nonfarm sectors such as processors, agrichemical inputs, and marketing.
- Greater cooperation among neighbors, and thus stronger farm communities.

Alternative food systems emphasize using the knowledge and skills of local people. They try to produce, process, package, and market food locally, to provide quality work, and to achieve local control over politics and regulation (Kloppenburg et al. 2000). Alternative food systems encourage food consumers and producers to reconnect and “to take responsibility for the quality of their food and the natural resources that produce it” (Grey 2000).

**ALTERNATIVE APPROACHES**

**Traditional Agriculture**

The most common kind of agriculture in the world is small-scale traditional agriculture (Altieri 1995:107). Traditional gardens are examples for reinhabitory food systems and follow most of the reinhabitory principles. Traditional agriculture tends to employ practices that “optimize productivity in the long term rather than maximize it in the short term” (Altieri 1995:107). It typically conserves biological and cultural diversity and has beneficial or limited negative impacts on both the on-and off-farm environment (Gliessman 1992:683). Traditional agriculture uses the knowledge and culture of local inhabitants rather than professionals. It relies mainly on solar energy and is not dependent on fossil energy sources. Such systems have less inputs and outputs than industrial systems, usually maintaining tight nutrient,
energy, water, and waste cycles. Farmers adapt their crops to their region's amount and distribution of rainfall. Traditional farming is locally adapted, and not dependent on massive alteration or control of the environment (Gliessman 1992:683). An advantage of traditional household gardens for development is that they do not use manufactured fertilizers, toxic pesticides, or fuel-powered machinery, so they are not reliant on expensive inputs, or marketing, transportation, or bureaucratic infrastructures (Cleveland and Soleri 1987).

Traditional agroecosystems have a genetically diverse base, with dozens or hundreds of locally adapted crop species and varieties grown in small patches and fields. Conserving the genetic diversity of crop plants in use reduces the need for seed preservation facilities. Careful selection and breeding increases pest and disease resistance. Many Native American farmers integrate wild species in their fields and allow wild relatives of crop plants to grow on the edges of patches or fields and interbreed with crop plants, increasing the genetic diversity of crops (Nabhan 1989:194). Cultivated areas often resemble wild areas and contain hundreds of domestic, semi-wild, and wild species (Cleveland and Soleri 1987). Farming systems usually combine animals and plants, increasing the stability of farming systems. Animals can be fed low-value or inedible plant products and convert them into meat, dairy products, manure, income, as well as hide and bone materials all year.

Traditional agriculturalists often use local wild food resources in addition to their domestic ones, and have extensive knowledge of local plant and animal communities, soils, and climate (Altieri 1995:116). Often gardens and orchards are mixed, and produce fruit, vegetables, medicines, craft or building materials, fodder for livestock, fuels, flowers, or market crops (Cleveland and Soleri 1987). Indigenous farmers maintain soil fertility by using fallow periods and crop rotations, inputs of manure or forest litter, and the use of legumes in cropping mixtures and rotations. In Guatemala, for example, and in other countries, farmers carry leaf litter to garden patches from surrounding forests (Altieri 1995:117).

A wide variety of cultural and biological practices are used to control pathogens in traditional farming systems, including trap crops, fallow periods, rotations, mulching, addition of organic matter, managing shade, using clean seeds, planting on mounds or raised beds, planting tubers whole, shallow planting, and the use of fire (Thurston 1992; Altieri 1995:108-112; Cleveland and Soleri 1987). Careful harvesting, storage, and the use of drying agents, such as ashes or chalk, reduce postharvest losses. Traditional farming systems manipulate structural and biotic diversity to improve crop protection. Structurally complex fields or
gardens with hedges, vines, trees, succulents, and upright annuals provide pest predators with habitat and nesting and perching sites (Nabhan 1997:213). Diversity minimizes risk of complete crop failure and reduces pest damage. Traditional farmers manipulate the size of the crop, its location, its density, and its diversity (Altieri 1995:118-120). Overplanting allows for a high acceptable threshold of loss. Cultivation reduces pest problems. Farmers use plant chemicals to repel or attract specific insects. Polyculture, also called intercropping, is common in traditional farming systems. Windbreaks of native or useful plants along the edges of gardens or fields maintain populations of beneficial insects and predators of pest species.

Organic Gardening

Reinhabitatory food systems emphasize gardening and have many approaches in alternative agriculture to draw from. The two most influential organic gardening writers nationally are Coleman (1992, 1995) and Jeavons (1995). West of the Cascades, the most influential garden writers are Solomon and Colebrook. Solomon (1993; 2000) developed locally adapted gardening and dry-gardening practices, and Colebrook (1989) focused on winter gardening. A locally adapted food system can incorporate many of these writers’ approaches.

Solomon founded Territorial Seed Company, a business located in the southern Willamette Valley emphasizing locally adapted seeds. In addition to Territorial Seeds, several other companies have focused on locally adapted food plants and their seeds and starts for the region west of the Cascades. Abundant Life Seed Company in Washington State also provides locally adapted seed for west of the Cascades. Raintree Nursery, also in Washington grows locally adapted woody food plants for the same region. Corvallis resident and plant breeder Alan Kapular has developed varieties of food plants adapted for the local area.

Eliot Coleman describes his approach as biological rather than chemical, based on “a partnership with nature” (Coleman 1992:14). Coleman advises a locally adapted approach where growers adapt their actions to soil, climate, and crops (Coleman 1995:181). He argues for building a “biologically oriented” view of agriculture (Coleman 1995:182). Coleman recommends taking advantage of soil flora and fauna, minimizing turning, tilling, or otherwise disturbing soil once the garden beds are prepared. He emphasizes reliance on farm-generated production inputs and “low-input production practices” including crop rotation, succession planting, green manures, animal manure management, efficient labor, season extension, and
others, making gains in production from management rather than purchases (Coleman 1995:3). Like most gardening writers, Coleman focuses on vegetable production, stressing simplifying production techniques, using the most efficient tools and machinery, reducing expenditures on purchased supplies, and marketing produce in the most remunerative way (Coleman 1995:3). Coleman argues that the “person:land area” ratio should not exceed 2.5 acres per person for diversified vegetable production. He states that such acreage can produce a year’s supply of the vegetables for 100 people (Coleman 1995:21).

Small-scale appropriate gardening technology is an important element of reinhabitatory food systems. Coleman advocates using tools such as European long-handled hoes, the broadfork, cold frames, soil-blocking equipment, human-powered cultivators and seeders, moveable greenhouses and tunnels, root cellars, and rotary spaders. He emphasizes taking pride in doing quality work, and building high skill levels among producers to save time and improve product quality (Coleman 1995:26). Coleman (1992) produces fresh vegetables all year in Maine without heated greenhouses. By producing crops all year, labor is spread out and processing is reduced by eating more vegetables fresh, limiting use of power to freeze, can, or dry them. Root cellars also reduce refrigeration requirements. Coleman points out that conventional agriculture has a negative view of nature (1995:179). He argues for a “plant positive” rather than a “pest negative” approach to pest problems, where growers view pests as indicators that cultural practices need improvement rather than as enemies (Coleman 1995:173, 181).

Coleman sees the European small farmer as a model (Coleman 1995:20). He believes that European small farmers have survived unlike Americans because they have offered quality rather than quantity, and they have had access to modern small-scale technology and local markets (Coleman 1995:29). Coleman points out that in much of Europe, standardization of food does not exist as in North America, and instead people cherish regional and varietal differences (1995:29).

John Jeavons’ group, Ecology Action (Jeavons 1995), based in Willits California, has synthesized intensive gardening approaches from around the world into an approach identified with the trademarked term “Biointensive Mini-Farming.” This approach seeks to produce the maximum amount of food per unit of land. The only soil amendment is compost and part of the production area is set aside to produce crops to compost. The biointensive method includes four techniques: double-digging, composting, intensive spacing, and companion planting.
Double-digging involves preparing the soil with a spade to a depth of two feet. Biointensive farming uses only human power and hand tools for production, and no purchased fertilizers, pesticides, or soil amendments. Proponents argue that 90% of the mini-farm should focus on subsistence, with 10% of the mini-farm typically set aside for producing income. Biointensive farming is gardening and vegan-based. Building on techniques from European peasant agriculture and the French intensive method, advocates have developed methods that they claim have been tried with success throughout the world and can feed 10 or more vegetarians their entire diet on one acre of land.

Most gardening books aim at national rather than regional audiences. Steve Solomon writes about locally adapted gardening practices for the region west of the Cascades and many of his recommendations would work well in a reinhabitory gardening approach. In writing a regional gardening book, Solomon reviews the advice of national writers. He thinks that many of the gardening practices advocated by Jeavons are unnecessary and poorly adapted to the region (Solomon 2000:7-8). Solomon says that the biointensive method can increase yields by 50%, but the shape of the vegetables is less desirable, and there is too much stoop labor and hand weeding. Solomon lays out his raised beds in straight rows at least 1 foot apart to allow for upright weeding. He argues that digging only one foot deep, using organic fertilizer and optimal amounts of compost will result in almost as high yields. Solomon (2000:110) also criticizes the crop rotation strategies of eastern garden writers as being ineffective regionally. His primary advice on rotations is to avoid planting identical species in the same location consecutively and to use winter cover crops (2000:111). He believes that the harsh winters in the northeast make gardening significantly different, and that the popular no-till mulch gardening approach does not work well in the region (2000:55-56). Without hard winters to reduce insect populations, earwigs, sow bugs, and slugs become major pests.

Solomon (2000:31) points out that regional soils are typically low in all nutrients, except potassium, particularly calcium, magnesium, and phosphorus. He believes that garden soils need lime, balanced organic fertilizer, and optimal levels of organic matter (2000:31). Solomon's organic fertilizer mix incorporates cottonseed or canola seed meal for nitrogen, lime for calcium, phosphate rock or bone meal for phosphorus, and kelp meal for trace minerals (2000:35). Fish meal is a complete fertilizer alternative. Solomon (2000:40) argues that legumes cannot provide adequate fertility for gardens, although they can for field crops in careful rotations. Solomon (2000:55) advocates the use of green manures, also called winter
cover crops, particularly small-seeded fava beans and crimson clover. These crops protect soils from erosion and compaction from winter rains, make the bed dry out earlier in the spring, provide a host for bacterial nitrogen fixation, and improve soil tilth.

Solomon (2000:16) advocates planting warm season crops later in the season than most garden writers to improve germination, growth rates, and reduce losses to slugs. He (1993) has also produced a book on dry gardening techniques for western Oregon. His main recommendations are to use wide plant spacings and maintain bare soil around the plants to conserve water. He proposes a garden design with crops that absolutely need water irrigated in the center of the garden patch, with species that require less or no water spaced progressively away from the center.

Solomon (2000:108) advises against constructing permanent raised beds, critiquing both Jeavons and Coleman’s approaches. He recommends making lightly raised beds by tilling an area and shoveling soil from the paths onto the beds and adding compost. Permanent enclosed raised beds are harder to rotate into pasture and more difficult to weed with hoes (2000:109). Solomon believes that symphylans, a native soil invertebrate west of the Cascades, create a problem for organic gardeners, since they feed on the organic matter typically applied heavily by organic gardeners. Solomon’s resolution to this problem is a soil management system he developed for the west of the Cascades region (2000:28). In this two-field or strip system the patches are rotated every three years from vegetables to pasture grass. Solomon (2000:30) recommends minimizing the amount of organic matter incorporated into gardens from off-site and adding minimal or no potassium.

Household food gardens have been a major subsistence strategy for thousands of years in many parts of the world, providing nutritional, social, and economic benefits (Cleveland and Soleri 1987). They continue to be important in industrialized regions, and they have little risk or costs. Yields typically increase as farm size shrinks (Cleveland and Soleri 1987). An urban garden in a desert environment more than tripled the yields of industrial production for equivalent crops (Cleveland and Soleri 1987). This garden provided gardeners with more than 50% of the RDA for vitamins A and C for 6 months with only 2-3 hours per week work (Cleveland and Soleri 1987). Gardens are a key element of rehabitatory food systems.
Organic Farming

Organic farming is the most prevalent form of alternative agriculture in terms of volume or value of production. Organic farming’s main distinguishing characteristics from conventional farming are excluding the use of synthetic fertilizers and pesticides, enhancing long-term soil fertility, fostering soil biological activity, carefully using machines, providing relatively insoluble crop nutrients made available by soil microorganisms, and providing nutrients through the use of legumes, biological fixation, crop residues and livestock wastes (Lampkin and Padel 1994). Organic farms integrate livestock more than conventional farms, and pay greater attention to animals evolutionary adaptations, behavioral needs and welfare, with respect to nutrition, housing, health, breeding and rearing (Lampkin and Padel 1994).

Organic farming varies dramatically in its relative local adaptiveness. Many regional operations are locally adapted in the sense that they focus on production for local markets. Many other organic farms are large scale and industrialized, including a local farm. Organic does not necessarily mean that food is produced “in an ecologically, energetically, or socially sustainable way” (Nabhan 2002:47). The national standards put in place in 1999 “may have negative impacts on local organic programs and their ability to remain flexible and, therefore, sustainable in local contexts” (DeLind 2000). Industrial and organic farming may merge, creating a greener version of industrialized food.

In organic agriculture, manure, seed, blood, feather, or fish meals, and the use of legume crops are substituted for conventional sources of nitrogen. Phosphorus comes from mined rock phosphate, or from ground bone from the livestock industry. Potassium comes from mined greensand, sunflower seed ash, or other products. Organic farmers also use fish meal or liquid fish fertilizer as a balanced organic fertilizer. Kelp meal and animal products provide trace minerals. Mined limestone deposits or oyster shells provide calcium and deacidification. Organic farmers tend to till shallowly with disk or chisel implements (Altieri 1995:184). Weeds are generally more of a problem than insects or pathogens on organic farms. Weed control methods include crop rotations, mechanical and hand cultivation, intensive crop spacing, timely seeding and transplanting, intercropping, and competitive crops. Organic farmers replace conventional pesticides for the control of weeds, pests, and pathogens with pesticides manufactured from plants and bacteria and the traditional methods of crop diversity, crop rotation, and mechanical and manual cultivation. Additional methods include microbial
agents, botanical insecticides, oils, soaps, and diatomaceous earth (Altieri 1995:184). Organic fungicides include sulfur, Bordeaux mixture, copper, and mixtures from plants and fish. Sex pheromone traps control adult moths in some operations.

Regional organic farms typically are small farms that produce vegetable or specialty crops. They mix farming and gardening techniques and focus on high quality vegetables that are more attractive and more expensive than conventional produce. Growing organic greens in the Willamette Valley lowlands is challenging because of cucumber beetles and flea beetles that fill the leaves with holes. To avoid this problem growers use plastic products such as row covers to manually cover the crops. Some growers that supply local markets site their farms in the Coast Range or the lower Cascades where cucumber beetles are less of a problem. Some organic farms that supply the area use Bt (Bacillus thuringensis), an organic biological control to control the larva of the exotic cabbage butterfly (Pieris rapae), a major pest of cabbage family crops such as broccoli. The growers I interviewed said they used other organic pesticides sparingly, controlling pests primarily with crop rotation, diverse fields, and accepting losses. Growers said that symphylans were not a major problem. Farmers abandoned infested sites or planted them with crops that tolerate symphylans. Use of water, plastic, and fossil fuels are major impacts of local organic farms and gardens.

CSA’s, Agroecology, Permaculture, Wild Farming

Another important variety of alternative agriculture is community supported agriculture (CSA), also known as subscription farming or guild marketing. In a CSA farm, farmers have a contract with local consumer subscribers who pay an up front fee and receive regular boxes of food during the harvest season. By surveying the consumer’s wants, farmers can plant specific crops desired by the subscribers. Consumers share financial risk by paying money up front. Selling food directly to consumers lowers transportation costs. The greater connection between farmer and consumer helps educate consumers and allows them to inspect and influence farmer practices. Subscription farming or marketing is a “farmer-consumer symbiosis, a relationship that benefits both parties” (Coleman 1995:199). In Japan some subscription farms supply their customers with nearly all their annual food, and involve customers in all major farming decisions (Coleman 1995:199). CSA farms also typically reduce waste by avoiding packaging and reusing boxes. Members who cannot use their boxes
give them to friends or donate them to people who need food. Subscription farms have many possibilities and several successful CSA farms exist in the Marys River region.

Agroecological approaches often use the concept of nature as model, assuming that ecosystems like forests or prairies are models of successful systems for agriculture to emulate. The idea of nature as measure in agricultural research was formalized early this century by Liberty Bailey, Dean of the Cornell University College of Agriculture, and Sir Albert Howard, the British agricultural scientist (Berry 1990). Bailey argues, “a good part of agriculture is to learn how to adapt one’s work to nature” (In Jackson 1994:75). Howard emphasized using the forest as a model for agriculture, the importance of healthy fertile soil, and the link between healthy soil and human nutrition. In his book, _An Agricultural Testament_, he describes a natural model for human agriculture (Howard 1943:4):

> Mother earth never attempts to farm without live stock [sic]; she always raises mixed crops; great pains are taken to preserve the soil and to prevent erosion; the mixed vegetable and animal wastes are converted into humus; there is no waste; the processes of growth and the processes of decay balance one another; ample provision is made to maintain large reserves of fertility; the greatest care is taken to store the rainfall; both plants and animals are left to protect themselves against disease.

A leading agroecological research centers in the United States is The Land Institute (TLI) in Salina Kansas (Jackson 1980, 1994; Soule and Piper 1992). TLI views natural ecosystems as the primary model for agroecosystems, and TLI is searching for a structural model, which “imitates the vegetative structures of natural communities in agricultural designs” (Soule and Piper 1992:127). Its research is focusing on the development of a domestic prairie agriculture modeled on native prairies of the central United States. Current research includes the development of a perennial wheat and perennial polycultures for livestock feed and grain crops (The Land Report 2000).

Permaculture is the only approach in alternative agriculture explicitly guided by biocentric ethics that seeks to build reinhabitory food systems. Permaculture originated in Tasmania and Australia in the 1970s. The word permaculture is a contraction of permanent agriculture and permanent culture. The philosophy of permaculture is “working with rather than against nature,” and the “observation of natural systems, the wisdom contained in traditional farming systems, and modern scientific and technological knowledge” (Mollison and Slay 1991:1). Permaculture has an explicit philosophy and set of ethics to direct its work
including the assumption that all living things have intrinsic worth. The root of permaculture philosophy is what it calls a “threefold ethic: care of the earth, care of people, and dispersal of surplus time, money, and materials towards these ends” (Mollison and Slay 1991:1).

Permaculture leaders advocate phasing out farming and replacing it with gardening. Mollison (1988:558) advocates taking the most destructive farmlands out of production immediately and restoring them to wildlands or converting them to gardens. He also advocates minimizing the land used by individuals, groups, or society for agriculture (Mollison 1988:558). Native plant use is a priority wherever possible. Animals are an important part of most permacultural designs. Orchards, gardens, forestry, aquaculture, wetlands, hedges and fence systems, and commercial scale projects are proposed. Permaculture is an all-encompassing movement to build a reinhabitory subculture, and its proponents make proposals for change in all aspects of subsistence and social and economic relations.

A national “wild farming” movement has emerged to connect alternative agriculture and the wilderness movement (Imhoff 2001:57). This movement includes initiatives to restore native plant hedgerows, pollinator habitat, timing farming practices to accommodate waterfowl and songbirds, agroforestry, and the revival of the Buffalo Commons (Imhoff 2001:57). Additional examples include shade-grown coffee, non-lethal predator control, wild harvested and organically processed labeling, and the wildway program linking wildlife corridors through farmland on the Adirondack coast. In Montana, ranchers in the Predator Friendly Wool program produce wool textiles and organic meat using fencing, guard animals, and hands-on management to reduce losses to predators. Ranchers in Arizona and New Mexico market Wolf Country Beef from ranches that accommodate wild predators or support reintroduction of Mexican wolves. The Pacific Rivers Council has initiated the Salmon Safe farming program in Oregon to reward farmers for reducing agrochemical and sediment runoff. In wild ecosystems such as Bristol Bay in Alaska, the 1999 salmon catch was certified as wild and the processing certified as organic (Imhoff 2001:58).

CONCLUSIONS

The Marys River region area has a relatively well-developed alternative food system compared to most regions in the United States, indicating that the rehabilitation process is started and has good potential. Many of the alternative approaches described in this chapter
are being experimented with in the region. Gardening is poorly developed but there is substantial interest. Several organic farms supply local markets with fruits, vegetables, and meats. The 1st Alternative Coop in Corvallis has a relatively large and increasing market share. Local farmers’ markets are thriving and growing. Supermarkets increasingly carry locally and organically grown foods. Several roadside stands operate in the area. CSA projects are varied and growing. Several projects, such as the youth garden project, and programs in local schools involve children in food production and processing, and teach children about foods and their origins and uses. Increasingly sophisticated science education teaches children about agroecosystems and food. A movement to improve the quality of food in primary and secondary schools is having an impact on institutional behavior. A reinhabitory approach in the region can unite these efforts and build on their strengths.
CHAPTER 7: RECOMMENDATIONS FOR A REINHABITORY FOOD SYSTEM

The history of Euroamerican food systems in the Marys River region shows a progressive movement away from the inhabitory approach of Native Americans. The problems of industrial food systems have convinced many people that the industrial vision and approach is misguided and damaging, and that a new vision is needed. I believe that reinhabitation offers a positive and comprehensive response to industrialism. Here I present my vision of possibilities for applying reinhabitory principles in the region. My goal is to highlight possibilities, not to tell people what to do, or speculate about what will happen. Interested people will choose the areas where they most want to work. I begin by examining whether there is enough land in the region to feed its population, and how land could be managed on a landscape level. Then proposals are given for specific changes in many elements of the food system. Reinhabitation is work, the trial and error process of learning how to live locally. The proposals in this chapter are seeds that can only grow through work.

LAND REQUIRED FOR AGRICULTURE AND DIET

First, I wanted to know how much local land would be required to feed the regional population, to see if a fully locally adapted food system would be possible in the Marys River region given the current population. The initial step was to calculate the population of the region from available Benton County data. The Center for Population Research and Census estimates that the population of Benton County in 1998 was 76,600 people (Oregon Blue Book 2000:255). I estimated that the population of the Marys River region in 1998 was 73,087 (appendix 2) by deriving a figure to subtract from the Benton County estimate. The first step was to divide the sum of the urban population of Benton County by the sum of all the rural and urban towns and cities in Benton County. The next step was to multiply the resulting percentage by the total population of Benton County. This gives an approximation of the regional population. The area of Benton County that is outside the Marys River region is entirely rural (figure 1).

Next, I multiplied the estimated regional population figure by national per capita consumption figures for major foods (National Agricultural Statistics Service 1999). This
generated an estimate of annual regional consumption of each food item. Then, I divided the annual regional consumption figures by yield per acre data for each food item, giving an estimate of land required to produce the food consumed regionally. Benton County yield estimates were used where available. Otherwise, Oregon or national estimates were used. Consumption and land estimate data are in appendix 3.

I will give an example of the process using wheat. The initial step is multiplying 1996 annual per capita consumption of 148.8 pounds by the regional population figure of 73,087, giving an estimate of 10,875,345 pounds of wheat consumed annually. Dividing the consumption estimate by the 4,625 pounds per acre yield averages for Benton County gives a figure of 2,351 acres. These estimates are necessarily rough because of the complicated nature of the industrial food system and limitations of the available data. Using similar estimates for other grains like oats and barley, 2,906 acres would provide the region with cereals and grains. If canola oil supplied the region with all its fat needs, 3,888 acres of rapeseed would need to be in production. Lard and other animal fats would be byproducts of dairy and meat production. Waste products from the production of fiber crops such as flax would provide additional oil crops.

Farmers could produce sugar beets locally to supply the region with sweeteners. I was unable to identify if beet yield figures indicated beet production or processed sugar. Assuming that sugar beets are used for all local sugar production, if the yield averages report sugar yields, only 194 acres would be required to produce all the sweeteners needed for the region. Adding a factor of 25 for processing would require 4,850 acres for sweeteners. The use of honey, stevia, or corn could substantially reduce this acreage. Crops such as clover or meadowfoam could be grown as bee food for honey production and serve as rotation crops for fodder, fertility, or oil crops, reducing land in agriculture.

Coleman estimates that 40 people can obtain their annual vegetable needs from a single organically farmed acre (1995:21). Given this estimate, 1,827 acres are necessary to provide vegetables for the local population. To compare Coleman’s estimate, I divided the annual regional vegetable consumption by an average yield figure for vegetable production. The average yield figure was obtained by summing the average yields of the four most commonly consumed vegetables, potatoes, onions, tomatoes, and lettuce. This calculation gives a figure of 769 acres required to grow the region’s vegetables, with an acre providing 95 or more people with their annual vegetable needs. I estimated that 963 acres of land would need to be
in fruit production. Combining Coleman’s more conservative estimate of 1,827 acres for vegetable production, with the 963 acres for fruit, and adding 1,000 acres for nuts and beans, gives an estimate of 3,790 acres to supply local consumers with fruits, vegetables, nuts, and legumes.

A reinhabitory food system would raise livestock primarily on local pasture, with supplemental hay, silage, and feed produced on local cropland. Linn County extension agent Pete Schreder (2002: personal communication) provided “ballpark” estimates for sustainable meat and dairy production on pasture. Schreder stated producers could raise a cow per acre on pasture with rotational grazing, providing 1,100-1,200 pounds of beef annually. Sheep on pasture typically yield 530 pounds of meat per acre.

Assuming pasture raised beef production with yields of 1,000 pounds per acre, it would require 7,119 acres to supply regional beef consumption requirements, and 11,935 acres to supply the full amount of red meat (beef, pork, veal, lamb) consumed in the region. Hog operations that raised hogs on mixed pasture, crop waste, and feed might use less land, since hogs are more than twice as efficient as cattle at feed conversion. Poultry is even more efficient at feed conversion than pork, especially broilers and turkey, and like hogs, can eat a variety of higher-yielding feeds than cattle. I assumed a reasonable 4,000-pound per acre feed crop yield and a feed conversion ratio of 350 pounds of feed to 100 pounds of meat, and 51 pounds of feed per 100 eggs. Given this yield, 6,427 acres would be required to produce feed for the poultry consumed annually in the region. To supply the region with eggs would take 2,209 acres. Schreder estimated that a dairy cow would require 1.0-1.5 acres on pasture but would need supplemental feed for high production. Assuming 2.0 acres for pasture and feed per cow, 2,433 dairy cows and 4,866 acres would supply the region with dairy products. The total acreage needed to supply the region with animal foods would be 25,437 acres, including 11,935 acres for total red meat, 8,636 acres for poultry and eggs, and 4,866 acres for dairy products. Fish and seafood could be caught locally, or traded for from residents on the coast or in the lower Columbia.

In 1997, 92,314 acres in the Marys River region were in farmland. My estimate of the acreage needed to produce the food locally for the regional population based on current national diets, is 41,871 acres in production. This includes approximately 2,906 acres for cereal crops, 4,850 acres for sweeteners, 3,888 acres to produce animal and vegetable fats, 1,000 acres for nuts and legumes, 963 acres for fruit, 1,827 acres for vegetables, 1,000 acres
for drugs and spices, and 25,437 acres for animal products. People could trade regional surpluses for foods from other regions. Seafood, fish, and wild meat and plant foods would come from local wildlands, harvesting trips to other areas, and trade.

Estimates on the footprint of human food systems vary widely. Wackernagel and Rees (1996:82,95,98) estimate that the average person in the Netherlands needs 1.1 acres to produce their food and 0.5 acres per person in India. Their figures include estimates of embodied energy in production, transportation, and waste disposal, and the land required to sequester carbon released in producing the energy. Using the estimate for Holland, 80,395 acres would be needed to produce food for the region, including land for embodied energy and to sequester carbon, still less than the available land. It is nearly double my estimate, which did not include land for embodied energy or to sequester carbon. For the local food system to rely entirely on solar energy, it would need land to grow crops to produce fuels for machinery and transportation, or use land in pasture for horses, perhaps requiring more than the available land. On the other side are estimates from biointensive farmers (Jeavons 1995) who claim to be able to feed 10 or more vegetarians on 1 acre of land. Applying this estimate to the Marys River region suggests that 7,309 acres or 7.9% of the region’s agricultural land would feed current residents.

My estimate of 41,871 acres in production assumes diets with excessive consumption of sweeteners and calories (3,800 calories per person per day). Reducing caloric consumption by 25% could increase health and reduce land needed in agriculture by 10,000 acres or more. Reducing red meat, grain-fed meat, sweetener, and fat consumption would reduce the need for land in production. The estimate of 41,871 acres is reasonable given what is possible in the region, and it requires less than half the 92,314 acres currently in agriculture. A locally adapted food system would have many savings in its use of land through diverse cropping systems, polyculture, mixing use of plants and animals, and taking advantage of the ecosystem services of healthy farmland and surrounding wildlands.

Diet powerfully shapes land use. Berry (1990:149) points out that eating is “an agricultural act,” and “how we eat determines, to a considerable extent, how the world is used.” Nabhan (2002:163) points out that “the way we garden, gather, fish, or forage can be a communion, or it can become an ecological calamity.” A locally adapted diet is seasonal and tailored to local ecosystems and local agriculture. Altering diet is a critical step in food system reinhabitation.
LAND USE AND PRODUCTION

Landscape Management

A primary issue for food system reinhabitation is how food production fits within an overall land-use strategy and where to locate food production in a mosaic of wild and domestic land. Combining the approaches of conservation biology and permaculture fits a reinhabitation strategy. To maximize long-term preservation of biodiversity, conservation biology has recommended a system of core reserves, buffer areas around them, and biological corridors linking them together (Noss 1992:11; Lertzman et al. 1997:366). The reserves are protected islands with the lowest level of human impact in the landscape. The buffer areas that surround the reserves and the corridors that connect them support low-impact activities like wilderness recreation, long-rotation forestry, and limited hunting, fishing, and gathering. Intensity of human use increases from near zero in the center of the reserves to high intensity outside the buffer areas and corridors. Permaculture works in the other direction, outward from highest intensity of human land use in urban areas, households, and farms, to wildlands. In this approach, a household, farmstead, or city, might have highly managed gardens immediately surrounding it, moving out to mixed farming, forestry, and then wildlands.

In a reinhabitory food system, Corvallis and Philomath could be managed using an approach where roughly 1/3 of the land could be in buildings, structures, and roads, 1/3 set aside habitat for wild plants and animals, and 1/3 in food production. Food plants can replace significant lawn acreage. People can maintain lawns without irrigation, fertilizers, or pesticides and mow them with push mowers or scythes. Urban residents could grow fruits and vegetables in and around Corvallis and Philomath on small, intensely managed plots. Farming of crops that need high-quality soils like many vegetables and flax could take place on the highest quality soils along the Willamette and Marys Rivers. Mixed farming could be in the next outward ring from Corvallis and Philomath, producing meat, dairy products, grains, vegetables, orchard crops, and soft fruit. Cooperative ownership of large land holdings might make it possible to move livestock seasonally from the uplands to the lowlands. Foothill forests can provide forest products used by local residents as well as deer, elk, fish, berries, and mushrooms.

The Marys River region has some of the most important ecosystems in the Willamette Valley in need of protection and expansion. Protecting, expanding, and connecting these areas
would allow wild food harvest for local consumption to increase. The largest remaining wetland prairie in the Willamette Valley is within Finley Refuge (Wilson et al. 1994). Finley Refuge could be a core lowland area to expand and attempt ecological restoration. Governments and private groups could work together to preserve the largest native prairie complex west of the Cascades largely on land currently in grass seed in Linn, Benton, and Lane Counties. This prairie complex could provide food as well as conservation, flood control, recreation, educational, and scientific benefits.

Reinhabitory food systems emphasize consumption of foods from native ecosystems, encouraging economic activities that rely on healthy, productive, intact ecosystems, such as fishing, hunting, or mushroom harvest. Use of native fungi, plants, and animals can develop in a way that promotes restoration and conservation of their habitats. Once adequate populations of native plants, animals, and fungi are reestablished, sustainable harvesting and marketing of their products might take place, as it does now to an extent with mushrooms and deer. Farmland that is unproductive or prone to flooding can be taken out of production and managed for wild foods.

Locally adapted agriculture recognizes local ecological limitations. Reinhabitory food systems would emphasize use of plants and animals that tolerate the annual summer drought, and minimize irrigation. Crops like wheat, fava beans, lentils, chickpeas, and tree crops that grow well during the cool, wet season, and require minimal irrigation are locally adapted. The poorly drained soils may be more suited to seasonally rotated livestock than most crops. Crops that require irrigation could be sited so that irrigation came from deep wells or the Willamette River to avoid irrigation from the Marys River and its tributaries during baseflow.

Crops and Livestock

Non-native plants and animals will provide most of the food in a reinhabitory system. Exotic crops can be adapted to and bred to fit the region's climate, soils, and other ecological characteristics. Local farmers could breed locally adapted varieties of wheat for breads, pastries, crackers, and pasta. Producers can grow a variety of other carbohydrate staples such as oats, triticale, quinoa, amaranth, wild rice, oats, rye, barley, and millet. Breeders can develop locally adapted perennial polycultures of grains for human and livestock food for the region. Experimentation could take place to see if upland or paddy rice could be adapted to the
region. Locally produced sugar beets and honey could supply the region with sweeteners. Research could examine other potential local crops for sweeteners such as camas.

A reinhabitory food system would produce oil crops locally and process them in small-scale or industrial oil presses. Growers would emphasize crops that are adapted to the local summer drought and need minimal irrigation. Canola, safflower, sunflower, flax, and walnuts are possible oil crops. Farmers could collect seeds of olives from high elevation sites in southern Europe and initiate a local breeding program to adapt olives as a crop.

The Marys River region can produce a greater variety of fruits and nuts than many regions in the world. The region is well suited to produce all the fruits consumed locally, except for bananas and citrus. Seasonal consumption of locally produced apples, pears, plums, cherries, apricots, peaches, nectarines, grapes, strawberries, raspberries, blueberries, huckleberries, salmonberries, and blackberries could increase. Late winter and early spring are the only limited times for fruit locally. With good variety selection and storage techniques, apples and pears can be stored without refrigeration almost through the winter to the beginning of strawberry season. Solar drying operations could preserve many fruits. Growers could experiment with introductions of lesser-known fruits such as quince, persimmons, kiwi, currants, gooseberries, serviceberry, lingonberry, elderberry, cranberries, chokeberry, mulberry, figs, paw paw, honeyberry, goumi, jujube, Japanese raisin tree, mountain ash, magnolia vine, sea berry, and roses for rose hips. Breeding programs can identify the best-adapted varieties, widen their seasonal availability, and increase their productivity, drought tolerance, and pest resistance.

Orchard crops would be particularly prominent in a locally adapted agriculture because the crops are perennial, grow well in polycultures, and have limited irrigation requirements. Tea already is a borderline crop for the region and breeding programs may make it a viable crop. Walnuts, hazelnuts, and chestnuts grow especially well in the region and are highly nutritious. Local residents working on re-inhabitation could reduce consumption of peanut butter and peanuts, which do not produce well locally, and increase consumption of walnuts, hazelnuts, and chestnuts. Breeders could breed almonds that produce locally, and develop disease resistant hazelnut varieties for the area, both through crosses between the native and European hazelnut, and by breeding the native hazel for nut production. Beans that grow well locally without irrigation such as lentil beans, fava beans, and chickpeas could take a greater
role in local diet. Breeders might be able to develop soybeans that produce better in local conditions.

Regional vegetable requirements might be supplied by home production and local farms. Small producers could supply an increased amount of roadside stands, farmers’ markets, and local stores. CSA’s could provide a large share the region’s vegetables. Increasing gardening is an important reinhabitory strategy. Involving people in food production increases knowledge and skills, and reduces food imports. Most of the people in the region live in Corvallis and Philomath, and most households could produce food on their lots or rent space to minifarmers by the square foot. Urban and rural food production can be encouraged and community garden programs expanded (Pirog et al. 2001:23). Gardening approaches need to fit contemporary personal or household goals. Local gardening approaches need to minimize time requirements, be inexpensive, and produce valued foods. Identifying skilled local gardeners and rewarding them for sharing their knowledge helps build reinhabitory processes.

Local people could select native plants from wild ecosystems and develop them as crops. Native plants that could be the focus of initial agricultural introductions are camas, other native lilies, yampah, wapato, tarweed, acorns, cattails, fern rhizomes, and miner’s lettuce. More rapid acceptance of native foods might occur if local people introduce foods such as camas, tarweed, acorns, and wapato as minor ingredients in foods such as pastas, breads, and cereals. Stinging nettle is a perennial plant with excellent potential as a garden vegetable. It is unsurpassed in nutrition and may be harvested repeatedly over a season.

Burbank was the first western plant breeder to systematically work on developing native plants. Burbank (1914:240) believed that camas could compete as a high-quality edible tuber with the potato. He (1914:246) bred hybrid camas plants with bulbs as large as 5.0 by 3.5 inches in a short time, but the bulb supply was lost after his death. Diabetics, particularly Native Americans, benefit from consumption of wild foods with plant fibers, tannins, and inulin which lower blood-sugar levels and improve insulin production (Nabhan 1997:203). Acorns are one of the best foods for controlling blood sugar. Camas is high in inulin and may be a useful food for diabetics.

Reinhabitory agriculture also produces biofuels, materials for industry, plastics, rubber, clothing, building materials, medicinal plants, and drugs. Flax, hemp, wool, buckskin, leather, and plant-based plastics are possible clothing materials to replace cotton and synthetics. Research could examine the native milkweed (*Asclepias speciosa*) for latex production for
clothing, condoms, containers, and rubber. The alternative medicine industry could contract with local producers to grow and process plants for medicine, helping farmers increase their incomes.

Reinhabitory food systems emphasize pasture-fed livestock production rather than feedlot operations. The region is especially well suited to pasture-fed livestock production with minimal use of supplemental feed. Farmers can reincorporate farming practices used during the diversified farming period. Some grass seed land could move into perennial pastures and hayfields. Pastures and feed crops can be perennial polycultures, with some mixtures incorporating native plants like camas that livestock will eat. A local dairy industry integrated with grain production could supply the Corvallis and Philomath markets. Local ranchers can produce and market meats using direct marketing and cooperative supply networks (Pirog et al. 2001:23). Livestock can be fed crops wastes or turned in to recently harvested fields. Farmers can fields into pasture to increase fertility and break pest cycles.

Urban areas can mix small livestock with gardens and lawns. Chickens, ducks, and insects are especially suited to urban production. Neighbors can create local egg grids, bringing extra eggs produced in given blocks or neighborhoods to a house or shed for sale to neighbors. Where animals such as squirrels, raccoons, house cats, opossums, or nutria become pests, they can be hunted and eaten, composted, or used as fertilizer or livestock feed. Livestock owners can lease small herds of sheep and goats to eliminate briars, or denude and fertilize land to prepare grassy areas for conversion to gardens.

A reinhabitory food system could give hunting, gathering, and fishing a larger role. The most important animal foods include deer, elk, cutthroat trout, geese, and ducks. Hunting deer, fishing, and gathering mushrooms already provides a significant amount of local food. In Australia, restaurants, health food stores, and outdoors people regularly purchase wild foods (Nabhan 1997:26). Markets may gradually develop for wild animals such as fish, geese, duck, elk, deer, insects, and nutria. Wild areas open to hunting of deer, elk, waterfowl, and other animals can supply a significant amount of the region’s meat. Restoring the Willamette River, the Marys River, and its tributaries to a healthy condition would allow considerable harvests of fish. Local residents could trade for fish and other seafood products from Newport, Waldport, or the Columbia, and transport the foods to the region by train or boat.

The practice of entomophagy, or eating insects, is an established part of most food systems around the world, particularly in non-industrialized cultures, and insects are
increasingly becoming part of food systems in industrialized countries (Phillips and Burkholder 1995:1). Insects harvested from the wild or farmed can be gradually incorporated into the food system, first as composting aids, livestock food, and as novelty foods. Later their consumption can increase as a source of quality fat, protein, vitamins, and minerals in the diet. Research needs to be performed on the food quality and safety of indigenous insects.

Farmers could develop small enterprises producing insects for high-value snack food production. Food conversion efficiencies for insects are higher than for other livestock like cattle or hogs (Lindroth 1993:4). The species of cricket (*Acheta domesticus*) propagated for fishing could be a cost competitive snack food. Small producers could grow crickets in large quantities with a small amount of equipment and a minimal capital outlay (DeFoliart 1989:34). The larvae of the greater wax moth (*Galleria* spp.) are extraordinarily palatable and farmers might grow and sell them as a gourmet food (DeFoliart 1989:34). Insect recycling systems can develop to convert organic wastes and under-used organic materials into high-quality swine, poultry, and fish feed (DeFoliart 1989:32). The black soldier fly (*Hermetia illucens*) is a quality food for fish, poultry, and swine and can rapidly transform wastes such as manures into compost, produce large amounts of livestock feed, and control house flies (Sheppard 1992:1).

**Conservation Farming**

The writing of Aldo Leopold can guide reiturbation. Leopold’s ideal for agriculture is harmony between culture and nature, “an optimal mix of the wild and the tame, of beauty and utility” (Callicott and Freyfogle 1999:22; Leopold 1999:208). Leopold advocates combining wildlands preservation and using land in a locally adapted way. He argues, “every region should retain representative samples of its original or wilderness condition” (Leopold 1999:197). Outside of these areas, Leopold advocates locally adapted farming and forestry. Leopold’s recommendations for healthy land are simple: maintain biological diversity, use land in a less violent way, pay attention to beauty in addition to utility, and keep human populations within the carrying capacity of the land (Temple 1999:238). He describes what he calls a “conservation farmer,” whose farming is guided by the land ethic (Leopold 1999:196). The conservation farmer maintains healthy soil, crops, and livestock and is willing to accept losses to avoid eliminating species.
Making a lasting locally adapted farming system will require the emergence of a culture of conservation farming. Berry (1990:207) argues that to use agricultural land appropriately, “the people who use it must know it well, must be highly motivated to use it well, must know how to use it well, must have time to use it well, and must be able to afford to use it well.” Nabhan (1997:166) points out that it is necessary to build “cultural continuity” among farmers and gardeners to extend skilled land use to future generations. Doing so will require building “conservation traditions” that develop and maintain conservation practices in food production for multiple generations (Nabhan 1997:162).

Many locally adapted conservation practices could be practiced in the region. Conservation farmers can start by carefully planning their land use, mapping their farms, dividing them into management units, and noting natural assets. Maps can include proposed restoration and conservation lands, existing natural vegetation, wildlife sightings, invasive plant infestations, seasonal and year-round water, agricultural land, buildings, and neighboring land (ODFW 2000:6). Difficult to access land like chronically flooded land or field corners can be taken out of production or planted to native plants. Individual farms and groups of farmers can work together to connect less intensively used habitats such as meadows, pastures, and fallow fields. Government incentive programs provide financial incentives to land managers to set aside habitat (ODFW 2000:4).

Conserving water is a major concern for regional agriculture. Phasing out all water withdrawals from streams and keeping withdrawals from wells below documented recharge rates might be a goal for reinhabitory agriculture. Water use could be reduced with a variety of conservation practices including watering deeply at night, knowing how much sprinkler systems apply per hour, monitoring watering, and clustering plants with similar water needs to reduce water consumption (Bormann et al. 1993:126).

Weeds are likely to be a major challenge for a locally adapted agriculture. Proper preparation of cropland reduces weed problems. Repeated tillage is a successful way to prepare seedbeds. Tilling at night reduces germination of weed seeds (ODFW 2000:7). Forcing weed germination by watering, and then tilling the weeds, reduces the seed bank. Tilling and exposing roots in hot weather and using summer cover crops such as buckwheat can also diminish weed problems. Solarization by covering soils with plastic sheeting in hot weather aids seedbed preparation. Cover crops help reduce erosion on fields and improve tilth.
Farmers and land users can “re-integrate agriculture and wildness” (Kirschenmann 2001c:7). Wildness provides free ecosystem services such as the benefits from soil microorganisms and invertebrates, wild pollinators, pest insect-consuming birds, and pest predators (Kirschenmann 2001c:7). Farmers could restore native plant hedgerows, shelterbelts, and pollinator habitat. Eliminating conventional agrichemicals such as pesticides provides many benefits, including increasing plant and insect diversity for birds and other wildlife (ODFW 2000:4). Locally adapted farms could help provide connectivity, protect and restore wildlife refugia, practice diversified land use, and minimize disturbance of soil biota and structure (MacKay 2001:55). Conservation farms would buffer streams and wetlands from roads and farming activities. Riparian buffers in agricultural land reduce streambank erosion, increase biodiversity, and improve habitat quality (Ecosystems Northwest 1999:91).

Farmers and other landowners can take many simple and inexpensive actions to improve habitat for native birds, black-tailed jackrabbits, snakes, and other wildlife (ODFW 2000). Reducing feral cat and dog populations and controlling pets during bird breeding seasons reduces fatalities of many wildlife species. Leaving scattered trees or shrubs in pastures or hayfields or constructing singing perches improves conditions for several birds. Conservation farmers could mark and preserve historic oaks and other native trees that predate Euroamerican settlement (Leopold 1999:173). Timing of farming practices can improve conditions for songbirds and waterfowl.

Carefully managed agricultural grasslands and rotational grazing practices can provide ecological benefits. Ranchers could rotate burning, grazing, and growing hay. Low-intensity burns of pastures should take place every 3-5 years (ODFW 2000:10). Grazing might take place in a deferred rest-rotation system, where one pasture per year is left ungrazed, helping breeding birds (ODFW 2000:10). Concerned managers could harvest hay crops after the breeding season of ground nesting birds. Research might examine optimal burning, mowing, and grazing practices and use of native plants in hay and pastureland. Local ranchers can use practices such as guard animals, improved fencing, non-lethal predator control, and raise hardy cattle like Spanish longhorns to coexist with large predators such as wolves.
Becoming dependent on solar energy is a major challenge for locally adapted food systems, particularly in the transportation system. Reinhabitation requires reexamining every technology and converting to technologies built regionally from local resources and powered by energy from local sources. Connecting local production and consumption would eliminate much of the transportation system's use of energy. The region's flat lowlands have excellent potential for trucking by teams of bicyclists or horses. Rail lines could link farms ringing Corvallis and Philomath and use human or horse powered cars or biodiesel, hydrogen, or fuel cell technology. Power for tilling, cultivating, and other uses could also be achieved with increased use of human and animal labor, and machinery powered by biodiesel, hydrogen, or fuel cells. Experimentation could establish local oil crops for biodiesel.

A locally adapted food system would use machines produced locally that are inexpensive, effective, and relatively easy to repair. Technology relating to composting, manure management, local fertilizer and amendment production, mulches, greenhouses and cold frames, refrigeration, and root cellaring are particularly important to develop for small producers. Local companies can manufacture tools like hoes, scythes, carts, seeders, and push mowers for local use. Science and engineering can improve hand tool technology. Corvallis and nearby Eugene both have innovative craftspeople designing and building human-powered machines, mostly for transportation. New tools for small-scale agricultural seeding, cultivating, and harvesting are in the experimental stage. In Eugene, the Center for Appropriate Transportation produces bikes used to deliver foods for local businesses. Producing vegetables year round and eating more seasonally can reduce energy used in freezing, canning, and drying produce. Using technologies like root cellars, and using fewer plastics in production, also can reduce energy use. Cell blocking technology can eliminate most use of plastic in growing transplants. Research might help growers make effective blocking media from materials on farms.

Locally adapted food systems have highly diversified processing and packaging industries. A reinhabitory food system would have many businesses turning the foods of local farmers into prepared foods for local consumption. Local operations can produce salsas, humus, and other prepared foods to sell in bulk in reusable containers. Local restaurants, institutions like hospitals and dormitories, and food processors could contract with local
farmers to produce the foods they need in a relationship like subscription farms. Local food processors and tool manufacturers could locate next to rail lines in Corvallis and Philomath. Local creameries could process and distribute dairy products, and small slaughterhouses or mobile slaughtering operations process meats. Food processors can dry, can, and freeze fruits and vegetables, roast nuts, and prepare nut butters. Oil press operations could process cooking oils from local crops and milling operations process starchy foods into meals or flours for use in breads, cereals, and pastas. Refineries might process local crops into sweeteners. Operations can manufacture food containers from local crops and raw materials and clothing from locally grown flax, hemp, and wool.

Cooperative organization may help address the problems of high property values and high capital costs in agriculture. Tool cooperatives at farm or neighborhood scale might form to reduce the costs of tools and machinery. Shareholders or members could purchase and rent machinery such as trucks, walking tractors, rotary spaders, lime or manure spreaders, or seeders. Groups of small producers can form purchasing blocks to save money by purchasing larger quantities of seed, soil amendments, or equipment. Neighboring producers might share composting facilities, oil presses, or harvesters. Labor trading and community labor could become more widespread, with farmers trading for future help with large tasks. The expansion of seed saving and exchange networks can help provide producers with locally adapted seed.

CULTURAL AND ECONOMIC

The knowledge and technology is available to have a locally adapted food system in the Marys River region. The main limiting factors are cultural and economic, not technological or ecological. Lasting reinhabitation of food systems requires changes in all parts of society. It will be impossible to build lasting reinhabitory food systems locally or anywhere without a culture of regionally committed, highly skilled people who know local food systems and natural history well. Building such a culture requires changing institutions and providing people with education, desirable models, and positive, connective experiences.

Education

Leopold (1999:197) argued that educational campaigns are needed to undo years of propaganda that taught that “land is a factory to be operated solely for profit.” He believed that
affection for nature as well as wonder and joy are more effective than guilt, reproach, fear, logic, or law at moving people to make comprehensive changes in their lifeway (Sanders 1999:xix). A primary role of education is to give people greater knowledge of food systems and the consequences of their food choices. Nabhan (2002:163) argues that “the more we understand where our food comes from, the greater the chance there is that we can save the living riches of the natural world.” Education can stimulate desire to participate in a local food system and give positive experiences that build attachment to local ecosystems and food systems.

Changing the consumption practices of the residents of the region is critical to reinhabitation of the food system. Altering the values of the population of the region is a major route to influence consumption practices. Public education and advertising campaigns at the local level can describe the personal, social, economic, and ecological benefits of eating locally grown foods, gardening, and food processing. Educators can present to consumers a more realistic portrait of full costs for food items including formerly hidden external social and ecological costs. A model for this approach is the educational materials put together at the University of Wisconsin’s Center for Integrated Agricultural Systems titled “Price Tags, Cost Tags,” (Pirog et al. 2001:24). The group Northwest Coalition for Alternatives to Pesticides (NCAP) has put together a publication that is a guide to local food consumption in southern Idaho (NCAP 2003:2). This guide is a source for consumers and provides information on local producers, their production practices, and the seasonal availability of foods. A similar guide could be produced for the Marys River region.

Public education about native ecosystems is necessary to increase the competency of participants in locally adapted food systems. Primary and secondary schools could have required programs with extensive education in agricultural skills, hunting and gathering skills, ethnobiology, and natural and cultural history. Local farms, food processors, and businesses can serve as educational resources. Students can work on farms and tour farms. Many strategies can help avoid the “extinction of experience” and increase involvement in local food systems. Nabhan (1997:73) recommends giving children more direct exposure to routine behaviors of wild animals in their natural habitats, more involvement with plants and animals in general, and exposure to teaching about food, subsistence, and natural history by community elders from different cultures.
Placing a much greater emphasis on outdoor and participatory ecological and subsistence
education could increase involvement in locally adapted food systems. Soule (1988) argues
that the best ways to reach people to become involved in sustainability or conservation issues
are through pleasurable experiences in nature. Soule (1988:468) believes that activities that
include “a sensory, physical experience of nature in the convivial company of like-minded
friends” promote “a wider love of nature.” Local residents can rehabilitate and preserve native
prairies, oak savanna, wetlands, and riparian forests near Corvallis and Philomath to serve as
education resources. In these areas, teachers can bring local children and interested adults for
positive visceral experiences harvesting and processing food. People can take part in activities
including acorn collection, camas processing, hunting geese, fishing, burning grasslands,
establishing tarweed patches, harvesting wapato wetlands, as well as work in gardens and
orchards. These activities promote affection for and connection to nature and local food
systems and participation in reinhabitation.

Kirschenmann (2001b:5) points out that consumers are increasingly asking questions
about food such as, “Where was it produced? Who grew it? How where the animals treated?
What was the impact on the environment? How were the workers treated? Did they get a fair
share of the profits?” This context is an opportunity to educate consumers and expand demand
for locally produced food. Local food systems can show consumers directly the answers to
these questions about food production. Concerned consumers demand food produced in
accordance with their values. To gain and retain market share, local producers need to
differentiate themselves from industrial food importers. Local producers can sell food with
transparent and verifiable stories about production, processing, transportation, and distribution
that appeal to local values. In Denmark, stories about food production are transmitted by
machines in food stores (Kirschenmann 2001b:5). Consumers scan the bar codes of foods and
monitors display images of farmers, their farms, and farm practices. This technology is high-
impact, but it may be beneficial by increasing consumer knowledge about the food system.

Writing, art, theater, and can help inspire people to care about people, nature, their local
areas, and the plants and animals they eat. Kittredge (1996:164) argues that people urgently
need, “a fresh dream of who we are, which will tell us how we should act . . . stories about
taking care of what we’ve got . . . stories in which our home is sacred, stories about making
use of the place where we live without ruining it.” Reinhabitation is one such story, one
alternative to industrialism. Writers and artists of all kinds are more frequently taking on the
theme of place, landscape, and the relationship between people and nature. The arts contribute by providing cultural traditions for a reinhabitory economy and food system. Writers tell stories that say what is possible and beautiful for a reinhabitory culture. Artists help connect people to nature, building reverence by showing the sacred aspects of plants, animals, food, and people.

Religion is another venue for reinhabitation. Food is part of the spiritual practice of millions of people. People of all faiths are increasingly trying to apply their religious values to social and ecological issues. Interfaith groups can hold public forums and advocate gardening and buying locally grown food. Church groups could purchase CSA shares, take farm tours, or facilitate gardening education. Religious leaders can lead discussions of the implications of religious values on participation in food systems. Connective rituals might be established for meals as well as local planting, harvesting, hunting, and gathering activities.

Regions west of the Cascades could cooperate to develop a regional manual and encyclopedia of reinhabitation. The encyclopedia could inventory all useful regional species, including plants, animals, fungi, microorganisms, and insects, provide nutritional and chemical analysis, and describe their historic and possible uses. The encyclopedia could include a calendar for home gardening and local hunting and gathering activities. Such a manual or encyclopedia could be a public document, with contributions from researchers and amateurs, available in libraries and electronically. The OSU extension service (Bane et al. 1993) has put together a resource guide for sustainable agriculture for Oregon and Washington. This is a useful example for a potential resource guide for food system reinhabitation.

Institutions

Institutions can contribute to the development of a locally adapted food system in many ways through incentives, regulation, taxation, tariffs, zoning, land-use planning, advertising, education, labeling, research, and enforcement. Public policy that would aid local reinhabitory food systems would be more community-based and less commodity-based. It would subsidize diverse local farms rather than monocultural export farms, and avoid subsidizing the production of raw materials for the global economy. Public policy could support agriculture
that produces public goods like improved soil and water quality, habitat for wild species, and ecosystems that are more resilient.

State and local government could provide incentives for food systems to become more energy efficient and locally adapted (Pirog et al. 2001:24). Incentives can encourage sustainable home production. Public policy can provide incentives and regulations for the development of food labels that inform consumers of environmental and community costs (Pirog et al. 2001:24). Public policies at the state level could provide incentives for local institutions to purchase locally produced foods. The state of Oregon could compel institutions that receive state money to increase their purchases of locally grown foods, and state agencies might assist institutions with funding and finding local food sources. Local business and institutions might be encouraged to purchase as much of their food locally as possible (Pirog et al. 2001:22). Successful projects in Iowa have substantially increased purchases of locally produced foods by local institutions such as hospitals, campus food services, and restaurants (Leopold Center for Sustainable Agriculture 2001). The Corvallis hospital and OSU could be encouraged to build relationships with and purchase foods from local producers.

Taxes are a potential force to make the food system more locally adapted and lower-impact. Government could index property and inheritance taxes based on farm size and presence of owners (Hanson 1996:281). High taxes on fossil fuel, agrichemicals, and heavy machinery might fund programs to help local growers who produce for local markets. Tariffs on imported and exported foods could fund advertising campaigns encouraging buying locally grown foods.

Changes in land and property rules and boundaries could help the development of a locally adapted food system. Watersheds, ecoregions, or geomorphic provinces could replace state and county boundaries. Beneficial property rights regimes would limit use, coordinate users, respond to environmental conditions, and have mechanisms for information gathering, monitoring, enforcement, and conflict resolution (Hanna et al. 1995:18). Absentee ownership and farm size might be limited (Hanson 1996:280). Property rights rules can "create expectations of long-term tenure and protect from the tyranny of short-term decisions" (Hanna et al. 1995:20). Small farmers could organize for land reform and access to land as well as greater power in shaping public agricultural policy. Changes in Oregon's land use laws could allow zoning of the urban fringe of Corvallis and Philomath for labor-intensive market gardens and for rural food producers to cluster dwellings.
Public and private research and extension programs support reinhabitation. Agricultural research and extension accelerates change when it focuses on long-term problems, prioritizing small-scale, site-specific technologies developed in farmers’ fields, with the active cooperation of small farmers (Altieri 1995:368). Local farms can develop partnerships with researchers. Researchers could focus on local adaptation and methods for small producers, examining disease resistant crops, biological control, crop rotations, soil ecology, polycultures, perennial crops, and season extension. Studies of different hedgerows and windbreaks might determine their benefits and drawbacks to biodiversity and agriculture. A long-term agricultural research program could list all possible crops and their potential for the region and run trials comparing crops and varieties in the region, leading to breeding programs focused around local adaptation, taste, nutrition, health, production, and genetic diversity.

Economy, Markets

In a locally adapted food system, people would produce their food at home or obtain it from directly from growers, from farm stands, CSA’s, in farmers’ markets, cooperatives, or locally owned stores. Buying from local sources would allow much of the more than 369 million dollars in regional spending on food, tobacco, coffee, and alcohol to stay in the region. Increasing use of CSA’s is one of the most promising possibilities for the regional food system. Different CSA’s might specialize in whole diets, vegetables, dairy, vegetable oil, medicines, or other goods. A daily farmers’ market emphasizing locally produced food modeled on markets in less developed countries could eventually form in Corvallis. Local government or a cooperative group of producers could fund such a market.

Trade of surplus food will be important in a reinhabitory food system. The Marys River region could trade surplus agricultural products to coastal people for marine resources or to the sparse Coast Range and Cascades populations for forest products. Some trade in food items such as olive oil, almonds, tea, and citrus could exist with the Sacramento Valley in California. Global trade is likely to continue for spices and coffee. Trade could occur with urban centers such as Portland and Eugene for manufactured goods.
CONCLUSIONS

The proposals in this section highlight some of the possibilities for building a reinhabitory food system. Alternative food systems are already established and active in the area. People can support and strengthen these efforts. People who work toward an inhabitory food system will have varied backgrounds, values, and interests. Some people might be interested in raising and breeding goats that thrive locally, and figuring out how to manage forage crops so the goats can get most of their food from range. Others might try to subsist from their home garden, or work to change institutional purchasing behavior. Some people may be interested in breeding locally adapted woody food plants or native plants for home gardens. On an individual level, everyone can contribute to reinhabitation of food systems. There is no correct place to begin. Many initial steps are personal, including paying attention to the appearance and taste of food, and giving thanks before meals to the workers, plants, and animals that made the meal possible. One place to start is to get to know the local area, walking, and learning the names of plants and animals. Another initial step is to learn about the food one consumes, asking questions about its origins. Growing a small garden, cooking with locally grown foods, or building a relationship with a farmer is a contribution to reinhabitation. If there is interest, improving skills at gardening, food processing, and food preparation may follow. For those with a serious interest in changing the food system, I think the best place to start is with public education, increasing urban gardening, and building on the assets of existing alternative approaches. There are endless possibilities. An advantage of reinhabitation is that it unites many different efforts with a common, inclusive, positive vision of reestablishing native cultures with regional cuisines and conserving traditions of land use.
CHAPTER 8: CONCLUSIONS

A reinhabitory food system is not a return to a hunting and gathering or agrarian past. It is a locally adapted food system that follows the principles of reinhabitation in a contemporary context. Snyder (1995:247) points out that reinhabitation:

doesn’t mean some return to a primitive lifestyle or utopian provincialism; it simply implies an engagement with community and a search for the sustainable sophisticated mix of economic practices that would enable people to live regionally and yet learn from and contribute to a planetary society.

The history of food systems in the Marys River region is important for building a locally adapted food system, both as a tool for teaching about regional food systems, and as a reservoir of possibilities to draw from. Reviving elements of Kalapuyan and diversified food systems can provide connective experiences that involve people in food systems while teaching about cultural and natural history. A local reinhabitory food system would follow general patterns of Kalapuyan and diversified food systems like relying on solar energy, obtaining food from local foodsheds, integrating plants and animals, and partial self-sufficiency. Industrial food systems are the antithesis of inhabitory systems. Descriptions of the widespread damage to people and nature caused by industrial systems are a part of education geared toward a shift to reinhabitory practices. However, a locally adapted food system can use elements of the industrial system like agroecological research and small-scale industrial machinery. A reinhabitory food system will build upon the strengths of the thriving alternative food stream.

The industrial food system is likely to maintain its dominance of the food stream in the near future. The corporations that control food systems continue to concentrate, and use marketing to shape consumption. Industrial food systems provide most consumers with what they want: large amounts of cheap, convenient foods that require little time to prepare or consume. Relentless conditioning shapes people to accept price as the preeminent value and shaper of the system. Participants in the food system have been divorced from production, and are dependent consumers. The skills needed to produce quality food or to evaluate qualitative differences in food and farming are largely lost. The costs to farming communities and
ecosystems of industrial food systems are out of sight to consumers who experience primarily the marketing and retail end of the food system. These factors add up to a culture fundamentally ignorant about the sources of its food, that values cheap prepared foods, and that cedes power in the food system to multinational corporations.

Local food production is likely to continue to grow but remain a small part of regional food systems until a major cultural shift occurs. Major changes in large-scale systems can occur suddenly and unpredictably. Such a shift occurred in Cuba beginning in 1989, when the Soviet Union cut off the flow of subsidized oil that maintained Cuba's industrial food system (Altieri 1995:196; Rosset and Benjamin 1994). A locally adapted Cuban food system quickly emerged, with increased home production, participation in community gardens, purchases at farmers' markets, and use of biological controls and vermiculture. The locally adapted system was able to expand rapidly partly because researchers and advocates worked for decades building a base of knowledge, interest, skills, and technology.

Grey (2000) argues that alternative food systems succeed “when small producers exploit the weaknesses of the industrial food stream.” An important weakness of industrial food systems is that they mass-produce food, minimizing the role of care. A key to exploiting this weakness is niche marketing, “which identifies the gaps left by integrated food producers” (Grey 2000). Opportunities for niche marketing include production of high quality vegetables, fruits, meats, and grains, using heirloom or unusual varieties of livestock or crops, and production using conservation farming methods that explicitly take into account the health of livestock, farmers, farm communities, and local ecosystems. The base of the industrial food system and of the capitalist economy is consumer spending and values. A major pathway for change in food systems is to cultivate values that lead to appreciation, purchase, and use of high quality foods produced locally with care.

The work of building a reinhabitory food system will contribute to the restoration and conservation of cultural and biological diversity. Building a locally adapted culture with conservation traditions is necessary to ensure the survival of healthy ecosystems over the long run. The long-term goal of reinition is the reestablishment of native, ecosystem-based cultures and economies. Jackson (1994:3) describes this goal as “becoming native to our places in a coherent community that is in turn embedded in the ecological realities of its surrounding landscape.” Snyder (1995:247) points out that reinhabitory people “are learning to live and think ‘as if’ they were totally engaged with their place for the long future.”
Cultures throughout the world have food traditions based on appreciating local foods and care in food production. Building native food systems requires developing and maintaining regional conservation farming, gardening, and food traditions, and a regional culture with a sense of place.

Reinhabitation is work trying to achieve what Elton (1958:145) called “a right relation between man and living things.” This relationship is substantially mediated by the food economy. Building a local food economy is work to enact this “right relation.” Leopold used the words harmony and health to describe the ideal of a positive balance or marriage of culture and nature (Callicott and Freyfogle 1999:17). He said that success in this relationship is “a harmonious balance between plants, animals, and people; between the domestic and the wild; between utility and beauty” (Leopold 1999:218). Cultivating and preserving harmony between culture and nature is a traditional goal (Berry 1990:107). This era provides an unprecedented opportunity for people to turn from industrialism and take on this vital, rewarding work. The work of reinhabitation is of the highest quality, involving engagement with community, time outdoors interacting with and learning about other forms of life, and gaining skills in a variety of crafts. The seemingly simple task of getting food locally is complex and challenging.

Despite more than 150 years of rapid development, there remains adequate land in agriculture to feed the local population and restore significant parts of the landscape to wildlands. The region will continue to be a national leader in the alternative agriculture movement. The process of reinhabitation is underway in the Marys River region and it will continue to grow. Reinhabitation offers a constructive vision of a way of life that can connect people to their regions, establish native cultures with distinctive food and land use traditions, and provide many benefits to ecosystems and human communities.
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APPENDICES
## APPENDIX 1: MARYS RIVER REGION HISTORICAL AND CURRENT ACREAGE

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<thead>
<tr>
<th>Area, Vegetation, and Land Use</th>
<th>Acreage</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Marys River Region</td>
<td>236,138</td>
<td></td>
</tr>
<tr>
<td>Marys River Watershed</td>
<td>198,400</td>
<td></td>
</tr>
<tr>
<td>Benton County</td>
<td>432,961</td>
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<tr>
<td>Marys River Region Historical Vegetation</td>
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<tr>
<td>Douglas-Fir</td>
<td>75,410</td>
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<tr>
<td>Oregon White Oak Savanna</td>
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<tr>
<td>Perennial Bunchgrass</td>
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<tr>
<td>Riparian</td>
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<tr>
<td>Open Water</td>
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<tr>
<td>Marys River Region Current Vegetation</td>
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<td>Forest: Douglas-Fir-W. Hemlock, W. Red Cedar</td>
<td>106,952</td>
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<tr>
<td>Agriculture</td>
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<td>Urban</td>
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<tr>
<td>Mixed Conifer/Mixed Deciduous Forest</td>
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<td>Oregon White Oak Forest</td>
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<tr>
<td>Douglas-Fir/White Oak Forest</td>
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<td>Grass-Shrub-Sapling or Regenerating Young Forest</td>
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<td>Palustrine Emergent</td>
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## APPENDIX 2: MARYS RIVER REGION 1998 POPULATION ESTIMATE

<table>
<thead>
<tr>
<th>Location</th>
<th>Population</th>
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<tr>
<td>Benton County</td>
<td>76,600</td>
</tr>
<tr>
<td>Corvallis</td>
<td>49,630</td>
</tr>
<tr>
<td>Philomath</td>
<td>3,770</td>
</tr>
<tr>
<td>Monroe</td>
<td>555</td>
</tr>
<tr>
<td>Adair Village</td>
<td>570</td>
</tr>
<tr>
<td>Summit</td>
<td>200</td>
</tr>
<tr>
<td>Kings Valley</td>
<td>200</td>
</tr>
<tr>
<td>Hoskins</td>
<td>200</td>
</tr>
<tr>
<td>Bellfountain</td>
<td>200</td>
</tr>
<tr>
<td>Alpine</td>
<td>200</td>
</tr>
<tr>
<td>Blodgett</td>
<td>200</td>
</tr>
<tr>
<td>Lewisburg</td>
<td>200</td>
</tr>
<tr>
<td>Alsea</td>
<td>250</td>
</tr>
<tr>
<td>North Albany</td>
<td>4,325</td>
</tr>
<tr>
<td>Corvallis, Philomath, and North Albany Population</td>
<td>57,725</td>
</tr>
<tr>
<td>Benton County Cities and Towns</td>
<td>60,500</td>
</tr>
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</table>

Urban percentage: \( \frac{\text{Sum of Population of Corvallis, Philomath, and North Albany}}{\text{Benton County City and Town Population}} \) = 95.41

Marys River Region Population: \( \text{Total Benton County Population} \times \text{Urban Percentage (1)} \) = 73,087


(1) Figure Not Exact Due to Rounding.
<table>
<thead>
<tr>
<th></th>
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<th></th>
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<tbody>
<tr>
<td>GRAINS</td>
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<tr>
<td>Total</td>
<td>198.4</td>
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<tr>
<td>Wheat</td>
<td>148.8</td>
<td>10875345</td>
<td>4625</td>
<td>2351 BC</td>
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<tr>
<td>Corn</td>
<td>22.9</td>
<td>1673692</td>
<td>10920</td>
<td>153 OR</td>
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<tr>
<td>Rice</td>
<td>18.9</td>
<td>1381344</td>
<td>5897</td>
<td>234 USA</td>
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<tr>
<td>Oats</td>
<td>6.6</td>
<td>482374</td>
<td>3450</td>
<td>140 BC</td>
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<tr>
<td>Barley</td>
<td>1.3</td>
<td>95013</td>
<td>3448</td>
<td>28 BC (1992)</td>
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<tr>
<td>Total acreage needed</td>
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<td>SWEETENERS</td>
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<td>Total</td>
<td>150.7</td>
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<td>Corn sweeteners</td>
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<td>Cane and beet sugar</td>
<td>66.6</td>
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<td>Sugar beets</td>
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<td>56800</td>
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<td>OR</td>
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<td></td>
<td></td>
<td>4850</td>
<td>Sugar beets x25 for processing</td>
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<td>FATS AND OILS</td>
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<tr>
<td>Total, fat content only</td>
<td>65.8</td>
<td>4809125</td>
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<td>Total animal fat</td>
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<td>Total vegetable fat</td>
<td>57.6</td>
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<td>Canola for oil</td>
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<td>1237</td>
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<td>Total acreage needed</td>
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<td>3888</td>
<td>Canola</td>
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<td>FOOD OR CROP</td>
<td>Per capita consumption</td>
<td>Regional consumption</td>
<td>Crop yields, pounds/acre</td>
<td>Regional land needed, acres</td>
<td>Data source, notes</td>
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<tr>
<td><strong>NUTS AND LEGUMES</strong></td>
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<td>Peanuts (shelled)</td>
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<td>146174</td>
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<td>Walnuts</td>
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<td>2780</td>
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<td>Hazelnuts</td>
<td>0.66</td>
<td>48237</td>
<td>3260</td>
<td>OR</td>
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<td>Dry edible beans</td>
<td></td>
<td></td>
<td>2040</td>
<td>OR</td>
<td></td>
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<td>1000 Estimate includes beans</td>
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<td><strong>FRUITS</strong></td>
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<td>Fresh total</td>
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<td>Apples</td>
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<td></td>
<td>22000</td>
<td>USA</td>
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<tr>
<td><strong>Total acreage needed</strong></td>
<td></td>
<td></td>
<td></td>
<td>963</td>
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<td><strong>VEGETABLES (1)</strong></td>
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<td>Total</td>
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<td>110.4</td>
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<td>Tomatoes</td>
<td>92.2</td>
<td>6738821</td>
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<td>USA, ave. of fresh and processed</td>
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<tr>
<td>Lettuce</td>
<td>29.2</td>
<td>2134140</td>
<td>28,700</td>
<td>USA, romaine</td>
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<tr>
<td>Onions</td>
<td>17.9</td>
<td>1308257</td>
<td>41400</td>
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<td><strong>Total acreage needed</strong></td>
<td></td>
<td></td>
<td></td>
<td>1827 Coleman 40 people/acre</td>
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## APPENDIX 3 (Continued)

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<tr>
<th>FOOD OR CROP</th>
<th>Per capita consumption</th>
<th>Regional consumption</th>
<th>Crop yields, pounds/acre</th>
<th>Regional land needed, acres</th>
<th>Data source, notes</th>
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<td>Coffee, green beans</td>
<td>8.9</td>
<td>650474</td>
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<td>Tobacco</td>
<td>4.5</td>
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<td>154 USA</td>
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<tr>
<td>Cocoa beans</td>
<td>4.2</td>
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<td>Tea, dry leaf</td>
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<tr>
<td>Total acreage needed</td>
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<td>1,000</td>
<td>Including 444 acres for tea, cocoa, and spices</td>
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<tr>
<td>Total red meat (2)</td>
<td>163.3</td>
<td>11935107</td>
<td>1000 lbs./acre</td>
<td>11,935</td>
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<td>Beef</td>
<td>97.4</td>
<td>7118674</td>
<td>1000 lbs./acre</td>
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<td>Pork, excluding lard</td>
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<td>Veal</td>
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<td>Lamb and mutton</td>
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<td>Total poultry</td>
<td>100.5</td>
<td>7345244</td>
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<td>6427 3.5 pounds feed/1 pound meat</td>
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<td>Chicken</td>
<td>82</td>
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<td>4,000 lbs. feed/acre</td>
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<td>Turkey</td>
<td>18.5</td>
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<tr>
<td>Eggs, number</td>
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<td>17321619</td>
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<td>2209 51 lbs. feed/100 eggs</td>
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<td>Fish and shellfish</td>
<td>14.7</td>
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<td>Edible weight</td>
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<td>Total acreage needed</td>
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<td>20571</td>
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<td>Red meat/poultry/eggs</td>
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<td><strong>DAIRY</strong></td>
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<td>Total (3)</td>
<td>575.5</td>
<td>42061568</td>
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<tr>
<td>Milk and cream (4)</td>
<td>223.6</td>
<td>16342253</td>
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<tr>
<td>Cheese</td>
<td>30.3</td>
<td>2214536</td>
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</tr>
<tr>
<td>Milk per cow</td>
<td></td>
<td>17290 2433 cows</td>
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<td>OR, 1996, lbs.</td>
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</tr>
<tr>
<td>Milkfat per cow</td>
<td></td>
<td>629</td>
<td></td>
<td>OR, 1996, lbs.</td>
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</tr>
<tr>
<td>Total acreage needed</td>
<td></td>
<td>4866 2.0 acres/cow</td>
<td></td>
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</tr>
<tr>
<td>FOOD OR CROP</td>
<td>Per capita consumption</td>
<td>Regional consumption</td>
<td>Crop yields, pounds/acre</td>
<td>Regional land needed, acres</td>
<td>Data source, notes</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------</td>
<td>----------------------</td>
<td>--------------------------</td>
<td>-----------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Total acreage for animal products</td>
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<td></td>
<td>25437 Red meat/poultry/eggs/dairy</td>
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</table>


(1) Vegetable consumption figures do not include home production. Consumption = residual after exports, nonfood use and ending stocks are subtracted from the sum of beginning stocks, domestic production and imports.

(2) Carcass weight.

(3) Milk equivalent, milkfat basis. Total dairy products.

(4) Fluid milk figures include commercial sales and milk consumed on farms.