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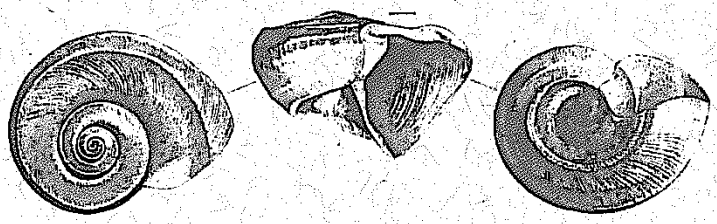
FRESHWATER MOLLUSKS OF THE UPPER KLAMATH DRAINAGE, OREGON



Helisoma (Carinifex) newberryi newberryi (Lea, 1856)

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FRESHWATER MOLLUSKS OF THE UPPER KLAMATH DRAINAGE, OREGON

1995 yearly report

Terrence J. Frest & Edward J. Johannes
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2517 NE 65th Street
Seattle, WA 98115

September 29, 1995

T14 Gastropods
T24 Bivalves.

Upper Klamath Lake is one of the few surviving Pliocene lakes and the only one with normal alkalinity and a large relict fauna. It is likely the best remaining window on environments prevalent in the interior West 2-17 million years ago.

-Frest & Johannes, 1995

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BACKGROUND

The Upper Klamath drainage has been a focus of malacological interest since the 1830s. This preoccupation is reflected in the fact that several mollusk species have their type localities there (*Lanx klamathensis*, *Vorticifex effusus dalli*, *Vorticifex klamathensis klamathensis*, *Vorticifex klamathensis sinitsini*, *Pyrgulopsis archimedis*). One federal candidate species, *Pisidium ultramontanum*, was previously known from the region. One other federal candidate, *Anodonta californiensis*, was discovered live in this region 1993. Some 14 Upper Klamath drainage species were included in the Clinton forest plan (FEMAT) report (Mollusc Species of Special Concern Within the Range of the Northern Spotted Owl, Frest & Johannes, 1991b, 1993b; see also Final Supplemental Environmental Impact Statement (FSEIS, 1994a); FSEIS Appendix J2 (FSEIS, 1994b), SEIS, 1993, 1994; and ROD, 1994); USFWS 1992a; as well as an additional 9 taxa from the middle Klamath drainage (Table 1). Essentially the same list of species was part of a report for the Interior Columbia Basin Ecosystem Management Project (Interior Columbia Basin Mollusk Species of Special Concern: Frest & Johannes, 1995a).

DEFINITION

As used herein, the Upper Klamath drainage includes Upper Klamath Lake proper and drainages tributary to it, specifically the Lost, Williamson, Sprague and Sycan river drainages, mostly in Klamath Co., Oregon. We also include the Link River and that portion of the Klamath River in Oregon from the Cascades crest (*i.e.*, from Johnson Creek east) to Klamath Falls. The California part of the Lost River drainage is not included. Neither are the Oregon Interior Basin drainages or such problematic areas as the Goose Lake Basin. Information on these areas is summarized in Frest & Johannes (1995a, 1995b). As tributaries, particularly springs, are often major focal areas of mollusk endemism, particular attention is paid to them.

The study area thus extends from the crest of the Cascades east of the Rogue and Umpqua river headwaters (coastal drainages) north to the Crater Lake area and just south of the adjoining Deschutes and John Day systems (Columbia drainage). On the east, internal drainages such as the Silver Lake, Summer Lake, and Lake Abert (Oregon Interior Basin) border the Upper Klamath; to the south and southeast, elements of the Sacramento system (Pit River) and Goose Lake fringe the Upper Klamath drainage.

ECOLOGY

Freshwater mollusks can inhabit permanent water bodies of all sizes; a few can tolerate conditions in temporary or seasonal situations as well. In terms of diversity, flowing water situations are generally most favorable, but lakes, in particular river lakes or spring-influenced bodies such as Clear Lake (Lake Co., California) or Upper Klamath Lake, may have exceptional faunas. In California, abundance, and sometimes diversity, is often highest in clear, spring-fed streams or large spring pools (limnocrenes: see **GLOSSARY**) with cold, well-oxygenated water, stable cobble-boulder substrate, and relatively minor aquatic macrophyte representation. Thus, prior to human modification-and to an extent still-the Upper Klamath Lake drainage provided exceptional mollusk habitat. Prior to the completion of various dam, reservoir, and impoundment projects, the lower and middle Klamath River and its tributaries also had a relatively diverse freshwater mollusk fauna. At present, this malacofauna persists in relatively free-flowing stretches of the river proper and in relatively undisturbed tributaries, for example the Jenny Creek area, Jackson Co., Oregon. The very large spring complexes (nasmodes) on the middle Klamath, such as Shoat Springs, and in the Upper Klamath drainage in particular those of the lower Williamson River, Spring Creek, Odessa Creek, and Short Creek, constitute exceptional freshwater mollusk habitat. Both lotic and lentic habitats are exceptional in the system. While sizable portions, especially on the north end, have been covered with deep pumice and volcanic ash comparatively recently from a geologic viewpoint, much of the central and southern portions of the area are eucrenic despite the general semiarid setting.

The majority of freshwater mollusk species are sensitive to pollution (Burch, 1989) regardless of source. Relatively few North American species tolerate warm waters, low dissolved oxygen, or seasonal fluctuations. The major exceptions to this are certain pulmonates in the families Physidae, Lymnaeidae, and Planorbidae and some sphaeriid species. These eurytopic taxa are characteristically widely distributed; some are intercontinental in occurrence. Most Upper Klamath species, however, are cold-water forms preferring clear and cold, unpolluted waters with dissolved oxygen (DO) levels near saturation. Most such stenotopic and stenothermal taxa are quite sensitive to hypoxic or anoxic conditions, in either the water column or substrate: certain

lymnaeids and sphaeriids and a few unionaceans are the major exceptions. Very few of the native cold-water species can tolerate algal blooms or dense macrophyte stands; and they also avoid or are excluded from areas with major diurnal DO and temperature fluctuations.

Most Upper Klamath drainage freshwater snails are grazers, largely of aufwuchs on stones. Most such species thus feed upon attached diatoms and smaller epiphytic algal taxa. The majority are best characterized as obligate perilithon feeders; a few can also (or prefer to, in some cases) graze periphyton, and a small number can also feed upon larger aquatic macrophytes. Some species, notably including *Valvata humeralis* and *Helisoma (C.) newberryi*, are obligate or facultative detritivores, often occurring on or in oxygenated mud substrates. Particulars for some taxa may vary. Certain *Fluminicola* and *Juga* species, for example, can eat seasonally infallen waterlogged deciduous tree leaves, even though the perilithon habit is more typical for the genera involved. The freshwater clams are filter feeders, extracting diatoms, other unicellular organisms including bacteria, and fine organic detritus from the water column. The larger bivalves are mostly very sensitive to low oxygen conditions and water chemistry; they concentrate heavy and transition elements when present, and have also been shown to concentrate organochloride herbicides, pesticides, and certain viruses. Their ability to lower metabolism and close their valves gives them some protection from event disturbances. Sphaeriids (the small so-called fingernail clams) vary considerably in habitats and requirements. Many of these small bivalves are eurytopic, widely distributed, and relatively pollution and disturbance-tolerant; but certain species are members of the cold-water group (notable examples here include *Pisidium (P.) ultramontanum, Pisidium (N.) punctatum, and P. (C.)* n. sp. 1) These taxa are reasonably considered comparatively stenotopic. Most unionaceans (the larger bivalves) prefer sand-gravel substrate, while many sphaeriids prefer mud-fine gravel. Certain freshwater snail species may be especially sensitive to disturbance. The Pacific Northwest endemic family Lancidae, for example, lacks either lungs or gills and has modified the shell shape into a limpet-like form. Respiration is accomplished entirely through the mantle; and all species seem especially sensitive to DO fluctuations or to hypoxic or anoxic conditions. The Upper Klamath form *Lanx klamathensis* Hannibal, 1912 is a local example.

In the Pacific Northwest, with its numerous oligotrophic mountain streams and springs, a number of species are specifically adapted to the typical habitat. These have been termed "cold water biota" in Idaho; they are of especial interest in that many of the region's endemic and threatened and endangered taxa fall into this group, and preservation of cold water biota is a designated major goal of water quality regulations. In Idaho, five such taxa from the middle Snake River have recently been added to the Endangered Species list (USFWS, 1992b), after extensive study (Frest & Bowler, 1993; Frest & Johannes, 1991a, 1992a, b, c; 1993c, d). Habitat characterization for these taxa is the same as that for many Upper Klamath drainage forms: "[a]ll

require exceptionally well-oxygenated, clean, water. They are currently restricted to areas with unpolluted, cold, clear, flowing water, and are intolerant of impoundments; turbid water; slack water; water with substantial quantities of dissolved herbicides, pesticides, nitrates, or phosphates; water with substantial quantities of suspended fine sediment; habitats with unstable substrate, regardless of particle size; hypoxic conditions, regardless of cause; and areas subject to frequent water level fluctuations. None are typically river edge [amphibious] or lentic species; all prefer lotic habitats" (Frest & Johannes, 1992b, p. 8). Of the taxa listed in Table 1, the following likely fall into the cold water group: *Valvata humeralis*, all *Pyrgulopsis* species; all *Lyogyrus* species; all *Fluminicola* species; *Stagnicola montanensis*; *Lanx patelloides*; *Helisoma (C.) newberryi*; all *Vorticifex* species; the larger bivalves; *Pisidium (P.) idahoense*, *P. (C.) contortum*; *P. (C.) pauperculum*; *P. (C.) ultramontanum*; *P. (N.) punctatum*, and *P. (C.)* n. sp. 1 (= Modoc Plateau peaclam of Taylor & Bright, 1987).

In general, limnetic habitats are very favorable for freshwater mollusks. There are a few strict limnocole (lake-restricted) taxa in the Upper Klamath drainage. Examples include *Pyrgulopsis archimedis*, *Pyrgulopsis* n. sp. 1, and *Lyogyrus* n. sp. 2. More common are limnophile species, such as *Vorticifex klamathensis klamathensis*; *Lyogyrus* n. sp. 4; and *Pisidium (C.) ultramontanum*. Quite a few taxa are restricted to or most common in limnocrenes. These include several *Fluminicola* species, of which *Fluminicola* n. sp. 1 is a prime example; many of the limnophiles; and such taxa as *Pisidium (C.) ultramontanum* and *P. (C.)* n. sp. 1. As in other parts of the U.S., there are a few amniphile taxa in the Upper Sacramento system also. As regards large-river taxa, the preeminent examples here are probably certain of the larger *Fluminicola* species, *Pisidium (C.)* n. sp., and *Lanx alta*. The river form of *Juga (O.) nigrina* is another amniphile; but this taxon seems to prefer smaller rivers and streams. Some large bivalves, such as *Margaritifera falcata*, are essentially amniphiles. For the majority of the cold-water stenotherms, spring-related environments in the broad sense are typical; and many are cold spring crenocoles or at least crenophiles.

Elsewhere in the western U.S., there are also warm spring (thermocrene) stenothermal taxa (thermicoles or thermiphiles), particularly in the Hydrobiidae; however, none have yet been found in the Upper Klamath drainage, even though some occur in the nearby Great Basin drainages (Hershler, 1994), including at least two in the Oregon Interior Basin. Most freshwater species have narrow salinity tolerances (this does not necessarily hold on the generic or family level, particularly for such families as the Hydrobiidae), and most freshwater forms are not tolerant of acidic or very alkaline waters: they prefer slightly alkaline habitats. Here again some Physidae, Planorbidae, or Sphaeriidae are the most prominent exceptions. As regards pH, many species prefer slightly alkaline waters. These are generally derived from calcareous strata and the regolith resulting from their weathering, *i.e.* such sedimentary units as limestone and dolomite. Diversity is

often lowest on basic igneous rocks such as granites. Many of the native cold-water taxa prefer or are restricted to coarse substrate (*i.e.*, are lithophiles). A few forms are pelophiles; good exemplars of the preference for muddy substrate are *Helisoma (C.) newberryi* and *Pisidium (C.) ultramontanum*. These two species are also stenothermal forms, requiring oxygenated soft substrate. This combination of preferences considerably restricts possible occurrence of these taxa under current conditions; however, both have extensive late Pliocene-Pleistocene fossil records (see Taylor, 1985; Taylor & Bright, 1987), indicating former widespread prevalence of this habitat in portions of the western U. S.

Some forms, particularly hydrobiid snails, may live only in phreatic waters, such as in subterranean caves, and may be only accidentally or not at all represented in epigean environments. These taxa often live in very low nutrient, low DO situations, generally in areas with extensive limestone karst, a landform not well represented locally.

LIFE HISTORY

Western U.S. freshwater mollusks pursue more than one life history strategy. While particular strategies may be typical of certain families, this must be evaluated on a species by species basis. Many of the cold water forms are semelparous breeders and have single-year life spans. Other taxa, such as *Valvata*, may sometimes live for two years. *Juga* is thought to have a life span of 5-7 years and to reach maturity in 3 years (Furnish, 1990). Certain of the pulmonates are iteroparous breeders and may live for several years: but the Lancidae have 1-year life spans and are semelparous. Most Northwest Hydrobiidae (*Fluminicola*, *Lyogyrus*, *Pyrgulopsis*) are short-lived and semelparous. Most Sphaeriidae are short-lived (essentially one year), but many are iteroparous, even though broods are often small. Unionacean bivalves have long life spans and are semelparous, often with comparatively long annual breeding seasons. Almost all of these large bivalves have a parasitic larval stage (the glochidial stage) resident for some weeks on the gills of freshwater fishes; they are dependent on the fish for distribution and successful completion of their life cycle. Host specificity varies from species to species; some are quite species specific. Thus, fish host distribution is as vital to their survival as is availability of proper subadult and adult habitat.

The breeding season for many of the Pacific Northwest cold-water snails appears to be between February-May, with egg laying and hatching taking place between March-July. Details and precise timing vary from species to species; but eggs are quite often laid about 1 month after copulation, and the eggs often hatch about one month after they are laid. Cold-water stenotherm breeding adults commonly die shortly after laying eggs. Metabolism varies seasonally and

diumally, with greater activity in the spring and summer and in the daytime. Certain species, particularly of freshwater snails, are also strongly photophobic. Seasonality, both in regard to metabolic rate and reproduction, appears to apply to river species more than to spring forms, but is still pronounced. Some species are quite sensitive to variations in insolation or to physical disturbance, often releasing their hold on the substrate if disturbed. Some species are relatively active; but the majority (even of the active forms) do not voluntarily travel far from their place of birth, and thus are sessile for all practical purposes. This is particularly true for the predominantly or totally perilithon feeders, such as *Vorticifex*, *Lanx*, and *Fluminicola*, and even some of the eurytopic types (such as many Physidae) may not travel far in flowing water habitats.

Given the foregoing, many Pacific Northwest freshwater mollusk species, particularly the cold water forms, can be characterized overall as stenotopic. As annual population turnover in most freshwater mollusk species is considerable (*e.g.* 90% or more for the hydrobiid *Fluminicola columbiana* and the lancid *Fisherola nuttalli*: Coutant & Becker, 1970 and unpublished data), and many breed only once, they can be quite vulnerable to major disturbance events. In disturbed streams, mollusks may be disproportionately affected: this often makes them particularly effective indicators of pollution and other forms of environmental disturbance. With so many streams in the Pacific Northwest affected by human modification (Benke, 1990), mollusks and their role in the ecosystem are often overlooked. In undisturbed habitats they are often extremely abundant, and in fact frequently dominate the invertebrate fauna in terms of biomass and number of individuals. The genus *Juga*, for example, may comprise more than 90% of the total invertebrate biomass in some streams (Hawkins & Furnish, 1987). Similar densities are often encountered in Northwest lotic settings with the genera *Fluminicola*, *Vorticifex*, *Pyrgulopsis*, *Lanx*, and *Corbicula*. Sphaeriids are also often very abundant (often dominant) in soft substrate communities. Examples of all of these occurrences (with the exception of the introduced *Corbicula*) still can be readily found in the Upper Klamath drainage, particularly in the lower Williamson River and the springs surrounding Upper Klamath Lake. Similar densities of the large bivalves *Gonidea angulata* and *Margaritifera falcata* have been seen elsewhere in comparable settings: the best example to date in this area is the lower Williamson River.

ROLE OF MOLLUSKS

Mollusks mostly fill the role of primary herbivores in freshwater aquatic ecosystems. The perilithon and periphyton feeders are very significant in terms of controlling growth of epiphytes. Some taxa are significant consumers of the larger aquatic macrophytes. Detritivore genera such as *Helisoma* and *Valvata* play a very significant role in recycling of organic detritus. The freshwater

bivalves are primary phytoplankton and zooplankton feeders. In turn, these mollusks serve as food to a variety of freshwater fish, including game fish. Examples include native trout, native salmonids, Dolly vardens, whitefish, sturgeon, and some sculpins and squawfish. Snails and smaller freshwater bivalves are also commonly consumed by larger aquatic insects, particularly larval forms, leeches, and by a variety of birds, including ducks, geese, herons, and cranes. Large freshwater clams (and some snails) are avidly eaten by raccoons, muskrats, otters, and beavers. These mollusks were utilized extensively for food, tools, and ornament by Native Americans as well; there are well-known local examples. Sphaeriids are consumed in vast numbers by bottom-feeding fish such as sturgeon and whitefish and by most water birds as well. The wide distribution of these small clams in aquatic environments has assured their utilization as a food resource by a variety of animal groups. Specialized species inhabit both warm and cold springs, temporary (including woodland vernal) ponds, swamps, sloughs, and backwaters, as well as the more preferred cold and clean permanent-water habitats. For basic ecology and biology (although with an eastern U.S. slant), recent papers by Brown (1991: gastropods) and McMahon (1991: bivalves) are useful. See also discussion of all of the foregoing in Frest & Johannes (1995a).

DRAINAGE HISTORY

The historic and current freshwater mollusk fauna of the Upper Klamath drainage can only be understood completely in relation to its biogeography. Faunal biogeography, as has become evident in recent years, is intimately connected to its geologic context, especially in regard to tectonics and lithostratigraphy. As it happens, the biota, particularly as reflected by freshwater fishes and mollusks, has often yielded clues as to a river system's development, if not the timing of major changes. Similarly, information on regional geologic history often yields information or defines constraints on drainage and faunal history. The literature is scattered, and will only be summarized briefly here. The best references for the local fauna are Taylor (1985) and Taylor & Bright (1987), and much of the following discussion is adapted from these works. The radiometric date framework for the region derives from Sarna-Wojcicki (1976).

It is well established that the current Snake River system of Washington, Oregon, Idaho, and Wyoming is composite. The Washington Snake and Hells Canyon were until the Pleistocene part of the Columbia drainage (Clearwater River). The current middle Snake River of Idaho for some time was connected to various Pacific drainages, notably the Klamath and Sacramento. The ancient Snake-California connection was first suggested by ichthyologists (Hubbs & Miller, 1948); some later works arrived at similar conclusions (*e.g.*, Miller, 1959, 1965; Miller & Smith, 1981; Smith, 1975, 1978, 1981). Geologists and malacologists reached parallel conclusions (Wheeler &

Cook, 1954; Taylor, 1966a; 1985; Taylor & Smith, 1981; Taylor & Bright, 1987; Repenning, Weasma, & Scott, 1995), based upon different lines of evidence. Various connections have been suggested, including the Klamath, Sacramento-Pit, and Sacramento-Feather systems. The most likely course (Taylor, 1985; Taylor & Bright, 1987) was through the Harney and Malheur Lake basins, thence to the Warner Lakes area, and thence to northeastern California and southwestern Oregon.

The basic scenario for the Late Cenozoic (the last 18 million years) can be summarized as follows. Some connection between the Sacramento-San Joaquin was established as early as the late Miocene, as indicated by fossil freshwater fishes (Smith, 1975, 1981) and mollusks (Taylor, 1985). In early Pliocene times (perhaps 3.5-4.0 MYBP), the upper Pit River (above the Falls) was a tributary of a Snake River that flowed northwestward to the Pacific. The likely connection was to the Klamath River in the Upper Klamath Lake region (Taylor & Bright, 1987). The somewhat smaller Sacramento system flowed south to a marine-freshwater embayment in the southern San Joaquin Valley. A diverse endemic fauna developed in the lower Sacramento-San Joaquin Valley that mostly became extinct by the early Pleistocene. Endemism also developed in the Pit and Upper Klamath drainages, then conjoined. By later Pliocene times (prior to 1.5 MYBP) the embayment had vanished, and the Sacramento River now flowed into Monterey Bay. In early Pleistocene times (perhaps 0.7-0.75 MYBP) there was a short-lived large lake in the San Joaquin Valley, and the San Joaquin had joined the Sacramento system. Species typical of the more northern drainages now invaded the San Joaquin for the first time, indicating that the Pit had by now been added to the Sacramento system. Interestingly, there is little indication of headward migration of forms from the lower Sacramento system, specifically above the Pit River Falls; and no indication of transfer of such forms to the Upper Klamath drainage.

By early Pleistocene times the former Snake River system was disrupted by block faulting related to the more extensive tectonics of the Basin and Range. Extensive sheet basalt flows characterize the northern periphery of the Basin, generally just outside the current Lahontan internal drainage. The result was the formation of numerous small internal drainage basins in southeastern Oregon and extreme northeastern California. Lahontan elements spread into some of these Basins during the Pleistocene, and some Snake River elements invaded Lahontan drainages, particularly east of the Sierra Nevada Mountains. The Klamath, Sacramento, and Snake systems assumed their present configurations at about this time, and extensive lakes formed in various of the now-internally draining Lahontan and peripheral basins. Considerable fluctuations of lake levels occurred during the remainder of the Pleistocene; in more recent years (4-6,000 YBP to the present), the overall effect has been reduction in lake volume and numbers.

Vigorous speciation has taken place in the Lahontan and peripheral basins, most undoubtedly pre-Pleistocene. Existing species with fossil records extend back as far as the

Miocene, and many were definitely present in the Pliocene. Species swarms are most evident in the genera *Pyrgulopsis* and *Tryonia*.; a similar local diversification occurs in *Lyogyrus*. Several of these endemic clusters have been described only very recently, and the process is ongoing: major works are Taylor (1966b), Hershler (1985), Taylor (1987), Hershler & Landeye (1988), Hershler & Sada (1987), Hershler (1989), Hershler & Thompson (1991), and Hershler (1994). Location of these groups gives some clue to former stream connections. *Tryonia* occurs from southern California across Arizona and New Mexico and southern Nevada and Utah east to west Texas, with peripheral sites in northern Mexico and Florida. *Pyrgulopsis* (*s.l.*) occurs in much the same area in the western U.S., but extends north to the periphery of the Great Basin and Snake River Plain, *i.e.* southeastern Oregon, southern Idaho, and western Wyoming and Montana, with occasional disjuncts elsewhere (see Frest & Johannes, 1995a, fig. 12). The *Pyrgulopsis* species group that Gregg & Taylor (1965) segregated as *Fontelicella* occurs on the Lahontan periphery, *i.e.* in the Snake River system in western Wyoming, southern and central Idaho, southwestern Oregon, on the Oregon-Washington border, and in northeastern California. The westernmost and southernmost occurrences are in the Upper Klamath system and in the Sacramento system (Pit and its tributaries). Occurrences of *Lyogyrus* are mostly on the northern periphery of the Great Basin, to the south coinciding with the distribution of *Fontelicella*. *Lyogyrus* obviously does not occur throughout the Sacramento or Klamath systems, but only in the headwaters: in the Sacramento system in the Pit and its tributaries and around and in Upper Klamath Lake. Species in these areas seem distinct from other western occurrences (Frest & Johannes, 1995a; see also fig. 13).

A short-lived connection between the ancestral Snake system and the Columbia Basin has been suggested by Allison (1968) and Taylor (1985). Most likely conduits during Pleistocene high lake stands from the interior drainages and pluvial lakes of southeastern Oregon to the lower Columbia River would be either the Deschutes or John Day Rivers, presumably *via* the Upper Klamath drainage. Taylor (1985) suggests that *Anodonta wahlametensis* and *Vorticifex effusus* may have entered the Columbia system by means of this route comparatively recently. Some evidence of such a connection remains, such as occurrences of small *Fluminicola* species in the Deschutes system (Taylor, 1985), and an occurrence of *Stagnicola apicina* in the Fossil Lake beds of Oregon. Original and long-lived separation of the Columbia and more southerly drainages was suggested by Taylor (1966a, 1985) because of the existence of species pairs in the two areas. Miocene examples occur in the freshwater snail genera *Bellamya* and *Juga* (*Calibasis*). The modern pairs *Vorticifex effusus* and *V. neritoides* and *Fisherola* and *Lanx* may be similar cases. We would also suggest species swarms in the snail genus *Juga (Oreobasis)* in the Deschutes River and Columbia Gorge (largely undescribed) *vs.* the Great Basin, southwest

Oregon and northern California (mostly described) as another example (see Frest & Johannes, 1995a for further discussion).

MOLLUSK BIOGEOGRAPHY

As may be inferred from the foregoing, the modern freshwater mollusk fauna of the Upper Klamath drainage is composite. At present, the system is bordered on the north by parts of the Deschutes and John Day systems (Columbia drainage). The western periphery interfingers with the Rogue and Umpqua systems, mostly in the area of Crater Lake. On the eastern margin are situated portions of the Oregon Interior Basin. To the southeast, the Upper Klamath drainage borders the California and Nevada Great Basin, now occupied by a series of small internal drainage systems. Notable among these is the Goose Lake basin, which in high water years may connect to the North Fork Pit River. Because the fish fauna of the Goose Lake basin seems quite distinct from both that of the Upper Klamath and the Pit drainages, and the affinities of much of this fauna are with the Great Basin, this area is generally grouped by biogeographers with the Great Basin. To the south, the Upper Klamath drainage interfingers with the Pit drainage.

In order to assess relationships of the Upper Klamath drainage freshwater mollusks, we found it necessary to consider the malacofaunas of the peripheral drainages in some detail. This became especially necessary as the number of new and rare taxa mounted. To properly assess their status, it is imperative to determine their full possible rage. To do this we first reviewed the literature. We have also conducted fairly extensive fieldwork in the peripheral drainages in the period between 1990-1994. In particular, a recent survey of the Upper Sacramento system should be mentioned (Frest & Johannes, 1993a; 1994a, b; 1995b), as well as the Tuscarora Pipeline survey (Frest & Johannes, 1994c), which involved part of the Upper Klamath drainage. R. Hershler also made available published and unpublished results of his and his collaborators' fieldwork in northeastern California and Interior Oregon (an example is Hershler, 1992 and in press). As nearly all of this was considered outside the direct purview of our contract, none of this work was billed to this contract; and it is not reported on except in passing here. It is relevant, however, in that failure to find many of the Upper Klamath drainage endemics in these areas after modern survey emphasizes the unique aspects of this drainage's fauna, and emphasizes the rarity of the endemic taxa.

A problematic area is the Goose Lake drainage. Because of the equivocal position and relationships of this drainage, we do not at present list any of our sites and their faunas from the Goose Lake area (collected recently for other projects), and did not pass along expenses for these sites to this project. Had all peripheral sites for which we have recent data been included,

the size of this report would have more than doubled. Still, we freely use this data where necessary to assess status and identity of some of the Upper Klamath drainage taxa. Some of this information is or will soon be available in the Interior Columbia Basin report (Frest & Johannes, 1995a), the last Upper Sacramento report (Frest & Johannes, 1995b), in Hershler & Frest (in press), or in Hershler (in press). For additional data, contact the authors.

As noted by Taylor (1985) and Taylor & Bright (1987), the Upper Klamath drainage and adjoining areas have had a complex Late Cenozoic history, traces of which are still reflected in the fauna; and certain species can be ascribed to specific points of origin. Significant species are discussed below individually. Mollusk biogeography in this area is complex. The fauna of the Klamath River below the Link River is quite distinct from that of the rest of the system. Various species seem to be endemic to Upper Klamath Lake proper. Apparently, certain taxa are restricted to the Williamson or to the Lost River drainages. Even on Upper Klamath Lake, there is some differentiation between spring faunas on the northwest and eastern periphery.

For the purposes of this report, the current Upper Klamath drainage malacofauna (Table 1) can be divided into several groups. One is common throughout much of North America. This is the largest single group here, as elsewhere, and includes approximately 35 native and 2 introduced species out of the 66 that have been ascribed to the Upper Klamath (Table 1). The other groups embrace more geographically restricted forms. The second covers 14 species likely to have originated in Upper Klamath Lake and immediately adjacent drainages, and largely or entirely restricted to it now. The third involves 5 species likely to have originated in, or at least recently are largely confined to, the Great Basin and peripheral internal drainages. This group includes the species associated with the course of the former Snake River. A few species seem to occur only in the Lost River and its tributaries. Some of these taxa have nearest relatives in the Pit River drainage: with further study, these may be included in the Great Basin group. A few species seem to be restricted to the Williamson and Sprague rivers and their tributaries. Finally, a few species appear to be endemic to the northwestern periphery of Upper Klamath Lake. These typically have sister species that occur in the Pit River or its tributaries.

The freshwater malacofauna of the Upper Klamath drainage is evidently quite distinct from that characteristic of most Pacific Northwest coastal streams. The high rates of endemism and the Great Basin element have few close parallels. In general, coastal rivers of Alaska, British Columbia, Washington, and much of Oregon were strongly affected by Wisconsinan glaciation and have few endemic forms. From Washington southward, the presence of one or two species of the freshwater snail genera *Fluminicola* (generally either so-called *nuttalliana*, *virens*, or related species: see Hershler & Frest, in press, for discussion of species identities) and *Juga* (subgenus *Juga*; generally either *silicula* or *plicifera*) is characteristic. In extreme southwestern Oregon and northwestern California, there are substantial changes in the fauna. The endemic western North

American freshwater pulmonate family Lancidae occurs in the Rogue, Umpqua, Klamath, Sacramento, and related drainages, with one species disjunct to the Columbia system and another endemic to large spring complexes in the middle Snake River drainage only. The earliest fossil record for the family is from Cretaceous units in Nevada; and most fossil records (Pliocene-Pleistocene) are from the Great Basin and peripheral areas. Endemic modern taxa occur in the Columbia Basin, Washington, Oregon, and Idaho (listing candidate *Fisherola nuttalli*); middle Snake River, Idaho (the Endangered *Lanx* n. sp.); the Umpqua River, Oregon (*Lanx subrotunda*); the Rogue and Klamath Rivers and vicinity, Oregon-California (*Lanx alta*); Upper Klamath Lake, Oregon (*Lanx klamathensis*); and the Sacramento system (*Lanx patelloides*).

Taylor (1985) and Taylor & Bright (1987) noted similarities in the freshwater mollusk faunas of the Upper Klamath system and the Pit River. They also noted, however, the existence of several lake forms in Upper Klamath Lake that for habitat reasons have no parallels in the Pit (and hence Sacramento drainage). Similarities include the presence of such Snake River-related (peripheral Lahontan or Great Basin) forms as *Helisoma (C.) newberryi*, lotic species of *Lanx* (*alta* and *patelloides* respectively), species in the *Juga* subgenus *Calibasis*, certain small *Fluminicola* species, *Pisidium (P.) ultramontanum*, *P. (C.)* n. sp. 1, and western occurrences of *Pisidium (N.) punctatum*. We would add some others. While Taylor did not note species pairs in the Upper Klamath *vs.* the Pit, such may occur. For example, one Upper Klamath species of *Lyogyrus* is very similar to the ancestral Snake drainage form *Lyogyrus greggi*; this species may not have a Pit counterpart. However, a second new species of *Lyogyrus* from the Upper Klamath Lake area has a Pit tributary congener (Frest & Johannes, 1995b). Similarly, a *Fontelicella*-group species very similar to *intermedia* occurs in the Upper Klamath area; the related *Pyrgulopsis* n. sp. 1 and 2 occur in the Pit drainage. At last one Upper Klamath drainage *Fluminicola* species is similar to the Sacramento *F. seminalis*. We have recently been collecting *Fluminicola* over the whole range of the genus as part of a systematic revision (with R. Hershler, NMNH). Among the findings are a number of small species, often spring-dwellers, with distinctive soft, and often shell, morphology. These forms correspond morphologically and ecologically to the southeastern U.S. *Somatogyrus* group and *Gillia altilis* and to the Great Basin swarms of endemic *Pyrgulopsis*. Most species occur in southwestern Oregon and northwestern California. The species in the Upper and Middle Klamath systems and Upper Sacramento system appear to be mostly distinct, but are clearly closely related. One difference between the Pit and the Upper Klamath drainages is the general rarity of *Juga* in the latter. This genus is also fairly widespread in the northeastern California Great Basin, so that its rarity here is puzzling.

There are probably some relations also with the Rogue and Umpqua systems of southwestern Oregon; but indications are that the malacofauna of these two systems, while very different from those immediately north and definitely related to those of the Sacramento and

Klamath (as witness the presence of Lancidae) are relatively depauperate and contain comparatively few endemics (Taylor, 1985 and our research to date). We have recently found small species of *Fluminicola*, however, in the headwaters of both systems that are reminiscent of those in both the Sacramento and Klamath drainages, *s.l.*

Outside of the Upper Sacramento system, the closest analogue, both taxonomically and ecologically, to the Upper Klamath drainage fauna is probably that of the middle Snake River, Idaho. The prevalence of oligotrophic lotic habitats with predominantly cobble substrate, basalt bedrock (in the Pit and middle Snake), and large spring complexes (nasmodes) are striking. Large-lake habitats are absent from the middle Snake, although this area had very extensive examples in the Pliocene and Pleistocene. As noted above, certain modern Snake River forms are thought to derive from the Sacramento system via the Upper Klamath (for example Pliocene Lake Idaho *Lanx* n. sp. aff. *patelloides* and modern *Lanx* n. sp.), and the relationship between the ancestral Snake system and Pliocene Lake Idaho and the upper Sacramento and Upper Klamath drainage has been discussed previously. Faunal similarities include the presence of local endemic river and spring hydrobiids and lancids, and the overall aspect (see Frest & Bowler, 1993, for list) is very close. The middle Snake, however, now lacks pleurocerids, although these (including the Sacramento-Klamath-Great Basin periphery subgenus *Calibasis*) were present in the Pliocene (Taylor, 1985). We have previously used the large spring complexes of the Pit River and Upper Klamath Lake as the closest modern analogy to Pliocene Lake Idaho, and compared the modern middle Snake River alcove spring complexes to the Fall River-Hat Creek springs (Frest & Johannes, 1992b).

It should be noted here that the mollusk species groups defined above often have parallels in other animal groups, in particular fish. Traces of the ancestral Snake system still survive in the Great Basin, Upper Klamath, and Sacramento, for example as reflected in the modern and fossil distribution of the sucker genera *Chasmistes* and *Deltistes* (Miller & Smith, 1981). The Snake-Great Basin relationship has been discussed by Smith (1978), Minkley, Hendrickson, & Bond (1985) and Sigler & Sigler (1987). The Sacramento-Snake connection as evidenced by fossil fish distribution has been described by Smith (1978, 1981) and Taylor & Smith (1981). Some notable parallels in the recent fauna should be noted here (distributions from Moyle, 1976; Moyle *et al.*, 1982; and McGinnis, 1984). The formerly widespread (in the Great Basin and peripheral drainages) sunfish genus *Archoplites* in modern times lived naturally only in the lower Sacramento and San Joaquin. The brook lamprey *Lampetra lethophaga* suggests a Pit-Upper Klamath connection. The related species *L. folletti* is a Klamath endemic. The closely related Modoc and Sacramento suckers *Catostomus microps* and *C. occidentalis* may provide another example. The tui chub *Gila bicolor* occurs in the Lahontan and peripheral drainages, the Klamath, and the upper Pit River, including Goose Lake. Among the sculpins, the Pit River endemic Rough

sculpin *Cottus asperrimus*, the Upper Klamath-Pit Marbled sculpin *C. klamathensis*, the Sacramento-San Joaquin [and a few coastal streams] Riffle sculpin *C. gulosus*, and the Upper Sacramento-Pit River (Upper Sacramento system as used herein) Pit sculpin *C. pitensis* have distributions parallel to the previously discussed mollusk groups.

Some workers have formally defined biotic provinces based on fish distribution (Moyle, 1976; McGinnis, 1984). Such units as the Sacramento Province, the Klamath Province (with two subprovinces, Upper and Lower, formally separated at Klamath Falls), and the Lahontan Province have direct mollusk parallels, as discussed above. For example, in *Fluminicola*, *F. turbiniformis* [as defined by Hershler & Frest (in press)] is mostly peripheral Lahontan. However, the closely related *Fluminicola* n. sp. 10 of Frest & Johannes (1995b) and a sister species have sites in the Upper Sacramento and Uppar Klamath systems. Similarly, there are small parallel species swarms, separate but related, in the Upper Sacramento and Upper and Lower Klamath drainages. Given the major differences in trophic level and life history between mollusks and fish, drainage changes related to major tectonic events are the most likely explanation for convergences in distribution, particularly of the many narrow endemics. This connection has been noted repeatedly in North America, and has been documented extensively elsewhere, for example in desert fishes and snails of the Great Basin. Ash Meadows and other Owens and Amargosa River (Death Valley) faunas, California and Nevada, and Arizona and New Mexico faunas provide well-documented examples (for mollusks, see Taylor, 1987; Hershler & Sada, 1987; Hershler & Landeye, 1988; and Hershler, 1989; for fish, see numerous articles in Minkley & Deacon, 1991). Similar relationships may exist also in crayfishes, *e.g.* the Endangered Pit River *Pacificastus fortis* and other *Pacificastus* species. Even more remarkably, distribution of certain land snail species, particularly in *Monadenia*, *Vespericola*, and related genera, seems to parallel that of the freshwater forms. There are likewise related endemic clusters of vascular plant species in the Klamath and Siskiyou Mountains; but these do not have Snake River parallels.

PREVIOUS WORK

No other detailed mollusk surveys aimed specifically at the Upper Klamath Lake drainage have been conducted prior to this one. However, many malacologists, both professional and amateur, have collected in this area since 1838. Particularly notable are efforts by Hanna, Smith, and others: early records from the area were compiled by Binney (1865) and by Henderson (1929, 1936b). The comprehensive bibliography by Taylor (1975) lists nearly all early efforts. Particularly notable are species descriptions and records of Smith (1975); Hanna (1922); Clench (1940); Berry (1947); and Taylor (1960, 1966b, 1985). Interest continues to this day , *e.g.*

Hershler (1994). Aside from published works, there are a number of unpublished locality records in the gray literature. Examples include sites visited in the 1950s and 1960s by D. W. Taylor (Gregg, unpub.). Additional localities in this area were collected in the 1970s by Clarke (1976 unpub.). Other sites are included in Frest & Johannes (1994c).

In evaluating the results of this survey, it proved useful to compile a list of species previously reported from the area and their reported habitats. Major sources were Henderson (1929, 1936a, b); Taylor (1977, unpub.; 1981; other unpublished notes); and our own previous work dating from 1991-1994. Terminology of the earlier works has been modernized, consistent with that described in **TAXONOMY** below. Results are summarized in Table 1.

METHODS

FIELD COLLECTIONS

Standard methods in malacology were used to implement the study. An initial (baseline) survey of the study area was conducted to evaluate habitat types, possible collection sites, and access. This was initiated in 1991 (before the present project) and continued in 1992-1993. Collection methods varied according to substrate type and degree of aquatic macrophyte or plant and animal epiphytic cover. In general, all areas were visually inspected first and then spot sampled to insure completeness of coverage and size and extent of major subhabitats prior to comprehensive collection. More systematic methods were used for formally defined sites. In coarse substrate areas such as cobble-boulder bars, a random sample of stones was removed along measured transects and the mollusks were either hand collected or brushed from them into a 7.5" X 13" [19.1 x 33.0 cm] tray. Areas with mud, sand, or silt substrate were sampled by excavating small areas of bottom sediment to a depth of about 3 cm using a dip net with an 8" [20.3 cm] diameter and effective mesh size of 40 [Tyler equivalent 35 mesh: openings 0.425 mm]. Areas with rooted aquatic macrophyte vegetation (*e.g.*, shallow portions of deep spring pools and channel edges in slow-moving streams) were also sampled using the same size dip net. Vegetation was retrieved with the net and then placed in 7.5" x 13" [19.1 x 33.0 cm] trays and vigorously shaken to dislodge all mollusks. In areas with bedrock or cobble-boulder substrate (most of the study area), the bedrock or liths were scrubbed underwater with a scrub brush. Dislodged material was caught and retained in a submerged 7.5" X 13" [19.1 x 33.0 cm] tray positioned downstream from the scraped surface. We took at least 10 subsamples from each sample site: the surface area represented at each was generally about 1 m^2. Most of our samples

were collected along a 100 ft. (approximately 30 m) transect. Where possible, transects were across the river or other water body; however, some transects were run parallel to shore, particularly where major tributaries joined the chosen body. In small springs, large samples were not feasible, and hand and dipnet collections the chosen methods. Large volumes of specimens were not typical, except from larger springs; these could be treated much as river sites. Where soft substrate (mud-fine gravel was locally significant, samples were collected and sieved separately from the coarse substrate samples in the field (to 40 mesh) to eliminate mud. Generally, a 9-16 oz. [266.2-473.2 ml] volume of sieved concentrate from each such site was saved and labeled separately. Where such samples contained large volumes of substrate (sand-fine gravel) and small numbers of mollusks, mollusk separation and relaxation was not practical, and the sample was preserved immediately. Regardless of origin, the collected material from each subsample from either coarse or fine substrate was decanted into a labeled 16 oz. [473.2 ml] container for further treatment. The subsamples were run through a standard sieve series (to 40 mesh) in the field to ensure collection of all mollusks and to eliminate very coarse and very fine organic debris, mud, and silt. For samples expected or known to contain difficult to identify species, we routinely employ relaxation, fixation, and preservation using a succession of menthol and propylene phenoxytol, dilute formalin, and either isopropyl or ethyl alcohol (Frest & Johannes, 1992b). While we were equipped for such techniques, they were not necessary for all samples.

Snails were typically not common in Upper Klamath Lake, but they were often abundant in the tributary creeks and springs. Samples frequently contained large volumes of organic material. It was necessary to sieve them upon collection to ensure relaxation and proper preservation. Sieved samples, generally a concentrate with a volume of 9-16 fluid oz. [266.2-473.2 ml], were placed in labeled jars. Each site required an average of 1 hour to collect. We made a special effort to collect drift samples; such samples often provide information as to composition and changes in mollusk faunas, at least dating to the last high-water period (Frest & Johannes, 1993a, b). Such samples were very rare here. The surrounding shoreline of major streams, lakes, and pools was also searched for unionacean mussels, and a representative sample retained. Notes on collection conditions, substrate, habitat, and associated flora and fauna were made at each site (see Appendix A for description; Appendix B for site maps).

Field work for this project in 1994 was conducted between June 16 and July 1, 1994. A draft report was issued in 1994 (Frest & Johannes, 1994d).

LABORATORY PROCEDURES

Preserved samples were resieved in the laboratory to remove fine sediment and plant and animal detritus, and the full volume was examined. The whole sample was picked for mollusks under a low-power binocular microscope. With many mollusk taxa (especially certain Physidae and Hydrobiidae), dissection, particularly of relaxed specimens, is necessary for proper identification. Of the species of special interest to this study, this can apply to the Pleuroceridae, Physidae, and Hydrobiidae. It is particularly significant here, as a number of new and previously described species, especially in the difficult hydrobiid genera *Fluminicola*, *Pyrgulopsis*, and *Lyogyrus*, were encountered. Dissections and drawings of selected specimens were done using standard methods under a Wild M3 microscope equipped with a drawing tube. Picked mollusks and other invertebrates have been retained for further study. The mollusks were placed in buffered 70% ethyl or isopropyl alcohol-15% glycerin-15% water to ensure fixation and intact long-term preservation. Alcohol-resistant paper and ink is used for preparation of permanent labels. Field and other information has been entered in a data base devoted to mollusk collection management (Deixis MolluscDB™).

TAXONOMY

The need for species-level identifications precluded the use of standard textbooks (*e.g.*, Pennak, 1989; Thorp & Covich, 1991). Very few of the common species found here are mentioned in Pennak (1989), and none of the most significant taxa. However, species-level manuals have long been available for many North American freshwater forms. Where possible, the standard references (Burch, 1989 or its two predecessors Burch & Tottenham, 1980-Burch, 1982b-Burch, 1988 and Burch, 1982a for gastropods; Burch, 1972 and Clarke, 1973, 1981 for sphaeriids: Burch, 1973 for unionacean bivalves) were used. For undescribed taxa and recent changes in nomenclature, reference was made to the periodical and gray literature (*e.g.* Taylor, 1981). For *Fluminicola*, extensive use was made of Hershler & Frest (in press). We also made use of our own rather extensive reference collections. We have also examined large numbers of specimens of some taxa in the major U.S. museums (see **MUSEUM COLLECTIONS**). Common names, and species endings, are generally those of Turgeon *et al.* (1988) where possible. Higher taxonomic arrangement is largely that of Vaught (1989), except for that for the Sphaeriidae, which follows McMahon (*in* Thorp & Covich, 1991) and for the Hydrobiidae. For limitations of the Vaught classification see Frest & Johannes (1995a).

In most cases, we use the species definitions and ranges of Taylor (especially Taylor, 1981) in preference to those cited in other sources for certain western North American forms. Our reasoning is as follows. Until his recent retirement (*pers comm.*, P. Bowler, 1991), Dwight Taylor had perhaps the most comprehensive knowledge of western North American freshwater mollusks of any one living. He collected, described, and published upon freshwater fossil and modern forms from Oregon, California, and adjacent states from the 1950's through 1988. His bibliography (Taylor, 1975) remains the standard reference for western North America. Freshwater mollusks have been collected extensively in Oregon, beginning with the pioneer work of J. G. Newberry and T. Nuttall. In the late nineteenth and early twentieth centuries, major collectors were H. Hemphill, H. Hannibal, and J. Henderson. Particularly important early to late twentieth century workers were S. S. Berry, G. D. Hanna, W. O. Gregg, E. P. Chace, and Taylor. Taylor worked closely with some of these investigators, including Berry and Gregg. In the course of his own extensive researches, he reexamined the types of essentially all western North American forms, among others. Comparatively recently, he reviewed the literature on, and summarized the status and distribution of, the described California freshwater forms (Taylor, 1981).

In order to facilitate comparison of species concepts, particularly between Taylor (1981) and Burch (1989), our use of certain names is discussed here. Moreover, a few nomenclatorial changes have been included to reflect work done by various workers since 1982 (the effective end of literature coverage in Burch, 1989 and Taylor, 1981):

1) We use *Pyrgulopsis* as defined in Hershler & Thompson (1987) and Hershler (1994) in preference to *Fontelicella* and the other taxa described by Gregg & Taylor (1965). In the long run, subdivision of *Pyrgulopsis* will undoubtedly prove useful, perhaps along the lines of Gregg & Taylor (1965). However, many species have been added to the genus (*s.l.*) in the last five years, particularly by Hershler (*op. cit.*); and many more remain to be described.

2) *Lyogyrus* has recently been raised to generic status by Hershler & Thompson (1991).

3) Taylor (1966a, 1985) uses the name *Lithoglyphus* in preference to *Fluminicola*. However, Thompson (1984) provided data that indicate the distinctness of the European and American forms ascribed to *Lithoglyphus*. Additional unpublished information strengthens this interpretation; and this genus is currently being revised (Hershler, 1994; Hershler & Frest, in press).

4) We follow the lymnaeid generic classification of Burch (1989) for *Stagnicola* and for *Fossaria*, but the species taxonomy of Taylor (1981). We follow Taylor (1981) and Vaught (1989) in regarding the Lancidae as a distinct family.

5) We follow the practice of Taylor (1981) in regard to *Menetus*. Taylor (1981, p. 160) believes that the two commonly used names, *cooperi* and *opercularis*, are misapplied. Specimens here placed in *M. callioglyptus* (Vanatta, 1895) would be regarded by Burch (1989) as *M.*

opercularis (Gould, 1847), a species that Taylor believes was restricted to Mountain Lake and is now extinct. The most comprehensive review of *Menetus* is in Baker (1945).

6) Taylor (1981) uses the species name *californica* (Rowell, 1863) for forms of *Fernissia* that would be included in *F. fragilis* (Tryon, 1863) by Burch (1989).

7) Pending further investigation, we follow the classification of Taylor (1981) in regard to the Physidae, recognizing relatively few species in Oregon.

8) We use *Anodonta californiensis* Lea, 1852 in preference to *A. nuttalliana* Lea, 1838 for some California winged *Anodonta*; others are *A. wahlametensis* Lea, 1838, as recognized by Taylor (1981).

9) The classification of the Sphaeriidae (=Pisidiidae of Vaught, 1989) largely follows McMahon (in Thorp & Covich, 1991). However, Taylor (1981) preferred the use of *Musculium raymondi* (Cooper, 1890) for specimens elsewhere called *M. lacustre* (Müller, 1774). Taylor (1981) uses the specific name *Musculium truncatum* (Gould, 1845): in other works, this species is referred to as *M. partumeium* (Say, 1822). Taylor (1981) preferred to retain *Pisidium contortum* Prime, 1854 and *Pisidium pauperculum* Sterki, 1896 as full species, rather than as subspecies or forms of *P. nitidum* Jenyns, 1832, as done by Clarke (1973, 1981) and others. Other minor nomenclatorial preferences are noted in the species discussions.

MUSEUM COLLECTIONS

Many records for freshwater mollusk species are unpublished data resident in the major U.S. natural history museums. Moreover, older published species citations, particularly for small forms such as Hydrobiidae and difficult groups such as the Physidae, vary in accuracy from worker to worker and are frequently wrong, as are some museum identifications. To confirm presence, identity, and collection date, it is necessary to rely heavily upon museum collections. A major advantage of employment of the taxonomy of Taylor (1981) is that he used museum collections extensively, as well as making many others himself; consistent identifications and methodology, and a high level of accuracy, in his work may be presumed. In the course of other research, we had compiled museum records for several Upper Klamath streams and examined specimens of many others. Particular emphasis was placed upon inspection of types, as published illustrations and descriptions, especially in older literature, cannot be assumed to be accurate. We have also recollected many species from their type localities (*i.e.* obtained topotype specimens), where such sites are still extant. In 1991, before this project began, we visited the following institutions, all known to have extensive western U.S. freshwater mollusk collections: Academy of Natural Sciences of Philadelphia (ANSP); California Academy of Sciences (CAS); Delaware Museum of

Natural History (DMNH); National Museum of Natural History (Smithsonian Institution) (NMNH); University of Michigan Museum of Zoology (UMMZ); University of Colorado Museum of Zoology (UCM). This effort will be expanded to other species and institutions in the next year.

Some early results are summarized in Table 5.

RESULTS

To date we have surveyed approximately 100 freshwater sites in the Upper Klamath drainage (**APPENDIX A**). About 65 had mollusks (Tables 3, 4); about 40 have endemics or Species of Special Concern. Hydrobiids were noted at 56 sites. Perhaps 35 have small *Fluminicola*; 29 large *Fluminicola*; 6 *Pyrgulopsis*; and 14 *Lyogyrus*. Four sites have *Carinifex*; 12 have *Lanx*; 3 [4 in 1991] sites have *Juga*; 1 site has *Pisidium ultramontanum*; and 1 has *Anodonta californiensis*. Occurrence of several Species of Special Concern at particular sites is typical. Certain areas are of special interest, especially the large spring complexes on both sides of Upper Klamath Lake and along the lower Williamson River. Endemics may occur in all of the major river systems, including the Sprague and Lost rivers. Much of the drainage basin of these two rivers is now unsuitable habitat for endemic mollusks, as is the upper Williamson. The northern portion of the Upper Klamath Lake Basin, including Klamath Marsh, may also be unsuitable due to the heavy pumice falls associated with Crater Lake's Mazama event. The middle Klamath system fauna remains largely unique and narrowly endemic, only partly related to that above the Link River.

A number of new taxa (at least 16 to date) were discovered here during field work conducted in 1991-1994. Many of these species appear to occur only in this area, *i.e.* are narrow endemics. Others may be restricted to the middle Klamath drainage. This degree of endemism is extraordinary. It may be ascribed to the pivotal position of Upper Klamath Lake and its comparative great age. The current fauna is a mix of coastal and Great Basin elements, with a few Great Basin periphery endemics as well. The continuance of this lake for a longer period than typical of Great Basin pluvial lakes may also have allowed local speciation. Upper Klamath Lake is one of the few surviving Pliocene lakes and the only one with normal alkalinity and a large relict fauna. It is likely the best remaining window on environments prevalent in the interior West 2-17 million years ago. Suggested former drainage connections with the Snake system and with the Sacramento system also have enhanced species diversity. The area may also have been a part of a former, short-lived connection to the Columbia system.

Endemism occurs in several freshwater snail genera. Notable are the hydrobiid genera *Fluminicola* (at least 11 new species), *Lyogyrus* (at least 3 new species), and *Pyrgulopsis* (at least 2 new species, plus *Pyrgulopsis archimedis*). Upper Klamath Lake has the only surviving lake *Pyrgulopsis* species; but its peripheral position to the Great Basin means that the high diversity and high rate of endemism in *Pyrgulopsis* characteristic of core Great Basin areas is not as prominent here. Instead, spring and small stream environments are occupied by a number of apparently endemic *Fluminicola* and *Lyogyrus* species with similar habitat requirements. Endemism also occurs in the aberrant pulmonate genera *Vorticifex* and *Lanx*, both of which have species adapted to pluvial lakes, and in the unusual planorbid genus *Carinifex*. Most of the endemic taxa are stenotopes, requiring clear, well-oxygenated conditions with some flow; most are stenothermal as well.

Some 66 mollusk taxa have formerly and (including the 17 new species) are now ascribed to the Upper Klamath drainage (Table 1). These include roughly 45 freshwater snails and 21 freshwater bivalves. To date, we have not collected 6 described freshwater snails and 3 described bivalve species believed to occur in the area, while we have added a substantial number of new taxa. Of the 99 site written up formally so far, 77 had freshwater mollusks, a respectable showing considering the degree of recent habitat change, and comparable to that observed elsewhere (*e.g.*, Frest & Johannes, 1994a). Diversity at those sites with freshwater taxa averages between 3 and 4 species, about what would be expected from a semiarid area with spring environments predominant. A few site have diversities comparable to those of the exceptional Upper Sacramento system nasmodes, and are comparable in their exceptional quality and endemic diversity as well. Previous treatments (Frest & Johannes, 1993b; ROD, 1994; USFWS, 1994; Frest & Johannes ,1995a) of the mollusks of this area have recognized some 31 species [20 freshwater gastropods; 7 freshwater bivalves; and 4 terrestrial gastropods] as Sensitive or in need of protection (Table 2). Frest & Johannes (1993b) gave special status to 18 taxa; 5 of these are ROD species; and 29 were covered in the Interior Columbia Basin report (Frest & Johannes, 1995a). None of these taxa are as yet federally listed, although 2 bivalve species are current C2 candidates.

Past and ongoing modifications of the Upper Klamath system, including dredging and/or diversion of peripheral spring and stream channels, manipulation of water levels, and nutrient enhancement have very drastically reduced habitat for most of the endemic taxa. Many survive only at spring sources or in spring-influenced areas.

Large numbers of springs are either now dry, converted to cattle troughs, or heavily grazed. Such sites lack interesting mollusk faunas. Even so, our original estimate of the number of endemics (Frest & Johannes, 1993; Table 1 here) is likely to prove conservative. While this is beyond the scope of our present contract, it should be noted that there also appear to be at least

a few endemic land snail taxa in the area, though not so many as in the lower Klamath River drainage (Roth, 1993; Frest & Johannes, 1993b, 1995a). These include undescribed *Monadenia* species and a *Vespericola* related to *V. sierranus*, another SOSC.

In the future, we intend to further explore the periphery of the Upper Klamath Lake drainage, especially the border with the Oregon Interior Province and the middle Klamath River portion. Preliminary indications are that we have in excess of 8 new *Fluminicola*; 3 *Lyogyrus*; and at least 3 *Pyrgulopsis* species. Novelties in *Lanx* and *Vorticifex* are probable also. Other highlights of the area include the best remaining populations of the large unionids *Margaritifera falcata* and *Gonidea angulata* in the state; the sizable number of relatively undamaged large cold spring complexes; and the occurrence at a few sites of the so-called mares eggs (gigantic *Nostoc* colonies), which we have seen nowhere else in the west.

SENSITIVE SPECIES

In order to aid in appraisal of the mollusk fauna and its conservation needs, individual species discussions are here provided for the more sensitive species. The final report will incorporate information on all taxa. The format is that of Frest & Johannes (1995a); site- and area-specific information will be provided in the final report.

FRESHWATER SNAILS

Nez Blade Snail Complex

✓ ***Fluminicola* n. sp. 1 Klamath pebblesnail**

found @ 9 sites: 9,10,15,16,17,24,57,66,67

Type locality: None, as the species has yet to be described.

Description: See final report for description. The tall subglobose conch, dark tentacles and eye patches but light body; and sickle-shaped, moderately large penis are distinctive features. This taxon was cited as *Fluminicola* n. sp. 1 in Frest & Johannes (1993b, 1995a).

Ecology: This species occurs in Upper Klamath Lake, a few major tributaries, and part of the Klamath River, generally in areas with gravel-boulder substrate, spring influx, and some flow. This species, like most *Fluminicola*, prefers clear, cold, oligotrophic flowing water with high DO. It is found only rarely in springs and avoids areas with dense macrophyte beds. It sometimes occurs with other endemic *Fluminicola* spp., *Lanx alta* or *Lanx klamathensis*, *Lyogyrus* spp., *Helisoma*

(Carinifex) newberryi, or *Pisidium ultramontanum*. Predominantly a perilithon grazer and lithophile.

Original distribution: Klamath River, Siskiyou Co., CA, and Klamath Co., OR; Upper Klamath Lake, Klamath Co., OR; probably once very widespread in this area.

Current distribution: Middle and upper Klamath River, but now very sporadic (absent from impoundments and polluted stretches), Siskiyou Co., CA; Upper Klamath Lake and major spring-fed tributaries, Klamath Co., OR, including sites in Winema and Rogue River National Forests and Upper Klamath Lake National Wildlife Refuge. Other localities are on Medford District BLM lands. We have collected this species recently from a total of nine sites (Table 3).

Threats: Much of Upper Klamath Lake is strongly eutropified, so that live populations of this species are restricted to areas with spring influx or influence, even though dredged shells indicate past ubiquity in the lake. This hydrobiid is absent from or rare in slow-moving or polluted impoundments, such as reservoirs. Springs in the lake bottom proper are badly affected by past dredging to facilitate log transport and by current severe nutrient enhancement and sedimentation. The species does not occur in areas with dense beds of such macrophytes as *Myriophyllum* and *Elodea*, nor in area subject to eutropification or periodic hypoxic episodes. Many springs in the area are so heavily grazed as to completely extirpate or greatly reduce this species. Others are connected to irrigation canal systems; resulting sedimentation and eutropification either eliminates or greatly reduces this species. Channeling for such systems, and for log transport long ago, has also much reduced habitat, even when water quality remains excellent.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate; ongoing and past threats; very substantial reduction in habitat. This species is undoubtedly declining in numbers and in number of sites. From first-year results of this survey, we do not anticipate major increase in either the geographic range of, or the number of sites with, this taxon.

Recommended status: This species has no special status at present; but is a ROD species (ROD, 1994). It was recommended for listing by Frest & Johannes (1993b, 1995a). It should minimally be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to indicate that Federal and State (OR) listing as Endangered is appropriate, in our opinion. In mitigation for listed and candidate fish species in the Upper Klamath Lake area, care should be taken to avoid impact to this species, which can occur in sucker spawning areas.

References: Frest & Johannes (1993b, 1995a); ROD (1994); Deixis Consultants, 1991-94.

✓ *Fluminicola* n. sp. 2 — tall pebblesnail

See site : 23

Type locality: None designated; undescribed species.

Description: See final report for description. The tall conical conch, moderate size, black body, tentacles, and viscera, and flanged penis are distinctive features. The distinctive verge of this and several other Upper Klamath Lake drainage taxa may merit separation as a genus. This taxon was cited identically in Frest & Johannes (1993b, 1995a).

Ecology: Confined to large undisturbed, very cold oligotrophic springs draining into Upper Klamath Lake, Klamath Co., OR. The species occurs on pebbles and cobbles and is a perilithon grazer. Few macrophytes are present, except for local *Veronica*. Most striking at one site are large numbers of *Nostoc pruniforme*, which in some areas cover the substrate like cobbles. A crenophile, and perhaps limnocrene only, species. A perilithon grazer and lithophile.

Original distribution: Likely restricted to larger springs tributary to Upper Klamath Lake and related drainages, CA-OR (especially Klamath Co., OR).

Current distribution: Known from a few sites, on private land adjacent to Winema National Forest, on nearby Upper Klamath Lake National Wildlife Refuge, and on Winema National Forest lands. At present, this species can be ascribed with certainty to a single site (Table 3); others require further work for confirmation.

Threats: Springs in the lake bottom proper are badly affected by past dredging to facilitate log transport and by current severe nutrient enhancement and sedimentation. The species does not occur in areas with dense beds of such macrophytes as *Myriophyllum* and *Elodea*, nor in area subject to eutropification or periodic hypoxic episodes. Many springs in the area are so heavily grazed as to completely extirpate or greatly reduce this species. Others are connected to irrigation canal systems; resulting sedimentation and eutropification either eliminates or greatly reduces this species. Channeling for such systems, and for log transport long ago, has also much reduced habitat, even when water quality remains excellent. Areas used for log transport or storage still have not regained populations of this species.

Criteria for inclusion: Local endemic; likely occurrence on public lands; riparian associate. From first-year results, we do not anticipate that further finds will greatly expand either the range or site totals.

Recommended status: Has none at present, although it is a ROD species (ROD, 1994). It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to indicate that this species should be federally listed as Endangered; it should be listed similarly in OR.

References: ROD (1994); Frest & Johannes (1995b); Deixis Consultants, 1991-94.

✓ *Fluminicola* n. sp. 3 — Klamath Rim pebblesnail

See sites 12 + ?

Type locality: None has been designated yet for this recently discovered species.

Description: See Frest & Johannes (1995b). Distinctive features of this taxon are the small size, rather evenly gray body and tentacles, and narrow, elongate, sickle-shaped penis. This taxon was cited under the same name in Frest & Johannes (1993b, 1995a).

Ecology: Small cold spring run; very shallow water; gravel-cobble substrate; no macrophytes present. The snail occurs only in shaded areas and may be photophobic. A perilithon grazer and lithophile.

Original distribution: Uncertain; likely restricted to the middle portion of the Klamath drainage, *i.e.* below Upper Klamath Lake and above Copco Reservoir; Klamath Co., OR and Siskiyou Co., CA.

Current distribution: Two sites in Klamath Co., OR, on Medford District BLM lands. The area is currently badly grazed; adjacent springs do not have this species. One site is so badly degraded that continued survival of the snail is doubtful. Judging from first-year results it is unlikely that future work will expand the geographic range and number of sites sufficiently as to militate against listing.

Threats: Grazing is severe in the region, and badly affects the only known sites. Springs in the area either lack mollusks due to heavy grazing or have other mollusk species. Diversion and capping of springs for stock usage is widespread in this area, and has eliminated many springs.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate.

Recommended status: This species has no special status at present; but was designated a ROD species recently (ROD, 1994). It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal and State (OR) listing as Endangered is appropriate; this species was recommended for listing previously by Frest & Johannes (1993b, 1995a). There is sufficient recently-collected information, and recent survey work, to demonstrate that listing is justified.

References: Frest & Johannes (1993b, 1995a); ROD (1994); Deixis collections, 1991.

✓ ***Fluminicola* n. sp. 7 Tiger Lily pebblesnail** IMGAS30X7
36,37,38,39,40,42,43,44,66,68,69,70,71+?

Type locality: Will be designated when the species is described.

Description: This is a small-medium sized low conical species with convex whorls; dark gray body; black snout and tentacles; moderate-length sickle-shaped unpigmented verge with moderately wide base and folds on the basal third; round aperture, with barely reinforced columella. For details, see final report. This taxon was cited identically in Frest & Johannes (1995a).

Ecology: Occurs only in medium-large oligotrophic cold, clear springs, generally with common wood fragments; mud-cobble (basalt and pumice) substrate; common *Rorippa* and *Mimulus*. Sites are generally in rich, partly open meadows and edges of *Pinus ponderosa* forest, with abundant sedges and grasses; *Saxifraga*; *Aconitum*; *Pyrola* spp.; *Spiranthes*; *Viola*, and other forbs. Springs are commonly associated with bogs or marshes. Water depth is shallow, and moderate to swift flow is characteristic. This crenophile species is primarily a lithophile and grazer of aufwuchs on stone surfaces, usually sides and undersides on cobbles. In quiet areas, this species will graze aufwuchs from macrophyte surfaces as well.

Original distribution: Probably abundant in the W. and N. parts of the Upper Klamath Lake drainage, Klamath Co., OR.

Current distribution: Still present in the less damaged portions of the larger springs on the NW side of Upper Klamath Lake. Some sites are on public lands, including Winema National Forest,

BLM, and Klamath Lake National Wildlife Refuge. We currently (Table 3) recognize 14 sites for this species.

Threats: Many springs in the area are so heavily grazed as to completely extirpate or greatly reduce this species. Others are connected to irrigation canal systems; resulting sedimentation and eutropification either eliminates or greatly reduces this species. Channeling for such systems, and for log transport long ago, has also much reduced habitat, even when water quality remains excellent. Areas used for log transport or storage still have not regained populations of this species. This taxon does not do well in impounded areas.

Criteria for inclusion: Local endemic; occurrence on public lands; loss of much of habitat. This species has undoubtedly declined from pre-settlement population levels.

Recommended status: This species has no special status at present. It should minimally be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. We recommend Federal and State (OR) listing as Threatened; there is sufficient recently-collected information, and recent survey work, to support this action.

References: Frest & Johannes (1995a); Deixis collections, 1990-1994.

***Fluminicola* n. sp. 8** **Lost River pebblesnail**

See site #80

Type locality: None designated as yet; undescribed species.

Description: See final report. The comparatively large globose shell; flanged verge; and body pigment pattern are distinctive. Cited under the same name in Frest & Johannes (1995a)

Ecology: At present, found only in springs or strongly spring-influenced portions of a medium-sized river. The species seems to prefer cold, clear water, coarse (gravel-cobble) substrate, and slow to swift, constant flow. This species is a lithophile and grazer of aufwuchs on stone surfaces, usually sides and undersides on cobbles. In quiet areas, this species will graze aufwuchs from macrophyte surfaces as well. Areas with this species have dense *Rorippa* stands, often with beds of other macrophytes (*Ceratophyllum*, *Elodea*, *Potamogeton crispus*, and *Potamogeton filiformis* nearby. The species is absent from areas which are strongly eutropified or seasonally have hypoxic or anoxic conditions. At one site, this species occurs with an unusual *Vorticifex* sp., *Pyrgulopsis* n. sp. 2 [Big Spring springsnail, *q.v.*], and common *Physella gyrina*.

Original distribution: Probably once widespread in the Lost River portion of the Upper Klamath drainage, Klamath Co., OR.

Current distribution: Found only in a couple of springs in the Lost River drainage. At present, survival can be confirmed only at a single site (Table 3).

Threats: Much of the Lost River receives nitrogen- and phosphorous-enriched runoff from farming, and the river is extensively integrated into the Upper Klamath Project. Much is heavily affected by siltation, and is choked with macrophyte beds. Large sections show periodic or seasonal hypoxia or anoxia and are turbid during much of the year. Flow is now very slow and reduced in volume seasonally in much of the system. Sections affected by the factors listed above have lost much of the native mollusk fauna, which includes this species. Many of the springs in this area have been diverted, capped, or otherwise altered, to the point of not providing

habitat for native mollusk species. This species is definitely declining, in terms of both numbers and habitat area and condition.

Criteria for inclusion: Local endemic; drastic decline in habitat condition and area.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to suggest that Federal and State (OR) listing as Endangered is appropriate for this taxon.

References: Frest & Johannes (1995a); Deixis collections, 1994.

***Fluminicola* n. sp. 9** **Wood River pebblesnail** IMGAS 30X9

Sites: 1,2,3,4,45,46,47,49,50,51,54,62,63,65,95

Type locality: Will be designated when the species is formally described and named.

Description: See final report. Distinctive features of this species are the small, blunt-topped subconical shell; gray body; and open umbilicus. Cited in the same manner in Frest & Johannes (1995a).

Ecology: Found in small-large spring complexes, generally with mixed mud-gravel (white pumice) substrate. Common bryophytes, *Rorippa*, *Mimulus*, sometimes *Myriophyllum*, *Potamogeton filiformis*, *Rivularia* and small *Nostoc*; most sites are well-shaded, in largely closed, rich *Pinus ponderosa* forest. This species is often found in small numbers in springs with other *Fluminicola* spp.; evidently an obligate crenophile, mostly a perilithon grazer.

Original distribution: Probably widespread on the N. end of Upper Klamath Lake, including part of the Williamson River and its major tributaries.

Current distribution: Known from a few large spring sites near the source of the Wood River and on the NE end of Upper Klamath Lake. Some of the known sites are on State of Oregon or Winema National Forest lands. At present, we recognize this species from a total of 15 sites (Table 3); there is some possibility that it is composite.

Threats: Much of the Wood River valley is heavily used for agriculture, including grazing. Large areas receive nitrogen- and phosphorous-enriched runoff from farming, and the river is extensively integrated into the Upper Klamath Project. Much is heavily affected by siltation, and is choked with macrophyte beds. Large sections show periodic or seasonal hypoxia or anoxia and are turbid during much of the year. Flow is now very slow and reduced in volume seasonally in much of the system. Sections affected by the factors listed above have lost much of the native mollusk fauna, which includes this species. Many of the springs in this area have been diverted, capped, or otherwise altered, to the point of not providing habitat for native mollusk species. This species is definitely declining, in terms of both numbers and habitat area and condition.

Criteria for inclusion: Local endemic; heavy human impacts to most of habitat.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to demonstrate that Federal and State (OR) listing as Endangered is appropriate.

References: Frest & Johannes (1995a); Deixis collections, 1991-1994.

1,2,3,5,7,8,45,46,47,48,49,50,51,52,53,54,64,65,95,96,97,98,99

***Fluminicola* n. sp. 10** **Crooked Creek pebblesnail** (1MGASG30EX)

Type locality: Will be designated when the species is formally described and named.

Description: See final report. Distinctive features of this species are the large, subconical, distally decollate shell; black body; *seminalis*-like but pigmented verge; and closed umbilicus.

Ecology: Found in medium-large cold spring complexes and spring-influenced streams, generally with mixed mud-gravel (often basalt or pumice) substrate. Common bryophytes, *Rorippa*, *Mimulus*, sometimes *Myriophyllum*, *Potamogeton filiformis*, *Rivularia* and small *Nostoc*; most sites are well-shaded, in largely closed, rich *Pinus ponderosa* forest. This species is often found in small numbers in smaller springs with other *Fluminicola* spp.; evidently an obligate crenophile, mostly a perilithon grazer.

Original distribution: Probably widespread on the N. and NE end of Upper Klamath Lake, including Crooked Creek and its major tributaries.

Current distribution: Known from a few large spring sites and streams on the NE end of Upper Klamath Lake. Some of the known sites are on State of Oregon or Winema National Forest lands. At present, we recognize this species from a total of 23 sites (Table 3); there is a good possibility that it is composite.

Threats: Much of the Crooked Creek area is heavily used for agriculture, including grazing. Large areas receive nitrogen- and phosphorous-enriched runoff from farming, and the stream and surrounding large springs are integrated small-scale irrigation projects or used for domestic or hatchery water supply. Much of the creek is heavily affected by siltation, and is choked with macrophyte beds. Large sections show periodic or seasonal hypoxia or anoxia and are turbid during much of the year. Sections affected by the factors listed above have lost much of the native mollusk fauna, which includes this species. Many of the springs in this area have been diverted, capped, or otherwise altered, to the point of not providing habitat for native mollusk species. This species is definitely declining, in terms of both numbers and habitat area and condition.

Criteria for inclusion: Local endemic; heavy human impacts to most of habitat.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to demonstrate that Federal and State (OR) listing as Endangered is appropriate.

References: Deixis collections, 1991-1994.

***Fluminicola* n. sp. 11** **Odessa pebblesnail**

See sites: 20, 21, 23

Type locality: Will be designated when the species is formally described and named.

Description: See final report. Distinctive features of this species are the large, fairly tall subconical shell; black body; flanged verge; and open umbilicus.

Ecology: Found in small-large spring complexes and runs, generally with mixed mud-gravel (basalt or pumice) substrate. Common *Rorippa*, *Mimulus*, sometimes *Myriophyllum*, *Potamogeton filiformis*, *Rivularia* and small *Nostoc*; most sites are in rather open meadow or in sparse *Pinus ponderosa* forest. This species is often found with other *Fluminicola* spp.; evidently an obligate crenophile, mostly a perilithon grazer.

Original distribution: Probably widespread on the NW end of Upper Klamath Lake.

Current distribution: Known from a few large spring sites (we currently recognize 3; see Table 3) in the Odessa Creek area. The known sites are on Winema National Forest or National Wildlife Refuge lands.

Threats: Much of the Odessa Creek area, including the source spring, is heavily used for agriculture, including grazing. Large areas receive nitrogen- and phosphorous-enriched runoff from farming, and the creek is extensively integrated into the Upper Klamath Project. Much is heavily affected by siltation, and is choked with macrophyte beds. Large sections show periodic or seasonal hypoxia or anoxia and are turbid during much of the year. Sections affected by the factors listed above have lost much of the native mollusk fauna, which includes this species. Many of the springs in this area have been diverted, capped, or otherwise altered, to the point of not providing habitat for native mollusk species. This species is definitely declining, in terms of both numbers and habitat area and condition.

Criteria for inclusion: Local endemic; heavy human impacts to most of habitat.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to demonstrate that Federal and State (OR) listing as Endangered is appropriate.

References: Deixis collections, 1991-1994.

***Fluminicola* n. sp. 12** **Ouxy Spring pebblesnail**

See sites: 16, +?

Type locality: Will be designated when the species is formally described and named.

Description: See final report. Distinctive features of this species are the small, blunt-topped turbinate shell; gray body; thin, unpigmented, sickle-shaped verge; and thick shell.

Ecology: Found in a single small-large spring complex, with mixed mud-gravel (red basalt-pumice) substrate. Common *Rorippa*, rare *Mimulus*, *Potamogeton filiformis*, *Rivularia* and small *Nostoc* are accompanying macrophytes, although much of the area has epiphytic algae only. This species

is evidently an obligate crenophile, mostly a perilithon grazer. The sites are spawning areas for two endemic sucker species.

Original distribution: Probably widespread on the E. side of Upper Klamath Lake, in the vicinity of Modoc Rim.

Current distribution: Known only from 2 sites currently, both in the same spring complex on the E. side of Upper Klamath Lake. Part of the known sites are on Winema National Forest lands.

Threats: Much of the Wood River valley is heavily used for agriculture, including grazing. Large areas receive nitrogen- and phosphorous-enriched runoff from farming, and the river is extensively integrated into the Upper Klamath Project. Much is heavily affected by siltation, and is choked with macrophyte beds. Large sections show periodic or seasonal hypoxia or anoxia and are turbid during much of the year. Flow is now very slow and reduced in volume seasonally in much of the system. Sections affected by the factors listed above have lost much of the native mollusk fauna, which includes this species. Many of the springs in this area have been diverted, capped, or otherwise altered, to the point of not providing habitat for native mollusk species. This species is definitely declining, in terms of both numbers and habitat area and condition.

Criteria for inclusion: Local endemic; heavy human impacts to most of habitat; occurrence with endangered sucker species.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to demonstrate that Federal and State (OR) listing as Endangered is appropriate.

References: Deixis collections, 1991-1994.

Fluminicola n. sp. 13 — Casebeer pebblesnail

See site #88

Type locality: Will be designated when the species is formally described and named.

Description: See final report. Distinctive features of this species are the small, blunt-topped subturbinate shell with nearly angulate periphery; gray body; and flanged verge.

Ecology: Found in one large spring complex, with mixed mud-gravel (basalt) substrate. Common bryophytes, *Rorippa*, *Mimulus*; in largely open, dry *Pinus ponderosa* forest. This species is evidently an obligate crenophile, mostly a perilithon grazer. *Physella virgata* is the only other mollusk seen thus far.

Original distribution: Probably widespread on the E. end of the Lost River drainage.

Current distribution: Known thus far just from a single site, privately owned. At least 6 other adjacent sites lack the species.

Threats: Much of the Lost River valley is heavily used for agriculture, including grazing. Large areas receive nitrogen- and phosphorous-enriched runoff from farming, and the river is extensively integrated into the Upper Klamath Project. Much is heavily affected by siltation, and is choked with macrophyte beds. Large sections show periodic or seasonal hypoxia or anoxia and

are turbid during much of the year. Flow is now very slow and reduced in volume seasonally in much of the system. Sections affected by the factors listed above have lost much of the native mollusk fauna, which includes this species. Many of the springs in this area have been diverted, capped, or otherwise altered, to the point of not providing habitat for native mollusk species. All other springs in the complex with this species , for example, are either completely diverted or so affected as to lack any mollusks. This spring is also heavily grazed; but partly protected by fencing; and survives in part because of its large size. This species is definitely declining, in terms of both numbers and habitat area and condition.

Criteria for inclusion: Local endemic; heavy human impacts to most of habitat.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to demonstrate that Federal and State (OR) listing as Endangered is appropriate.

References: Deixis collections, 1991-1994.

***Fluminicola* n. sp. 14** **Lake of the Woods pebblesnail**

See sites: 29,30,74,77,79,80

Type locality: Will be designated when the species is formally described and named.

Description: See final report. Distinctive features of this species are the small, blunt-topped subconical shell; gray body; narrow, unpigmented verge; and small, open umbilicus.

Ecology: Found in small-large spring complexes, generally with mixed mud-gravel (basalt or pumice) substrate. Macrophytes include common bryophytes, *Rorippa*, *Mimulus*, less common *Myriophyllum*, *Potamogeton filiformis*, *Rivularia* and small *Nostoc*. Most sites are comparatively open, in dry *Pinus ponderosa* forest. This species is often found in small numbers in springs with other *Fluminicola* spp.; evidently an obligate crenophile, mostly a perilithon grazer.

Original distribution: Probably widespread on the SW end of Upper Klamath Lake and in portions of the Lost River drainage.

Current distribution: Known from a few spring sites near the Lake of the Woods and in part of the Lost River drainage. Some of the known sites are on State of Oregon or Klamath District BLM lands. At present, we recognize this species from a total of 6 sites (Table 3); there is some possibility that it is composite.

Threats: Much of the Lost River valley is heavily used for agriculture, including grazing. Large areas receive nitrogen- and phosphorous-enriched runoff from farming, and the river is extensively integrated into the Upper Klamath Project. Much is heavily affected by siltation, and is choked with macrophyte beds. Large sections show periodic or seasonal hypoxia or anoxia and are turbid during much of the year. Flow is now very slow and reduced in volume seasonally in much of the system. Sections affected by the factors listed above have lost much of the native mollusk fauna, which may include this species. Many of the springs in this area have been diverted, capped, or otherwise altered, to the point of not providing habitat for native mollusk species. This species is definitely declining, in terms of both numbers and habitat area and condition.

Criteria for inclusion: Local endemic; heavy human impacts to most of habitat.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to demonstrate that Federal and State (OR) listing as Endangered is appropriate.

References: Deixis collections, 1991-1994.

Not listed.

***Helisoma (Carinifex) newberryi newberryi* (Lea, 1858)** **Great Basin rams-horn**

Type locality: Rising River, Hat Creek, Shasta Co., CA. Probable holotype USNM 120991; probable paratype USNM 9256.

Description: The best description and illustrations are in Baker (1945); see also figures in Burch (1989). *Carinifex* has often been accorded separate generic status, which seems reasonable in view of its internal anatomy, at least as described by Baker (1945) and very different ecology from *Helisoma* (*s.s.*). Be that as it may, we follow Taylor (1981) and Burch (1989) for the time being in regarding *Carinifex* as a subgenus. Burch (1989), noting comments of previous authors, opined that there may be only a single living species of *Carinifex*, and relegated most of the former species to the status of subspecies. It is amusing to note that the major author so quoted, Henry Pilsbry, was himself the author of two additional subspecies. This (sub)genus needs detailed work; however, we would note that, at least as described by Baker (1945) there appear to be very substantial anatomical differences between *jacksonense* and *ponsonbyi*, treated by Burch as a form of *newberryi newberryi*. One form, *Helisoma (Carinifex) minor* (J. G. Cooper, 1870), was overlooked by Burch (1989); this is likely a full species, as indicated by Taylor (1981). Cited as *Helisoma (Carinifex) newberryi newberryi* (Lea, 1858) in Frest & Johannes (1991b, 1993b, 1995a).

Ecology: "Larger lakes and slow rivers, including larger spring sources and spring-fed creeks. The snails characteristically burrow in soft mud and may be invisible even when abundant." (Taylor, 1981). Can occur with *Pisidium ultramontanum*, *Lanx klamathensis*, or several other endemic mollusks, particularly *Fluminicola* spp. Areas with this species generally have well-oxygenated but soft substrate; macrophytes such as *Chara*, *Myriophyllum*, *Elodea*, *Veronica*, and *Potamogeton filiformis* common but not abundant; and clear, very cold, slowly flowing water. Typically, they are very large spring pools or strongly spring-influenced areas in larger streams or lakes.

This pelophile species generally occurs just below the sediment surface and is a detritus feeder. The ecology, need for continually well-oxygenated soft substrate, and detritus-feeding habitat have long been known to be unusual for the family (Planorbidae) generally. Very few other planorbids are crenophiles or prefer limnocrenes; very few are cold-water stenotherms. The most closely analogous planorbids are members of the genus *Vorticifex*. See discussion in Frest & Johannes (1993c, 1994, 1995b).

Original distribution: Taylor & Smith (1981) and Taylor (1985) illustrate a total of 14 historic sites for all forms of the species.; 1 in western WY, 3 in southwestern OR; 1 in UT; 7 in northeastern CA; and 2 in eastern CA. Many of these are either now known to be extinct or have not been recollected recently. The specialized habitat guarantees that not many more sites can be found; in any case, recent collection of the Upper Klamath Lake and Pit River drainages by us (see, *e.g.*, Frest & Johannes, 1993b, 1994a, 1995a, 1995b) and of the Great Basin by R. Hershler and his collaborators, including us, indicates that few sites survive.

This species had an extensive distribution in the Plio-Pleistocene and even Holocene lakes in the Great Basin and Oregon Interior Basin; see Taylor (1985) and Figure 16 herein.

Current distribution: "In California known from six local drainages, in which the species survives in probably only four....Sheepy Creek [Siskiyou County; may now (visited in 1991) be extinct]...Pit River, including the large spring-pools and their outflows of Fall River and Hat Creek; known downstream to above Squaw Creek, but probably extinct in the lower segment of its range. Eagle Lake, Lassen County. Lake Tahoe and adjacent slow segment of its outflow, Truckee River...." (Taylor, 1981, p. 158). The UT (Utah Lake) and Owens Valley, CA populations are extinct. Some of the CA and OR sites are within the range of the Northern Spotted Owl. Surviving sites are in Winema National Forest, Upper Klamath Lake National Wildlife Refuge and in Lassen National Forest (*e.g.* Eagle Lake); others may be located on BLM lands in the vicinity of Fall River Mills, CA. Other sites are known from tributaries to Upper Klamath Lake (this survey). We currently recognize 7 sites in this drainage (Table 3).

Threats: Springs in Upper Klamath Lake proper are badly affected by past dredging to facilitate log transport and by current severe nutrient enhancement and sedimentation. The species does not occur in areas with dense beds of such macrophytes as *Myriophyllum* and *Elodea*, nor in areas subject to eutropification or periodic hypoxic episodes. Many springs in the Great Basin and Oregon Interior Basin are so heavily grazed as to completely extirpate or greatly reduce this species. Others are connected to irrigation canal systems; resulting sedimentation and eutropification either eliminates or greatly reduces this species. Channeling for such systems, and for log transport long ago, has also much reduced habitat in the Upper Klamath Lake area, even when water quality remains excellent. Areas used for log transport or storage still have not regained populations of this species.

Criteria for Inclusion: Local endemic; occurrence on public lands; riparian associate; very specialized and uncommon habitat; past and current threats to habitat; reduction in numbers and loss of historic sites.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to demonstrate that this taxon should be Federal and State (OR and CA) Endangered, in our judgment.

References: Taylor (1981); Taylor & Smith (1981); Taylor (1985); Frest & Johannes (1991b, 1993a, b; 1994a; 1995a, b); Deixis collections, 1989-1994.

✓ ***Lanx alta*** **(Tryon, 1865)** **highcap lanx** need CI code
8, 21, 64?, 95

Type locality: Klamath River (no specific locality). Holotype ANSP 21960a.

Description: The best description and illustrations are those of Baker (1925). See also illustrations in Burch (1989). Distinctive shell features of this lancid are the relatively large, evenly dark red shell and height about 2/3 of greatest shell length. Burch (1989) recognizes subgenera in *Lanx*; but, like Taylor (1981) we see no reason at present for distinguishing *Walkerola* Hannibal, 1912, which is based solely on the low shell. Cited under the same name in Frest & Johannes (1995a).

Ecology: "Large rivers and major tributaries, on boulders or rock in current" [Taylor (1981, p. 157)]. Low to medium elevations; the species is an amniphile, perilithon feeder, and lithophile found in areas with stable cobble-boulder substrate and excellent water quality. Like other lancids, this species respires through an unusual system unique for pulmonates; a heavily vascularized mantle and enlarged heart are elements (Baker, 1925). Lack of gills or lungs typical of many pulmonates limit the habitat of the lancids generally to areas not subject to hypoxia or anoxia, and generally to cold, clear, flowing waters, especially oligotrophic streams and areas with considerable spring influence.

Original distribution: "Drainages of Umpqua and Klamath rivers, OR, to South Fork of Trinity River (tributary to Klamath River), California; Smith River, California" (Taylor, 1981, p. 157). Counties are Josephine, Jackson, and Curry on the Rogue River (including sites in Siskiyou National Forest: sites in Rogue River National Forest may be extirpated); and Del Norte, Humboldt, and Siskiyou cos. [CA], plus Klamath Co., OR (Klamath River). Old sites were in Winema, Klamath, Six Rivers, and Trinity National Forests. Some of these sites are known to survive. The species also occurs in the Rogue National Wild and Scenic River. Relevant to this work are occurrences in the upper part of the Klamath River below Link River and in the Williamson River.

Current distribution: Recently (1991-94) collected alive by us in the Klamath River in CA and Rogue River in OR; now extinct in most of the Klamath River and part of the Rogue River; status in other rivers in its range uncertain. Umpqua specimens are better assigned to *Lanx subrotundata* (*q.v.*), as in Burch (1989). Systematic position of populations in the Williamson River and in large nasmodes, collected by us from 1991-1994, is not yet clear, although these bear some resemblance to *Lanx altus*. See final report for discussion. We so far recognize 4 sites for this species locally.

Threats: Much of the upper Klamath River is impounded; the species does not generally occur in such areas. *Lanx altus* is also absent from areas downstream from waste water returns, *i.e.* below as well as in John Boyle Reservoir. Warm, slow, nutrient-enriched, or turbid water also lack this species, so that much of the Klamath and Rogue rivers are now unsuitable habitat.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate.

Recommended status: Currently has none. We recommended listing of this species previously (Frest & Johannes, 1991b, 1993b, 1995a). Minimally, it should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Existing evidence is sufficient that this species should be Federal and State (OR and CA) Endangered.

References: Taylor (1981); Burch (1989); Frest & Johannes (1991b, 1993b, 1995a); Deixis Consultants, 1991-94.

need shade

✓ ***Lanx klamathensis* Hannibal, 1912** **scale lanx**

3, 7, 57, 98, 99, 23, 24, 26

Type locality: South end of Upper Klamath Lake, Klamath Falls, Klamath Co., OR. Types in CAS collections.

Description: See Hannibal (1912) and Baker (1925); the illustration in Burch (1989) is also helpful. The low and thin shell, many times wider and longer than high, is quite characteristic. Hannibal (1912) erected the subgenus *Walkerola* for this species; Burch (1989) recognizes this;

but we, like Taylor (1981) see no reason at present to do so. Shell height *vs.* width in *Lanx* is better regarded as a species-level character. Cited identically in Frest & Johannes (1995a).

Ecology: A form restricted to large, spring-fed lakes and streams and limnocrene springs. The species, like all lancids, is an obligate perilithon grazer and lithophile, and occurs on cobbles and boulders, generally in areas with current and always at sites with oxygenated, high-quality clear water. This species commonly is found with a variety of other rare forms, including *Pyrgulopsis archimedis*, *Pyrgulopsis* n. sp. 1, *Lyogyrus* spp., *Fluminicola* spp., and *Vorticifex klamathensis klamathensis*. Lack of gills or lungs typical of many pulmonates limit the habitat of the lancids generally to areas not subject to hypoxia or anoxia, and generally to cold, clear, flowing waters, especially oligotrophic streams and areas with considerable spring influence.

Lake-living species of *Lanx* appear to have been relatively widespread in some of the OR Interior Basin Pliocene-Pleistocene lakes, such as that once existing near Ft. Rock. Most such lakes are either now dry or are alkaline, which condition is inimical to most mollusk species, including this one. This appears to be the last surviving lake species.

Original distribution: Upper Klamath Lake basin, Klamath Co., OR and Siskiyou Co., CA, likely including Lower Klamath Lake and Tule Lake as well as Upper Klamath Lake. Occurrence in Lake of the Woods uncertain.

Current distribution: Survives at a few spring-buffered sites in the Upper Klamath Lake, area, including the Link River and localities in Winema National Forest and Upper Klamath Lake National Wildlife Refuge. The Tule Lake population (Tule Lake National Wildlife Refuge) may be extinct. Other sites are possible in the same areas and in Rogue River National Forest. Population trends in this species, both in terms of sites and numbers, are clearly downward. Judging from survey work thus far, significant range extensions or the location of large numbers of additional sites are very unlikely.

At present, we have noted 8 sites for this species (Table 3).

Threats: Much of the lake habitat for this Upper Klamath Lake drainage endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Agency Lake populations appear to be extinct, dating at least from the drying of this area in 1993. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified. Even in the best remaining spring pools and spring-fed creeks, the species seems to be confined to limited areas with the best water quality. Most large springs and spring-fed pools are also heavily grazed currently; the species does not seem able to tolerate such disturbance.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate; extensive human modification to rather specialized habitat; ongoing threats.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient information of recent vintage exists to establish that this species should be Federal and State (OR and CA) Endangered.

References: Baker (1925); Taylor (1981); Burch (1989); Frest & Johannes (1993b, 1995a); Deixis Consultants, 1991-94.

***Lyogyrus* n. sp. 3** **Klamath duskysnail**

see sites: 5,6,94?

Type locality: Undescribed taxon; none yet designated.

Description: This small (under 1.5 mm as adult) species has a light yellow, mostly translucent shell, small flat protoconch, and low conical spire of about 3 convex whorls. The shell surface is smooth except for the initial whorls; the mantle is unpigmented, as is the body, including snout, tentacles, and external male genitalia. The aperture is rounded, slightly thickened on the columellar side, and has a sinuous outline, as well as being slightly prosocline. Nearest relationships are to the nodose duskysnail and a sister species confined to small portions of the Pit River drainage, Northern CA (Frest & Johannes, 1993a, b, 1994a, 1995b). The nodose duskysnail has a nodose shell with a distinctly higher spire. The CA species is smaller and has a more depressed spire, with a simply rounded peritreme. This taxon was cited as *Lyogyrus* n. sp. 4 in Frest & Johannes (1993b) and as above in Frest & Johannes (1995a).

Ecology: Lives on undersides and sides of boulders and cobbles in a large lake, in areas with spring influence. Macrophytes are generally absent at its sites, and the species appears to be photophobic. This species frequently occurs with other rare mollusk taxa, such as *Lanx klamathensis*, *Pyrgulopsis archimedis*, *Pyrgulopsis* n. sp. 1, and *Vorticifex klamathensis klamathensis*. A perilithon grazer and lithophile, as are many of the western U.S. species in this genus.

Original distribution: Upper Klamath Lake (both sides), including the Link River, Klamath Co., OR.

Current distribution: Known to survive at about 3 sites (Table 3), all somewhat sheltered from eutropification by spring influx, on private land and in Upper Klamath Lake National Wildlife Refuge and Winema National Forest. Other sites are possible in the same areas. From our survey results thus far, large numbers of additional sites are unlikely.

Threats: Much of the lake habitat for this Upper Klamath Lake endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Agency Lake populations appear to be extinct, dating at least from the drying of this area in 1993. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified. Even in the best remaining spring pools and spring-fed creeks, the species seems to be confined to limited areas with the best water quality. Most large springs and spring-fed pools are also heavily grazed currently; the species does not seem able to tolerate such disturbance. Remaining sites are threatened by eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species. Most sites are themselves remnants, with large areas now lacking this species due to an earlier cycle of habitat modification.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate. Comprehensive survey of the Upper Klamath drainage is now underway; to date there is little reason to expect that many more site will be found.

Recommended status: Currently has none. We have previously (Frest & Johannes (1993c) recommended listing of this taxon. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (OR) Endangered.

References: Taylor (1985a); Frest & Johannes (1993b, 1995a); Deixis Consultants, 1990-94.

***Lyogyrus* n. sp. 4** **nodose duskysnail**

15,16,17, +?

Type locality: Recently discovered taxon; none as yet.

Description: This diminutive (less than 1.5 mm spire height) taxon has a yellow translucent shell with about 3 convex whorls, a low conical spire, and prominent nodes on the upper whorls. It much resembles *Lyogyrus* n. sp. 3; but is taller, and that species lacks nodes. This taxon was cited as *Lyogyrus* n. sp. 5 in Frest & Johannes (1993b), and as above in Frest & Johannes (1995a).

Ecology: Occurs on undersides and sides of cobbles and boulders in spring complex draining into Upper Klamath Lake and rarely in spring-influenced outflow from lake; *Rorippa* present, but snails on rocks only; species appears photophobic. Occurs with other Species of Special Concern, including *Pyrgulopsis archimedis*, *Pyrgulopsis* n. sp. 1, *Lanx klamathensis*, and *Vorticifex klamathensis klamathensis*. This lithophile species is a perilithon grazer and appears also to be a limnophile, absent from the numerous large springs and spring pools around Upper Klamath Lake

Original distribution: Upper Klamath Lake and major spring tributaries, Klamath Co., OR.

Current distribution: Known from 4 sites on Upper Klamath Lake (Table 3), one in Winema National Forest; very rare at one site. A few other sites are possible in the Upper Klamath Lake basin, *e.g.* Upper Klamath Lake National Wildlife Refuge. First year and other recent survey results indicate that finds of large numbers of additional sites are improbable.

Threats: Much of the lake habitat for this Upper Klamath Lake drainage endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Agency Lake populations appear to be extinct, dating at least from the drying of this area in 1993. Most of the large springs draining directly into Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified. Even in the best remaining such spring pools and spring-influenced lake stretches, the species seems to be confined to limited areas with the best water quality. These are also Endangered sucker spawning areas, and care must be taken to avoid extirpating or further limiting the mollusk in order to enhance sucker populations.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate. Sufficient recent survey work has been done to indicate that this species is a very narrow endemic in need of protection, with most former habitat now lacking the species.

Recommended status: Has none at present. We have previously (Frest & Johannes (1993b, 1995a) recommended listing of this taxon. The species should be listed as Endangered federally and by the State of OR. Sites are threatened by eutropification, urban and industrial pollution, and habitat modification to accommodate Endangered sucker species.

References: Frest & Johannes (1993b, 1995a); Deixis Consultants, 1992-4.

***Lyogyrus* n. sp. 5** **mare's egg duskysnail**

See sites: 1,8,23,24,50,52?,66,98?

Type locality: Recently discovered, undescribed taxon; none yet designated.

Description: This taxon was cited as *Lyogyrus* n. sp. 6 in Frest & Johannes (1993b) and as herein in Frest & Johannes (1995a). The small size, low but attenuate spire, and dark mantle are distinctive.

Ecology: Occurs on undersides of cobbles and boulders and of very large *Nostoc* colonies (locally termed mare's eggs) in spring-influenced sites in a large lake and a large, spring-influenced creek. Can occur with other Species of Special Concern, such as *Lanx klamathensis, Helisoma (Carinifex) newberryi,* and *Fluminicola spp.* A crenophile, lithophile, and perilithon feeder, perhaps photophobic as well.

Original distribution: Upper Klamath Lake and vicinity, Klamath Co., OR.

Current distribution: So far found at 8 sites only (Table 3), one on private land interfingered with units of Winema National Forest and Upper Klamath Lake National Wildlife Refuge and 2 others apparently on Winema National Forest lands. A small number of additional sites could exist, in the areas mentioned previously and Upper Klamath Lake National Wildlife Refuge. From early results, it is evident that substantial range extension or increment of currently known live sites are very unlikely.

We are reviewing occurrences of this species, which may be composite. The Sprague River specimens are especially problematic.

Threats: Much of the past or potential lake habitat for this Upper Klamath Lake drainage endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified. Even in the best remaining spring pools, spring-influenced lake areas, and spring-fed creeks, the species seems to be confined to limited portions with the best water quality. Most large springs and spring-fed pools are also heavily grazed currently; the species does not seem able to tolerate such disturbance.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate; modification and loss of most habitat; threats to rest of habitat.

Recommended status: At present has no special status. We have previously (Frest & Johannes (1993b, 1995a) recommended listing of this taxon. Should be a federal and State of OR Endangered species. Upper Klamath Lake is badly eutropified, and this species seems to occur only in relatively unpolluted areas with strong, permanent spring influence. These are also commonly sucker spawning sites, hence subject to modification to enhance habitat for three listed Upper Klamath Lake fish species.

Rsferences: Frest & Johannes (1993b, 1995a); Deixis Consultants, 1992.

***Pyrgulopsis archimedis* Berry, 1947** **Archimedes pyrg**

See sites: 6, 15, 16, 17

Type locality: Upper Klamath Lake in vicinity of Algoma, Klamath Co., OR.

Description: For comprehensive description and illustration of both shell and soft part morphology see Hershler (1994). There are only two strongly carinate western North American *Pyrgulopsis* species: this and the genotype, *Pyrgulopsis nevadensis*. This species is more strongly carinate; larger; and has a less attenuate spire.

This species was first reported from Upper Klamath Lake some time before its description (Henderson, 1924, 1929, 1936b; Hanna, 1930; Clench, 1940). Berry (1947) was the first to recognize its distinctness, which has since been conclusively demonstrated (Hershler, 1994). Limnophile *Pyrgulopsis* species are unusual, although more common in the Interior Basin (OR) Pliocene-Pleistocene pluvial lakes. This species was cited identically in Frest & Johannes (1993b, 1995a).

Ecology: Large-lake hydrobiid, now surviving only in areas with spring influence to counter eutropification and subsequent periodic low DO_2. This taxon prefers areas with gravel-boulder (basalt and pumice) substrate and few macrophytes. It occurs with several other Species of Special Concern, namely *Lanx klamathensis*, *Pyrgulopsis* n. sp. 1, *Pisidium ultramontanum*, *Lyogyrus* n. sp. 4, *Fluminicola* n. sp. 1, and *Vorticifex klamathensis klamathensis*. It is a perilithon feeder, generally grazing on lower and lateral sides of larger stones, and a lithophile.

Original distribution: Upper Klamath Lake and Tule Lake, Klamath Co., OR and Siskiyou Co., CA; likely occurred also in Lower Klamath Lake as well. The related (and now likely extinct) genotype *Pyrgulopsis nevadensis* occurred in Walker and Pyramid Lakes, NV.

Current distribution: Known now from 4 spring-influenced sites in Upper Klamath Lake, Klamath Co., OR (Table 3). Two sites are in Winema National Forest. Sites in Upper Klamath Lake National Wildlife Refuge (W. side of Upper Klamath Lake) are probable. The Tule Lake population is likely extinct. Substantial range extension or increment of currently known live sites are both very unlikely, as indicated by our results to date.

Threats: Much of the lake habitat for this Upper Klamath Lake endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified, as spring influence no longer compensates for the lake's general condition. Even in the best remaining spring pools and spring-fed creeks feeding into the lake, the species seems to be confined to limited areas with the best water quality. Remaining sites are threatened by eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate. To date there is little reason to expect that many more sites will be found, judging from survey results thus far.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (OR) Endangered, as also recommended by Frest & Johannes (1993b, 1995a). The species lives only in the limited areas of the lake not completely affected by eutropification, as they have considerable spring influx. These sites are spawning areas for three Endangered sucker species and hence may be modified as part of recovery actions for the fish.

References: Berry (1947); Hershler (1994); Frest & Johannes (1993b, 1995a); Deixis Consultants, 1992-1994.

***Pyrgulopsis* n. sp. 1** **Klamath Lake springsnail**

See sites 6 + 15

Type locality: New species, none designated at present.

Description: This species was cited as *Pyrgulopsis* n. sp. 1 in Frest & Johannes (1993b, 1995a). It is similar to the crenophile *Pyrgulopsis intermedia*, but has dark tentacles and darker body pigmentation and blunt upper whorls. Cited in the same manner in Frest & Johannes (1995a).

Ecology: Found on cobbles and boulders in spring-influenced areas of a large lake. It occurs with several other Species of Special Concern, namely *Lanx klamathensis*, *Pyrgulopsis archimedis*, *Pisidium ultramontanum*, *Lyogyrus* n. sp. 4, and *Vorticifex klamathensis klamathensis*, and *Vorticifex effusus dalli*. Primarily a lithophile and perilithon feeder.

Lake-dwelling (limnophile) *Pyrgulopsis* species are now somewhat unusual, though apparently widespread in the OR, CA, and NV Great Basin Plio-Pleistocene pluvial lakes. Other Western U. S. examples are *Pyrgulopsis nevadensis* and *Pyrgulopsis archimedis*; for a fossil example, see Taylor and Smith (1981).

Original distribution: Upper Klamath Lake, Klamath Co., OR. This species seems to be an Upper Klamath Lake endemic, with different ecology and morphology than the closely related *Pyrgulopsis intermedia* and another undescribed spring and stream form from NE CA.

Current distribution: Known to survive at two sites, both on the east side of the lake (Table 3; Appendices A, B). One site is in Winema National Forest. Other sites are possible in the vicinity. However, it is unlikely that the range or total number of sites will be expanded greatly in the future, given recent (1990-1994) work in the Upper Klamath Basin, NE CA, and Interior Basin of OR by us and by R. Hershler *et al.*

Threats: Much of the lake habitat for this Upper Klamath Lake endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified. Even in the best remaining spring pools and spring-fed creeks feeding into the lake, the species seems to be confined to limited areas with the best water quality. Remaining sites are threatened by eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species. Most sites are themselves remnants, with large areas now lacking this species due to an earlier cycle of habitat modification.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate. Comprehensive survey of the Upper Klamath drainage is now underway; to date there is little reason to expect that many more sites will be found.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (OR) Endangered, as noted also by Frest & Johannes (1995a). The species lives only in the limited areas of the lake not completely affected by eutropification, as they have considerable spring influx. These sites are spawning areas for three Endangered sucker species and hence may be modified as part of recovery actions for the fish.

References: Frest & Johannes (1995a); Deixis Consultants, 1991-94.

***Pyrgulopsis* n. sp. 2** **Big Spring springsnail** = LOST RIVER SPRINGSNAIL (Frest changed name 1997 report)

See sites # 29 + 80

Type locality: None; to be designated when species is described.

Description: This species is a member of the *intermedia* group, typified by having penes with penial, terminal, and ventral glands only (Hershler, 1994). Details of penial morphology, shell size and shape, and female internal anatomy distinguish the species. This is perhaps the smallest member yet discovered. Cited identically in Frest & Johannes (1995a).

Ecology: Found in a large cold spring complex, with abundant *Rorippa*; some *Mimulus* at sides; *Chara* in deep areas; other macrophytes in impacted areas on Lost River side of complex *Ceratophyllum*, *Elodea*, *Potamogeton crispus*, *Potamogeton filiformis*, although the snail is rare or absent in such areas. Flow slow-moderate; substrate mud, sand, minor gravel and cobbles. This species is most common on mud substrate (is a pelophile) and appears to be a detritivore. Common associates at one site include *Fluminicola* n. sp. 8 [Lost River pebblesnail, *q.v.*], *Vorticifex* sp., and *Physella gyrina*.

Original distribution: Probably once common in the Lost River drainage. So far, this species has not been found in the rest of the Upper Klamath drainage; nor in such adjoining areas as the Goose Lake, NE CA Great Basin, and upper Pit River drainage, although related *Pyrgulopsis* species occur there, and these areas have been surveyed recently in some detail (Frest & Johannes, 1993a, 1994a, c, 1995a; Hershler, 1992, in press).

Current distribution: Known from a single large spring complex tributary to the Lost River, Klamath Co., OR, and possibly from another, nearby spring complex (Table 3, Appendices A, B). From our survey results thus far, it is unlikely that the geographic range of this taxon will be greatly expanded by future work, nor that large numbers of additional sites will be found. Sites on Klamath District BLM lands are possible.

Threats: Much of the Lost River receives nitrogen- and phosphorous-enriched runoff from farming, and the river is extensively integrated into the Upper Klamath Reclamation Project. Much is heavily affected by siltation, and is choked with macrophyte beds. Large sections show periodic or seasonal hypoxia or anoxia and are turbid during much of the year. Flow is now very slow and reduced in volume seasonally in much of the system. Sections affected by the factors listed above have lost much of the native mollusk fauna, which includes this species. Many of the springs in this area have been diverted, capped, or otherwise altered, to the point of not providing habitat for native mollusk species. Groundwater recharge for some springs is also nutrient-enriched, presumably from farm runoff. This species is definitely declining, in terms of both numbers and habitat area and condition.

Criteria for inclusion: Local endemic; drastic decline in habitat condition and area; possible occurrence on public lands.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to suggest that Federal and State (OR) listing as Endangered is appropriate for this taxon, as recommended earlier by Frest & Johannes (1995a).

References: Frest & Johannes (1995a); Deixis collections, 1994.

***Vorticifex effusus dalli* (Baker, 1945)** **Dall rams-horn**

See sites: 6 + 15

Type locality: Klamath Falls, Klamath Co., OR [presumably, head of Link River]; holotype USNM 219747 paratypes USNM 219747.

Description: This is a large form for the genus, with few whorls, a rapidly expanding, thin, yellowish shell, flat spire, prominent regular periostracal fringes, and varices beneath each periostracal fringe. For illustrations of shell and anatomy, see Baker (1945). *Vorticifex effusa costata* (Hemphill, 1890) has periodic periostracal fringes; but these are minor; there are no varices, no "pure" populations are known to occur, and the feature is variable, suggesting that synonymy with *Vorticifex effusus* (*s.s.*) is reasonable. *Vorticifex mailliardi* (Hanna, 1924), from Eagle Lake, CA, is similar in appearance and anatomy (from preliminary studies), and also occurs in a Great Basin periphery remnant pluvial lake; if this proves so on further work, then Hanna's name would have priority.

Note that Turgeon *et al.* (1988) use *Vorticifex effusus* for the nominate form, while Burch (1989) uses *Vorticifex effusa*. Presumably, the former represents a correction to match the masculine gender of *Vorticifex*, *vs.* the feminine *Parapholyx*. Burch (1989) notes that *Vorticifex* is based on a fossil type, while *Parapholyx* has a living type species. Granting that fossil shells can be difficult to relate to living genera, which are often anatomically based, at least in part, for the moment there appears to be no conflict, *i.e.* competing recent genera with different anatomies but vicarious shell morphology. It thus seems reasonable to place all forms in *Vorticifex*, as Burch did.

Ecology: A lithophile and perilithon feeder, found mostly on larger cobbles and boulders, in areas with some current, in a large, spring-fed lake. Macrophytes may be present at sites, but the species seems more interested in stable solid surfaces This species also appears to be a limnophile. Remaining sites are in areas with strong spring influence, although this form has not been collected from the springs themselves. It occurs with several other Species of Special Concern, namely *Lanx klamathensis*, *Pyrgulopsis* n. sp. 1, *Pyrgulopsis archimedis*, *Pisidium ultramontanum*, *Fluminicola* n. sp. 1, *Vorticifex klamathensis klamathensis*, and *Lyogyrus* n. sp. 4.

Original distribution: Upper Klamath Lake drainage; certainly Upper Klamath Lake itself, and possibly Lower Klamath Lake and Tule Lake, Klamath Co., OR, and Siskiyou and Modoc cos., CA.

Current distribution: Survives at a very few sites in Upper Klamath Lake, Klamath Co., OR. At present, we can confirm only 2 (Table 3). The more sensitive species in Tule Lake and Lower Klamath Lake are extirpated, due to "reclamation" of a large part of both and use of the remnants as sumps for irrigation runoff. Existing sites may be in Winema National Forest or other public lands. Sites in Upper Klamath Lake National Wildlife Refuge (W. side of Upper Klamath Lake) are probable. The best remaining site is in the Link River, outlet to Upper Klamath Lake. Substantial range extension or increment of currently known live sites are both very unlikely.

Threats: Much of the lake habitat for this Upper Klamath Lake endemic is considerably eutropified, has soft substrete, or both; the species is absent from such areas. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified, as spring influence no longer compensates for the lake's general condition. Even in the lake areas adjacent to best remaining spring pools and spring-fed creeks feeding into the lake, the species seems to be confined to limited areas with the best water quality. Remaining sites are threatened by

eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species. The Link River site in Klamath Falls is subject to development and urbanization pressures in its own right.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate. Comprehensive survey of the Upper Klamath drainage is now underway; to date there is little reason to expect that many more sites will be found.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (OR) Endangered, as also suggested by Frest & Johannes (1995a). The species lives only in the limited areas of the lake not completely affected by eutropification, as they have considerable spring influx and/or flow. These sites are spawning areas for three Endangered sucker species and hence may be modified as part of recovery actions for the fish.

References: Baker (1945); Frest & Johannes (1995a); Deixis Consultants, 1991-1994.

***Vorticifex effusus diagonalis* (Henderson, 1929)** **lined rams-horn**

See sites: 50, 53, 54, 95

Type locality: Crater Lake, Crater Lake National Park, Upper Klamath Lake drainage, Klamath Co., OR; holotype UCM 15940a; paratypes UCM 15940; other paratypes in UI (Baker Collection 3926).

Description: For original description, and illustrations, see Henderson (1929); see also Baker (1945). This subspecies is large and thin-shelled; the diagonal raised lines of the shell are seen occasionally on individuals of other subspecies, but are not universal, as here.

Ecology: This form lives in spring-fed lakes and limnocrenes, as well as exceptionally large spring-fed creeks. Spring influence; very cold, clear, oligotrophic water; and fair depth are among the common factors; this species is effectively both a crenophile and limnophile. Macrophytes and epiphytic algae are sparse, with *Veronica* and rather scattered *Rorippa* the most frequent. Limy substrate is common, often muddy, but ranging to gravel and cobbles; the snails are restricted to hard substrate. Most sites have abundant large woody debris.

Original distribution: Crater Lake and adjoining parts of the Upper Klamath Lake drainage, Klamath Co., OR.; may have occurred in suitable habitat in other lakes and streams in the same drainage, *e.g.* Lower Klamath Lake and Tule Lake.

Current distribution: Known from a few sites in Crater Lake [Crater Lake National Park] and Upper Klamath Lake and its major tributaries (including one site in Winema National Forest and one in an Oregon State Park). With first-year survey results in, it is clear that substantial range extension or increment of currently known live sites are both very unlikely. We recognize 4 sites to date (Table 3).

Threats: Much of the lake habitat for this Upper Klamath Lake drainage endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Most of the large springs and spring-fed creeks peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified. Others have been capped for water supply or are heavily grazed. No Upper Klamath Lake sites are known

to survive. Remaining sites are threatened by eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species.

Criteria for inclusion: Riparian associate; local endemic; occurrence on public lands; riparian associate.

Recommended status: Currently, this subspecies has no special status. It minimally should be considered a sensitive species by the National Park Service, Forest Service, BLM, Bureau of Reclamation, and other land management and wildlife agencies. Sufficient survey work has been conducted in recent years as to demonstrate that this taxon should be Federal and State (OR) Endangered, as noted also by Frest & Johannes (1995a).

References: Henderson (1929); Baker (1945);Frest & Johannes (1995a); Deixis Consultants, 1991-92.

***Vorticifex klamathensis klamathensis* (Baker, 1945)** **Klamath rams-horn**

See sites 6 + 67?

Type locality: Apparently head of Link River, Klamath Falls, Upper Klamath Lake, Klamath Co., OR (Baker, 1945). holotype USNM 406024; paratypes USNM 406024, 219748.

Description: A large form, with few whorls, a shallow, rapidly expanding, nearly flat spire; reddish, thin shell, and no periostracal fringes or varices. For original description and illustrations of anatomy and shell, see Baker (1945). See also Frest & Johannes (1995b; discussion of *Vorticifex* n. sp. 1). Cited under the same name in Frest & Johannes (1993b, 1995a).

Ecology: Lives on cobbles and boulders in flowing water in a spring-influenced streams and a large remnant pluvial lake. It occurs with several other Species of Special Concern, namely *Lanx klamathensis*, *Pyrgulopsis* n. sp. 1, *Pyrgulopsis archimedis*, *Pisidium ultramontanum*, *Fluminicola* n. sp. 1, *Vorticifex effusus dalli*, and *Lyogyrus* n. sp. 4. A lithophile and perilithon feeder, found mostly on larger cobbles and boulders, in areas with some current. Macrophytes may be present at sites, but the species seems more interested in stable solid surfaces This species also appears to be a limnophile. Remaining sites are in areas with strong spring influence, although this form has not been collected from the springs themselves.

Original distribution: Upper Klamath Lake drainage; certainly Upper Klamath Lake itself, and possibly Lower Klamath Lake and Tule Lake, Klamath Co., OR, and Siskiyou and Modoc cos., CA.

Current distribution: Survives at a very few sites (currently 2 confirmed sites: Table 3) in Upper Klamath Lake, Klamath Co., OR. The more sensitive species in Tule Lake and Lower Klamath Lake are extirpated, due to "reclamation" of a large part of both and use of the remnants as sumps for irrigation runoff. Existing sites may be in Winema National Forest or other public lands. Sites in Upper Klamath Lake National Wildlife Refuge (W. side of Upper Klamath Lake) are probable. The best remaining site is in the Link River, outlet to Upper Klamath Lake. As the first year survey results make clear, substantial range extension or increment of currently known live sites are both very unlikely.

Threats: Much of the lake habitat for this Upper Klamath Lake endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of

irrigation projects; the species is absent from most areas so modified, as spring influence no longer compensates for the lake's general condition. Even in the lake areas adjacent to best remaining spring pools and spring-fed creeks feeding into the lake, the species seems to be confined to limited areas with the best water quality. Remaining sites are threatened by eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species. The Link River site in Klamath Falls is subject to development and urbanization pressures in its own right.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (OR) Endangered, to repeat the recommendations of Frest & Johannes (1993b, 1995a). The species lives only in the limited areas of the lake not completely affected by eutropification, as they have considerable spring influx and/or flow. These sites are spawning areas for three Endangered sucker species and hence may be modified as part of recovery actions for the fish.

References: Baker (1945); Frest & Johannes (1993b, 1995a); Deixis Consultants, 1991-1994.

***Vorticifex klamathensis sinitsini* (Baker, 1945)** **Sinitsin rams-horn**

See sites: 7, 48?, 98, 99

Type locality: Barclay Springs, Hagelstein Park, Upper Klamath Lake, Klamath Co., OR. Holotype USNM 531029; paratypes USNM 531029; topotypes USNM 531064.

Description: For original description, anatomy, and illustrations, see Baker (1945). This subspecies is smaller, has a thicker and more globose shell, and a higher spire than the nominate form. Cited under the same name in Frest & Johannes (1993b, 1995a).

Ecology: A crenophile, living in large cold springs with coarse substrate. Macrophytes present commonly may include abundant *Rorippa* and common *Mimulus* and *Veronica*. Water depth ranges from a few inches to 2 feet, flow is moderately rapid. Associated mollusks include *Fluminicola* sp. and *Lanx klamathensis*. This taxon is a lithophile and perilithon grazer.

Original distribution: Known at present only from a single site; and possibly from 2 others (Table 3) as above. Likely to occur in other springs in the same region, although large numbers of new sites are precluded by recent surveys.

Current distribution: See above. As indicated by first-year survey results, substantial range extension or increment of currently known live sites are both very unlikely.

Threats: Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified, as spring influence no longer compensates for the lake's general condition. Even in the lake areas adjacent to best remaining spring pools and spring-fed creeks feeding into the lake, the species seems to be confined to limited areas with the best water quality. The single definite remaining site is threatened by eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species.

Criteria for inclusion: Local endemic; probable occurrence on adjoining public lands (Winema National Forest, Upper Klamath Lake National Wildlife Refuge); riparian associate. The spring is being modified currently to enhance listed fish species' spawning habitat.

Recommended status: This taxon has no special status at present; but was recently made a ROD species (ROD, 1994). Minimally, it should be considered a sensitive species by the Forest Service, BLM, Bureau of Reclamation, and other relevant federal and state land management and wildlife agencies. Sufficient recent survey work has been done to show that it should probably be considered Endangered both by the federal government and by OR, as also stated by Frest & Johannes (1993b, 1995a).

References: Baker (1945); Frest & Johannes (1993b, 1995a); ROD (1994); Deixis Consultants, 1991-94.

FRESHWATER BIVALVES

IMBIV04020 ***Anodonta californiensis*** **Lea, 1852 California floater**
see: site 21

Type locality: "Rio Colorado," actually a former distributary of the river, approximately New River, Imperial County, California. " (Taylor, 1981, p. 142).

Description: For best description and illustrations, see Burch (1973, 1975b). This form does not closely resemble other described western anodontids, except for *Anodonta wahlametensis* [*q.v.*]. That species has a much more conspicuous wing and different beak sculpture. This species has been confused in the literature with *Anodonta nuttalliana nuttalliana* and with *Anodonta nuttalliana idahoensis*. The best treatment is that of Taylor (1977, *unpub.*; 1981), who regards *Anodonta nuttalliana nuttalliana* as a synonym of *Anodonta wahlametensis* and *Anodonta nuttalliana idahoensis* as a synonym of *Anodonta californiensis*. It should be noted that the lectotype of *Anodonta nuttalliana idahoensis* was fixed by Johnson & Baker (1973), according to ICZN (1985), Article 74 b, c; and treatment of type material by Coan & Roth (1987, p. 324) is thus incorrect. As noted by Taylor (1981), there is some chance that *Anodonta californiensis* is a composite species; this needs to be carefully studied. One implication would be that protection is more justified, in that all component taxa would have limited ranges, and the whole group is already known to have been much reduced in range and abundance. This species was cited also in Frest & Johannes (1991b, 1993b, 1995a).

Ecology: "Lakes and slow rivers" (Taylor, 1981, p. 142), generally on soft substrates (mud-sand), in fairly large streams and lakes only, in relatively slow current. A low elevation species, found in both lakes and lake-like stream environments; basically a limnophile. A filter-feeder, as are all unionaceans. The host fish for the glochidial stage of this bivalve is (are?) unknown; note that the fate of the fish larval host(s) also limits and determines the distribution of this species.

Original distribution: Lower Willamette and lower Columbia rivers in OR and WA from The Dalles to the mouth. In larger slow streams of northern CA as far south as the northern San Joaquin Valley. The former range includes Wahkiakum, Cowlitz, Clark, Skamania, and Klickitat cos., WA; Clatsop, Columbia, Multnomah, Hood River, and Wasco cos., OR; and Siskiyou, Shasta, Lassen, Modoc, and Tehama cos., CA.

Current distribution: Taylor (1981) reports that this species is probably eradicated over much of its original range. We have not found living specimens in the Willamette and lower Columbia River in searches from 1988-1990. Still survives in the Fall River and Pit River, Shasta Co., CA (see Frest & Johannes, 1995b); some possible specimens collected by USFWS near The Dalles, 1990. Apparently extinct in the upper Sacramento River. Also survives in the Okanogan River, Chelan Co., WA, Parts of Roosevelt Lake, Ferry Co., WA (*pers. comm.*, T. Burke, 1994), and Curlew Lake, Ferry Co., WA. This species was likely heavily impacted by the BPA dams and impoundments; see comments under *Physella columbiana*. Of the nearly 500 Columbia Basin sites surveyed by Frest & Neitzel (in press a, b; see also Neitzel & Frest, 1993), only three had live or recently dead specimens of this species. It is clearly declining in numbers and in area occupied throughout its range. The species appears to be extinct or nearly extinct in UT and NV (see, *e.g.*, Clarke & Hovingh, 1993) and is very limited in distribution in AZ. The middle Snake River populations are much circumscribed, but may be the best extant (Frest, 1992).

Locally, we can confirm only a single site as yet (Table 3).

Threats: Extensive diversion of CA rivers for irrigation, hydroelectric, and water supply projects has much reduced the CA range of this species. This species can tolerate some water pollution; but not heavy nutrient enhancement or similar problems.

Much of the middle Snake River in ID is rapidly becoming eutropified, due to agricultural runoff, trout farms, and urbanization along the river corridor. Much of the river is impounded behind a series of small dams; this is also detrimental for cold-water species such as this taxon. The area has been declared water-quality limited by EPA and the State of Idaho. Fine sediment influx, generally from the same causes, is also a major problem. A recent (1994) landslide impacted some of the historic sites. Introduction of exotic mollusk species (Bowler, 1990) may also be a factor in the species' decline. Springs in this area have been impacted by ground water pollution from agricultural and dairy operations; diverted into irrigation systems; capped and diverted for stock, domestic, industrial, and piscicultural water supply; heavily grazed; and dried due to groundwater drawdown.

In the lower Columbia River region threats include impoundments; continued siltation and other impacts on the few remaining sites with habitat characteristics approximating pre-impoundment conditions on the lower Columbia. Harbor and channel "improvements" in the vicinity of Portland, The Dalles, and John Day Dam; nutrient enrichment of the lower Columbia due to agricultural run off. The Lower Granite Reservoir, WA population noted by Frest & Johannes (1992b) appears to have been extirpated by the 1992 drawdown. Declines in numbers and/or distribution of the fish host(s) may also be involved.

This taxon is declining, in terms of area occupied and number of sites and individuals.

Criteria for inclusion: Current C2 Federal candidate; occurrence on public lands; affected by federal projects; current and ongoing threats.

Recommended status: Currently this species is a C2 candidate (USFWS, 1994a). It minimally should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent survey work has been done to demonstrate that this species should be Federal and State (OR, ID, WA, AZ, UT, WY, and CA) Threatened.

References: Burch (1973, 1975b); Taylor (1981); Frest (1992); Frest & Johannes, 1992b; 1993a, 1993b, 1995a; Neitzel & Frest (1993); Frest & Neitzel (in press a, b); Deixis Consultants, 1988-1994.

IMBIV04180 ***Anodonta wahlametensis* Lea, 1838** **Willamette floater**
not found

Type locality: Near the mouth of the Willamette River, Multnomah Co., OR.

Description: The best treatment of this species is in Burch (1973, 1975b). Most closely similar in shell characters is *Anodonta californiensis*; but that species is much less strongly alate and has very different beak sculpture. Literature treatments of alate western *Anodonta* species vary; we prefer to follow Burch (1973, 1975b) and Taylor (1981), which are based on much first-hand field and museum collection experience. See discussion of *Anodonta californiensis*, above, for further information. Also cited in Frest & Johannes (1993b) under the same name.

Ecology: "Lakes and slow rivers" (Taylor, 1981, p. 142), generally on soft substrates (mud-sand), but also on gravel, in fairly large streams and lakes only, in relatively slow current. A low elevation filter-feeding species. This species is both an amniphile and a limnophile. The host fish for the glochidial stage of this species is (are?) unknown; note that the fate of the fish larval host(s) also limits and determines the distribution of this species.

Original distribution: Lower Willamette River, and lower Columbia River in OR and WA from The Dalles to the mouth. In larger slow streams of northern CA as far south as the northern San Joaquin Valley. The former range includes Wahkiakum, Cowlitz, Clark, Skamania, and Klickitat cos., WA; Clatsop, Columbia, Multnomah, Clackamas, Marion, Hood River, and Wasco cos., OR; and Siskiyou, Shasta, Lassen, Modoc, Tehama, Glenn, Butte, Yuba, Sutter, Yolo, and Sacramento cos., CA. Significance of this bimodal distribution pattern is discussed in Taylor (1985) and herein.

Current distribution: Taylor (1981) reports that this species is probably eradicated over much of its original range. We have not found living specimens in the Willamette and lower Columbia River in searches from 1988-1990. Not found by Tetra Tech (1991-1993, 1993) either. Still survives in the Fall River, CA (1991); one possible specimen collected by USFWS near The Dalles, 1990. Appears to be extinct in the upper Sacramento River and almost certainly in the lower Sacramento as well (Frest & Johannes, 1993b, e, 1994a, 1995a, b). The lower Columbia populations were likely essentially extirpated by the construction and continued operation of the BPA dams and impoundments; see further comments under *Physella columbiana*. Could survive locally in deep pools with oxygenated substrate; we have no definite sites here as yet.

Threats: Extensive diversion of CA rivers for irrigation, hydroelectric, and water supply projects has much reduced the CA range of this species. In the lower Columbia River region threats include impoundments; continued siltation and other impacts on the few remaining sites with habitat characteristics approximating pre-impoundment conditions on the lower Columbia. Harbor and channel "improvements" in the vicinity of Portland, The Dalles, and John Day Dam; nutrient enrichment of the lower Columbia due to agricultural run off. Decline in numbers and/or distribution of the glochidial host(s) could also be a factor. This taxon is declining, in terms of area occupied and number of sites and individuals.

Criteria for inclusion: Local endemic; possible occurrence on public lands; considerable reduction in range and loss of historic sites; effects of federal projects on habitat; continued and ongoing threats.

Recommended status: At present, this species has no special status. It minimally should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent survey work has been done to indicate that this species should be Federal and State (OR, WA, and CA) Endangered, as also recommended by Frest & Johannes (1991b, 1993b, 1995a, b, c).

References: Burch (1973, 1975b); Taylor (1981); Frest & Johannes (1991b, 1993b, 1995a, b, c); Deixis Consultants, 1988-1992.

IMBIV5 1220 ***Pisidium (Cyclocalyx) ultramontanum* Prime, 1865** **montane peaclam**

See sites: 15, 16, 17

Type locality: "Canoe Creek (now Hat Creek), probably at Rising River, Shasta County, California" (Taylor, 1981, p. 146).

Description: See Burch (1972, 1975a) for description and illustrations. No other North American sphaeriid closely resembles this taxon. Cited under the same name in Frest & Johannes (1993b, 1995a).

Ecology: Generally found on sand-gravel substrate in spring-influenced streams and lakes, and occasionally in limnocrenes; characteristically in areas with high mollusk diversity. Associates often include other Species of Special Concern, such as *Lanx klamathensis*, *Helisoma newberryi*, *Pyrgulopsis archimedis*, *Fluminicola* n. sp. 1, and *Lyogyrus* spp. This species is effectively both a crenophile and limnophile.

Original distribution: Periphery of the Great Basin in OR to Klamath River and Pit River, OR-CA, as well as some of the larger lakes (Upper Klamath Lake, Tule Lake, Eagle Lake, possibly Lower Klamath Lake), Klamath Co., OR and Siskiyou, Lassen, and Modoc cos., CA.

Current distribution: Some populations are extinct, including those in the Tule Lake and Lower Klamath Lake areas. Known to survive in the Upper Klamath Lake area (including sites in Winema National Forest and Upper Klamath National Wildlife Refuge), the middle Pit River (Frest & Johannes, 1993b, 1994a, 1995a, b), and at Eagle Lake (Lassen National Forest). Sites may exist in Shasta National Forest also, although old sites there appear to be extinct. The species is definitely declining in number of sites, range, and numbers.

We can confirm survival of this species at 3 sites in the Upper Klamath Lake drainage (Table 3). Surprisingly, we have not found it as yet in more than one of the large nasmodes tributary to the Lake proper.

Threats: Best remaining populations are in the Upper Klamath Lake area. Much of the lake habitat for this Upper Klamath Lake endemic is considerably eutropified, has soft substrete, or both; the species is absent from such areas. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified, as spring influence no longer compensates for the lake's general condition. Even in the lake areas adjacent to best remaining spring pools and spring-fed creeks feeding into the lake, the species seems to be confined to limited areas with the best water quality. Remaining sites are threatened by eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species. The Link River site in Klamath Falls is subject to development and urbanization pressures in its own right. Klamath River sites may now be extinct, due to impoundment and water pollution. Great Basin populations in general occur(ed) in large spring pools (limnocrenes). Overpumping of ground water; grazing; diversion and capping of springs for stock, industrial, and domestic water supply; and geothermal development are problems for these populations.

Criteria for inclusion: Local endemic; federal listing candidate; occurrence on public lands; riparian associate.

Recommended status: Currently a C2 candidate (USFWS, 1994a). Otherwise, has no special protected status; minimally, the Forest Service, BLM, and other appropriate land and wildlife agencies should consider this a sensitive species. It should be considered Endangered in CA, OR, and federally, as stated previously (Frest & Johannes, 1993b, 1995a, b).

References: Taylor (1981, 1985); Frest & Johannes (1993b, 1994, 1995a, b); Deixis Consultants, 1991-92.

mud Elvoda.

***Pisidium (C.)* n. sp. 1** **Modoc peaclam**

Type locality: None designated as yet; undescribed taxon.

Description: None available at present. The only literature reference is Taylor & Bright (1987), as "Modoc Plateau *Pisidium*".

Ecology: Found only in relatively large, spring-influenced streams and lakes, characteristically in areas with high mollusk diversity. Associates may include other Species of Special Concern, such as *Lanx klamathensis*, *Helisoma newberryi*, *Pyrgulopsis archimedis*, *Fluminicola* n. sp. 1, and *Lyogyrus* spp. This species is effectively both an amniphile and limnophile, with spring influence apparently also a *desideratum*.

Original distribution: Upper Klamath Lake drainage in OR to Klamath River and middle-upper Pit River, OR-CA, Klamath Co., OR and Siskiyou, Shasta, and Modoc cos., CA. The fossil record extends across southern OR (OR Interior Basins) to SE ID (Taylor & Bright, 1987, fig. 6).

Current distribution: There are six historic populations, mostly on the Modoc Plateau (Taylor & Bright, 1987, fig. 6). Some populations are extinct, including some or all of those in the Klamath River and Pit River. Known to survive in the Upper Klamath Lake area (possibly including sites in Winema National Forest and Upper Klamath National Wildlife Refuge) and possibly in the middle or upper Pit River. The species is definitely declining in number of sites, range, and numbers.

We can at present confirm survival of a single Upper Klamath Lake drainage population (Table 3).

Threats: Best remaining populations may be in the Upper Klamath Lake area. Much of the lake habitat for this Upper Klamath Lake endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified, as spring influence no longer compensates for the lake's general condition. Even in the lake areas adjacent to best remaining spring pools and spring-fed creeks feeding into the lake, the species seems to be confined to limited areas with the best water quality. Remaining sites are threatened by eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species. The Link River site in Klamath Falls is subject to development and urbanization pressures in its own right. Klamath River and some or all Pit River sites may now be extinct, due to impoundment and water pollution. Great Basin populations in general presumably occurred in large river environments. Overpumping of ground water; grazing; diversion and capping of springs for stock, industrial, and domestic water supply; and geothermal development are problems for populations in this area, if any remain.

Criteria for inclusion: Local endemic; occurrence on public lands; continued threats to very specialized habitat.

Recommended status: Currently this undescribed form has no status. Minimally, it should be considered sensitive by the Forest Service, BLM, and other appropriate federal and state wildlife and land management agencies. Sufficient recent survey work has been done in the species' known current and fossil range (*e.g.* Frest & Johannes, 1993a, 1994, 1995a; see also various Snake River surveys by Frest & Johannes and others, summarized in USFWS, 1993) to establish that this taxon should be considered Endangered in CA, OR, and federally. We made the same recommendation in Frest & Johannes (1993b, 1995a).

References: Taylor & Bright (1987); Deixis Consultants, 1991-94.

LAND SNAILS

***Monadenia (Monadenia)* n. sp. 1 Modoc Rim sideband**

Type locality: None designated as yet; undescribed taxon.

Description: This comparatively small *Monadenia* species has a shell shape much like that of *Monadenia fidelis fidelis*. It is typically about 40% smaller (to 20 mm at 6 -6 1/2 whorls) but has an equal- or slightly larger sized umbilicus (proportionately much wider). The upper surface is generally a dirty yellow, with coarse and irregular radial growth lines and spotty spiral striation. Banding is well-developed; the base and peripheral band are dark brown.

Ecology: Restricted to large-scale dry and open vesicular basalt taluses at lower elevations. Commonly, taluses with this species have accompanying seeps or springs, and snail colonies are found mostly near talus base, *i.e.* close to the lake. Plants associated include *Urtica*, *Clematis*, *Sorbus*, *Prunus*, and *Celtus*. Surrounding plant community is sage scrub. Few other land snails co-occur. A xerophile species.

Original distribution: Probably once common on both sides of Upper Klamath Lake (Pilsbry, 1939).

Current distribution: A few colonies at the SE end of Upper Klamath Lake, Klamath Co., OR, including sites on Winema National Forest lands. We have been unable thus far to locate surviving colonies on the west side of Upper Klamath Lake, although old museum records exist. The species appears to be declining in areas occupied and numbers, due to a combination of human modification of habitat and extended dry periods in its area of occurrence.

Threats: Talus mining and quarrying in vicinity of remaining sites; road building and road and railroad track (Burlington Northern) maintenance along the US 97 and OR 140 corridors; roadside and trackside spraying for weed control. This area has suffered recent rock slides (1993, 1994); proposed measures to alleviate that problem may eliminate colonies.

Criteria for inclusion: Local endemic; occurrence on public lands; ongoing threats. Population trends (number of sites, number of individuals) are downward. It is unlikely that many additional sites will be found.

Recommended status: At the present time this species has no special status; it should be considered a sensitive species by the Forest Service and BLM. Federal and State (OR) listing as Endangered is appropriate, due to specialized habitat and obvious threats to that habitat, as well as recent habitat loss.

References: Pilsbry (1939); Deixis collections, 1991-1994.

***Pristiloma (Pristinopsis) arcticum? crateris* Pilsbry, 1946** **Crater Lake tightcoil**

Type locality: One mile south of Crater Lake, Klamath Co., OR; holotype ANSP 147788a; paratypes ANSP 147788; other paratypes should be in UCM collections; but not listed by Wu & Brandauer (1982).

Description: See Pilsbry (1946) for best description and illustration; this is the undescribed species referred to by Henderson (1929). Taxonomy follows Riedel (1980). The anatomy is unknown. This taxon was referred to as *Pristiloma arcticum crateris* Pilsbry, 1946 in Frest & Johannes (1993b) and as above in Frest & Johannes (1995a).

Ecology: Uncertain. Related species found at high elevations live along small streams, in leaf litter in forest, near the edges of seeps or bogs, and under cushion plants in open mountain meadows. Persistence of moisture for a good part of the year is a *desideratum.*

Original distribution: A single site in Crater Lake National Park, Klamath Co., OR.

Current distribution: Uncertain; has not been recollected recently. Occurrence in adjoining portions of Umpqua and Winema National Forests, including areas considered for protection of the Northern Spotted Owl, is possible.

Threats: Uncertain; most of the area surrounding Crater Lake National Park have been logged and are currently being grazed,

Criteria for inclusion: Local endemic; occurrence on public lands.

Recommended status: This species has no special status at present, although it was cited as a ROD species (ROD, 1994). It was recommended as a listing candidate by Frest & Johannes (1993c, 1995a). At the least, it should be considered a sensitive species by the Forest Service, BLM, National Park Service, and other land management and wildlife agencies. Federal and State (OR) listing as Threatened is appropriate for the reasons just cited.

References: Henderson (1929); Pilsbry (1946); Frest & Johannes (1993c).

***Vespericola sierranus* (Berry, 1921)** **Siskiyou hesperian**

Type locality: Two miles north of Weed, Siskiyou Co., CA; holotype Berry 5087; paratype ANSP 130455.

Description: The best description and illustrations at present are those of Pilsbry (1940). We anticipate more thorough treatment sometime in the future by B. Roth. There is some possibility that this species is composite: in particular, the Upper Klamath Lake population has distinctive shell features. We have not yet had time to examine the anatomy of this form.

Ecology: Spring seeps, deep leaf litter along stream banks, and under debris on ground (Roth, 1993). Moist valley, ravine, gorge, or talus sites are preferred, *i.e.* low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a *desideratum*, and this species may occur in areas with running water or alongside streams and spring pools. It has been found on such plants as *Rorippa*, in association with other *Vespericola* species, *Prophysaon*, *Oxyloma*, and *Deroceras*. A strong notophile.

Original distribution: Broadly scattered sites in the following counties: OR, Jackson, Klamath; CA, Siskiyou, Plumas, Nevada, Placer, El Dorado (Roth, 1993).

Current distribution: Cited by Roth (1993) from about 17 localities. Among other areas, there are sites in Shasta and Trinity National Forest. Other localities apparently with this species are in Rogue River National Forest and on BLM lands (Medford District). Recently (1994), a single site was found in Klamath Co., OR (Upper Klamath Lake). Taxonomic status of material from this disjunct site needs further investigation.

Criteria for inclusion: Old growth and riparian associate; occurrence on public lands.

Recommended status: This species has no special status at present, although it was included as . It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal listing as Threatened is appropriate for the reasons just cited. Note extensive recent searches by Roth, Miller, and Frest & Johannes (summarized in Roth (1993) and Frest & Johannes (1995a)). It was recommended for listing by Frest & Johannes (1993b, 1995a, b).

References: Pilsbry (1940); Roth (1972, 1993); Frest & Johannes (1993b, 1994a, 1995a, b); Deixis Consultants, 1991-94.

WATCH LIST

Under this heading are discussed taxa which are known or have been reported to occur in the Interior Columbia Basin; are known to have lost much of their range; and are regarded as sensitive species, *i.e.* especially associated with mature, relatively undisturbed forests; riparian areas; springs; and/or some combination of specialized or especially impacted habitat. However,

these taxa may have had a comparatively broad range originally; or may be species which currently known or thought to be common outside the area of assessment elsewhere in the U.S. or in adjacent countries. These taxa are not regarded as in imminent danger of extinction without protection currently (although this may change rapidly, depending upon the management strategy adapted for public lands, and upon the effectiveness of its implementation).

These taxa should be regarded as sensitive by land management and wildlife planners, and their status should be carefully and periodically reviewed. Complacency in regard to their status and needs is *not* suggested.

FRESHWATER BIVALVES

IMBIVI9010 ***Gonidea angulata*** **(Lea, 1838)** **western ridgemussel**
See Sites 64+95

Type locality: "Lewis's River" [Snake River], Idaho; types not seen.

Description: See Burch (1973, 1975b) for best short description and illustration. This taxon is very distinctive.

Ecology: Found mostly in creeks and rivers of all sizes; rarely in lakes or reservoirs unless with substantial flow. This amniphile, filter-feeding taxon can live on firm mud substrate as well as on more coarse materials (which are more typical). More pollution-tolerant than some unionids; but still absent from highly polluted areas and places with unstable or very soft substrate. The host fish for the glochidia of this species is (are?) unknown.

Original distribution: "Southern British Columbia to southern California, eastward to southern Idaho and northern Nevada" (Taylor, 1981). It should be noted that the species had a limited distribution W. of the Cascades, particularly in WA and OR, where most sites N. of SW OR are doubtful.

Current distribution: Uncertain. Known to be extirpated from many of the old sites, including much of the Snake system; but still common in some areas. Still occurs sporadically in some major tributaries to the Columbia and Snake, such as the Okanogan River (WA) and Clearwater River, Hells Canyon, and middle Snake River (ID). Formerly in Little Granite Reservoir (Frest & Johannes, 1992c); but this population is believed to have been extirpated by the 1993 drawdown.

Threats: Extensive diversion of CA rivers for irrigation, hydroelectric, and water supply projects has much reduced the CA range of this species. This species can tolerate some water pollution; but not heavy nutrient enhancement or similar problems. For some recent records, see Taylor (1981), Frest & Johannes (1991a, 1992b, c, 1993b, 1994a, 1995a, b).

Much of the middle Snake River in ID is rapidly becoming eutropified, due to agricultural runoff, fish farms, and urbanization along the river corridor. Much of the river is impounded behind

a series of small dams; this is also detrimental for cold-water species such as this taxon. The area has been declared water-quality limited by EPA and the State of Idaho. Fine sediment influx, generally from the same causes, is also a major problem. A recent (1994) landslide impacted some of the historic sites. For some recent ID sites for this species, see references under Frest & Johannes (in part).

In the lower Columbia River region threats include impoundments; continued siltation and other impacts on the few remaining sites with habitat characteristics approximating pre-impoundment conditions on the lower Columbia. Harbor and channel "improvements" in the vicinity of Portland, The Dalles, and John Day Dam; nutrient enrichment of the lower Columbia due to agricultural run-off.

This taxon is declining, in terms of area occupied and number of sites and individuals. Note that the fate of the fish larval host(s) also limits and determines the distribution of this species.

Criteria for inclusion: Regional endemic; loss of historic sites; human modification throughout range; concentration of human activities within preferred habitat; occurrence on public owned or regulated lands.

Recommended status: We do not recommend Federal or State (WA, OR, ID) listing as this point, although the species minimally should be considered sensitive by the BLM, Forest Service, and other appropriate land management and wildlife agencies. More survey work needs to be done on this species, particularly in OR.

References: Burch (1973, 1975b); Taylor (1981); Deixis collections, 1987-1994.

IMBIV27020 ***Margaritifera falcata* (Gould, 1850)** **western pearlshell**

See sites: 28, 64, 95

Type locality: "Puget Sound, Oregon" [*sic*: now Washington]; holotype USNM 5893, according to Johnson (1964).

Description: For best short description and illustration see Burch (1973, 1975b). The generally purple nacre and hermaphroditic condition are distinctive as compared to *Margaritifera margaritifera*, the most closely related species. See also discussion in Taylor (1988b).

Ecology: Primarily an amniphile species; medium-sized streams are preferable, although sometimes found in streams considerably narrower than 1 m (*contra* Clarke, 1981); rarely, in lakes with stream-like conditions. Generally in fast, clear, very cold areas with coarse substrate. In undisturbed streams, this species may cover the bottom. Host fish for the glochidia include chinook salmon, rainbow trout, brown trout, brook trout, specked dace, Lahontan redside, and Tahoe sucker (Clarke, 1981).

Original distribution: "Southern Alaska to central California, eastward to western Montana, western Wyoming, and northern Utah" (Taylor, 1981).

Current distribution: Extinct in most of the Snake system (except for upper tributaries, including the Blackfoot River (ID) and some major creeks in ID and WY); extinct from many of the coastal streams, in which it was once ubiquitous. Status of interior populations needs further work; extinct in the Okanogan River, *e.g.* many populations do not appear to have reproduced for many years.

Populations persist locally in parts of the Coeur d'Alene system, including the Coeur d'Alene River and St. Maries River.

Threats: Extensive diversion of rivers for irrigation, hydroelectric, and water supply projects has much reduced the WA, OR, ID, and CA range of this species. This species is not as tolerant of water pollution as *Gonidea angulata* and *Anodonta kennerlyi*; heavy nutrient enhancement, siltation, unstable substrate, or similar problems extirpate populations. For some recent records, see Taylor (1981), and Frest & Johannes (1991a, 1992b, 1993e, 1994a, 1995b).

Much of the middle Snake River in ID is rapidly becoming eutropified, due to agricultural runoff, fish farms, and urbanization along the river corridor. Much of the river is impounded behind a series of small dams; this is also detrimental for cold-water species such as this taxon. The area has been declared water-quality limited by EPA and the State of Idaho. Fine sediment influx, generally from the same causes, is also a major problem. A recent (1994) landslide impacted some of the historic sites. For some recent ID sites for this species, see references under Frest & Johannes (in part). Conditions in the Snake are typical for many of the rivers in this species' range. We have seen no live specimens from the mainstem Snake recently.

In the lower Columbia River region threats include impoundments; continued siltation and other impacts on the few remaining sites with habitat characteristics approximating pre-impoundment conditions on the lower Columbia. Harbor and channel "improvements" in the vicinity of The Dalles and John Day Dam; nutrient enrichment of the lower Columbia due to agricultural run-off. We have seen no live specimens from the mainstem Columbia recently.

This taxon is declining, in terms of area occupied and number of sites and individuals. Note that the fate of the fish larval host(s) also limits and determines the distribution of this species.

Criteria for inclusion: Regional endemic; loss of most historic sites; human modification of habitat throughout the range; occurrence on public lands.

Recommended status: We do not recommend formal Federal or State (WA, OR, ID, MT, WY, NV, & UT) listing at this point, although the species should be considered sensitive by the BLM, Forest Service, National Park Service, and other land management, wildlife, and water regulatory agencies. Further work needs to be done to document range changes. it should be noted, however, that populations showing repeated reproduction (at least several age classes) are now the exception rather than the rule.

References: Burch (1973, 1975b); Taylor (1981); Deixis collections, 1987-1994.

EXTRALIMITAL SENSITIVE TAXA POSSIBLY IN THE PROJECT AREA

LAND SNAILS

***Discus shimeki cockerelli* Pilsbry, 1898** **no common name**

Type locality: Saguache Co., CO; ANSP 73671 (Pilsbry, 1948).

Description: See Pilsbry (1948) for description and discussion. See also Frest & Johannes (1993d).

Ecology: In Wyoming and South Dakota this species is found in a variety of habitats, ranging from streamside slope bases in rich pine and spruce forest to mountain meadows. Most sites are relatively undisturbed, shaded, and perennially moist.

Original distribution: Rocky Mountain states, according to Pilsbry (1948). Two California site are doubtful, according to Roth (pers comm., 1994). Also reported from "east side Upper Klamath Lake" by Baker; we have thus far not seen this lot.

Current Distribution: Sporadic in the Rocky Mountain states and provinces. We have not seen it in the Upper Klamath Lake area; but have not made strenuous efforts to locate it as yet.

Threats: Grazing and logging in the Rockies; also disturbance or destruction of riparian vegetation and of springs and seeps, partly for agricultural purposes.

Criteria for inclusion: This subspecies is a current federal C2 candidate. Status of the nominate form needs to be investigated more thoroughly, as noted by Frest & Johannes (1993d). The species is rare in South Dakota.

Recommended status: None at present; requires further investigation.

References: Pilsbry (1948); Frest & Johannes (1993d).

FRESHWATER SNAILS

Fluminicola modoci Hannibal, 1912 — Modoc pebblesnail

Type locality: Fletcher Spring, near SW end of Goose Lake, Modoc Co., CA. The figured type may be the specimen illustrated as *Amnicola micrococcus* in Hannibal in Keep (1911 [1910]); this may be the specimen (former SU 5777, now in CAS) designated as type by Taylor and Smith (1971); other material (paratypes) CAS 60798, 60799, 66545. The specimen illustrated by Hannibal (1912) as this species appears to be the same one illustrated as *Paludestrina longinqua* in Hannibal (1911).

Description: See Hershler & Frest (in press) for comprehensive discussion and illustration. Taylor (1966b, 1985) regarded this species as a synonym of *Fluminicola turbiniformis*; with comprehensive revision of the named *Fluminicola* species, this is not tenable. Problems remain with this taxon, in that the description and some of the type lot indicate a tall conical species, probably a *Pyrgulopsis*. The Fletcher Spring lot may contain two species of *Fluminicola*, the other of which is certainly undescribed. The revision by Hershler & Frest (in press) for the time being accepts this taxon as a valid species of *Fluminicola* with a small, moderately tall-low conical decollate spire, somewhat as in the specimen regarded by Taylor & Smith (1971) as the holotype. This is by no means certain, although such a taxon does indeed exist; and the Taylor & Smith specimen may not be the holotype.

Ecology: Found in medium-large springs; a crenocole. Sites with this species have slow-swift flow; clear, very cold water; and common *Rorippa* and *Mimulus*. Substrate varies from sand and mud to basalt cobble and boulder, with most specimens occurring in areas with coarse substrate. Other small *Fluminicola* species, *Pyrgulopsis*; *Physella*; and sphaeriids co-occur, although this species is the usual dominant.

Original distribution: Known with certainty only from springs on the W. side of Goose Lake, Modoc Co., CA. The species is included here because Goose Lake and its associated drainages extend into Lake Co., OR. We have recently collected small *Fluminicola* spp. there, which may represent this or other taxa. Such taxa have been known to occur in the OR portion of the drainage since the 1970s (D. W. Taylor, *unpub.*).

Current distribution: Currently (Hershler & Frest, in press) known to persist only in a few springs on the SW end of Goose Lake. Some of the springs in this area are on Modoc or Fremont National Forest lands.

Threats: Springs in this area are heavily grazed, including the type locality. Many mapped springs are now dry, due to grazing, diversion, and capping for stock and domestic usage. Others have become heavily eutropified, due to integration into irrigation systems.

Criteria for inclusion: Very local endemic; occurrence on public lands; loss of populations and threats to the specialized habitat of this species.

Recommended status: This species has no special status at present. Minimally, it should be considered a sensitive species by the Forest Service, BLM, and other appropriate land management and wildlife agencies. We recommend listing as Endangered Federally and in CA (and possibly in OR as well), as we did in Frest & Johannes, 1995a, b). We are currently doing a comprehensive survey of this drainage (Frest & Johannes, 1993e, 1994, 1995b); much of NE CA has recently been surveyed for springsnails by R. Hershler *et al.* (1990-1994).

References: Hannibal (1911, 1912); Taylor & Smith (1971);Frest & Johannes (1995a, b); Hershler & Frest (in press); Deixis collections, 1993-1994.

GLOSSARY

amnicole (n.) organism living only in or preferring stream environments; stream dweller.

amniphile (n.) preferring stream environments.; **amniphilic** is the adjective.

aufwuchs (n.) the organic coating on stones or other underwater surfaces in permanent water bodies; consists of diatoms, protozoans, small algal epiphytes; fungi; and bacteria. The major food resource for lithophile taxa, and for perilithon and periphyton feeders (*q.v.*).

calciphile (n.) a species requiring relatively large amounts of free calcium ions for its shell or for other physiology- or metabolism-related reasons; used here for certain land snail and slug species; there are calciphile plants as well.

crenocole (n.) organism living only in spring environments; spring dweller.

crenophile (n.) preferring spring environments; crenophilic is the adjective.

detritivore (n.) aqueous taxon feeding on organic particles in sediment.

edaphic (adj.) pertaining to soil conditions, such as composition, pH, zone, etc.

epigean (adj.) pertaining to surface, as opposed to underground, waters.

epiphyte (n.) (small) organism living attached to a (larger) substrate particle or other organism; **epiphytic** is the adjective.

epibiont (n.) organism (plant or animal) living attached to another organism or substrate particle

eucrenic (adj.) well-watered; having numerous springs.

eurytopic (adj.) of or pertaining to an organism with broad habitat tolerances.

insolation (n.) the amount of sunlight striking the ground.

iteroparous (adj.) capable of reproducing more than once during a lifetime

limnetic (adj.) of or pertaining to lakes; living in lakes.

limnocole (n.) organism restricted to or preferring lake environments; lake dweller.

limnocrene (n.) spring pool, with or without outlet; generally used for rather large pools.

limnophile (n.) preferring lake environments; **limnophilic** is the adjective.

nasmode (n.) spring complex; spring family; area with a number of nearby springs originating from the same source.

nasmodic (adj.)	having large numbers of springs.
notophile (n.)	a species tolerant of or requiring very moist conditions for at least part of its life, such as occur alongside permanent streams, seeps or springs; used here for certain land snail and slug species. The adjective is **notophilic**.
pelophile (n.)	preferring muddy environments; **pelophilic** is the adjective.
perilithon (n.)	those organisms growing on stones; usually refers to the smaller (near to microscopic, and consisting of just one or a few cells per individual) and inconspicuous epiphytic algae, diatoms, protozoans, bacteria and fungi, rather than to larger organisms or plants; **aufwuchs**, in part.
periphyton (n.)	those organisms growing on submerged stems and other parts of aquatic macrophytes; usually refers to the smaller (near to microscopic, and consisting of just one or a few cells per individual) and inconspicuous epiphytic algae, diatoms, protozoans, bacteria and fungi, rather than to larger organisms or plants; **aufwuchs**, in part.
phreatic (adj.)	of or pertaining to groundwater crevices; living in underground waters.
regolith (n.)	the parent rock from which the soil in an area is derived; or that lithology most influencing edaphic conditions.
semelparous (adj.)	reproducing only once in a lifetime.
stenotherm (n.)	organism having narrow temperature tolerances.
stenotopic (adj.)	of or pertaining to an organism having narrow habitat tolerances.
thermicole (n.)	organism living only in or preferring warm spring environments.
thermiphile (n.)	preferring warm spring environments; **thermiphilic** is the adjective.

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TABLES

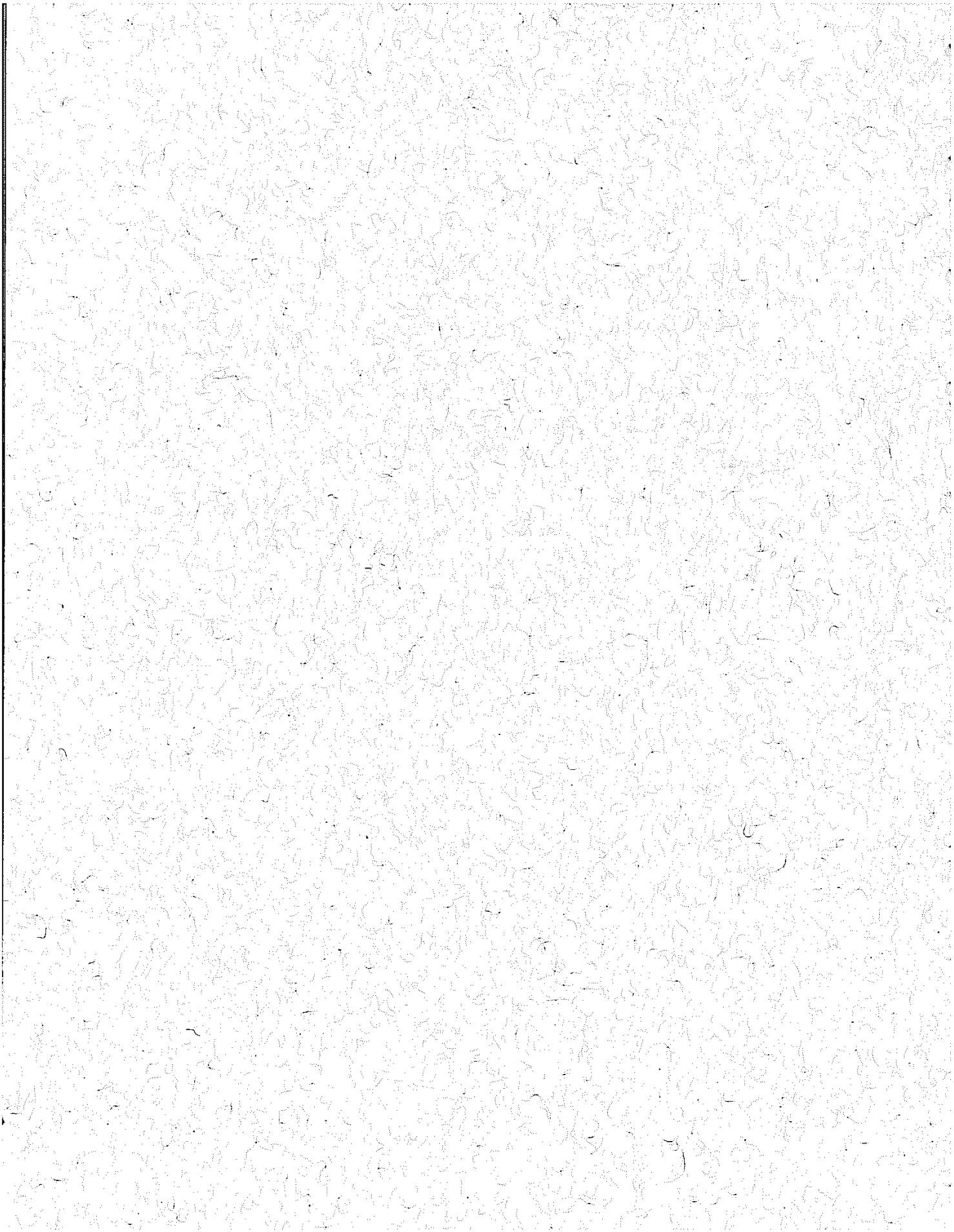


TABLE 1. FRESHWATER MOLLUSKS OF THE UPPER KLAMATH DRAINAGE.

[illegible]	[illegible]
GASTROPODA	
Valvata humeralis Say, 1829	perennial water bodies, rivers
Juga (Oreobasis) nigrina (Lea, 1856)	smaller perennial streams, springs
Juga (Oreobasis) "nigrina" Frest & Johannes, 1995b	large springs and larger streams
Pyrgulopsis n. sp. 1 Frest & Johannes, 1995a	large springs and spring-fed creeks, lakes
Pyrgulopsis n. sp. 2 Frest & Johannes, 1995a	large and small springs
Lyogyrus n. sp. 3 Frest & Johannes, 1995a	large spring-fed lakes or rivers
Lyogyrus n. sp. 4 Frest & Johannes, 1995a	large spring-fed lake
Lyogyrus n. sp. 5 Frest & Johannes, 1995a	large springs or spring-fed streams
Fluminicola n. sp. 1 Frest & Johannes, 1995a	spring-influenced rivers, large springs
Fluminicola n. sp. 2 Frest & Johannes, 1995a	small springs
Fluminicola n. sp. 3 Frest & Johannes, 1995a	spring sources or small springs
Fluminicola n. sp. 7 Frest & Johannes, 1995a	larger springs
Fluminicola n. sp. 8 Frest & Johannes, 1995a	larger springs
Fluminicola n. sp. 9 Frest & Johannes, 1995a	small springs
Fluminicola n. sp. 10 Frest & Johannes, 1995a	large springs, spring-influenced streams
Fluminicola n. sp. 11 Frest & Johannes, 1995a	spring-fed creek
Fluminicola n. sp. 12 Frest & Johannes, 1995a	springs
Fluminicola n. sp. 13 Frest & Johannes, 1995a	springs
Fluminicola n. sp. 14 Frest & Johannes, 1995a	springs and spring-fed creeks or rivers
**Radix auricularia* (Linnaeus, 1758)	widespread, often w/ abundant macrophytes
Lymnaea stagnalis appressa Say, 1821	lakes, ponds, slow streams
Stagnicola (Hinkleyia) caperata (Say, 1829)	small water bodies seasonally dry
Stagnicola (Hinkleyia) montanensis (Baker, 1913)	small flowing water bodies, seasonally dry
Stagnicola (Stagnicola) elodes Say, 1821)	water bodies and slow streams
Fossaria (Bakerilymnaea) bulimoides (Lea, 1841)	seeps and small streams
Fossaria (Fossaria) modicella (Say, 1825)	shallow water, amphibious along stream edges
Fossaria (Fossaria) parva (Lea, 1841)	amphibious around small water bodies
**Psuedosuccinea columella* (Say, 1817)	almost ubiquitous in warmer waters
Lanx alta (Tryon, 1865)	large-medium rivers, ? large spring pools
Lanx patelloides (Lea, 1856)	large rivers and tributaries, large spring pools
Gyraulus (Torquis) parvus (Say, 1816)	almost ubiquitous
Helisoma (Carinifex) newberryi newberryi (Lea, 1858)	spring-influenced lakes, rivers, & creeks
Planorbella (Pierosoma) subcrenata (Carpenter, 1857)	slow streams, water bodies at high elevations
Planorbella (Pierosoma) tenuis (Dunker, 1850)	slow streams, water bodiies
Vorticifex effusus dalli (Baker, 1945)	well-oxygenated lakes, springs, streams
Vorticifex effusus diagonalis (Henderson 1929)	well-oxygenated lakes, springs, streams
Vorticifex effusus effusus (Lea, 1856)	well-oxygenated lakes, springs, streams
Vorticifex klamathensis klamathensis (Baker, 1945)	well-oxygenated lakes, springs, streams
Vorticifex klamathensis sinitsini (Baker, 1945)	larger springs and their outflows
Menetus (Menetus) callioglyptus (Vanatta, 1895)	lakes and streams
Promenetus exacuous exacuous (Say, 1821)	perennial seeps, small springs, & ponds
Promenetus umbilicatellus (Cockerell, 1887)	seasonal ponds, ditches, marshes
Ferrissia rivularis (Say, 1817)	almost ubiquitous in well-oxygenated water
Physella (Physella) gyrina (Say, 1821)	almost ubiquitous
Physella (Costatella) virgata (Gould, 1855)	almost ubiquitous

TABLE 1. FRESHWATER MOLLUSKS OF THE UPPER KLAMATH DRAINAGE. (cont.)

SPECIES	HABITAT
BIVALVIA	
Anodonta californiensis Lea, 1852	lakes, rivers
Anodonta oregonensis Lea, 1838	lakes, rivers
Anodonta wahlametensis Lea, 1838	lakes, larger rivers
Gonidea angulata (Lea, 1838)	large creeks, rivers, rarely lakes
Margaritifera falcata (Gould, 1850)	rivers, large creeks
**Corbicula fluminea* (Müller, 1774)	artificial or disturbed water bodies, streams
Sphaerium striatinum (Lamarck, 1818)	creeks, rivers, lakes
Musculium raymondi (Cooper, 1890)	perennial water bodies
Musculium securis (Prime, 1852)	fluctating perennial water bodies
Musculium truncatum (Gould, 1845)	warmer water bodies & streams
Pisidium (Pisidium) idahoense Roper, 1890	large cold springs
Pisidium (Cyclocalyx) casertanum (Poli, 1791)	seasonal and perennial water bodies
Pisidium (Cyclocalyx) compressum Prime, 1852	perennial creeks and rivers
Pisidium (Cyclocalyx) contortum Prime, 1854	perennial lakes and ponds
Pisidium (Cyclocalyx) pauperculum Sterki, 1896	perennial rivers, large spring-fed creeks
Pisidium (C.) ultramontanum Prime, 1865	spring-fed lakes and large streams
Pisidium (C.) n. sp. 1 Frest & Johannes ,1995a	spring-fed lakes and large streams
Pisidium (Cyclocalyx) variabile Prime, 1852	perennial streams
Pisidium (Cyclocalyx) ventricosum Prime, 1851	seasonally fluctuating water bodies
Pisidium (Neopisidium) insigne Gabb, 1868	perennial seeps, small springs
Pisidium (Neopisidium) punctatum Sterki, 1895	low-gradient rivers, large spring runs

*= introduced species

TABLE 2. STATUS OF UPPER KLAMATH MOLLUSKS.

SPECIES	STATUS			
	FWS[1]	ROD[2]	ISP[3]	FS[4]
FRESHWATER GASTROPODA				
Pyrgulopsis archimedis Berry, 1947	Sp, E	-	S, E	-
Pyrgulopsis n. sp. 1 Frest & Johannes, 1995a	Sp, E	-	S, E	-
Pyrgulopsis n. sp. 2 Frest & Johannes, 1995a	-	-	S, E	-
Lyogyrus n. sp. 3 Frest & Johannes, 1995a	Sp, E	-	S, E	-
Lyogyrus n. sp. 4 Frest & Johannes, 1995a	Sp, E	-	S, E	-
Lyogyrus n. sp. 5 Frest & Johannes, 1995a	Sp, E	-	S, E	-
Fluminicola n. sp. 1 Frest & Johannes, 1995a	Sp, E	yes	S, E	-
Fluminicola n. sp. 2 Frest & Johannes, 1995a	Sp, E	yes	S, E	-
Fluminicola n. sp. 3 Frest & Johannes, 1995a	Sp, E	yes	S, E	-
Fluminicola n. sp. 7 Frest & Johannes, 1995a	-	-	S, T	-
Fluminicola n. sp. 8 Frest & Johannes, 1995a	-	-	S, E	-
Fluminicola n. sp. 9 Frest & Johannes, 1995a	-	-	S, E	-
Stagnicola (Hinkleyia) montanensis (Baker, 1913)	-	-	W	-
Lanx alta (Tryon, 1865)	Sp, T	-	S, E	-
Lanx klamathensis Hannibal, 1912	Sp, E	-	S, E	-
Helisoma (Carinifex) newberryi newberryi (Lea, 1858)	Sp, E	-	S, E	-
Vorticifex effusus dalli (Baker, 1945)	-	-	S, E	-
Vorticifex effusus diagonalis (Henderson, 1929)	-	-	S, E	-
Vorticifex klamathensis klamathensis (Baker, 1945)	Sp, E	-	S, E	-
Vorticifex klamathensis sinitsini (Baker, 1945)	Sp, E	yes	S, E	-

SPECIES	STATUS			
	FWS[1]	ROD[2]	ISP[3]	FS[4]
TERRESTRIAL GASTROPODA				
Discus shimeki cockerelli (Pilsbry, 1898)	-	-	-	C2
Monadenia (Monadenia) n. sp. 1 Frest & Johannes, 1995a	-	-	S, E	-
Pristiloma arcticum? crateris Pilsbry, 1946	Sp, T	yes	S, T	-
Vespericola sierranus (Berry, 1921)	Sp, T	-	S, T	-

TABLE 2. STATUS OF UPPER KLAMATH MOLLUSKS (cont.).

SPECIES	STATUS			
	[illegible]	[illegible]	[illegible]	[illegible]
Anodonta californiensis Lea, 1852	Sp, E	-	S, T	C2
Anodonta oregonensis Lea, 1838	-	-	-	-
Anodonta wahlametensis Lea, 1838	Sp, E	-	S, E	-
Gonidea angulata (Lea, 1838)	-	-	W	-
Margaritifera falcata (Gould, 1850)	-	-	W	-
Pisidium (C.) ultramontanum Prime, 1865	Sp, E	-	S, E	C2
Pisidium (C.) n. sp.1	-	-	S, E	-

EXPLANATION:

C2 = Federal ESA category 2 candidate: see USFWS (1994)
E = Recommended for federal ESA listing as Endangered; see Frest & Johannes (1993, 1995a)
S = Sensitive species; see Frest & Johannes (1995a)
Sp = Species of Special Concern; see Frest & Johannes (1993)
T = Recommended for federal ESA listing as Threatened; see Frest & Johannes (1993, 1995a)
W = Watch List; see Frest & Johannes (1995a)

[1] = Mollusc Species of Special Concern Within the Range of the Northern Spotted Owl (Frest & Johannes, 1993)
[2] = Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl and Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (ROD, 1994)
[3] = Interior Columbia Basin Mollusk Species of Special Concern (Frest & Johannes, 1995a)
[4] = Endangered and Threatened Wildlife and Plants; Animal Candidate Review for Listing as Endangered or Threatened Species; Proposed Rule (USFWS, 1994)

TABLE 3. UPPER KLAMATH SITE FAUNAL LISTS: GASTROPODS.

TAXON NAME	SITE NUMBER										
	1	2	3	4	5	6	7	8	9	10	11
Ferrissia rivularis									.002	.001	
Fluminicola n. sp. 1									x	x	
Fluminicola n. sp. 2											
Fluminicola n. sp. 3											
Fluminicola n. sp. 7											
Fluminicola n. sp. 8	.005	.003	.007	.001							
Fluminicola n. sp. 9	x	x	x	x			.002	.011			
Fluminicola n. sp. 10	x	x	x		x		x	x			
Fluminicola n. sp. 11	.007	.005	.009		.010						
Fluminicola n. sp. 12											
Fluminicola n. sp. 13											
Fluminicola n. sp. 14											
Fossaria (B.) bulimoides											
Fossaria (Fossaria) modicella											
Fossaria (Fossaria) parva											
Gyraulus (T.) circumstriatus											
Gyraulus (T.) parvus											
Helisoma (C.) newberryi			x								
Juga (Oreobasis) "nigrina"											
Juga (Oreobasis) nigrina								.001			x
Lanx alta			.004				.002	x			
Lanx klamathensis			x				x				
Lymnaea stagnalis appressa					.002	.001					
Lyogyrus n. sp. 3					x	x					
Lyogyrus n. sp. 4	.002							.003			
Lyogyrus n. sp. 5	x							x			
Menetus (M.) callioglyptus			x								
Physella (Costatella) virgata											
Physella (Physella) gyrina			x							x	
Planorbella (P.) subcrenata											
Planorbella (P.) tenuis											
Promenetus umbilicatellus											
**Psuedosuccinea columella*						.002					
Pyrgulopsis archimedis						x					
Pyrgulopsis n. sp. 1						x					
Pyrgulopsis n. sp. 2						.001					
**Radix auricularia*											
Stagnicola (H.) caperata											
Stagnicola (H.) montanensis											
Stagnicola (Stagnicola) elodes						?					
Valvata humeralis						.001					
Vorticifex effusus dalli						x					
Vorticifex effusus diagonalis											
Vorticifex effusus effusus			x			.001				x	
Vorticifex k. klamathensis						x	.001				
Vorticifex k. sinitsini							x				
	3	2	3	1	2	5	3	3	1	1	

TABLE 3. UPPER KLAMATH SITE FAUNAL LISTS: GASTROPODS (cont.).

TAXON NAME	SITE NUMBER										
	12	13	14	15	16	17	18	19	20	21	22
Ferrissia rivularis				.002							
Fluminicola n. sp. 1				x	x	x					
Fluminicola n. sp. 2	.001					.003					
Fluminicola n. sp. 3	x										
Fluminicola n. sp. 7											
Fluminicola n. sp. 8											
Fluminicola n. sp. 9											
Fluminicola n. sp. 10									.001	.002	
Fluminicola n. sp. 11					.001				x	x	
Fluminicola n. sp. 12					x						
Fluminicola n. sp. 13											
Fluminicola n. sp. 14											
Fossaria (B.) bulimoides											
Fossaria (Fossaria) modicella											
Fossaria (Fossaria) parva											
Gyraulus (T.) circumstriatus											
Gyraulus (T.) parvus											
Helisoma (C.) newberryi				x							
Juga (Oreobasis) "nigrina"							x				
Juga (Oreobasis) nigrina	x	x	x							.002	
Lanx alta										x	
Lanx klamathensis											
Lymnaea stagnalis appressa											
Lyogyrus n. sp. 3				.001		.002					
Lyogyrus n. sp. 4				x	x	x					
Lyogyrus n. sp. 5											
Menetus (M.) callioglyptus											
Physella (Costatella) virgata									x		
Physella (Physella) gyrina		[x]		x			x	x			
Planorbella (P.) subcrenata								x			
Planorbella (P.) tenuis											
Promenetus umbilicatellus											
Psuedosuccinea columella				.001		.003					
Pyrgulopsis archimedis				x	x	x					
Pyrgulopsis n. sp. 1				x							
Pyrgulopsis n. sp. 2											
Radix auricularia								x			
Stagnicola (H.) caperata								x			
Stagnicola (H.) montanensis											
Stagnicola (Stagnicola) elodes											
Valvata humeralis				.002							
Vorticifex effusus dalli				x							
Vorticifex effusus diagonalis											
Vorticifex effusus effusus					x?				x		
Vorticifex k. klamthensis											
Vorticifex k. sinitsini											

1 5 4 3 1 2

1 1 1

TABLE 3. UPPER KLAMATH SITE FAUNAL LISTS: GASTROPODS (cont.).

TAXON NAME	SITE NUMBER										
	23	24	25	26	27	28	29	30	31	32	33
Ferrissia rivularis		.003									
Fluminicola n. sp. 1	.001	x									
Fluminicola n. sp. 2	x										
Fluminicola n. sp. 3											
Fluminicola n. sp. 7											
Fluminicola n. sp. 8											
Fluminicola n. sp. 9											
Fluminicola n. sp. 10	.003										
Fluminicola n. sp. 11	x										
Fluminicola n. sp. 12											
Fluminicola n. sp. 13 Gasbeer							.002	.001			
Fluminicola n. sp. 14 Lake of Woods							x	x			
Fossaria (B.) bulimoides											
Fossaria (Fossaria) modicella											
Fossaria (Fossaria) parva											
Gyraulus (T.) circumstriatus											
Gyraulus (T.) parvus											
Helisoma (C.) newberryi		x									
Juga (Oreobasis) "nigrina"											
Juga (Oreobasis) nigrina											
Lanx alta	.005	.006		.001							
Lanx klamathensis	x	x		x							
Lymnaea stagnalis appressa		x									
Lyogyrus n. sp. 3											
Lyogyrus n. sp. 4	.004	.005									
Lyogyrus n. sp. 5	x	x									
Menetus (M.) callioglyptus			x								
Physella (Costatella) virgata											
Physella (Physella) gyrina		x				x					
Planorbella (P.) subcrenata		x									
Planorbella (P.) tenuis											
Promenetus umbilicatellus											
*Psuedosuccinea columella											
Pyrgulopsis archimedis											
Pyrgulopsis n. sp. 1							.001				
Pyrgulopsis n. sp. 2							x				
*Radix auricularia											
Stagnicola (H.) caperata		x									
Stagnicola (H.) montanensis											
Stagnicola (Stagnicola) elodes											
Valvata humeralis											
Vorticifex effusus dalli											
Vorticifex effusus diagonalis											
Vorticifex effusus effusus	x	x?	x				x	x			
Vorticifex k. klamthensis											
Vorticifex k. sinitsini											

4 3 1 2 1

TABLE 3. UPPER KLAMATH SITE FAUNAL LISTS: GASTROPODS (cont.).

TAXON NAME	SITE NUMBER										
	34	35	36	37	38	39	40	41	42	43	44
Ferrissia rivularis											
Fluminicola n. sp. 1											
Fluminicola n. sp. 2											
Fluminicola n. sp. 3			.004		.005	.003	.001			.002	
Fluminicola n. sp. 7			x	x	x	x	x		x	x	x
Fluminicola n. sp. 8											
Fluminicola n. sp. 9											
Fluminicola n. sp. 10					.004						
Fluminicola n. sp. 11					x						
Fluminicola n. sp. 12											
Fluminicola n. sp. 13											
Fluminicola n. sp. 14											
Fossaria (B.) bulimoides				x							
Fossaria (Fossaria) modicella											
Fossaria (Fossaria) parva											
Gyraulus (T.) circumstriatus											
Gyraulus (T.) parvus											
Helisoma (C.) newberryi											
Juga (Oreobasis) "nigrina"											
Juga (Oreobasis) nigrina											
Lanx alta											
Lanx klamathensis											
Lymnaea stagnalis appressa											
Lyogyrus n. sp. 3											
Lyogyrus n. sp. 4											
Lyogyrus n. sp. 5											
Menetus (M.) callioglyptus			x	x		x		x			
Physella (Costatella) virgata											
Physella (Physella) gyrina											
Planorbella (P.) subcrenata											
Planorbella (P.) tenuis											
Promenetus umbilicatellus											
**Psuedosuccinea columella*											
Pyrgulopsis archimedis											
Pyrgulopsis n. sp. 1											
Pyrgulopsis n. sp. 2											
**Radix auricularia*											
Stagnicola (H.) caperata											
Stagnicola (H.) montanensis											
Stagnicola (Stagnicola) elodes											
Valvata humeralis											
Vorticifex effusus dalli											
Vorticifex effusus diagonalis											
Vorticifex effusus effusus						x					
Vorticifex k. klamthensis											
Vorticifex k. sinitsini											
			1	1	2	1	1		1	1	1

TABLE 3. UPPER KLAMATH SITE FAUNAL LISTS: GASTROPODS (cont.).

TAXON NAME	SITE NUMBER										
	45	46	47	48	49	50	51	52	53	54	55
Ferrissia rivularis											
Fluminicola n. sp. 1											
Fluminicola n. sp. 2											
Fluminicola n. sp. 3											
Fluminicola n. sp. 7	.001					.002					
Fluminicola n. sp. 8			.006							.009	
Fluminicola n. sp. 9	x	x	x	.012	x	x	x		.013	x	
Fluminicola n. sp. 10	x	x	x	x	x	x	x	x	x	x	
Fluminicola n. sp. 11			.008							.014	
Fluminicola n. sp. 12	.006					.004					
Fluminicola n. sp. 13											
Fluminicola n. sp. 14											
Fossaria (B.) bulimoides											
Fossaria (Fossaria) modicella											
Fossaria (Fossaria) parva											
Gyraulus (T.) circumstriatus											
Gyraulus (T.) parvus											
Helisoma (C.) newberryi											
Juga (Oreobasis) "nigrina"											
Juga (Oreobasis) nigrina											
Lanx alta											
Lanx klamathensis											
Lymnaea stagnalis appressa											
Lyogyrus n. sp. 3							.001				
Lyogyrus n. sp. 4											
Lyogyrus n. sp. 5						x		x?			
Menetus (M.) callioglyptus			x	x		x		x			
Physella (Costatella) virgata											
Physella (Physella) gyrina				x							
Planorbella (P.) subcrenata											
Planorbella (P.) tenuis											
Promenetus umbilicatellus										x	
**Psuedosuccinea columella*											
Pyrgulopsis archimedis											
Pyrgulopsis n. sp. 1											
Pyrgulopsis n. sp. 2											
**Radix auricularia*											
Stagnicola (H.) caperata				x							
Stagnicola (H.) montanensis											
Stagnicola (Stagnicola) elodes											
Valvata humeralis											
Vorticifex effusus dalli						.001			.002	.003	
Vorticifex effusus diagonalis						x			x	x	
Vorticifex effusus effusus	x	x	x		x			x?			
Vorticifex k. klamthensis				.002							
Vorticifex k. sinitsini				x?							
	2	2	2	2	2	4	2	2	2	3	

TABLE 3. UPPER KLAMATH SITE FAUNAL LISTS: GASTROPODS (cont.).

TAXON NAME	SITE NUMBER										
	56	57	58	59	60	61	62	63	64	65	66
Ferrissia rivularis		.004									.005
Fluminicola n. sp. 1		x									x
Fluminicola n. sp. 2											
Fluminicola n. sp. 3											.006
Fluminicola n. sp. 7											x
Fluminicola n. sp. 8							.008			.010	
Fluminicola n. sp. 9							x	x	.003	x	
Fluminicola n. sp. 10									x	x	
Fluminicola n. sp. 11										.015	
Fluminicola n. sp. 12											
Fluminicola n. sp. 13											
Fluminicola n. sp. 14											
Fossaria (B.) bulimoides											
Fossaria (Fossaria) modicella											
Fossaria (Fossaria) parva											
Gyraulus (T.) circumstriatus											
Gyraulus (T.) parvus											
Helisoma (C.) newberryi											
Juga (Oreobasis) "nigrina"											x
Juga (Oreobasis) nigrina											
Lanx alta		.007							.003		
Lanx klamathensis		x							x?		
Lymnaea stagnalis appressa											
Lyogyrus n. sp. 3											
Lyogyrus n. sp. 4											
Lyogyrus n. sp. 5											.007
Menetus (M.) callioglyptus											x
Physella (Costatella) virgata											x
Physella (Physella) gyrina	x	x							x		x
Planorbella (P.) subcrenata	x										
Planorbella (P.) tenuis											
Promenetus umbilicatellus										x	
**Psuedosuccinea columella*											
Pyrgulopsis archimedis											
Pyrgulopsis n. sp. 1											
Pyrgulopsis n. sp. 2											
**Radix auricularia*	x	x									
Stagnicola (H.) caperata	x	x									x
Stagnicola (H.) montanensis											
Stagnicola (Stagnicola) elodes											
Valvata humeralis	x	x									
Vorticifex effusus dalli											
Vorticifex effusus diagonalis											
Vorticifex effusus effusus		x?							x	x?	
Vorticifex k. klamthensis											
Vorticifex k. sinitsini											
		2					1	1	2	2	3
									2		

TABLE 3. UPPER KLAMATH SITE FAUNAL LISTS: GASTROPODS (cont.).

TAXON NAME	SITE NUMBER										
	67	68	69	70	71	72	73	74	75	76	77
Ferrissia rivularis	.006										
Fluminicola n. sp. 1	x										
Fluminicola n. sp. 2											
Fluminicola n. sp. 3		007	008	009	010						
Fluminicola n. sp. 7		x	x	x	x						
Fluminicola n. sp. 8											
Fluminicola n. sp. 9											
Fluminicola n. sp. 10											
Fluminicola n. sp. 11											
Fluminicola n. sp. 12											
Fluminicola n. sp. 13								.005			004
Fluminicola n. sp. 14								x			x
Fossaria (B.) bulimoides											
Fossaria (Fossaria) modicella				x							
Fossaria (Fossaria) parva											
Gyraulus (T.) circumstriatus											
Gyraulus (T.) parvus											
Helisoma (C.) newberryi	x										
Juga (Oreobasis) "nigrina"											
Juga (Oreobasis) nigrina											
Lanx alta											
Lanx klamathensis											
Lymnaea stagnalis appressa	x										
Lyogyrus n. sp. 3											
Lyogyrus n. sp. 4											
Lyogyrus n. sp. 5											
Menetus (M.) callioglyptus	x	x									
Physella (Costatella) virgata											
Physella (Physella) gyrina	x										
Planorbella (P.) subcrenata											
Planorbella (P.) tenuis											
Promenetus umbilicatellus											
**Psuedosuccinea columella*											
Pyrgulopsis archimedis											
Pyrgulopsis n. sp. 1											
Pyrgulopsis n. sp. 2											
**Radix auricularia*											
Stagnicola (H.) caperata											
Stagnicola (H.) montanensis											
Stagnicola (Stagnicola) elodes											
Valvata humeralis	x										
Vorticifex effusus dalli											
Vorticifex effusus diagonalis											
Vorticifex effusus effusus	.002										
Vorticifex k. klamthensis	x?										
Vorticifex k. sinitsini											

TABLE 3. UPPER KLAMATH SITE FAUNAL LISTS: GASTROPODS (cont.).

TAXON NAME	SITE NUMBER										
	79	79	80	81	82	83	84	85	86	87	88
Ferrissia rivularis											
Fluminicola n. sp. 1											
Fluminicola n. sp. 2											
Fluminicola n. sp. 3											
Fluminicola n. sp. 7			.001								
Fluminicola n. sp. 8			x								
Fluminicola n. sp. 9											
Fluminicola n. sp. 10											
Fluminicola n. sp. 11											
Fluminicola n. sp. 12											.001
Fluminicola n. sp. 13		.005	.003								x
Fluminicola n. sp. 14		x	x								
Fossaria (B.) bulimoides											
Fossaria (Fossaria) modicella											
Fossaria (Fossaria) parva											
Gyraulus (T.) circumstriatus											
Gyraulus (T.) parvus			x								
Helisoma (C.) newberryi											
Juga (Oreobasis) "nigrina"											
Juga (Oreobasis) nigrina											
Lanx alta											
Lanx klamathensis											
Lymnaea stagnalis appressa											
Lyogyrus n. sp. 3											
Lyogyrus n. sp. 4											
Lyogyrus n. sp. 5											
Menetus (M.) callioglyptus											
Physella (Costatella) virgata											
Physella (Physella) gyrina		[x]		x	x		[x]				
Planorbella (P.) subcrenata											
Planorbella (P.) tenuis											
Promenetus umbilicatellus											
**Psuedosuccinea columella*											
Pyrgulopsis archimedis											
Pyrgulopsis n. sp. 1			.002								
Pyrgulopsis n. sp. 2			x								
**Radix auricularia*							[x]				
Stagnicola (H.) caperata											
Stagnicola (H.) montanensis											
Stagnicola (Stagnicola) elodes				x	x						
Valvata humeralis											
Vorticifex effusus dalli											
Vorticifex effusus diagonalis											
Vorticifex effusus effusus			x								
Vorticifex k. klamthensis											
Vorticifex k. sinitsini											

1 3 1

TABLE 3. UPPER KLAMATH SITE FAUNAL LISTS: GASTROPODS (cont.).

TAXON NAME	SITE NUMBER										
	89	90	91	92	93	94	95	96	97	98	99
Ferrissia rivularis											
Fluminicola n. sp. 1											
Fluminicola n. sp. 2											
Fluminicola n. sp. 3											
Fluminicola n. sp. 7											
Fluminicola n. sp. 8							.011				
Fluminicola n. sp. 9							x	.001	.002		
Fluminicola n. sp. 10							x		x	x	x
Fluminicola n. sp. 11							.016				
Fluminicola n. sp. 12								x			
Fluminicola n. sp. 13											
Fluminicola n. sp. 14											
Fossaria (B.) bulimoides											
Fossaria (Fossaria) modicella											
Fossaria (Fossaria) parva											
Gyraulus (T.) circumstriatus											
Gyraulus (T.) parvus						x					
Helisoma (C.) newberryi										x	x
Juga (Oreobasis) "nigrina"											
Juga (Oreobasis) nigrina							.003	x			
Lanx alta							x				
Lanx klamathensis										x	x
Lymnaea stagnalis appressa						.003					
Lyogyrus n. sp. 3						x?					
Lyogyrus n. sp. 4										.006	
Lyogyrus n. sp. 5										x?	
Menetus (M.) callioglyptus						x	x				
Physella (Costatella) virgata	x										
Physella (Physella) gyrina						x	x		x	x	
Planorbella (P.) subcrenata											
Planorbella (P.) tenuis											
Promenetus umbilicatellus					x						
Psuedosuccinea columella											
Pyrgulopsis archimedis											
Pyrgulopsis n. sp. 1											
Pyrgulopsis n. sp. 2											
Radix auricularia											
Stagnicola (H.) caperata									x		
Stagnicola (H.) montanensis											
Stagnicola (Stagnicola) elodes											
Valvata humeralis						x			x		
Vorticifex effusus dalli							.004				
Vorticifex effusus diagonalis							x				
Vorticifex effusus effusus						x					
Vorticifex k. klamthensis										.001	
Vorticifex k. sinitsini										x	x

Corrected for T. Frest 3/6/98

1 4 1 1 4 3

TABLE 3. UPPER KLAMATH SITE FAUNAL LISTS: GASTROPODS (cont.).

TAXON NAME	NUMBER OF OCCURRENCES	
Ferrissia rivularis	0	
Fluminicola n. sp. 1	9	IMGASG308X
Fluminicola n. sp. 2	1	IMGASG317X
Fluminicola n. sp. 3	2	IMGASG309X
Fluminicola n. sp. 7	14	IMGASG318X
Fluminicola n. sp. 8	1	IMGASG311X
Fluminicola n. sp. 9	15	IMGASG321X
Fluminicola n. sp. 10	23	IMGASG305X
Fluminicola n. sp. 11	3	IMGASG315X
Fluminicola n. sp. 12	2	IMGASG316X
Fluminicola n. sp. 13	1	IMGASG304X
Fluminicola n. sp. 14	6	IMGASG310X
Fossaria (B.) bulimoides	1	
Fossaria (Fossaria) modicella	1	
Fossaria (Fossaria) parva	0	
Gyraulus (T.) circumstriatus	0	
Gyraulus (T.) parvus	2	
Helisoma (C.) newberryi	7	
Juga (Oreobasis) "nigrina"	2	
Juga (Oreobasis) nigrina	4	
Lanx alta	4	IMGASX040X
Lanx klamathensis	8	IMGASX041X
Lymnaea stagnalis appressa	2	
Lyogyrus n. sp. 3	3	IMGASX003X
Lyogyrus n. sp. 4	4	IMGASX006X
Lyogyrus n. sp. 5	8	IMGASX005X
Menetus (M.) callioglyptus	15	
Physella (Costatella) virgata	2	
Physella (Physella) gyrina	20	
Planorbella (P.) subcrenata	3	
Planorbella (P.) tenuis	0	
Promenetus umbilicatellus	2	
**Psuedosuccinea columella*	0	
Pyrgulopsis archimedis	4	IMGASX020X
Pyrgulopsis n. sp. 1	2	IMGASX025X
Pyrgulopsis n. sp. 2	2	IMGASX023X
**Radix auricularia*	5	
Stagnicola (H.) caperata	7	
Stagnicola (H.) montanensis	0	
Stagnicola (Stagnicola) elodes	2	
Valvata humeralis	5	
Vorticifex effusus dalli	2	IMGASX070X
Vorticifex effusus diagonalis	4	IMGASX071X
Vorticifex effusus effusus	20	
Vorticifex k. klamthensis	2	IMGASX072X
Vorticifex k. sinitsini	3	IMGASX073X

TABLE 4. UPPER KLAMATH SITE FAUNAL LISTS: BIVALVES.

TAXON NAME	SITE NUMBER										
	1	2	3	4	5	6	7	8	9	10	11
Anodonta californiensis											
Anodonta wahlametensis											
Anodonta oregonensis											
Gonidea angulata											
Margaritifera falcata											
Corbicula fluminea											
Sphaerium striatinum											
Musculium raymondi											
Pisidium idahoense											
Pisidium casertanum			x								
Pisidium compressum											
Pisidium pauperculum			x								
Pisidium ultramontanum											
Pisidium n. sp. 1											
Pisidium variabile											
Pisidium insigne		x									
Pisidium punctatum											
SITE DIVERSITY	3	3	9	1	2	5	3	2	2	3	1

TABLE 4. UPPER KLAMATH SITE FAUNAL LISTS: BIVALVES.
(cont.)

TAXON NAME	SITE NUMBER										
	12	13	14	15	16	17	18	19	20	21	22
Anodonta californiensis										x	
Anodonta wahlametensis										app	
Anodonta oregonensis											
Gonidea angulata											
Margaritifera falcata											
Corbicula fluminea											
Sphaerium striatinum											
Musculium raymondi											
Pisidium idahoense										x	
Pisidium casertanum											
Pisidium compressum											
Pisidium pauperculum				.007		.005					
Pisidium ultramontanum				x	x	x					
Pisidium n. sp. 1											
Pisidium variabile											
Pisidium insigne											
Pisidium punctatum				x							
SITE DIVERSITY	2	3	1	9	6	4	2	4	3	4	0

TABLE 4. UPPER KLAMATH SITE FAUNAL LISTS: BIVALVES.
(cont.)

TAXON NAME	SITE NUMBER										
	23	24	25	26	27	28	29	30	31	32	33
Anodonta californiensis											
Anodonta wahlametensis											
Anodonta oregonensis											
Gonidea angulata						.001					
Margaritifera falcata						x					
Corbicula fluminea											
Sphaerium striatinum											
Musculium raymondi		x									
Pisidium idahoense											
Pisidium casertanum											
Pisidium compressum											
Pisidium pauperculum											
Pisidium ultramontanum											
Pisidium n. sp. 1											
Pisidium variabile											
Pisidium insigne							x				
Pisidium punctatum											
SITE DIVERSITY	5	10	3	1	0	2	4	2	0	0	0

TABLE 4. UPPER KLAMATH SITE FAUNAL LISTS: BIVALVES.
(cont.)

TAXON NAME	SITE NUMBER										
	34	35	36	37	38	39	40	41	42	43	44
Anodonta californiensis											
Anodonta wahlametensis											
Anodonta oregonensis											
Gonidea angulata											
Margaritifera falcata											
Corbicula fluminea											
Sphaerium striatinum								x			
Musculium raymondi											
Pisidium idahoense											
Pisidium casertanum			x		x	x					
Pisidium compressum											
Pisidium pauperculum					x						
Pisidium ultramontanum											
Pisidium n. sp. 1											
Pisidium variabile					x		x				
Pisidium insigne			x								x
Pisidium punctatum											
SITE DIVERSITY	0	0	4	3	5	4	2	2	1	1	2

TABLE 4. UPPER KLAMATH SITE FAUNAL LISTS: BIVALVES.
(cont.)

TAXON NAME	SITE NUMBER										
	45	46	47	48	49	50	51	52	53	54	55
Anodonta californiensis											
Anodonta wahlametensis											
Anodonta oregonensis											
Gonidea angulata											
Margaritifera falcata											
Corbicula fluminea											
Sphaerium striatinum								x			
Musculium raymondi											
Pisidium idahoense											
Pisidium casertanum			x	x				x			
Pisidium compressum											
Pisidium pauperculum			x								
Pisidium ultramontanum											
Pisidium n. sp. 1											
Pisidium variabile			x	x				x			
Pisidium insigne			x					x		x	
Pisidium punctatum											
SITE DIVERSITY	3	3	8	7	3	5	3	7	2	5	0

TABLE 4. UPPER KLAMATH SITE FAUNAL LISTS: BIVALVES.
(cont.)

TAXON NAME	SITE NUMBER										
	56	57	58	59	60	61	62	63	64	65	66
Anodonta californiensis											
Anodonta wahlametensis											
Anodonta oregonensis									.001		
Gonidea angulata									x		
Margaritifera falcata									x .002		
Corbicula fluminea											
Sphaerium striatinum											
Musculium raymondi	x										
Pisidium idahoense											
Pisidium casertanum	x							x			x
Pisidium compressum											
Pisidium pauperculum											
Pisidium ultramontanum											
Pisidium n. sp. 1											
Pisidium variabile		x								x	x
Pisidium insigne										x	
Pisidium punctatum											
SITE DIVERSITY	7	8	0	0	0	0	1	2	6	6	9

TABLE 4. UPPER KLAMATH SITE FAUNAL LISTS: BIVALVES.
(cont.)

TAXON NAME	SITE NUMBER										
	67	68	69	70	71	72	73	74	75	76	77
Anodonta californiensis											
Anodonta wahlametensis											
Anodonta oregonensis											
Gonidea angulata											
Margaritifera falcata											
Corbicula fluminea											
Sphaerium striatinum	x										
Musculium raymondi											
Pisidium idahoense	x										
Pisidium casertanum				x						x	
Pisidium compressum											
Pisidium pauperculum											
Pisidium ultramontanum											
Pisidium n. sp. 1											
Pisidium variabile											
Pisidium insigne										x	
Pisidium punctatum											
SITE DIVERSITY	9	2	1	3	1	0	0	1	0	2	1

TABLE 4. UPPER KLAMATH SITE FAUNAL LISTS: BIVALVES.
(cont.)

TAXON NAME	SITE NUMBER										
	78	79	80	81	82	83	84	85	86	87	88
Anodonta californiensis											
Anodonta wahlametensis											
Anodonta oregonensis											
Gonidea angulata											
Margaritifera falcata											
Corbicula fluminea											
Sphaerium striatinum											
Musculium raymondi											
Pisidium idahoense											
Pisidium casertanum			x								
Pisidium compressum											
Pisidium pauperculum											
Pisidium ultramontanum											
Pisidium n. sp. 1											
Pisidium variabile											
Pisidium insigne											
Pisidium punctatum											
SITE DIVERSITY	0	2	6	2	2	0	2	0	0	0	1

TABLE 4. UPPER KLAMATH SITE FAUNAL LISTS: BIVALVES.
(cont.)

TAXON NAME	SITE NUMBER										
	69	80	81	82	83	84	85	86	87	88	89
Anodonta californiensis											
Anodonta wahlametensis											
Anodonta oregonensis							,002				
Gonidea angulata							x				
Margaritifera falcata							x				
Corbicula fluminea							,003				
Sphaerium striatinum							x			x	x
Musculium raymondi											
Pisidium idahoense											
Pisidium casertanum							x		x	x	x
Pisidium compressum											
Pisidium pauperculum											
Pisidium ultramontanum											
Pisidium n. sp. 1						x					
Pisidium variabile							x		x	x	x
Pisidium insigne											
Pisidium punctatum											
SITE DIVERSITY	1	0	0	0	1	7	11	2	6	9	8

TABLE 4. UPPER KLAMATH SITE FAUNAL LISTS: BIVALVES. (cont.)

TAXON NAME	NUMBER OF OCCURRENCES	
Anodonta californiensis	1 (21 = site #)	IMBIV04020
Anodonta wahlametensis	0 —	IMBIV04180
Anodonta oregonensis	0	
Gonidea angulata	2 (61, 95)	IMBIV19010
Margaritifera falcata	3 (28, 64, 95)	IMBIV27020
Corbicula fluminea	0	
Sphaerium striatinum	6	
Musculium raymondi	2	
Pisidium idahoense	2	
Pisidium casertanum	17	
Pisidium compressum	1	
Pisidium pauperculum	3	
Pisidium ultramontanum	3 (15, 16, 17)	IMBIV51220
Pisidium n. sp. 1	1	
Pisidium variabile	12	
Pisidium insigne	9	
Pisidium punctatum	1	

TABLE 5. MUSEUM RECORDS FOR UPPER KLAMATH MOLLUSKS.

LOT NO./ INSTITUTION	NO. OF SPECS.	LOCALITY	COLLECTOR(S)
TAXON			
Lanx klamathensis			
UMMZ 62749	many	Upper Klamath Lake at S. boundary of reservation, Klamath Co., OR	
UMMZ 102565	5	Algoma, E. sideof North Klamath Lake, Klamath Co., OR	J. Henderson
UMMZ 102560	5	Klamath R. at Keno, OR	H. Hannibal
UMMZ 102561	14	North Klamath Lake, Klamath Co., OR	H. Hannibal
UMMZ 62751	2	E. shore of Agency Lake, Klamath Co., OR	-
UMMZ 102562	7	Klamath R. near Keno, Klamath Co., OR	S. S. Berry
UMMZ 102564	3	Klamath Lake, Klamath Co., OR	McAndrew
CAS 38286	6	Klamath Lake, Klamath Co., OR	ex F. L. Button coll.
CAS 32554	many	Klamath Lake, W. side, 1 mi. N. of mouth [of Link R.]	G. D. Hanna & J. L. Nichols, 7/29
CAS 32538	10	Klamath Lake, at outlet	G. D. Hanna & J. L. Nichols, 7/29
CAS 32537	20	Klamath Lake	E. Rixford, 1938
CAS 38271	4	Klamath Lake	C. L. Fox, 6/24
CAS 38269	1	Klamath Lake	-
CAS 38270	many	4 1/2 mi. N. of Algoma, Klamath Lake	G. D. Hanna & J. L. Nichols, 1929
CAS 38285	10	Klamath Lake	A. G. Smith, 1913
UCM 15930	1	Klamath Lake, OR	-
UCM 15930	many	Klamath Lake, OR	-
UCM 17744	1	Outlet of Klamath Lake, OR	-
UCM 17744	several	Outlet of Klamath Lake, OR	-
ANSP 80012	1	Upper Klamath Lake	E. D. Cope, 1879

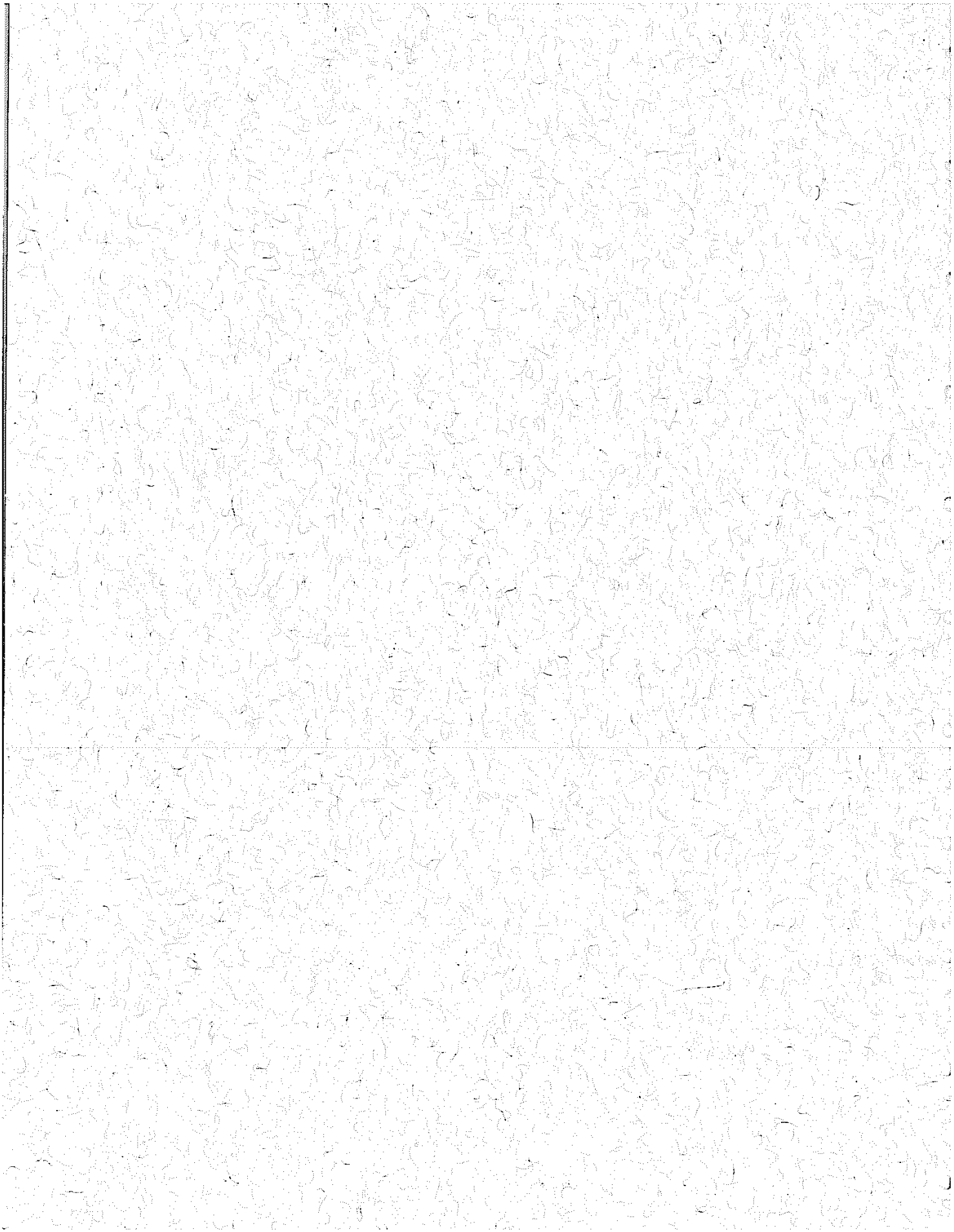
TABLE 5. MUSEUM RECORDS FOR UPPER KLAMATH LAKE MOLLUSKS. (cont.)

LOT NO./ INSTITUTION	NO. OF SPECS.	LOCALITY	COLLECTOR(S)
TAXON			
Lanx klamathensis			
ANSP 113843	4	Upper Klamath Lake near head of Link River	H. Hannibal
ANSP 158749	2	Outlet of Link River, Klamath Co., OR	H. B. Baker, 1929
ANSP 158327	1	Ouxy Siding, E. side of Klamath Lake, OR	H. B. Baker, 1928
ANSP 346768	18	Barclay Springs, near Algoma, Klamath Lake, 42.21N 121.49W , OR	W. Walton, July 15, 1946
NMNH 334387	6	Upper Klamath Lake, OR	J. Henderson
NMNH 334388	8	Lake Klamath, Klamath Falls, OR	W. Westgate
NMNH 380814	8	Upper Klamath Lake, OR	J. Henderson
Lanx alta			
UMMZ 62782	1	Sprague R. opposite Ferguson Butte, Klamath Co., OR	-
UMMZ 62783	3	Klamath R. at Spencer Creek, Klamath Co., OR	-
UMMZ 102568	4	Klamath R. at Klamath Hot Springs, OR	S. S. Berry
UMMZ 243537	many	Klamath R. 1/4 mi. above junction of Shasta R.with the Klamath R. CA	
UMMZ 62781	many	Lost R. near Bonanza, Klamath Co., OR	-
CAS 32552	3	Williamson R., Collier Memorial State Park, OR	G. D. Hanna, 8/26/62
CAS 38267	many	Shasta R. near mouth, Siskiyou Co., CA	G. D. Hanna & Nicholson, 1929
CAS 38265	many	Klamath R. at Hamburg, Siskiyou Co, CA	W. F. Barbot
CAS 38268	many	Klamath R., Hornbrook, CA	ex R. Coats coll.
CAS 38262	many	Klamath R. near Oak Flat Creek	A. G. Smith, 7/6/24
CAS 38250	7	Klamath R., Siskiyou Co., CA	ex W. J. Reynolds coll.
CAS 32551	3	Klamath R., Klamathon, CA	G. A. Coleman, 11/13/24
CAS 75011	3	Klamath R., near Scott Bar	W. Keeler
UCM 17715	many	Klamath R. near Klamathon, CA	-

TABLE 5. MUSEUM RECORDS FOR UPPER KLAMATH LAKE MOLLUSKS. (cont.)

LOT NO./ INSTITUTION	NO. OF SPECS.	LOCALITY	COLLECTOR(S)
TAXON			
Lanx alta			
UCM 17728	many	Klamath R. S. of Hornbrook, near Klamathon, CA	J. Henderson
UCM 17730	5	Shasta R. 4 mi. above junction with Klamath R.	J. Henderson
UCM 21644	many	Shasta R. 1 1/2 mi. above junction with Klamath R.	J. Henderson
ANSP 21960	1	Klamath R.	W. M. Gabb
ANSP 330081	1	Klamath R.	W. M. Gabb
ANSP 76793	32	Klamath R., Klamathon, Siskyou Co., CA	R. C. McGregor
ANSP 137796	2	Klamathon, Klamath R., CA	G. A. Cole
DMNH 54539	2	Klamath River, Klamathon, CA	
DMNH 81241	4	Klamath River, CA	
DMNH 52162	2	Klamath River, CA	M. E. Porter, 1972
Juga (O.) nigrina			
UMMZ 65617	4	Shasta R. E. of Mt. Shasta, Shasta Co., CA	
UMMZ 134023	many	E. Shasta R., near Weed, Siskiyou Co., CA	H. Hannibal
UMMZ 134025	7	Spring near Klamath Falls, Klamath Co., OR	-
CAS 24132	12	Klamath Co., OR, 4 1/2 mi. N. of Algoma, Klamath Lake	G. D. Hanna & Nicholson, 1929
CAS 30193	6	Klamath Lake	-

APPENDICES



APPENDIX A
SITES

Map coordinates are from the latest available USGS 7.5' series topographic maps. Legal coordinates are given when practical; where survey is irregular, projected coordinates are given, orienting from the northwest section corner wherever possible. Some areas have not been surveyed, or the survey is sufficiently irregular as to make use of township and range difficult. Hence, UTM coordinates are also supplied, in the format favored by Crawford (1983). Road names, road numbers and land ownership were confirmed using DeLorme Mapping's Oregon Atlas and Gazetteer, Winema National Forest 1986 and Fremont National Forest 1987 1:126,720 maps. Site descriptions are a partial dump from Deixis MolluscDB™. Number in parentheses at the end of each entry refers to site map page number (see Appendix B).

Site entry format: Project site number, Deixis locality number [in brackets], locality name, coordinates (UTM; legal), quadrangle (name and year), county, drainage, mountain range, valley, geographic description, elevation, depth, habitat description, locality remarks, collector remarks, date collected, and collectors.

Collector abbreviations as follows:

TF= Terrence J. Frest
EJ= Edward Johannes
JJ= James Johannes

1. [630] South source springs to the Wood River. Zone 10: 583,750E 4,731,980N. SW¼ SE¼ NE¼ SE¼ sec. 3, T33S R7 1/2E, Fort Klamath 1985 quad., Klamath Co. Wood River-Agency Lake-Upper Klamath Lake-Link River-Lake Euwauna-Klamath River. Wood River Valley. Unnamed source spring to the Wood River at Jackson F. Kimball State Park campground, N. of Fort Klamath,. off Sun Mountain Road (OR 232, FS 2300). Elev. 4197'. Depth 4-22'. Large cold spring pool and run; probably several springs as sources; abundant wood fragments at source; locally abundant *Rorippa*, bryophytes, *Mimulus*; uncommon small *Nostoc*; mud-sand-pumice gravel-rare cobble substrate. Very cold; slow-swift; clear; shallow-deep. Some modification at some spring sources; possibly partly dug out. Hand and dip net collections; partly sieved in field. Abundant *Fluminicola* locally (2 species); uncommon sphaeriids. 8/15/1991 TF, EJ, JJ! Recollect at southern spring sources; dip net and tray; field sieved to eliminate pumice. Good relaxation. Two species of *Fluminicola*; rare *Lyogyrus*; uncommon sphaeriids. 6/24/1994 TF, EJ! (B12)

2. [631] First unnamed spring south of Klamath State Fish Hatchery. Zone 10: 586,470E 4,722,210N. NE¼ NE¼ SE¼ SW¼ sec. 1, T34S R7½E, Fort Klamath 1985 quad., Klamath Co. Crooked Creek-Wood River-Agency Lake-Upper Klamath Lake-Link River-Lake Euwauna-Klamath River. First unnamed spring *ca.* 0.1 mi. S. of Klamath State Fish Hatchery on E. side of road to hatchery, *ca.* 0.5 mi. N. off OR 62. Elev. 4190'. Depth 0-2'. Small somewhat modified cold spring run; abundant *Rorippa* to E. of access road; less common below. Predominantly basalt cobble substrate to E. of road, with some mud and sand patches; slow; clear; moderately cold. Partly diverted into hatchery; collected below diversion structure. Hand and dip net collection. Common small *Fluminicola* on cobbles; rare sphaeriids (not collected). 8/15/1991 TF, EJ, JJ! Dip net and tray collection. Common small *Fluminicola* on cobbles; rare sphaeriids (not collected). 6/23/1994 TF, EJ! (B14)

3. [632] Tecumseh Spring. Zone 10: 586,770E 4,721,340N. SW¼ NE¼ SW¼ NE¼ sec. 12, T34S R7½E, Fort Klamath 1985 quad., Klamath Co. Crooked Creek-Wood River-Agency Lake-Upper Klamath Lake-Link River-Lake Euwauna-Klamath River. Tecumseh Spring, beside (E. of) Crater Lake Highway (OR 62), 0.2 rd. mi. S. of OR 62 crossing of Crooked Creek, just S. of access road to Klamath Fish Hatchery, just NE of Agency Hill. Elev. 4153'. Depth 1-36". Large, partly modified cold spring complex and pool; local *Rorippa*; dense *Myriophyllum* and *Ceratophyllum* beds in deeper areas, some substantial *Chara* stands; mostly mud substrate, with scattered gravel, cobbles, boulders, especially on E. side and S. end. Partly dug out and diverted as water source. Hand and dip net collection. Abundant *Fluminicola*; very common *Carinifex*; sphaeriids; *Physella*; very rare dead *Lanx*. 8/15/1991 TF, EJ, JJ! Dip net and tray, hand collections; partly sieved in the field. Abundant *Fluminicola*; very common *Carinifex*; sphaeriids; *Physella*; rare *Lanx* on cobbles. 6/24/1994 TF, EJ! (B14)

4. [633] Wood River Springs. Zone 10: 583,440E 4,732,680N. NE¼ NE¼ SW¼ NE¼ sec. 3, T33S R7½E, Fort Klamath 1985 quad., Klamath Co. Wood River-Agency Lake-Upper Klamath Lake-Link River-Lake Euwauna-Klamath River. Wood River Valley. Wood River Springs, source springs to the Wood River, north of Jackson F. Kimball State Park, NE of Fort Klamath, off Sun Mountain Road (OR 232, FS 2300). Elev. 4200'. Depth 1-2". Cold springs with mostly fine gravel and sand (pumice) substrate; some large wood fragments; local dense *Rorippa*. Heavily grazed, with snails (common small *Fluminicola*) surviving only in fortuitously protected areas. Hand and dip net collecting. 8/15/1991 TF, EJ, JJ! (B12)

5. [634] Crooked Creek 1. Zone 10: 586,580E 4,721,600N. SW¼ SW¼ NW¼ NE¼ sec. 12, T34S R7½E, Fort Klamath 1985 quad., Klamath Co. Crooked Creek-Wood River-Agency Lake-Upper Klamath Lake-Link River-Lake Euwauna-Klamath River. Crooked Creek above (E. of) Crater Lake Highway (OR 62) crossing just E. of access road to Klamath State Fish Hatchery. Elev. 4148'. Depth 1-18". Spring-fed cold creek with mixed mud, sand, pumice gravel substrate; no

macrophytes. Common large black *Fluminicola*. Hand, brush and tray collection. 8/15/1991 TF, EJ! (B14)

6. [635] Link River at USGS north gauging station. Zone 10: 599,550E 4,674,920N. NE¼ SW¼ SW¼ NW¼ sec. 32, T38S R9E, Klamath Falls 1985 quad., Klamath Co. Link River-Lake Ewauna-Klamath River. At USGS N. gauging station on the W. bank of the Link River, just N. of the Power station, W. of Klamath Falls. Elev. 4098'. Depth 1-48". River with substrate ranging from pebbles to boulder-size rocks. Rapids. Abundant *Vorticifex klamathensis*; common *Pyrgulopsis archimedis*; *Pyrgulopsis* n. sp.!; uncommon *Lyogyrus*; common sphaeriids. Hand and dip net collections. 8/15/1991 *Vorticifex klamathensis*; common *Pyrgulopsis archimedis*; *Pyrgulopsis* n. sp.!; uncommon *Lyogyrus*; common sphaeriids. Hand, dip net, brush and tray collections. 10/26/1992 TF, EJ, JJ! (B21)

7. [636] Barkley Spring. Zone 10: 597,930E 4,692,700N. Quarter sections not practical; sec. 6, T37S R9E, Modoc Point 1985 quad., Klamath Co. Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Barkley Spring at the S. end of Hagelstein County Park, W. side of Algoma Road, E. of US 97 (The Dalles-California Highway) and Upper Klamath Lake, below Modoc Rim, ca. 13 mi. N. of Klamath Falls. Predominantly sand and fine pumice-basalt gravel; local mud in quiet areas and where channel dug out; basalt boulders at one spring source. S. spring partly diverted into irrigation channel. Rare *Lanx*; common large *Fluminicola*; *Vorticifex* locally common; type locality of *Vorticifex klamathensis sinitsini* Baker, 1945. Hand collection. Collected in both spring run and lake. 8/15/1991 TF, EJ, JJ! (B27)

8. [637] Williamson River at the Waterwheel Campground. Zone 10: 591,540E 4,708,360N. NW¼ SW¼ SW¼ NE¼ sec. 21, T35S R7E, Agency Lake 1985 quad., Klamath Co. Williamson River-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Waterwheel Campground W. off US 97 bridge on the N. side of the Williamson River, opposite Williamson River Pumping Station. Elev. 4142'. Depth 1-4". River with gravel-cobble-some mud substrate; no macrophytes; very common odd lumber mill effluent-type algae and some protozoan coating on rocks. Gravel bar rapids. Common small *Lanx*; uncommon large *Fluminicola*. Hand collection. 8/15/1991 TF, EJ, JJ! (B3)

9. [638] Upper Klamath Lake north of Rattlesnake Point. Zone 10: 596,552E 4,688,792N. projected SE¼ SE¼ SE¼ NW¼ SW¼ sec. 23, T37S R8E, Wocus 1985 quad., Klamath Co. Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Upper Klamath Lake just N. of Rattlesnake Point and W. of the intersection of Algoma Road and US 97, along W. side of B. N. R. R. levee. Elev. 4143'. Depth 1-4'. Red pumice boulders and cobbles; local mud bottom. No macrophytes, but epiphytic algae common. One large species of *Fluminicola* abundant. Very rare *Lyogyrus*. Hand collection. 8/15/1991 TF, EJ, JJ! (B35)

10. [639] Klamath River at the John C. Boyle Power Plant. Zone 10: 577,140E 4,660,260N. SW¼ NE¼ SW¼ NW¼ sec. 13, T40S R6E, Chicken Hills 1986 quad., Klamath Co. Klamath River. Klamath River on N. side just E. of the John C. Boyle Power Plant at RM 220.6, BLM lands. Elev. 3350-3360'. Depth 1-24". River with large scale rapids with boulders. Quit pools scattered to side. Swift current and deep pools in center. In quiet areas, *Elodea*, *Potamogeton crispus*, *Ceratophyllum*. Collected ¼ mi. section of the river. *Juga* (*Oreobasis*) scattered, mostly in quiet pools near shore in shallow water. *Lanx* abundant throughout, most common in deep or more in current: become more rare offshore and in most violent rapids. *Fluminicola* uncommon, in quiet pools. *Vorticifex effusus* and *Physella* mostly in quiet pool edges. Hand collected. 8/16/1991 TF, EJ, JJ! (B6)

11. [640] Unnamed spring south of John C. Boyle Power Plant. Zone 10: 576,440E 4,659,140N. NE¼ NE¼ NW¼ NE¼ sec. 23, T40S R6E, Chicken Hills 1986 quad., Klamath Co. Klamath River.

Unnamed spring 0.8 rd. mi. S. of John C. Boyle Power Plant on W. side of the gravel road and Klamath River (RM 219.5), BLM lands. Elev. 3400'. Depth 0-0.5". Shallow road side spring. Rock face (basalt) and adjacent rock and mud spring run. Very shallow: almost a trickle. Hand collected. *Juga* mostly juveniles. No aquatic vegetation. 8/16/1991 TF, EJ, JJ! (B6)

12. [641] Unnamed spring at Klamath River RM 212.5. Zone 10: 571,700E 4,652,820N. NE¼ SE¼ SW¼ SE¼ sec. 5, T41S R6E, Mule Hill 1985 quad., Klamath Co. Klamath River. Unnamed spring run on Klamath Rim above heavily grazed flat (former fen), N. of Klamath River (RM212.5), BLM lands. Elev. 3450'. Depth 0-0.5". Small cold spring with gravel-cobble substrate, sparse sand and mud. No aquatic vegetation. Hand collected. *Juga* uncommon, Very small *Fluminicola* sp. 3 moderately common. 8/16/1991 TF, EJ, JJ! (B28)

13. [642] Unnamed spring at Klamath River RM 210.8. Zone 10: 569,590E 4,652,080N. NW¼ NW¼ SE¼ SE¼ NW¼ sec. 7, T41S R6E projected from NE corner, Mule Hill 1985 quad., Klamath Co. Klamath River. Unnamed spring run on NW side of dirt road below Klamath Rim, N. of Klamath River (RM 210.8). Elev. 3220'. Depth 1-6". Heavily grazed area. No aquatic vegetation. Mud bottom with some cobbles-boulders. *Juga (Oreobasis)* moderately abundant, mix of adults and juveniles; hand collected. *Physella* sp. rare; not collected. 8/8/1991 TF, EJ, JJ! (B28)

14. [643] Unnamed double spring run at Klamath River RM 209.7. Zone 10: 567,920E 4,651,160N. SW¼ NE¼ SW¼ SW¼ SE¼ sec. 12, T41S, Mule Hill 1985 quad., Klamath Co. Klamath River. Double spring run below and to E. of power (Pacific Light) substation below Klamath Rim, N. side of Klamath River at RM 209.7. Elev. 2860'. Depth 1-6". Heavily grazed area. Two narrow (< 18") spring runs which have cobbles and boulder and some mud. *Scirpus* on sides. Depth to 6". Hand collected. *Juga* fairly abundant, mostly adults & subadults (normal population distribution). 8/16/1991 TF, EJ, JJ! (B29)

15. [799] Upper Klamath Lake at Rattlesnake Point. Zone 10: 596,456E 4,688,648N. projected NE¼ SW¼ SW¼ SE¼ SW¼ sec. 23, T37S R8E, Wocus 1985 quad., Klamath Co. Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Upper Klamath Lake at Rattlesnake Point just SW of the intersection of Algoma Road and US 97, W. of B. N. R. R. levee. Elev. 4143'. Depth 2-4'. Lake with mud bottom with scattered basalt boulders; rare bedrock (red pumice, basalt) exposures. Common *Pyrgulopsis archimedis*; *Pisidium ultramontanum* rare; mostly dead *Carinifex*; uncommon *Vorticifex klamathensis*; rare *Lyogyrus* sp. 4; uncommon *Fluminicola* sp. 1. Collected by hand and dip net. 10/26/1992 TF, EJ, JJ! (B35)

says effusis delli in table. and sp. 1 .. abundance?

16. [800] Unnamed Springs near Ouxy Spring. Zone 10: 596,888E 4,694,528N. NE¼ SW¼ NW¼ NE¼ sec. 1, T37S R8E, Modoc Point 1985 quad., Klamath Co. Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Unnamed Springs near Ouxy Spring below US 97 at road mile 260.8 on the E. shore of the Upper Klamath Lake below Modoc Rim, Winema National Forest. Elev. 4143'. Depth 0-1". Shallow spring runs with red basalt [pumice- like texture] gravel- scattered cobble substrate. Local to abundant *Rorippa*. Hand, brush and tray and dip net collection. Common *Lyogyrus* sp. 4; *Fluminicola* sp. 1+2; rare *Pyrgulopsis archimedis*; rare *Pisidium ultramontanum*. Collected at unusually low water stage of lake. 10/26/1992 TF, EJ, JJ! (B27)

17. [801] Upper Klamath Lake offshore of Ouxy Spring. Zone 10: 596,886E 4,694,528N. NE¼ SW¼ NW¼ NE¼ sec. 1, T37S R8E, Modoc Point 1985 quad., Klamath Co. Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Offshore of Ouxy Spring below US 97 at road mile 260.8 on the E. shore of the Upper Klamath Lake below Modoc Rim, Winema National Forest. Elev. 4143'. Depth 1-4'. Spring influenced lake with red basalt [pumice- like texture] gravel- scattered cobble substrate. No macrophytes; local epiphytic algae. Common *Lyogyrus* sp. 4; *Fluminicola* sp. 1; *Pyrgulopsis archimedis*; abundant *Pisidium ultramontanum*. Collected at unusually low water stage of lake. Hand, brush, tray and dip net collections. 10/26/1992 TF, EJ, JJ! (B27)

18. [803] Sucker Spring. Zone 10: 597,300E 4,693,750N. NE¼ SW¼ NE¼ SE¼ sec. 1, T37S R8E, Modoc Point 1985 quad., Klamath Co. Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Sucker Spring on the E. side of Upper Klamath Lake below Modoc Rim. Elev. 4143'. Depth 0-2". Cold spring with well-rounded boulder-cobble substrate with local dense *Rorippa. Juga (Oreobasis)* abundant; full ontogeny. Rare *Physella*. Brush and tray, hand collections. Collected at unusually low lake water levels. 10/26/1992 TF, EJ, JJ! (B27)

19. [804] Boat ramp on the west side of Upper Klamath Lake. Zone 10: 587,260E 4,684,920N. SW¼ NW¼ NW¼ NE¼ sec. 36, T37S R7E, Howard Bay 1985 quad., Klamath Co. Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Boat ramp on the on W. side of Upper Klamath Lake at Howard Bay just off OR 140. Elev. 4143'. Depth 1-4'. Lake with predominantly mud substrate and scattered basalt cobbles, boulders; rip-rap near shore. Dense macrophytes off shore but none close (*Ceratophyllum*, *Nelumbo*). Rather warm and turbid; nil velocity. No live mollusks except *Physella*; dead *Stagnicola*, *Planorbella* (not collected). 10/27/1992 TF, EJ, JJ! (B20)

20. [805] Camporee Spring. Zone 10: 577,270E 4,697,800N. NW¼ NW¼ NW¼ NE¼ sec. 24, T36S R6E, Pelican Bay 1985 quad., Klamath Co. Odessa Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Camporee Spring along Odessa Creek at Odessa Campground off OR 140 on FS 3639, Upper Klamath Lake, Winema National Forest. Elev. 4143'. Depth 1-5". Spring with basal boulders, cobbles, and pebbles. Vesicular basalt or pumice pebbles are present. No macrophytes; common epiphytic algae (*Cladophora*). Only adult *Fluminicola* sp. 11 were found in spring; most abundant at mouth. Spring collected at extreme low-water level in Upper Klamath Lake; usually underwater at normal water levels. Hand, tray, and brush collections. 10/27/1992 TF, EJ, JJ! (B32)

21. [806] Odessa Creek at Camporee Spring. Zone 10: 577,270E 4,697,800N. NW¼ NW¼ NW¼ NE¼ sec. 24, T36S R6E, Pelican Bay 1985 quad., Klamath Co. Odessa Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Odessa Creek on both sides of Camporee Spring in Odessa Campground off OR 140 on FS 3639, Upper Klamath Lake, Winema National Forest. Elev. 4143'. Depth 1-5'. Creek with sparse cobbles (except near spring); mostly mud-gravel substrate, including fossil fish bones. *Elodea* 8-9' from shore. Dredged creek channel on either side of the nearby Camporee Spring. Dip net, trawl, and hand collections. Common *Carinifex*, *Pisidium idahoense*; *Fluminicola* sp. 11; uncommon *Lanx* and *Lyogyrus* sp. ? on rocks. Rare *Anodonta californiensis*?. 10/27/1992 TF, EJ, JJ! (B32)

22. [807] Unnamed spring. Zone 10: 576,100E 4,697,450N. NW¼ NW¼ SE¼ NE¼ sec. 23, T36S R6E, Pelican Bay 1985 quad., Klamath Co. Odessa Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Spring west of Odessa and Camporee Spring on the west side of OR 140, Winema National Forest. Elev. 4154'. Depth 0". Boulder-cobble substrate. Spring runs now dry. No live mollusks. 10/27/1992 TF, EJ, JJ! (B32)

23. [808] Harriman Spring. Zone 10: 574,060E 4,701,960N. SW¼ SW¼ SW¼ NE¼ sec. 3, T36S R6E, Pelican Bay 1985 quad., Klamath Co. Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Harriman Spring in Harriman Spring Resort at Harriman Lodge, W. side of Upper Klamath Lake near Pelican Bay. Elev. 4143'. Depth 2-38". Composite spring channel with red basalt cobble-boulder bottom draining directly into Upper Klamath Lake. Rare *Rorippa* near shore. Offshore *Veronica* and very abundant huge *Nostoc pruniforme* accumulations. Both spring sources and offshore runs were collected. Lake levels unusually low. Collected by hand, dip net, brush and tray. Common *Fluminicola* sp. 2 (possibly 2 species); common *Lyogyrus* sp. 3 on *Nostoc* undersides and rocks; common *Vorticifex* and uncommon *Lanx* on rocks. 10/27/1992 TF, EJ, JJ! (B31)

24. [809] Malone Spring. Zone 10: 575,180E 4,708,850N. SW¼ SW¼ NE¼ NW¼ sec. 14, T35S R6E, Crystal Spring 1985 quad., Klamath Co. Cherry Creek-Fourmile Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Malone Spring is 0.4 mi. from turnoff at a picnic area, Upper Klamath Lake, Winema National Forest. Elev. 4143'. Depth 0-4'. Cold spring with mud with occasional cobbles. Macrophytes present. Hand and dipnet collections. Rare *Carinifex*, *Lanx*; uncommon *Fluminicola*, *Lyogyrus*, *Lymnaea stagnalis*, sphaeriids. 10/27/1992 TF, EJ, JJ! Recollected at normal lake level: trawl, dip net and tray collections. Fauna as above; but more common *Carinifex*, *Fluminicola*, *Lymnaea*. Dip net and dredge collections. 6/23/1994 TF, EJ (B10)

25. [810] Mares Egg Spring. Zone 10: 576,850E 4,723,300N. sec. 2, T34S R6E, Mares Egg Spring 1985 quad., Klamath Co. Crane Creek-Fourmile Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Mares Egg Spring, Winema National Forest. Elev. 4147'. Depth 0-13". Very cold spring pool with Rorippa and Mimulus mostly confined to edges; Nostoc accumulations in deeper pool. Substrate predominantly sand, silt, mud; some highly calcareous. Clear; deep in center. Common downed trees, wood. Spring level has dropped due to illegal dredging of Crane Creek by a farmer. Rare *Vorticifex*; common *Fluminicola* in small side springs on N. end; rare sphaeriids in main pool. 10/27/1992 TF, EJ, JJ! Revisited after some repair of 1992 damage; water level higher; *Nostoc* not improved. Not collected. (B24)

26. [839] Klamath River at RM 214.9. Zone 10: 574,400E 4,652,610N. SE¼ SE¼ NE¼ SE¼ SW¼ sec. 3, T41S R6E, Chicken Hills 1986 quad., Klamath Co. Klamath River. West side of the Klamath River SE of Grizzly Butte below Klamath Rim at RM 214.9. Elev. 3160'. River with boulder substrate. Polluted. *Lanx* rare. Hand collected. 8/16/1991 TF, EJ, JJ! (B7)

27. [1115] Penny Spring. Zone 10: 574,550E 4,663,040N. NW¼ NE¼ SW¼ NW¼ SE¼ sec. 3, T40S R6E, Chicken Hills 1986 quad., Klamath Co. Klamath River. Penny Spring at the site of Penny Spring Guard Station just off OR 66 (N. side) and E. of Hayden Mountain Summit. Elev. 4550'. Mud-sand-cobble substrate; no epiphytic algae or macrophytes. Almost dry spring; most diverted for water source at now-abandoned guard station. No mollusks. 8/16/1991 TF, EJ, JJ! (B6)

28. [1753] South Fork Sprague River at Forest Service picnic ground. Zone 10: 667,340E 4693,020N. SW¼ NW¼ SW¼ NW¼ SE¼ sec. 8, T37S R15E, Paradise Mountain 1988 quad., Klamath Co. S. Fork. Sprague River-Sprague River-Williamson River-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. South Fork Sprague River at Forest Service Sprague River Picnic Area, off and N. of OR140 about 0.7 rd. mi., Fremont National Forest. Elev. 4400'. Depth 2-12". Partly impounded small river; sand-cobble substrate; small riffle-pools; scattered macrophytes (*Myriophyllum*, *Potamogeton filiformis*); common *Cladophora*. Rare *Margaritifera falcata*, *Physella*; hand and dip net collections. Somewhat eutropified. 6/20/1994 TF, EJ! (B30)

29. [1761] Unnamed spring near Beatty Gap. Zone 10: 644,240E 4,700,500N. NW¼ NW¼ NW¼ SE¼ SW¼ sec. 13, T36S R12E, Ferguson Mountain 1988 quad., Klamath Co. Sprague River-Williamson River-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Large unnamed spring in pasture, originating just W. of OR 140, 1.5 mi. E. of Beatty, W. of Beatty Gap. Elev. 4320'. Depth 2-9". Large cold spring with mostly sand and mud substrate, with local basalt cobbles; no macrophytes; scattered *Mimulus*; some small *Rivularia* colonies. Common small *Fluminicola*, rare *Vorticifex*, very rare *Pyrgulopsis*. Dip net and tray collections. Area heavily grazed. 6/21/1994 TF, EJ! (B11)

30. [1762] Brown Spring. Zone 10: 639,190E 4,706,410N. SE¼ NW¼ NE¼ NW¼ NW¼ sec. 33, T35S R12E, Beatty 1988 quad., Klamath Co. Sycan River-Sprague River-Williamson River-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River, Sprague River Valley. Brown Spring to E. of

Oregon Pines Road. Elev. 4320'. Depth 2-6". Eutrophic large cold spring pond with abundant filamentous algae, *Myriophyllum*; common *Elodea*; *Potamogeton crispus*; *Ceratophyllum*; mud-fine gravel substrate. Uncommon small-sized *Fluminicola* sp. 11 and sphaeriids; rare *Vorticifex* on algae; common *Physella*. Spring heavily grazed; partly dug out and diverted into irrigation system. 6/21/1994 TF, EJ! (B4)

31. [1763] Calohan Spring. Zone 10: 632,000E 4,690,580N. SE¼ NW¼ NW¼ SW¼ SE¼ sec. 15, T37S R12E, Yonna 1988 quad., Klamath Co. Wildhorse Creek-Buck Creek-Lost River-Klamath River. Bly Mountain. Calohan Spring on N. side of Bly Mountain Pass 0.3 mi. and just W. of OR 140. Elev. 5040'. Dry spring. No mollusks. 06/21/1994 TF, EJ! (B37)

32. [1764] Wildhorse Spring. Zone 10: 631,810E 4,689,290N. Center NE¼ NE¼ SW¼ sec. 22, T37S R12E, Yonna 1988 quad., Klamath Co. Wildhorse Creek-Buck Creek-Lost River-Klamath River. Bly Mountain. Wildhorse Canyon. Wildhorse Spring on S. side of Bly Mountain Pass 0.6 mi. and just W. of OR 140, Wildhorse Canyon. Elev. 4960'. Dry spring. No mollusks. 06/21/1994 TF, EJ! (B37)

33. [1777] Rock Creek 1. Zone 10: 574,280E 4,711,500N. NE¼ NE¼ NE¼ NW ¼ SE¼ sec. 3, T35S R6E, Crystal Spring 1985 quad., Klamath Co. Rock Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Rock Creek 0.5 mi. W. of Westside Road on FS 3419, W. of Agency Lake, Winema National Forest. Elev. 4260'. Depth 1-5". Small very cold creek with cobble substrate; *Rivularia*, small *Nostoc*; no macrophytes; no caddis flies., clear, slow current. No mollusks, creek possibly dries (rarely?); dip net and hand collections attempted. 6/22/1994 TF, EJ! (B10)

34. [1778]. Rock Creek 2. Zone 10: 575,100E 4,711,810N. W½ SW¼ NW¼ SE ¼ NW¼ sec. 2, T35S R6E, Crystal Spring 1985 quad., Klamath Co. Rock Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Distributary channel of Rock Creek on W. side of West Side Road, ca. 0.3-0.5 mi. N. of FS 2419 turnoff, W. of Agency Lake. Elev. 4165'. Depth 0-1". Mostly cobble substrate; no algae or macrophytes. No mollusks, almost dry creek. 6/22/1994 TF, EJ! (B10)

35. [1779] Cherry Creek. Zone 10: 574,740E 4,717,230N. Center SE¼ SW¼ SW ¼ SW¼ sec. 14, T34S R6E, Crystal Spring 1985 quad., Klamath Co. Cherry Creek-Fourmile Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Cherry Creek channel along (W. of) West Side Road, about 0.45 mi. S. of Tiger Lily Spring, NW of Agency Lake, in Winema National Forest. Elev. 4238'. Cobble substrate, almost dry creek, no epiphytic algae or macrophytes. No mollusks. 6/22/1994 TF, EJ! (B9)

36. [1780] Unnamed spring south of Tiger Lily Spring. Zone 10: 574,450E 4,718,330N. Center NW¼ NE¼ SE ¼ NE¼ sec. 15, T34S R6E, Crystal Spring 1985 quad., Klamath Co. Cherry Creek-Fourmile Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Small spring 0.1 mi. S. of Tiger Lily Spring and E. of (just below) West Side Road, Winema National Forest. Elev. 4200'. Depth 2-4". Cold spring with predominantly mud (uncommon gravel and cobbles) substrate; common wood fragments. No macrophytes; in open meadow with *Spiranthes*, *Mimulus*, *Allium* spp., *Aconitum*, *Saxifraga*. Common small *Fluminicola*, sp. 7 rare *Promenetus*, sphaeriids; dip net and tray collections. Snails absent at source, present near E. fence line. Channeled and diverted to Cherry Creek; impacted by grazing. 6/22/1994 TF, EJ! (B9)

37. [1781] Tiger Lily Spring. Zone 10: 574,470E 4,718,430N. SE¼ NW¼ NE¼ SE ¼ NE¼ sec. 15, T34S R6E, Crystal Spring 1985 quad., Klamath Co. Cherry Creek-Fourmile Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Tiger Lily Spring just E. of (below) Westside Road and 0.3 mi. S. of mouth of Nannie Creek, NW of Agency Lake, Winema

National Forest. Elev. 3990'. Depth 2-6". Three cold spring channels with abundant *Mimulus*, *Saxifraga*; rarer *Spiranthes* (wet rich open meadow); mud-cobble substrate; no macrophytes; some epiphytic algae. Uncommon *Fluminicola*; abundant or absent locally depending on grazing; dip net and tray collections. Mostly diverted to irrigation ditch; heavily grazed; 3 separate spring channels over 0.1 mi.; 1 without snails. 6/22/1994 TF, EJ! (B9)

38. [1782] Jack Spring. Zone 10: 575,320E 4,719,890N. SE¼ SE¼ NE¼ SE ¼ NW¼ sec. 11, T34S R6E, Mares Egg Spring 1985 quad., Klamath Co. Cherry Creek-Fourmile Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Jack Spring ca. 0.45 mi. S. of Fourmile Spring just E. of West Side Road, Winema National Forest. Elev. 4160'. Depth 1-6". Small narrow cold spring channels (two) in *Pinus ponderosa* forest and partly open meadow. No macrophytes; common *Mimulus*, *Aconitum*, *Allium* spp., tiger lily; less common *Spiranthes*, *Salix*, *Prunus*, *Cornus stolonifera*; common *Pyrola* spp.; abundant wood fragments; mud substrate with uncommon cobbles. *Fluminicola* uncommon; dip net and tray collections. Impacted by grazing, fire. 6/22/1994 TF, EJ! (B25)

39. [1783] Fourmile Spring. Zone 10: 575,790E 4,720,340N. SE¼ NE¼ NE¼ NW ¼ NE¼ sec. 11, T34S R6E, Mares Egg Spring 1985 quad., Klamath Co. Fourmile Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Fourmile Spring at head of Fourmile Creek, E. of West Side Road, ca. 0.75 mi. S. of mouth of Threemile Creek, Winema National Forest. Elev. 4158'. Depth 12-38". Large deep (dug out) cold spring pool tributary to strongly agriculturally impacted creek; W. end open, deep; *Nostoc*, rare algae and moss, common wood fragments; mud substrate; rest soupy mud, abundant epiphytic algae (*Cladophora*), *Ceratophyllum*. *Fluminicola* and *Vorticifex* rare, very rare *Menetus* and sphaeriids; dip net collections. Mostly dug out and deepened; *Fluminicola* and *Vorticifex* only in extreme W. end. Mollusks very rare elsewhere (*Menetus*, sphaeriids). 6/22/1994 TF, EJ! (B25)

40. [1784] Unnamed spring on Westside Road. Zone 10: 575,090E 4,724,240N. SE¼ SE¼ SE¼ SE ¼ NW¼ sec. 35, T33S R6E, Mares Egg Spring 1985 quad., Klamath Co. Crane Creek-Fourmile Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Unnamed spring channels (3) E. of FS 3300 0.15 mi. N. of junction with Sevenmile Road, Winema National Forest. Elev. 4170'. Depth 0-3". Three small cold spring channels in a very wet *Pinus ponderosa* forest and closed sedge-grass meadow, abundant wood fragments; no macrophytes. *Fluminicola* very rare and local, uncommon sphaeriids; dip net and hand collections. Several small and shallow spring runs, some with high gradient. 6/22/1994 TF, EJ! (B24)

41. [1785] Unnamed spring on Westside Road. Zone 10: 575,100E 4,724,200N. SE¼ SE¼ SE¼ SE ¼ NW¼ sec. 35, T33S R6E, Mares Egg Spring 1985 quad., Klamath Co. Wood River Valley. Crane Creek-Fourmile Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Unnamed spring pool E. of FS 3300 0.15 mi. N. of junction with Sevenmile Road, Winema National Forest. Elev. 4160'. Depth 0-36". Cold spring pool with mud substrate and patchy gravel; abundant wood fragments; no macrophytes. Very cold; clear; nil velocity. Snails (*Menetus*, sphaeriids) rare; hand (off wood fragments) and dip net collections. 6/22/1994 TF, EJ! (B24)

42. [1786] Short Creek unnamed springs-south end. Zone 10: 575,360E 4,725,400N. SE¼ SW¼ SE¼ NW¼ SE¼ sec. 26, T33S R6E, Mares Egg Spring 1985 quad., Klamath Co. Short Creek-Sevenmile Creek-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Spring runs at S. end of Short Creek pool, ca. 0.88 mi. N. of FS 3300 from Sevenmile Road junction, Winema National Forest. Elev. 4160'. Depth 0-4". Several small-medium sized steep and shallow cold spring runs (S. part of large spring complex); mud-cobble (red vesicular basalt) substrate; abundant *Mimulus*, *Allium*, *Aconitum*, bryophytes, etc. (rich cool open meadow); no macrophytes. Very cold, clear, swift current. Uncommon *Fluminicola*;

abundant *Vespericola*; hand, dip net and tray collections. Near fence line and impacted by grazing; spring partly diverted into irrigation canal. 6/22/1994 TF, EJ! (B24)

43. [1787] Short Creek unnamed springs-middle. Zone 10: 575,390E 4,725,450N. NE¼ SW¼ SE¼ NW¼ SE¼ sec. 26, T33S R6E, Mares Egg Spring 1985 quad., Klamath Co. Short Creek-Sevenmile Creek-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Spring runs near middle of Short Creek pool, ca. 0.9 mi. N. of FS 3300 from Sevenmile Road junction, Winema National Forest. Elev. 4160'. Depth 2-6". Several small-medium sized steep and shallow cold spring runs (middle part of large spring complex); mud-cobble (red vesicular basalt) substrate; abundant *Mimulus*, *Allium*, *Aconitum*, *Pyrola*, bryophytes, etc. (rich cool open meadow); no macrophytes. Cold, clear, swift current. Common *Fluminicola*. Hand, dip net and tray collections. Some grazing impact; springs partly diverted into irrigation canal. 6/22/1994 TF, EJ! (B24)

44. [1788] Short Creek unnamed springs-north end. Zone 10: 575,400E 4,725,520N. NE¼ NW¼ NE¼ SW¼ SE¼ sec. 26, T33S R6E, Mares Egg Spring 1985 quad., Klamath Co. Wood River Valley. Short Creek-Sevenmile Creek-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Spring runs on N. end of Short Creek pool, ca. 0.95 mi. N. of FS 3300 from Sevenmile Road junction, Winema National Forest. Elev. 4160'. Depth 2-6". Several small-medium sized steep and shallow cold spring runs (N. part of large spring complex); mud-cobble (red vesicular basalt) substrate; abundant *Mimulus*, *Allium*, *Aconitum*, *Pyrola*, bryophytes, etc. (rich cool open meadow); no macrophytes. Cold, clear, swift current. Common *Fluminicola*, *Vespericola*; hand, dip net, and tray collections. Minor grazing impact; springs partly diverted into irrigation canal. 6/22/1994 TF, EJ! (B24)

45. [1789] North source springs of Klamath State Fish Hatchery. Zone 10: 586,380E 4,722,500N. SW¼ SE¼ NE¼ NE¼ SW¼ sec. 1, T34S R7½E, Fort Klamath 1985 quad., Klamath Co. Crooked Creek-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Unnamed springs at N. end of Klamath State Fish Hatchery, ca. 0.7 rd. mi. on access road from Crater Lake Highway (OR 62); concrete pool against rock rim; 3 major spring runs at upper end; and channel from catchment pool. Elev. 4200'. Depth 1-28". Cold springs and pool with mud, sand, and basalt cobbles; some *Myriophyllum* locally; *Mimulus* at source. Clear swift flows. *Fluminicola* abundant (2 species)-small at source; uncommon *Vorticifex* on solid surfaces in pool and channel; hand, dip net, and tray collections; most collected from cobbles. Concrete pool was drained for modifications at time of our collection. Odd "*Prophysaon*". 6/23/1994 TF, EJ! (B14)

46. [1790] Klamath State Fish Hatchery-2nd channel. Zone 10: 586,340E 4,722,500N. NE¼ NW¼ SE¼ NE¼ SW¼ sec. 1, T34S R7½E, Fort Klamath 1985 quad., Klamath Co. Crooked Creek-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Second spring channel from N. source springs of Klamath State Fish Hatchery, ca. 0.7 mi. on access road from Crater Lake Highway (OR 62). Elev. 4160'. Depth 4-18". Large cold spring run from multiple sources; mud, sand and rare cobbles area; sizable *Myriophyllum* beds; rare *Mimulus*. Clear swift current. Abundant small-sized *Fluminicola*; rarer *Vorticifex*; snails abundant on *Myriophyllum*; dip net and tray collections. Large multiple spring sources; run diverted into fish hatchery. 6/23/1994 TF, EJ! (B14)

47. [1792] Second unnamed spring south of Fort Klamath site. Zone 10: 584,900E 4,726,320N. NW¼ NE¼ NW¼ SW¼ NE¼ sec. 26, T33S R7½E, Fort Klamath 1985 quad., Klamath Co. Fort Creek-Wood River-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Large unnamed spring and run at base of Sugar Hill, ca. 0.5 mi. SE of site of Fort Klamath, N. of Agency Lake, Winema National Forest. Elev. 4160'. Depth 4-24". Large, partly dug out, cold spring; mud-pumice cobble substrate; common wood debris; scattered

Myriophyllum; common *Mimulus* at sides of run; deep pool at head. Abundant *Fluminicola*; rarer *Vorticifex*; common sphaeriids. Hand and dip net collections. Grazed despite fencing; somewhat modified. 6/23/1994 TF, EJ! (B13)

48. [1793] Agency Spring. Zone 10: 587,770E 4,718,920N. NE¼ SE¼ NE¼ SW¼ SW¼ sec. 18, T34S R7E, Agency Lake 1985 quad., Klamath Co. Agency Creek-Crooked Creek-Wood River-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Agency Spring just E. of OR 62 and Klamath Agency. Elev. 4180'. Depth 4-36". Large, dug-out, cold spring pool; mostly mud with scattered red basalt cobbles; scattered *Myriophyllum*; abundant wood fragments. Clear; slow flow. Abundant medium-sized tall *Fluminicola*; common *Vorticifex* and sphaeriids; uncommon *Stagnicola*. Dip net and hand collections. Dug out and dammed (former small power plant to the W.). 6/23/1994 TF, EJ! (B2)

49. [1794] Second unnamed spring south of Klamath Fish Hatchery. Zone 10: 586,470E 4,722,100N. SE¼ SE¼ NE¼ SE¼ SW¼ sec. 1, T34S R7½E, Fort Klamath 1985 quad., Klamath Co. Crooked Creek-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Unnamed spring run ca. 0.15 mi. S. of Klamath State Fish Hatchery and W. of access road (below), 0.15 rd. mi. from Crater Lake Highway (OR 62). Elev. 4170'. Depth 1-6". Several cold spring runs on vegetated talus and combined channel below; *Spiranthes*, bryophytes, *Cystopteris*; mud-cobble (basalt) substrate with some pumice; talus open with wet meadow vegetation; *Mimulus*, common *Myriophyllum*. Clear slow flow. Abundant *Fluminicola* (2 spp.?); uncommon *Vorticifex*. Hand, dip net, and tray collections. Partly diverted to hatchery at head. 6/24/1994 TF, EJ! (B14)

50. [1795] Third unnamed spring south of Klamath Fish Hatchery. Zone 10: 586,540E 4,721,960N. Center SW¼ SW¼ SW¼ SE¼ sec. 1, T34S R7½E, Fort Klamath 1985 quad., Klamath Co. Crooked Creek-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Unnamed spring run ca. 0.25 mi. S. of Klamath Hatchery and W. of access road (below), ca. 0.35 rd. mi. N. of Crater Lake Highway (OR 62), Winema National Forest. Elev. 4180'. Depth 2-10". Small cold spring runs on vegetated talus (open and wet meadow) and combined run below; abundant *Mimulus*, scattered *Myriophyllum* and rare *Rorippa*; sand-basalt cobble substrate with fine pumice. Not shown on USGS map. Abundant *Fluminicola* (2 spp.?); uncommon *Vorticifex*. Hand, dip net, and tray collections. Partly diverted at source to hatchery. 6/24/1994 TF, EJ! (B14)

51. [1796] Fourth unnamed spring south of Klamath Fish Hatchery. Zone 10: 586,560E 4,721,920N. SE¼ SW¼ SW¼ SW¼ SE¼ sec. 1, T34S R7½E, Fort Klamath 1985 quad., Klamath Co. Crooked Creek-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Unnamed spring run ca. 0.30 mi. S. of Klamath Hatchery and W. of access road (below), ca. 0.30 rd. mi. N. of Crater Lake Highway (OR 62), Winema National Forest. Elev. 4180'. Depth 1-11". Several small cold spring runs on open basalt talus with wet meadow vegetation and combined run below; abundant *Mimulus*; rare *Myriophyllum*; basalt cobbles-mud. Abundant *Fluminicola* (2 spp.); uncommon *Vorticifex*. Hand, dip net, and tray collections. Partly diverted at source to hatchery. 6/24/1994 TF, EJ! (B14)

52. [1797] Crooked Creek 2. Zone 10: 586,440E 4,722,060N. NE¼ NW¼ SE¼ NE¼ SW¼ sec. 1, T34S R7½E, Fort Klamath 1985 quad., Klamath Co. Crooked Creek-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Crooked Creek collected ca. 0.20 mi. S. of Klamath Fish Hatchery, below (W. of) access road, E. of Crater Lake Highway (OR 62), near locality 1794. Elev. 4155'. Depth 6-21". Large slow spring-fed cold creek; dominantly mud substrate; *Scirpus*, sedges, some *Myriophyllum*. Abundant medium-sized *Fluminicola*; *Menetus*. Dip net collections. Agricultural impact. 6/24/1994 TF, EJ! (B14)

53. [1798] Fort Creek below Reservation Spring. Zone 10: 584,780E 4,727,700N. Projected from NW corner; SW¼ NW¼ SW¼ SW¼ NE¼ sec. 23, T33S R7½E, Fort Klamath 1985 quad., Klamath Co. Fort Creek-Wood River-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Fort Creek collected 0.3 mi. from source (Reservation Spring), ca. 0.7 mi. NE of Fort Klamath (site), 1.5 mi. E. of Fort Klamath, off (E. of) Sun Mountain Road (OR 232, FS 2300) on FS 990, Winema National Forest. Elev. 4180'. Depth 4-18". Large cold spring with pumice cobble and sand; no macrophytes; common *Cladophora*; some wood fragments. *Fluminicola* and *Vorticifex* rare (more common at source, locality 1799); dip net and tray collections. Grazed badly; impounded below (*ca.* 0.3 mi. S.). Dam presently breached but may be repaired. 6/24/1994 TF, EJ! (B13)

54. [1799] Reservation Spring. Zone 10: 585,080E 4,728,100N. Projected from NW corner; NW¼ NE¼ SE¼ NW¼ NE¼ sec. 23, T33S R7½E, Fort Klamath 1985 quad., Klamath Co. Fort Creek-Wood River-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Reservation Spring, ultimate source of Fort Creek, ca. 1.0 mi. NE of Fort Klamath (site), 1.7 mi. E. of Fort Klamath, off (E. of) Sun Mountain Road (OR 232, FS 2300), Winema National Forest. Elev. 4180'. Depth 4-18". Large and very cold spring at source with pumice cobble-sand substrate; no macrophytes; common *Mimulus* at edges; in *Pinus ponderosa* and *Pinus* forest; swift flow. Abundant *Fluminicola* (2 spp.); uncommon *Vorticifex*. Dip net and tray collections. Relatively pristine; grazed elsewhere. 6/24/1994 TF, EJ! (B13)

55. [1851] Wood River at Wood River Picnic Ground. Zone 10: 582,600E 4,728,750N. NW¼ SE¼ SE¼ NW¼ SW¼ sec. 15, T33S R7½E, Fort Klamath 1985 quad., Klamath Co. Wood River-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Wood River Picnic Ground on Wood River at about RM15, ca. 0.45 mi. NNE of Fort Klamath, 0.70 rd. mi. off (W. of) Sun Mountain Road (OR 232, FS 2300), Winema National Forest. Elev. 4180'. Depth 2-43". River with sand, gravel, and cobbles substrate; deep pools; no macrophytes; rare *Myriophyllum*. No mollusks; dip net collections attempted. Unstable substrete? 6/24/1994 TF, EJ! (B12)

56. [1852] Odessa Spring. Zone 10: 576,840E 4,697,600N. NE¼ SW¼ SW¼ NE¼ NW¼ sec. 24, T36S R6E, Pelican Bay 1985 quad., Klamath Co. Odessa Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Odessa Spring at Wampler Ranch, ca. 0.55 mi. E. of OR 140 (Lake of The Woods Highway). Elev. 4147'. Depth 4-36". Eutrophic and modified large spring pond and run; source of Odessa Creek; trashed; abundant filamentous algae, *Ceratophyllum*, *Elodea*; predominant mud substrate. Planorbella, common sphaeriids, Radix, *Physella*, rare Valvata; dip net and tray collections. Agriculture-impacted. 6/25/1994 TF, EJ! (B32)

57. [1853] Odessa Creek east of Odessa Spring. Zone 10: 577,000E 4,697,720N. SW¼ SW¼ NE¼ NE¼ NW¼ sec. 24, T36S R6E, Pelican Bay 1985 quad., Klamath Co. Odessa Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Odessa Creek ca. 0.23 mi. E. of Odessa Spring, below the mouth of unnamed spring, Winema National Forest. Elev. 4147'. Depth 4-40". Large spring-fed creek; local *Myriophyllum*, *Potamogeton crispus*, *Elodea*, *Ceratophyllum*; some filamentous algae; mud-cobble substrate. Abundant *Fluminicola*; common *Vorticifex*, uncommon *Lanx klamathensis*; hand, dip net and tray collections. 6/25/1994 TF, EJ! (B32)

58. [1854] Channel in Klamath Marsh along Silver Lake Road. Zone 10: 608,200E 4,749,870N. SW¼ NE¼ NW¼ SE¼ SW¼ sec. 8, T31S R9E, Military Crossing 1988 quad., Klamath Co. Klamath Marsh-Williamson River-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Dug-out channel on Silver Lake Road (Klamath County 676), S. end of Klamath Marsh, Klamath National Wildlife Refuge. Elev. 4510'. Depth 1-40". Deep channel paralleling road; "black water", in peat; muddy-organic substrate; common *Nelumbo*, *Ceratophyllum*. No mollusks; dip net collection attempted. Dug-out channel, in peat. 6/26/1994 TF, EJ! (B26)

59. [1855] Wocus Butte Spring. Zone 10: 609,235E 4,741,940N. SE¼ SE¼ SW¼ NE¼ SE¼ sec. 5, T32S R9E, Wocus Bay 1988 quad., Klamath Co. Klamath Marsh-Williamson River-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wocus Butte. Wocus Butte Spring on E. side of Wocus Butte, W. of FS 4357 and Wocus Bay, Klamath Marsh, Winema National Forest. Elev. 3850'. Depth 1". Almost dry small cold spring with pumice substrate. No mollusks. 6/26/1994 TF, EJ! (B36)

60. [1856] Recovery Spring. Zone 10: 608,970E 4,739,100N. SE¼ SW¼ SE¼ SW¼ NE¼ sec. 17, T32S R9E, Wocus Bay 1988 quad., Klamath Co. Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Recovery Spring along Klamath County 43, above Millhayes Meadow, Winema National Forest. Elev. 4640'. Dry small spring; pumice substrate. No mollusks. Dry spring. 6/26/1994 TF, EJ! (B36)

61. [1857] Hog Creek at Klamath County 43 crossing. Zone 10: 601,550E 4,736,120N. NW¼ NW¼ NW¼ SW¼ NW¼ sec. 27, T32S R8E, Fuego 1988 quad., Klamath Co. Hog Creek-Williamson River-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Hog Creek at Klamath County 43 crossing, Winema National Forest. Elev. 4620'. Depth 0-4". Cold creek with muddy substrate; no macrophytes. No mollusks; dip net collection attempted. Almost dry. 6/26/1994 TF, EJ! (B16)

62. [1858] Williamson River Campground-north spring. Zone 10: 594,340E 4,723,360N. Projected from SW corner; SE¼ SW¼ NE¼ NE¼ NW¼ sec. 2, T34S R7E, Soloman Butte 1988 quad., Klamath Co. Williamson River-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Unnamed small spring on W. side of Williamson River toward N. end of Williamson River Campground off (E. of) FS 9730, Winema National Forest. Elev. 4195'. Depth 0-3". Small cold spring with abundant *Rorippa*; cobble-mud substrate; several small runs. Cold; clear; slow flow. Not shown on USGS map. Common small *Fluminicola*; hand, dip net and tray collections. Somewhat impacted by human traffic. 6/26/1994 TF, EJ! (B33)

63. [1859] Williamson River Campground-south spring. Zone 10: 594,335E 4,723,360N. Projected from SW corner; NE¼ NW¼ SE¼ NE¼ NW¼ sec. 2, T34S R7E, Soloman Butte 1988 quad., Klamath Co. Williamson River-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Unnamed small spring on W. side of Williamson River, flowing out from below (E. of) well with hand pump in Williamson River Campground off (E. of) FS 9730, Winema National Forest. Elev. 4195'. Depth 0-2". Very small cold spring with cobble-mud substrate; *Rorippa* covered. Clear; cold; slow flow. Fe staining on substrate. Not on USGS map. Sparse *Fluminicola*; hand and dip net collections. Partly piped at source. 6/26/1994 TF, EJ! (B33)

64. [1860] Williamson River at Williamson River Campground. Zone 10: 594,360E 4,723,400N. Projected from SW corner; E½ NW¼ SE¼ NE¼ NW¼ sec. 2, T34S R7E, Soloman Butte 1988 quad., Klamath Co. Williamson River-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Williamson River on E. side of Williamson River Campground off (E. of) FS 9730, Winema National Forest. Elev. 4195'. Depth 2-34". Cold river with predominantly basalt cobble; riffles to deep pools; spring-influenced; abundant *Myriophyllum* locally; common *Elodea* (2 spp.) locally, some filamentous algae; bryophytes, *Potamogeton filiformis* uncommon. Abundant *Fluminicola*, common *Vorticifex*, *Lanx*, *Margaritifera falcata*, *Gonidea angulata*; rarer sphaeriids, *Physella*. Hand, dip net, and tray collections. Exceptional mollusk habitat. 6/26/1994 TF, EJ! (B33)

65. [1861] Unnamed spring at head of Spring Creek. Zone 10: 591,310E 4,724,450N. NW¼ SW¼ SW¼ SW¼ NE¼ sec. 33, T33S R7E, Fort Klamath 1985 quad., Klamath Co. Spring Creek-Williamson River-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Unnamed spring at head of Spring Creek, S. of Spring Creek Campground at the end of FS 9732, W. of US 97, N. of Collier Memorial State Park, Winema National Forest. Elev. 4190'. Depth 2-15". Large, cold, partly

artesian spring; basalt bedrock, pumice sand/gravel and scattered gravel substrate; common *Rorippa*, white *Liparis*. Common *Fluminicola*, uncommon *Vorticifex*; dip net and tray collections. Relatively pristine large spring. 6/26/1994 TF, EJI (B15)

66. [1867] Crystal Spring. Zone 10: 575,420E 4,713,800N. SE¼ SE¼ NE¼ NE¼ NW¼ sec. 35, T34S R6E, Crystal Spring 1985 quad., Klamath Co. Crystal Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Crystal Spring at head of Crystal Creek 0.25 mi. E. of West Side Road at site of Crystal. Elev. 4145'. Depth 4-36". Diffuse cold spring, deep pool (dug out) at origin of Crystal Creek; dense macrophytes (*Ceratophyllum*, *Elodea*) and dense epiphytic algae offshore; mud-red basalt cobble substrate; common wood. Common *Carinifex* and *Vorticifex*; uncommon *Lyogyrus* and *Fluminicola*. Dip net and tray collections. Mostly dug out; snails out only near W. shore. 6/27/1994 TF, EJI (B9)

67. [1868] Recreation Creek at Rocky Point Resort boat launch. Zone 10: 575,120E 4,703,020N. SW¼ NE¼ NE¼ SW¼ SW¼ sec. 35, T35S R6E, Pelican Bay 1985 quad., Klamath Co. Recreation Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. N. side of boat launch at Rocky Point Resort, above the mouth of Recreation Creek on Pelican Bay (Upper Klamath Lake), Winema National Forest. Elev. 4150'. Depth 12-60". Large cold creek channel with dense macrophytes (*Ceratophyllum*, local *Myriophyllum*, common *Elodea*, common *Potamogeton crispus*); mud-gravel and cobble (red basalt) substrate. Spring influenced through the gravel bottom locally, anoxic mud elsewhere. Abundant *Carinifex*, common *Vorticifex*, *Pisidium idahoensis*; rare *Fluminicola*. Trawl, dip net and tray collections. 6/28/1994 TF, EJI (B31)

68. [1869] Second unnamed spring north on FS 3300. Zone 10: 575,280E 4,724,680N. NE¼ SE¼ SW¼ NW¼ NE¼ sec. 35, T33S R6E, Mares Egg Spring 1985 quad., Klamath Co. Crane Creek-Fourmile Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Unnamed spring to E. of FS 3300, ca. 0.4 mi. N. of junction with Sevenmile Road. Elev. 4160'. Depth 0-14". Cold spring with mud substrate; thick *Elodea* in pool. *Fluminicola* (moderate sized) moderately abundant in pool; rare elsewhere. Dip net and tray collections. Heavily grazed; partly dug out and channeled. 6/28/1994 TF, EJI (B24)

69. [1870] Third unnamed spring north on FS 3300. Zone 10: 575,380E 4,725,900N. NE¼ SW¼ SE¼ SW¼ NE¼ sec. 26, T33S R6E, Mares Egg Spring 1985 quad., Klamath Co. Short Creek-Sevenmile Creek-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Unnamed spring to E. of FS 3300, ca. 1.25 mi. N. of junction with Sevenmile Road, Winema National Forest. Elev. 4180'. Depth 0-6". Several anastomosing moderately steep very cold spring runs; slow-moderate clear flow; open meadow with white orchids, *Aconitum*, sedges, abundant *Mimulus*, bryophytes. *Fluminicola* uncommon, sporadically distributed; hand, dip net and tray. Relatively intact spring. 6/26/1994 TF, EJI (B24)

70. [1871] Fourth unnamed spring north on FS 3300. Zone 10: 575,650E 4,726,500N. NE¼ SE¼ NW¼ SE¼ NE¼ sec. 26, T33S R6E, Mares Egg Spring 1985 quad., Klamath Co. Short Creek-Sevenmile Creek-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River Valley. Unnamed spring lake on Short creek, ca. 1.65 mi. N. on FS 3300 from junction with Sevenmile Road and E. of FS 3300, Winema National Forest. Elev. 4175'. Depth 12-36". Deep cold pool; dug-out springs; pumice gravel and mud substrate with abundant wood, no macrophytes. *Fluminicola* very rare, in comparatively deep water. Mostly destroyed (dug out). 6/28/1994 TF, EJI (B24)

71. [1872] Source spring to Short Creek. Zone 10: 575,680E 4,727,720N. NW¼ SW¼ NE¼ SE¼ NE¼ sec. 26, T33S R6E, Mares Egg Spring 1985 quad., Klamath Co. Short Creek-Sevenmile Creek-Agency Lake-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Wood River

Valley. Source spring of Short Creek, E. of FS 3300 and S. 0.4 mi. from junction with Sevenmile Road, Winema National Forest. Elev. 4190'. Depth 4-12". Cold spring with pumice gravel and mud; common wood and coniferous needles; common bryophytes. Common medium-sized *Fluminicola*; dip net and tray collections. Relatively intact; modified at source. 6/28/1994 TF, EJ! (B24)

72. [1873] Spencer Creek above Spencer Creek Hook-Up Road crossing. Zone 10: 574,440E 4,674,920N. SW¼ SE¼ SW¼ NW¼ NE¼ sec. 34, T38S R6E, Spencer Creek 1986 quad., Klamath Co. Spencer Creek-Klamath River. Spencer Creek above crossing of Spencer Creek Hook -Up Road, ca. 1.6 mi. W. of Clover Creek Road, BLM lands. Elev. 4090'. Depth 2-8". Large cold creek; cobble-gravel substrate; no macrophytes; common brown algae. No mollusks; dip net and hand collections attempted. Agricultural and grazing impact. 6/29/1994 TF, EJ! (B34)

73. [1874] Unnamed spring on Clover Creek Road. Zone 10: 566,065E 4,681,670N. SW¼ SE¼ SE¼ SE¼ SW¼ sec. 2, T38S R5E, Lake of the Woods South 1985 quad., Klamath Co. Buck Lake-Spencer Creek-Klamath River. Small unnamed spring above (W. of) Clover Creek Road and 0.7 mi. E. of locality 1875, inholding in Winema National Forest. Elev. 4980'. Depth 0-1". Cold clear spring with *Mimulus*; sedge meadow above and below road. Sphaeriids only, not retained. Collected by hand and dip net. Area grazed severely. 6/29/1994 TF, EJ! (B23)

74. [1875] Unnamed spring off FS 950. Zone 10: 565,285E 4,681,900N. NW¼ NE¼ SE¼ SE¼ SE¼ sec. 3, T38S R5E, Lake of the Woods South 1985 quad., Klamath Co. Buck Lake-Spencer Creek-Klamath River. Unnamed spring just W. of FS 950 0.1 mi. and N. of Clover Creek Road, Winema National Forest. Elev. 4980'. Depth 1-6". Small cold spring run in a mostly dry creek bed in extensive boggy sedge meadow; cobble-mud substrate; no macrophytes; common bryophytes; *Aconitum*, *Saxifraga*, *Dodecatheon*, blazing star, *Spiranthes*, cranberry, *Allium* spp. in meadow. Common *Fluminicola*; hand, dip net and tray collections. Meadow grazed. 6/29/1994 TF, EJ! (B23)

75. [1876] Crystalline Spring. Zone 10: 565,060E 4,684,340N. NW¼ NE¼ SW¼ SE¼ NE¼ sec. 34, T37S R5E, Lake of the Woods South 1985 quad., Klamath Co. Unnamed Creek-Buck Lake-Spencer Creek-Klamath River. Crystalline Spring below (W. of) FS 3790, ca. 1.8 mi. E. from Dead Indian Memorial Road, Winema National Forest. Elev. 5260'. Depth 0-2". Small cold spring in wet sedge meadow; *Salix*, Saxifraga, *Spiranthes*, *Allium* spp., etc.; mud substrate. Sphaeriids only, not retained. Hand, dip net collections. Badly grazed; damaged by selective logging. 6/29/1994 TF, EJ! (B23)

76. [1877] Rainbow Springs. Zone 10: 565,680E 4,685,800N. NE¼ SE¼ SE¼ SW¼ NW¼ sec. 26, T37S R5E, Lake of the Woods South 1985 quad., Klamath Co. Rainbow Creek-Lake of the Woods-Seldom Creek-Fourmile Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Rainbow Springs at head of Rainbow Creek, to E. 0.1 mi. from FS 3750, S. of Lake of the Woods, Winema National Forest. Elev. 5115'. Depth 1-6". Several small anastomosing cold spring runs in wet sedge meadow; primarily mud bottom with occasional basalt cobbles; *Mimulus*, common bryophytes in runs; *Saxifraga*, bryophytes, *Aconitum*, *Spiranthes*, *Dodecatheon*, blazing star, etc. Not on USGS map. Common small *Fluminicola*; dip net and tray collections. Grazed, but meadow in good condition. 6/29/1994 TF, EJ! (B22)

77. [1878] Unnamed Rainbow Creek spring. Zone 10: 564,880E 4,686,820N. SE¼ NE¼ NE¼ SW¼ SE¼ sec. 22, T37S R5E, Lake of the Woods South 1985 quad., Klamath Co. Rainbow Creek-Lake of the Woods-Seldom Creek-Fourmile Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Unnamed spring S. of (below) FS 3750 to E. of unnamed tributary to Rainbow Creek, S. of Lake of the Woods, Winema National Forest. Elev. 5050'. Depth 0-2". Cold spring with mud-fine gravel substrate; very short run; no macrophytes; rare bryophytes; in wet

sedge meadow with *Spiranthes*, *Aconitum*, *Saxifraga*, etc. Not on USGS map. Sphaeriids only, not retained; dip net and hand collections. 6/29/1994 TF, EJ! (B22)

78. [1879] Rainbow Creek at FS 3750 crossing. Zone 10: 564,630E 4,687,220N. SE¼ NE¼ NE¼ SW¼ SE¼ sec. 22, T37S R5E, Lake of the Woods South 1985 quad., Klamath Co. Rainbow Creek-Lake of the Woods-Seldom Creek-Fourmile Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Rainbow Creek at crossing of FS 3750, ca. 0.5 mi. SW from Dead Indian Memorial Road, S. of Lake of the Woods, Winema National Forest. Elev. 5020'. Depth 2-6". Small cold creek (spring-fed above); cobble substrate; no macrophytes; common brown algae and wood fragments; small *Nostoc*. No mollusks; hand and dip net collections. 6/29/1994 TF, EJ! (B22)

79. [1880] Cold Creek south of Lake of the Woods. Zone 10: 565,320E 4,688,000N. NE¼ SE¼ NE¼ NE¼ sec. 22 & NW¼ SW¼ NW¼ NW¼ NW¼ sec. 23, T37S R5E, Lake of the Woods South 1985 quad., Klamath Co. Cold Creek-Lake of the Woods-Seldom Creek-Fourmile Creek-Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Cold Creek on both sides of Dead Indian Memorial Road, S. end of Lake of the Woods, Winema National Forest. Elev. 4970'. Depth 0-2". Very small cold creek; mud-gravel substrate with abundant conifer needles and wood; no macrophytes; uncommon bryophytes. Clear slow current. Very rare *Fluminicola* and sphaeriids; hand and dip net collections. Relatively pristine except to E. 6/29/1994 TF, EJ! (B22)

80. [1881] Big Springs at Bonanza. Zone 10: 632,150E 4,672,820N. SE¼ NW¼ NE¼ SE¼ SW¼ sec. 10, T39S R11E, Bonanza 1988 quad., Klamath Co. Lost River-Klamath River, Yonna Valley. Big Springs on E. side of Bonanza in Big Springs City Park, W. side of Lost River. Elev. 4118'. Depth 2-21". Two large cold springs with mostly mud substrate with some basalt cobbles; very abundant and large *Rorippa* to W.; to E., *Lemna*, filamentous algae, *Potamogeton crispus*, *Potamogeton filiformis*, *Elodea*. Abundant *Fluminicola* (2 spp?), *Pyrgulopsis*; less common *Physella*, *Helisoma*; hand, dip net and tray collections. Partly diverted for city water supply (at source); partly impounded by backflooding from Lost River. 6/30/1994 TF, EJ! (B5)

81. [1882] Ben Hall Spring. Zone 10: 652,690E 4,676,130N. SE¼ SE¼ SE¼ SW¼ SW¼ sec. 35, T38S R13E, Goodlow Mountain 1988 quad., Klamath Co. Ben Hall Creek-Miller Creek-Lost River-Klamath River. Ben Hall Spring on NW side of Gerber Reservoir, E. side of Ben Hall Creek, W. of Gerber Road, BLM lands. Elev. 4845'. Depth 18". Former spring converted to cow trough; no free flow. *Stagnicola*, *Physella* dip net collections. Snails from trough. Totally piped to trough. 6/30/1994 TF, EJ! (B19)

82. [1883] Ben Hall Creek. Zone 10: 652,640E 4,676,160N. SE¼ SW¼ SE¼ SW¼ SW¼ sec. 35, T38S R13E, Goodlow Mountain 1988 quad., Klamath Co. Ben Hall Creek-Miller Creek-Lost River-Klamath River. Ben Hall Creek on NW arm of Gerber Reservoir and 0.1 mi. NW of Ben Hall Spring off (W. of) Gerber Road, BLM lands. Elev. 4840'. Depth 0-6". Creek with mud and gravel; common epiphytic algae; *Potamogeton filiformis*; *Ceratophyllum*; channel dry above site. Common *Stagnicola* and *Physella*; dip net collections. Trenched and occasional flooded by reservoir. 6/30/1994 TF, EJ! (B19)

83. [1884] Stan H. Spring. Zone 10: 653,640E 4,676,840N. NW¼ SE¼ NW¼ NE¼ SE¼ sec. 35, T38S R13E, Goodlow Mountain 1988 quad., Klamath Co. Ben Hall Creek-Miller Creek-Lost River-Klamath River. Stan H. Spring in BLM campground, NW of Gerber Reservoir, E. of Gerber Road. Sign indicates this spring is named Stan H. Spring despite USGS 7.5' map. Elev. 4860'. Dry spring. Piped by BLM; spring dry even in trough. 6/30/1994 TF, EJ! (B19)

84. [1885] Barnes Creek spring 1. Zone 10: 657,340E 4,678,300N. SW¼ NW¼ SE¼ NW¼ SW¼ sec. 29, T38S R14E, Gerber Reservoir 1988 quad., Klamath Co. Barnes Creek-Miller Creek-Lost

River-Klamath River. Unnamed spring 0.3 mi. E. Barnes Creek, N. side of Gerber Dam Road (FS 3814), N. end of Gerber Reservoir. Elev. 4860'. Depth 1-28". Large cold clear spring run; mud substrate; dense *Rorippa*, Lemna, in boggy pasture. *Physella* and *Radix* only, dip net collected; not retained. Heavily pastured; boggy. 6/30/1994 TF, EJ! (B17)

85. [1886] Barnes Creek spring 2. Zone 10: 657,420E 4,678,260N. NE¼ SW¼ SE¼ NW¼ SW¼ sec. 29, T38S R14E, Gerber Reservoir 1988 quad., Klamath Co. Barnes Creek-Miller Creek-Lost River-Klamath River. Unnamed spring 0.35 mi. E. of Barnes Creek, N. side of Gerber Dam Road (FS 3814), N. end of Gerber Reservoir. Elev. 4860'. Depth 1-28". Dry spring. No mollusks, dry spring. 6/30/1994 TF, EJ! (B17)

86. [1887] Barnes Creek spring 3. Zone 10: 657,665E 4,678,180N. NW¼ NE¼ NW¼ SE¼ SW¼ sec. 29, T38S R14E, Gerber Reservoir 1988 quad., Klamath Co. Barnes Creek-Miller Creek-Lost River-Klamath River. Unnamed spring 0.5 mi. E. of Barnes Creek, N. side of Gerber Dam Road (FS 3814), N. end of Gerber Reservoir. Elev. 4850'. Dry spring. No mollusks. Dry spring. 6/30/1994 TF, EJ! (B17)

87. [1888] J Spring run. Zone 10: 658,735E 4,676,875N. NW¼ SE¼ NE¼ NE¼ SE¼ sec. 32, T38S R14E, Gerber Reservoir 1988 quad., Klamath Co. Barnes Creek-Miller Creek-Lost River-Klamath River. Large spring run of J Spring, *ca.* 1.6 mi. SE of Barnes Creek on E. side of Gerber Dam Road (FS 3814) and Gerber Reservoir. Elev. 4960'. Dry spring run. No mollusks. 6/30/1994 TF, EJ! (B17)

88. [1889] Casebeer Spring run. Zone 10: 660,220E 4,674,430N. NW¼ NE¼ SW¼ NE¼ NE¼ sec. 9, T39S R14E, Gerber Reservoir 1988 quad., Klamath Co. Barnes Valley Creek-Miller Creek-Lost River-Klamath River. Casebeer Spring run on E. of Gerber Reservoir, N. side of Gerber Dam Road (FS 3814). Elev. 4960'. Depth 0-2". Shallow large cold spring run; mud, gravel and basalt cobbles; scattered *Mimulus* and *Rorippa*. Common medium-sized *Fluminicola* and rare *Physella*; hand collection. Heavily grazed. 6/30/1994 TF, EJ! (B18)

89. [1890] First spring south of Casebeer Spring. Zone 10: 660,490E 4,674,050N. SE¼ SE¼ NE¼ SE¼ NE¼ sec. 9, T39S R14E, Gerber Reservoir 1988 quad., Klamath Co. Barnes Valley Creek-Miller Creek-Lost River-Klamath River. First unnamed spring 0.3 mi. S. of Casebeer Spring run, E. side of Gerber Dam Road (FS 3814) and Gerber Reservoir. Elev. 5040'. Dry spring, all diverted to field irrigation. No mollusks. Dry spring. 6/30/1994 TF, EJ! (B18)

90. [1891] Second spring south of Casebeer Spring. Zone 10: 660,500E 4,673,970N. SE¼ NE¼ SE¼ SE¼ NE¼ sec. 9, T39S R14E, Gerber Reservoir 1988 quad., Klamath Co. Barnes Valley Creek-Miller Creek-Lost River-Klamath River. Second unnamed spring 0.4 mi. S. of Casebeer Spring run, E. side of Gerber Dam Road (FS 3814) and Gerber Reservoir, BLM lands. Elev. 5040'. Dry spring, all diverted to field irrigation. No mollusks. Dry spring. 6/30/1994 TF, EJ! (B18)

91. [1892] Third to fifth springs south of Casebeer Spring. Zone 10: 660,520E 4,673,740N. E½ NE¼ NE¼ NE¼ SE¼ sec. 9, T39S R14E, Gerber Reservoir 1988 quad., Klamath Co. Barnes Valley Creek-Miller Creek-Lost River-Klamath River. Third to fifth unnamed springs 0.5 mi. S. of Casebeer Spring run, E. side of Gerber Dam Road (FS 3814) and Gerber Reservoir, BLM lands. Elev. 5030'. Three dry small springs, all diverted to field irrigation. No mollusks. Dry springs. 6/30/1994 TF, EJ! (B18)

92. [1893] Sixth spring south of Casebeer Spring. Zone 10: 660,540E 4,673,600N. NW¼ NW¼ SW¼ NW¼ SW¼ sec. 10, T39S R14E, Gerber Reservoir 1988 quad., Klamath Co. Barnes Valley Creek-Miller Creek-Lost River-Klamath River. Sixth unnamed springs 0.7 mi. S. of Casebeer

Spring run, E. side of Gerber Dam Road (FS 3814) and Gerber Reservoir, BLM lands. Elev. 5000'. Dry spring, all diverted to field irrigation. No mollusks. Dry spring. 6/30/1994 TF, EJ! (B18)

93. [1894] Crystal Castle Spring. Zone 10: 597,245E 4,711,020N. SE¼ SE¼ NW¼ SW¼ SW¼ sec. 7, T35S R8E, Chiloquin 1988 quad., Klamath Co. Sprague River-Williamson River-Upper Klamath Lake-Lost River-Klamath River. Crystal Castle Spring on NE side of Chiloquin Ridge Road (FS 5810), Winema National Forest. Elev. 4600'. Depth 0-2". Cold spring with common *Mimulus*; some wet meadow plants, *e.g. Aconitum*, *Spiranthes*; narrow channel; mud-gravel substrate. Small *Menetus*; dip net collection. Badly grazed, mostly piped. 7/1/1994 TF, EJ! (B8)

94. [1895] Sprague River upstream of Chiloquin Ridge Road bridge. Zone 10: 595,095E 4,715,120N. NW¼ NW¼ SE¼ NE¼ NE¼ sec. 35, T34S R7E, Chiloquin quad., Klamath Co. Sprague River-Williamson River-Upper Klamath Lake-Lost River-Klamath River. S. side of Sprague River upstream of Chiloquin Ridge Road (FS 5810) at fisherman's access. Elev. 4220'. Depth 6-20". Cold river with abundant macrophytes (*Potamogeton crispus*, *Potamogeton* filiformis; *Elodea*; Myriophyllum; *Ceratophyllum*; sponges; some filamentous algae; silt, mud and sand pocket on dominantly cobble substrate; medium-sized shallow river with partly cemented substrate. Rare *Valvata*; uncommon *Lyogyrus*; uncommon *Vorticifex*; uncommon *Fluminicola*; common *Margaritifera falcata*, *Gonidea angulata*. Hand and dip net collections. Somewhat eutropified; snails abundant. 7/1/1994 TF, EJ! (B8)

95. [1896] Spring Creek at Collier State Park. Zone 10: 591,680E 4,722,180N. E½ SW¼ NE¼ SE¼ SW¼ sec. 4, T34S R7E, Fort Klamath 1985 quad., Klamath Co. Williamson River-Upper Klamath Lake-Lost River-Lake Ewauna-Klamath River. Spring Creek collected on W. side, in picnic and day use area N. of museum, Collier State Park. Elev. 4190'. Depth 6-48". Large deep spring channel; silt and mud, some cobble and basalt bedrock; rare macrophytes (*Myriophyllum*); abundant wood. Abundant large *Lanx* and *Vorticifex*; uncommon *Fluminicola*, rare *Physella* and *Menetus*. Hand and dip net collections. 7/1/1994 TF, EJ! (B15)

96. [2152] Ouxy Spring. Quarter sections not practical; sec. 1, T37S R8E, Modoc Point 1985 quad., Klamath Co. Upper Klamath Lake-Link River-Lake Ewauna-Klamath River. Ouxy Spring source and run collected under and on both sides of B. N. R. R. tracks to W. of US 97, ca. 0.9 mi. NW of Hagelstein County Park, E. side of Upper Klamath Lake, at base of Modoc Rim. Elev. 4150'. Depth 0-2". Small shallow cold spring run; mostly sandy, with basalt cobbles locally; no macrophytes or epiphytic algae. Chub spawning area to source; suckers at mouth. Abundant *Juga* (*Oreobasis*), mostly immature; common *Fluminicola*. Hand collection. Suckers spawning at mouth (Lost River, Shortnose); chubs spawning at head of spring run. 4/26/1995 TF, EJ, SW! (B27)

97. [1697] Barkley Spring-middle cove. Zone 10: 597,860E 4,692,760N. Quarter sections not practical; sec. 6, T37S R9E, Modoc Point 1985 quad., Klamath Co. Upper Klamath Lake-Link River-Lake Euwauna-Klamath River. Small cove in center of N-S. channel in Hagelstein County Park, midway between N. and S. source springs, W. of Algoma Road near the junction with US 97 (The Dalles-California Highway), E. side of Upper Klamath Lake below Modoc Rim, ca. 13 mi. N. of Klamath Falls. Elev. 4150'. Depth 1-52". Large limnocrene pool in small cove; mostly mud and gravel substrate; abundant Potamogeton crispus, some *Potamogeton filiformis*; *Ceratophyllum*, *Elodea*; abundant epiphytic algae; common deciduous leaves. Mostly open shoreline. Dip net and tray collections. Common *Fluminicola*; uncommon *Stagnicola*, *Physella*, *Valvata*, and sphaeriids. No spawning gravel. 4/27/1995 TF, EJ! (B27)

98. [1698] Barkley Spring-opposite north source spring. Zone 10: 597,820E 4,692,820N. 1/4 sections not practical; sec. 6, T37S R9E, Modoc Point 1985 quad., Klamath Co. Upper Klamath Lake-Link River-Lake Euwauna-Klamath River. Cold spring run, W. side, opposite N. source

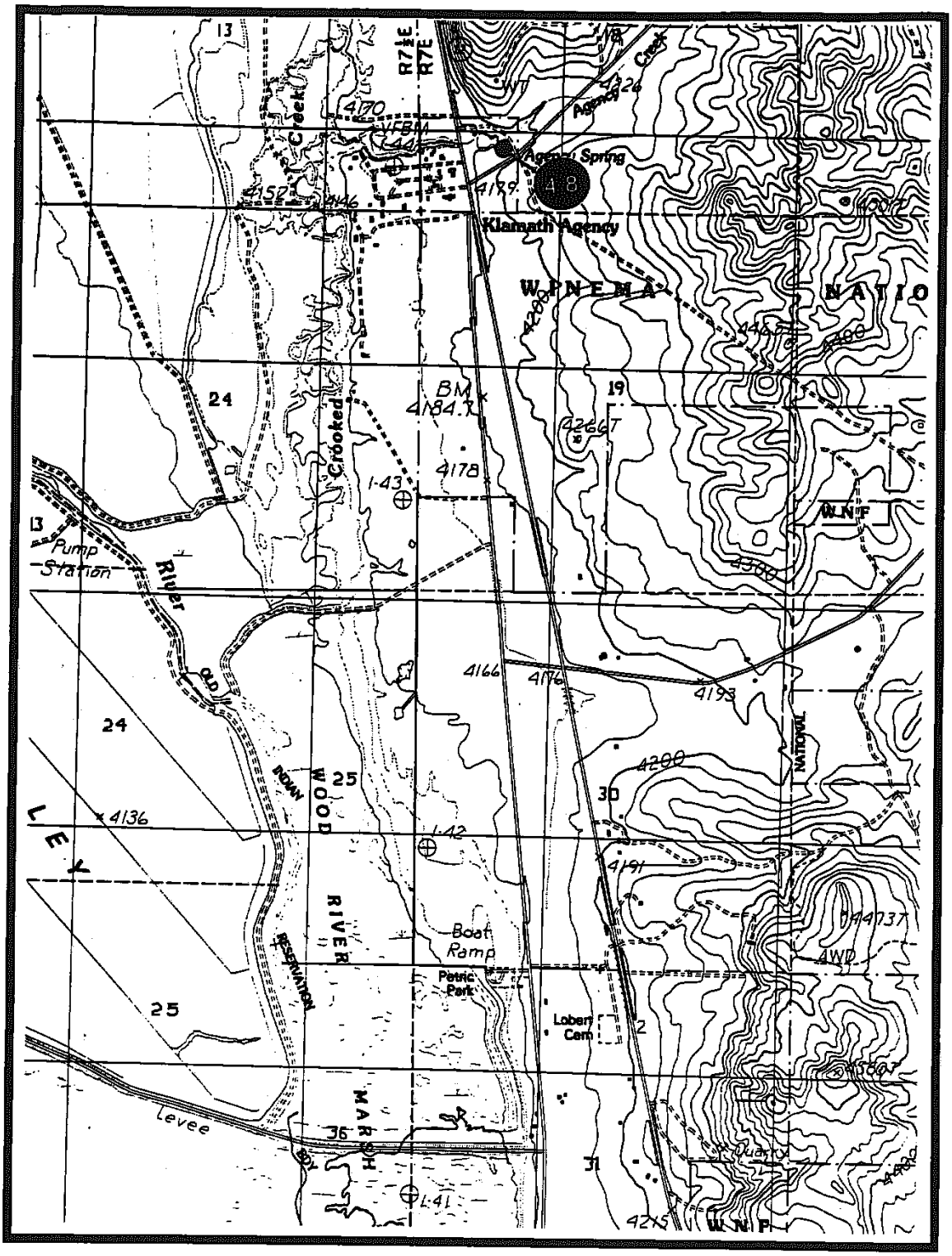
spring, N. end of Hagelstein County Park, between Algoma Road and US 97 (The Dalles-California Highway), E. side of Upper Klamath Lake below Modoc Rim, 13 mi. N. of Klamath Falls. Elev. 4150'. Depth 0-48". Large cold spring run; mixed mud, gravel, rare cobble substrate; abundant epiphytic algae; common *Ceratophyllum*, *Elodea*, some *Lemna trisulca*; effectively a limnocrene. Spawning gravel placed sometime in 1994. Dip net and tray collections. Abundant *Fluminicola*; common sphaeriids; uncommon *Carinifex*, *Vorticifex*; rare *Lyogyrus*, *Physella*. 4/27/1995 TF, EJI (B27)

99. [1699] Barkley Spring-north source spring. Zone 10: 597,820E 4,692,880N. Quarter sections not practical; sec. 6, T37S R9E, Modoc Point 1985 quad., Klamath Co. Upper Klamath Lake-Link River-Lake Euwauna-Klamath River. Large cold spring at N. end of Hagelstein County Park, between Algoma Road and US 97 (The Dalles-California Highway), E. side of Upper Klamath Lake below Modoc Rim, ca. 13 mi. N. of Klamath Falls. Elev. 4150'. Depth 2-60". Large basalt boulders with mud patches; abundant wood and plant fragments; abundant *Ceratophyllum*; *Elodea*; epiphytic algae uncommon; large cold spring and adjacent run, effectively a limnocrene. Spawning gravel placed nearby sometime in 1994. Dip net and tray collections. Uncommon *Carinifex*; large sphaeriids; uncommon *Lanx* and *Vorticifex* on rocks; common *Fluminicola*. 4/27/1995 TF, EJI (B27)

APPENDIX B. SITE MAPS.

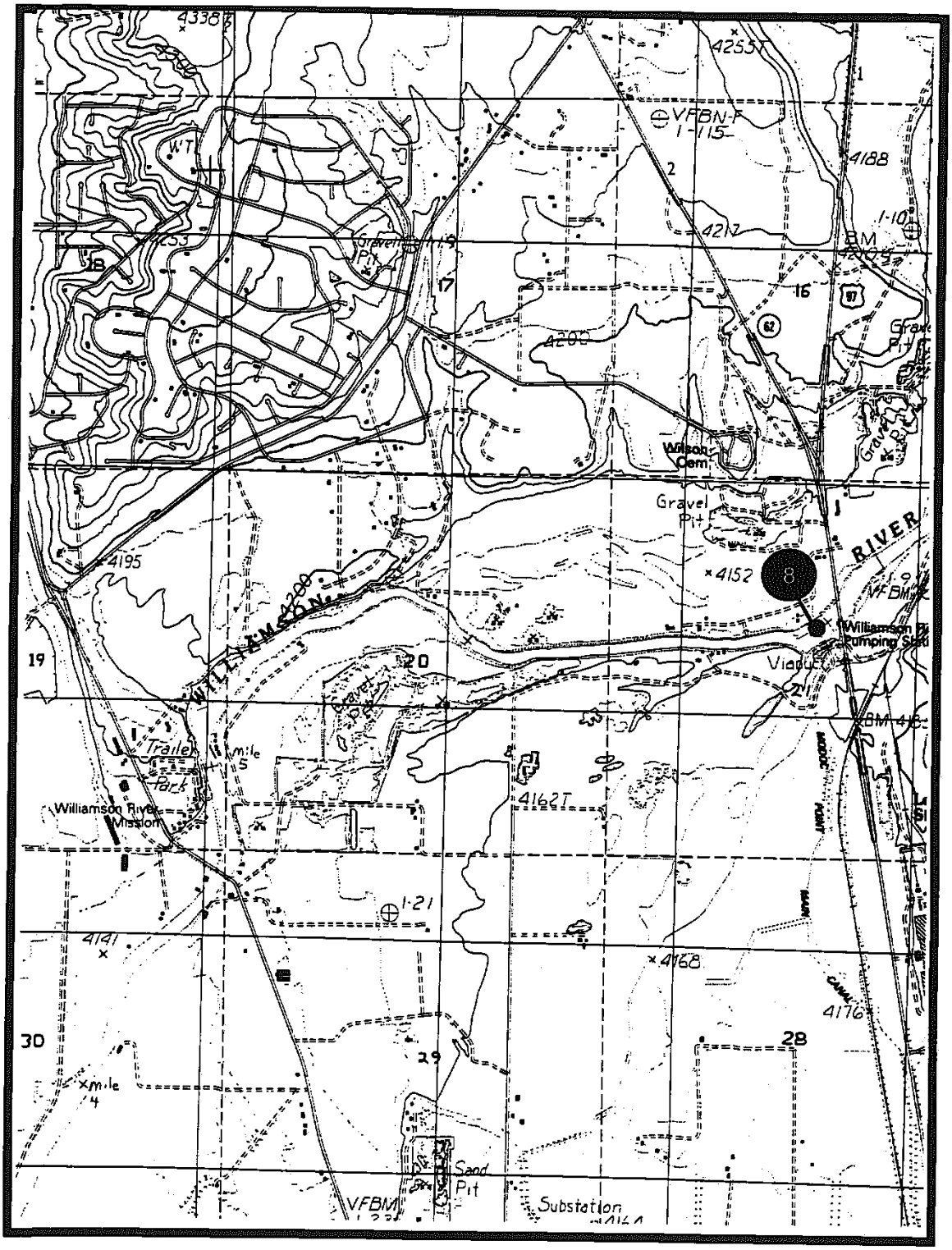
Maps of localities visited during this survey. Base map derived from appropriate USGS 7.5' topographic series and at same scale (1:24,000). For details see Appendix A.

QUADRANGLE	SITES	MAP
Agency Lake 4212158	48	B2
Agency Lake	8	B3
Beatty 4212143	30	B4
Bonanza 4212124	80	B5
Chicken Hills 4212211	10-11, 27	B6
Chicken Hills	26	B7
Chiloquin 4212157	93-94	B8
Crystal Spring 4212251	35-37, 66	B9
Crystal Spring	24, 33-34	B10
Ferguson Mountain 4212142	29	B11
Fort Klamath 4212168	1, 4, 55	B12
Fort Klamath	47, 53-54	B13
Fort Klamath	2-3, 5, 45-46, 49-52	B14
Fort Klamath	65, 95	B15
Fuego	61	B16
Gerber Reservoir	84-87	B17
Gerber Reservoir	88-92	B18
Goodlow Mountain	81-83	B19
Howard Bay	19	B20
Klamath Falls 4212127	6	B21
Lake of the Woods South 4212232	76-79	B22
Lake of the Woods South	73-75	B23
Mares Egg Spring 4212261	25, 39, 40-44, 68-71	B24
Mares Egg Spring	81-82	B25
Military Crossing	58	B26
Modoc Point 4212147	7, 16-18, 96-99	B27
Mule Hill 4212212	12-13	B28
Mule Hill	14	B29
Paradise Mountain 4212038	28	B30
Pelican Bay 4212241	23, 67	B31
Pelican Bay	20-22, 56-57	B32
Soloman Butte 4212167	62-64	B33
Spencer Creek	72	B34
Wocus 4212137	9, 15	B35
Wocus Bay	59-60	B36
Yonna	31-32	B37

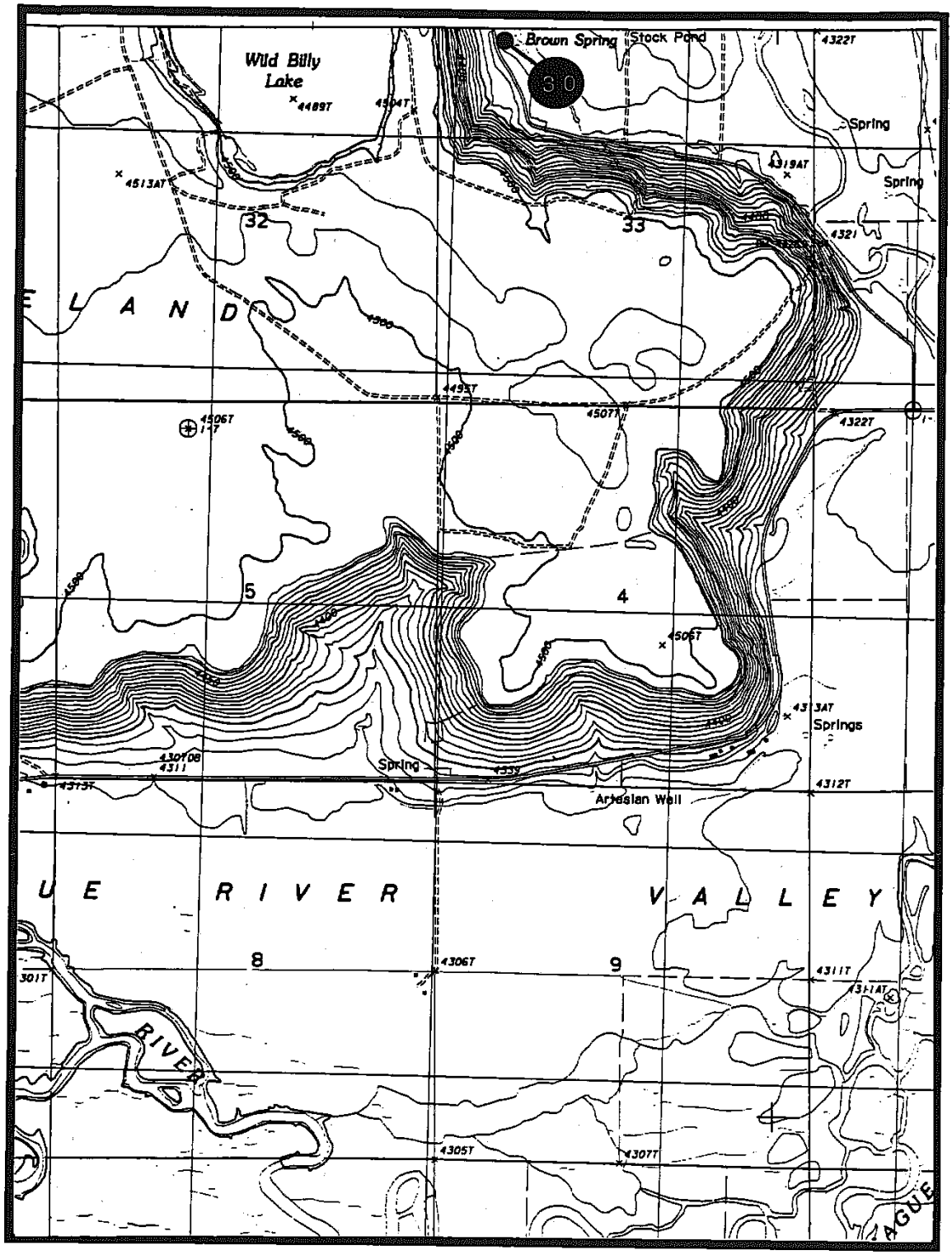


AGENCY LAKE QUADRANGLE, KLAMATH CO., OR
SITE 48

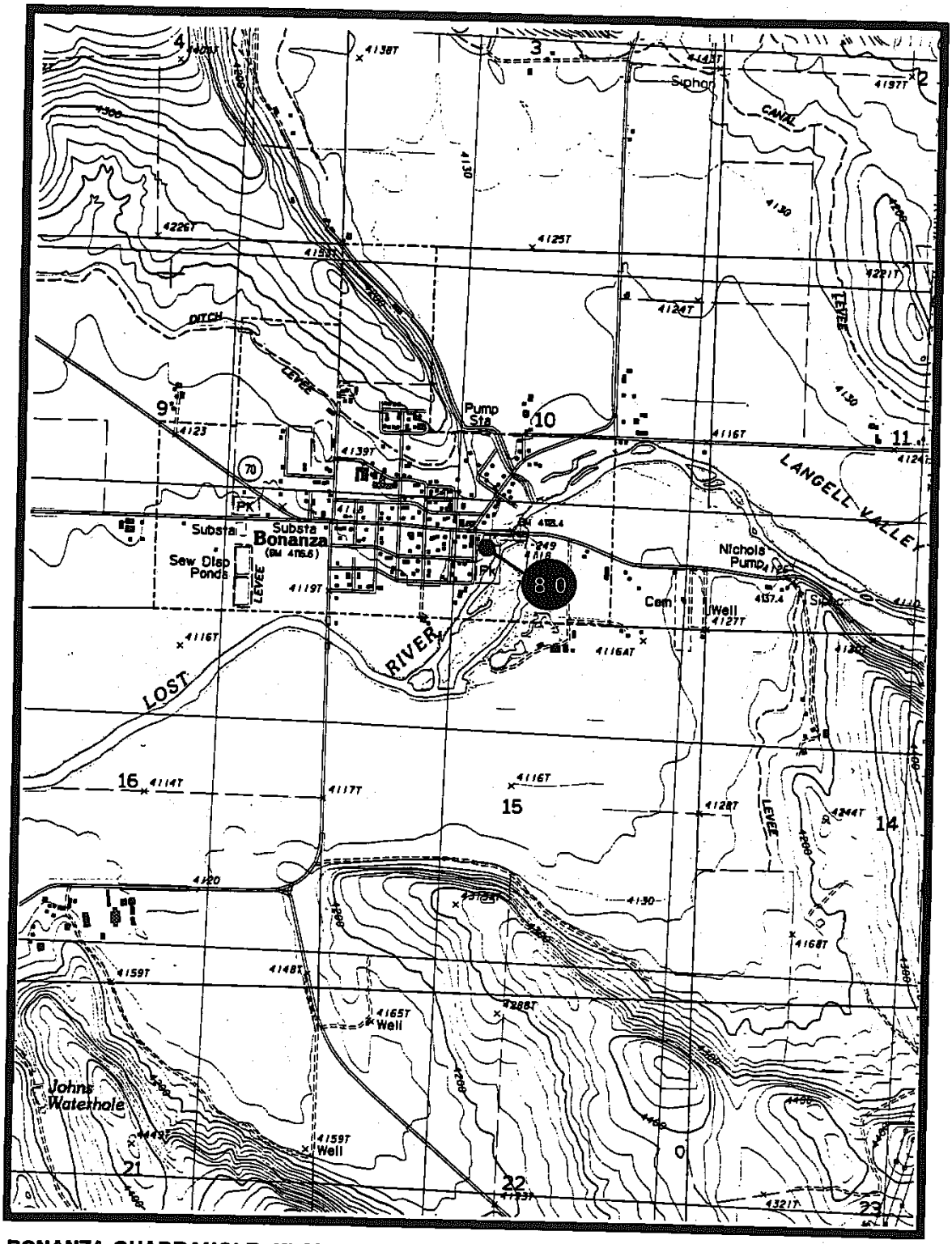
B2



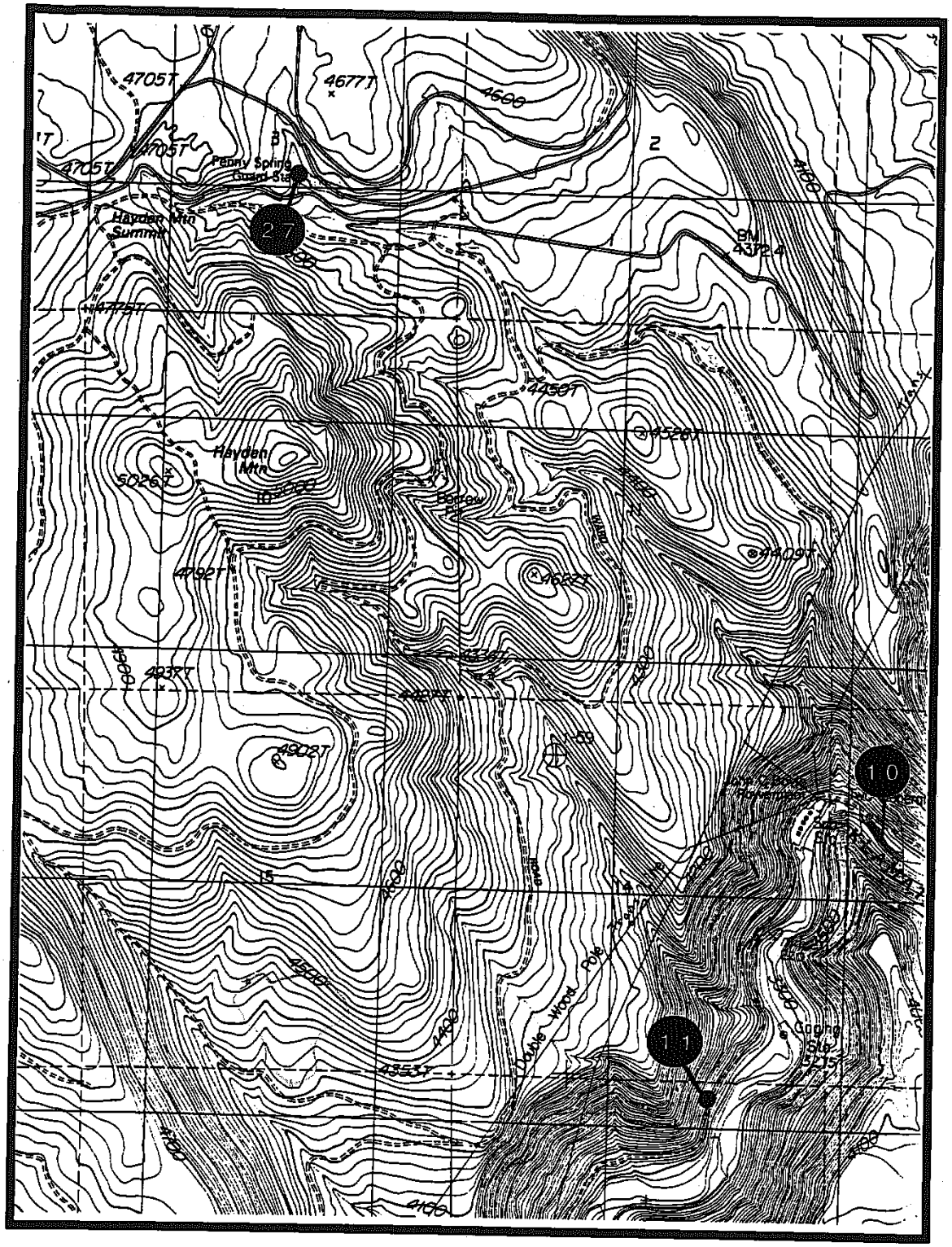
AGENCY LAKE QUADRANGLE, KLAMATH CO., OR
SITE 8



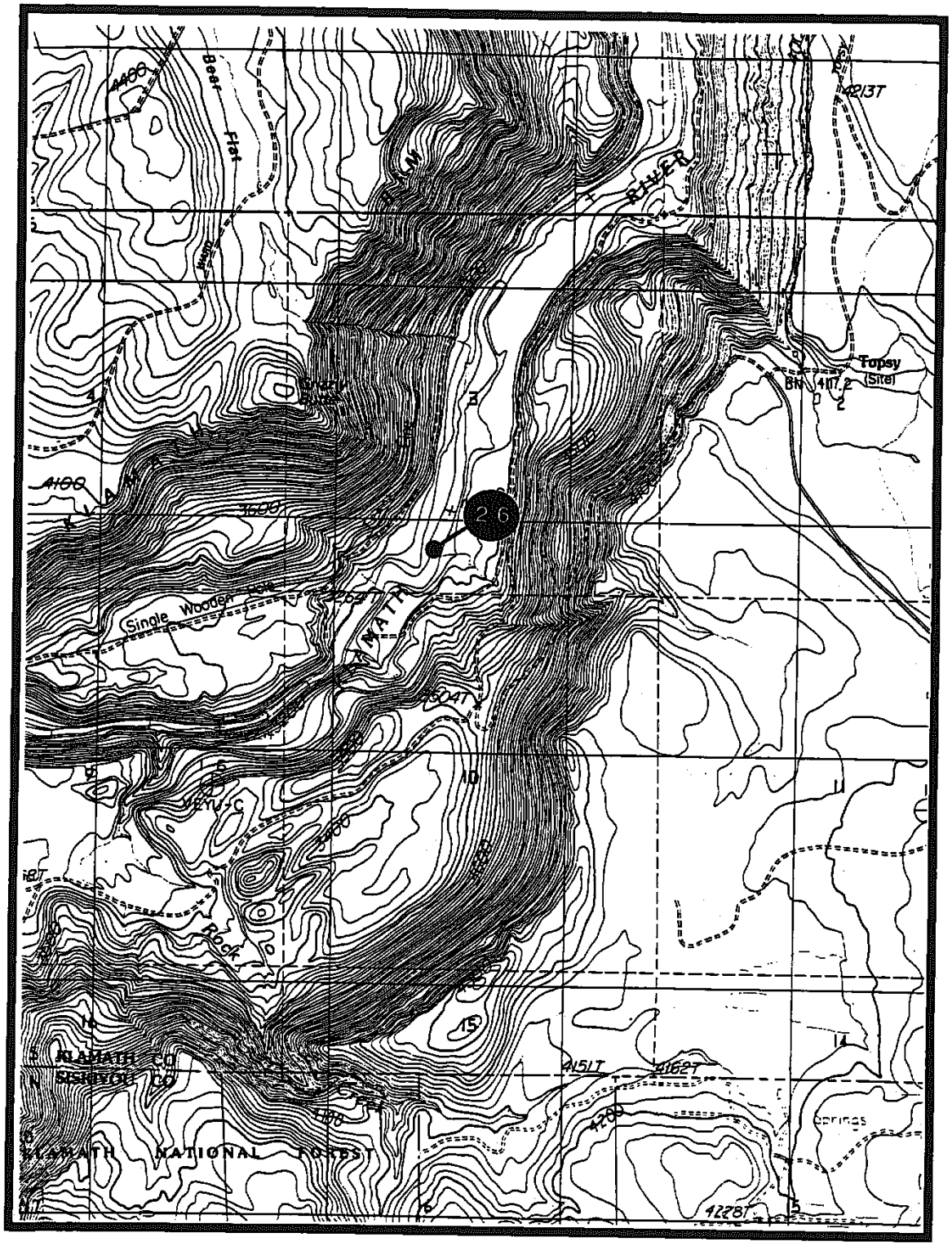
BEATTY QUADRANGLE, KLAMATH CO., OR
SITE 30



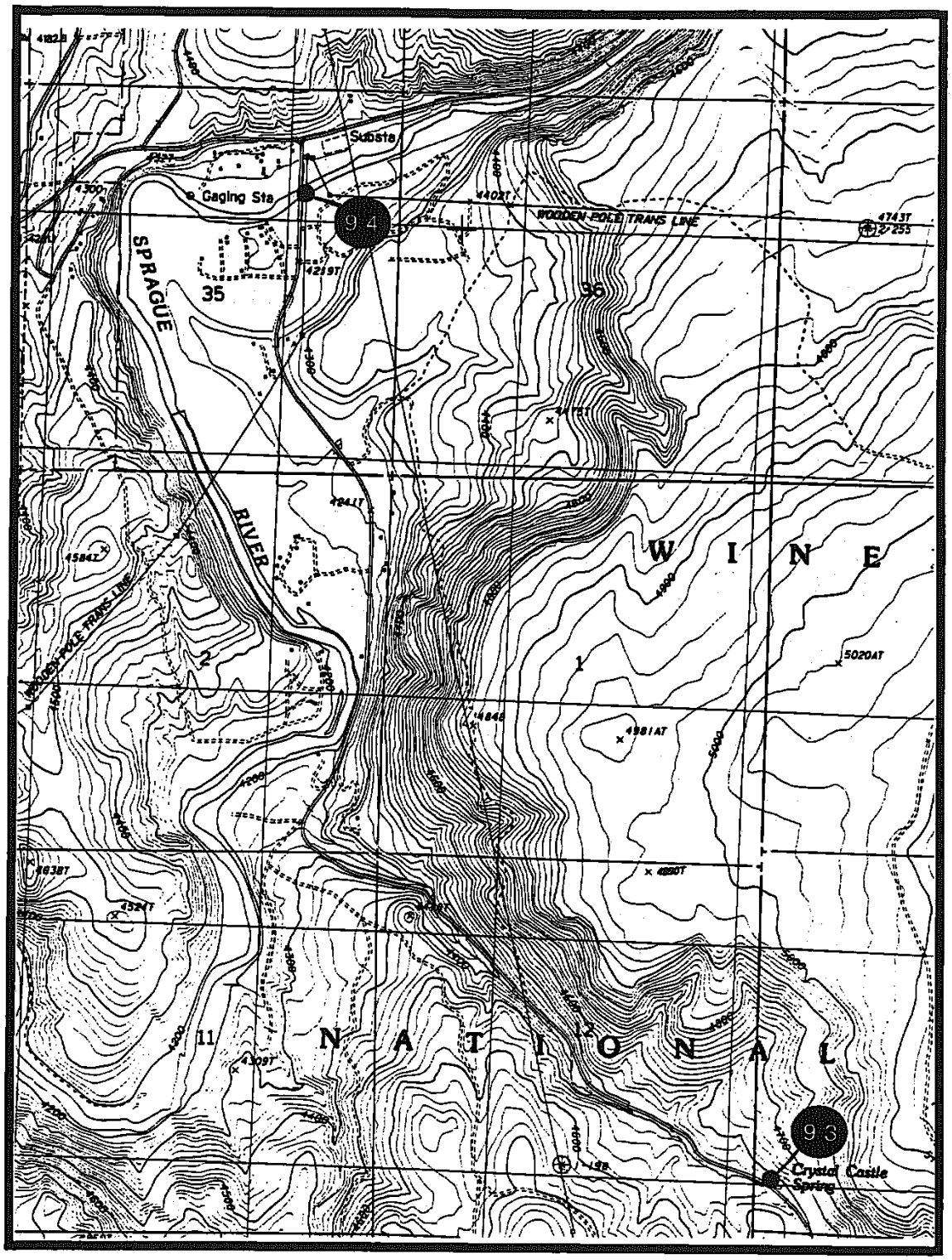
BONANZA QUADRANGLE, KLAMATH CO., OR
SITE 80



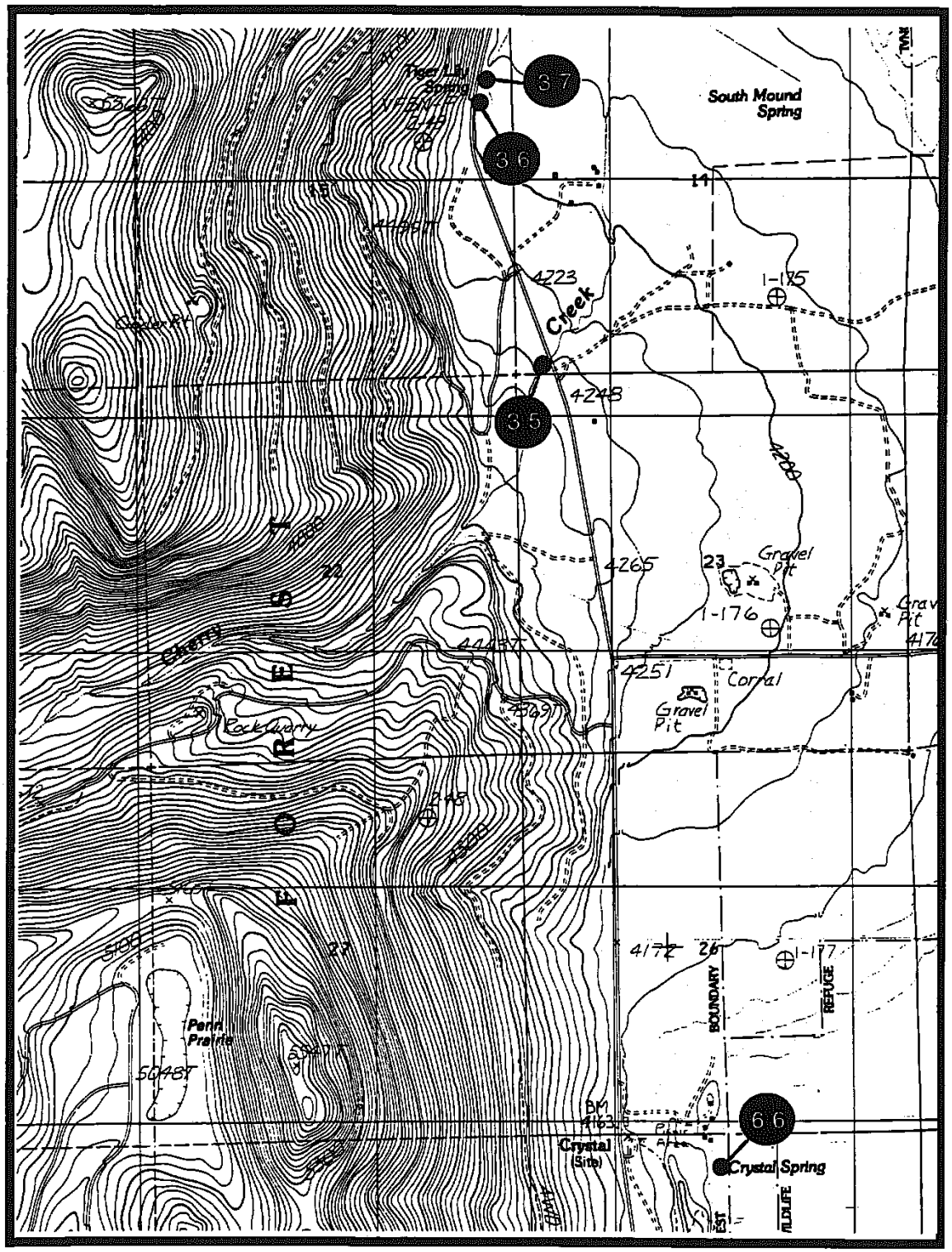
CHICKEN HILLS QUADRANGLE, KLAMATH CO., OR
SITES 10, 11, 27



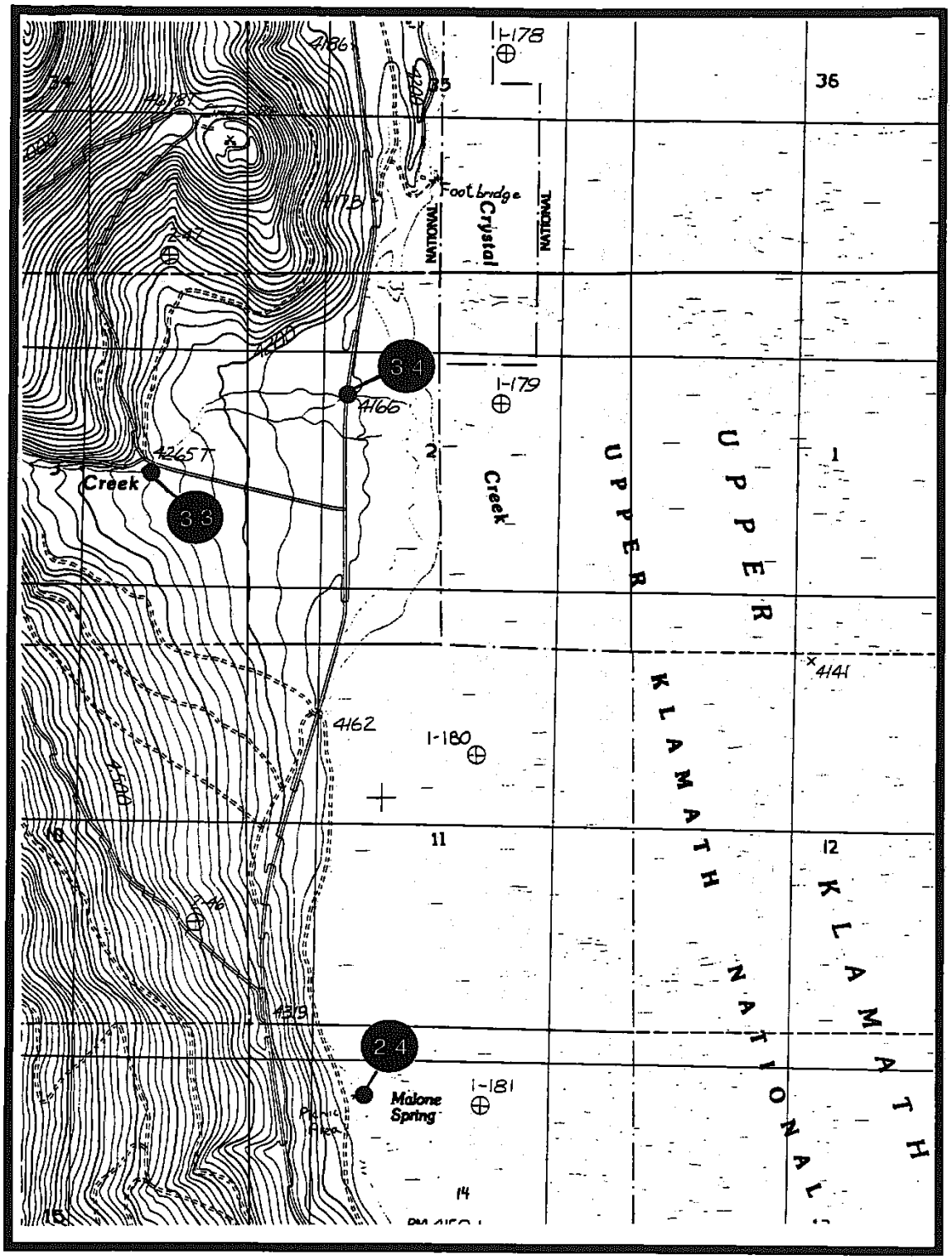
CHICKEN HILLS QUADRANGLE, KLAMATH CO., OR
SITE 26



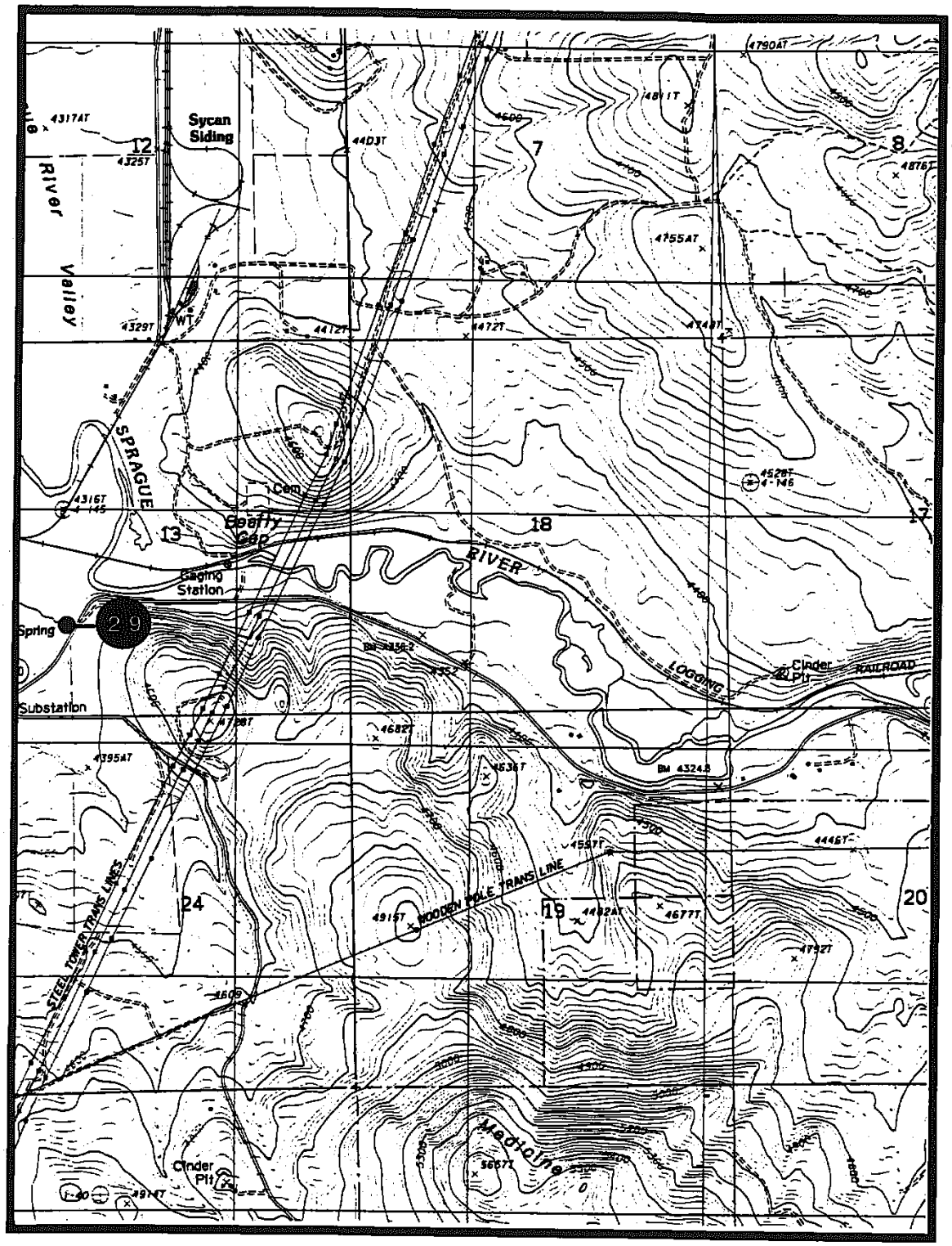
CHILOQUIN QUADRANGLE, KLAMATH CO., OR
SITES 93, 94



CRYSTAL SPRING QUADRANGLE, KLAMATH CO., OR
SITES 35, 36, 37, 66

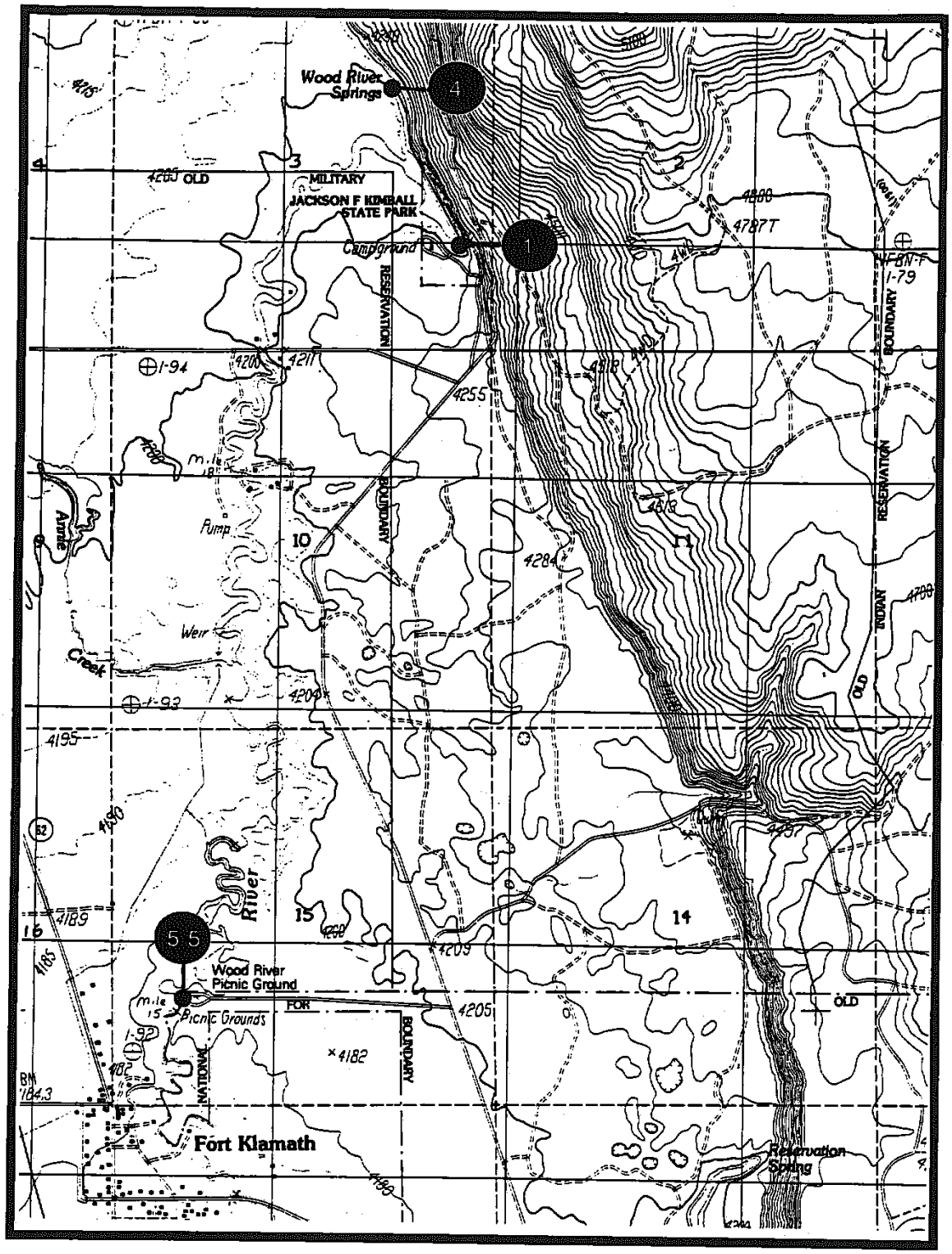


CRYSTAL SPRING QUADRANGLE, KLAMATH CO., OR
SITES 24, 33, 34



FERGUSON MOUNTAIN QUADRANGLE, KLAMATH CO., OR
SITE 29

B11



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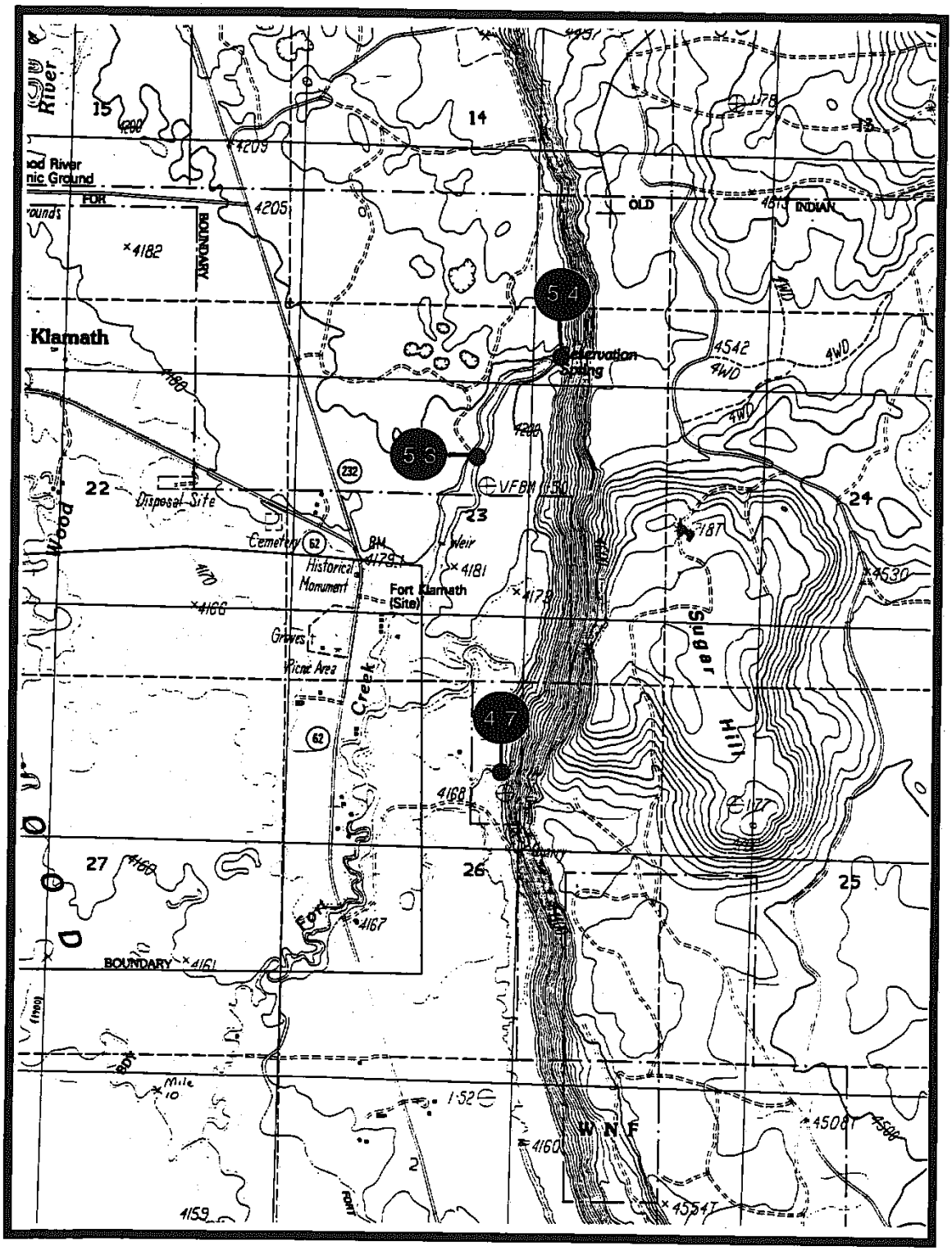
SITES 1, 4, 55



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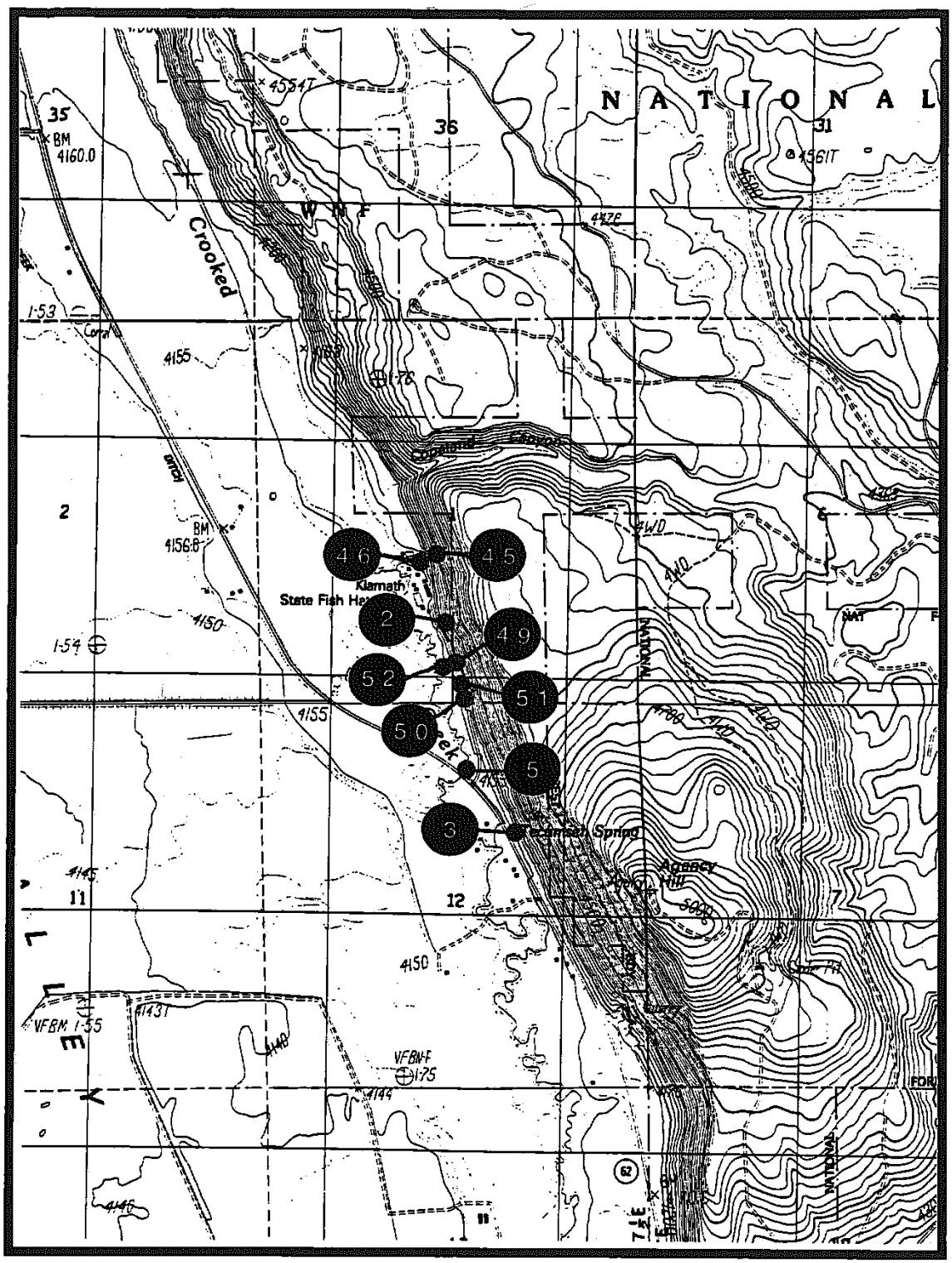

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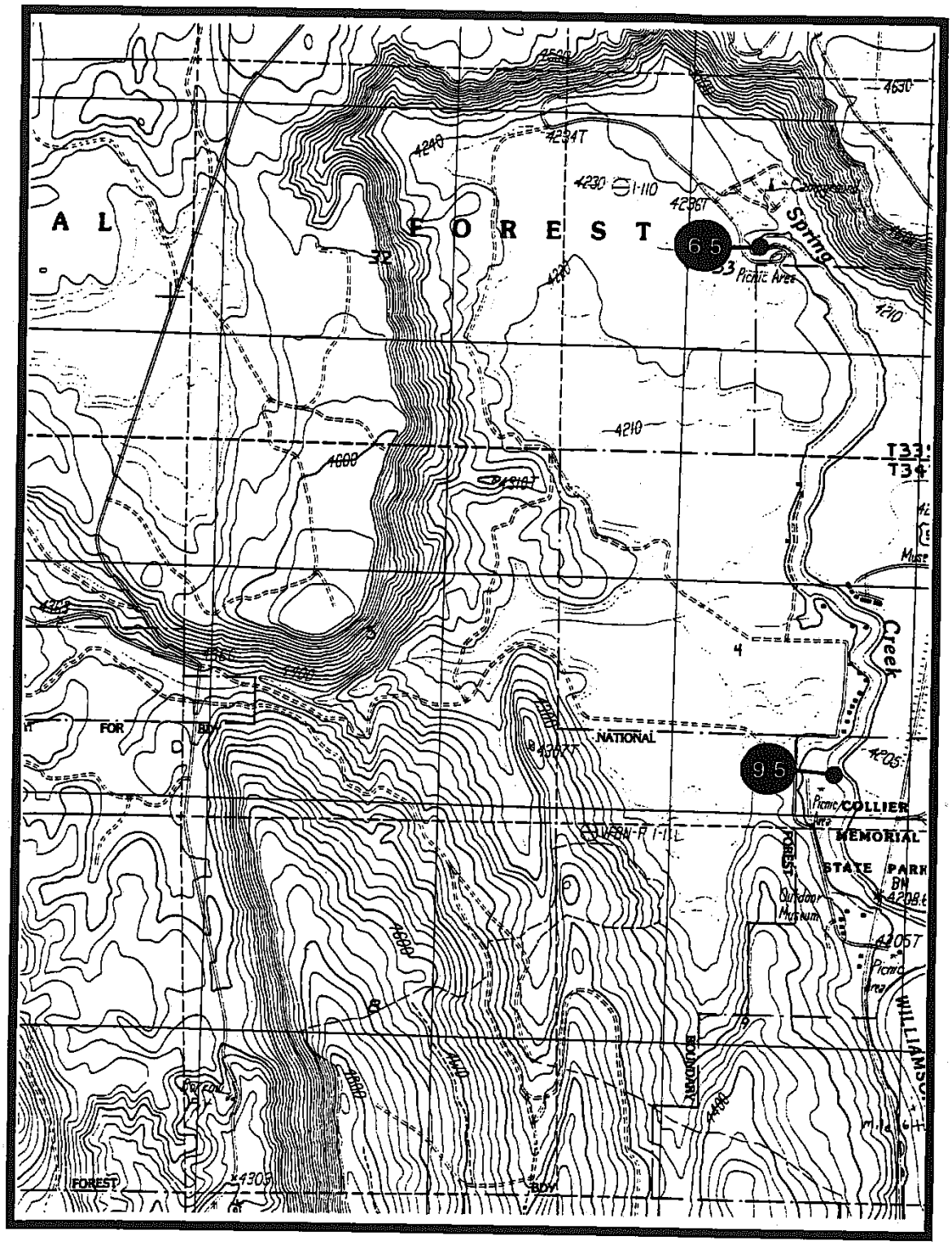

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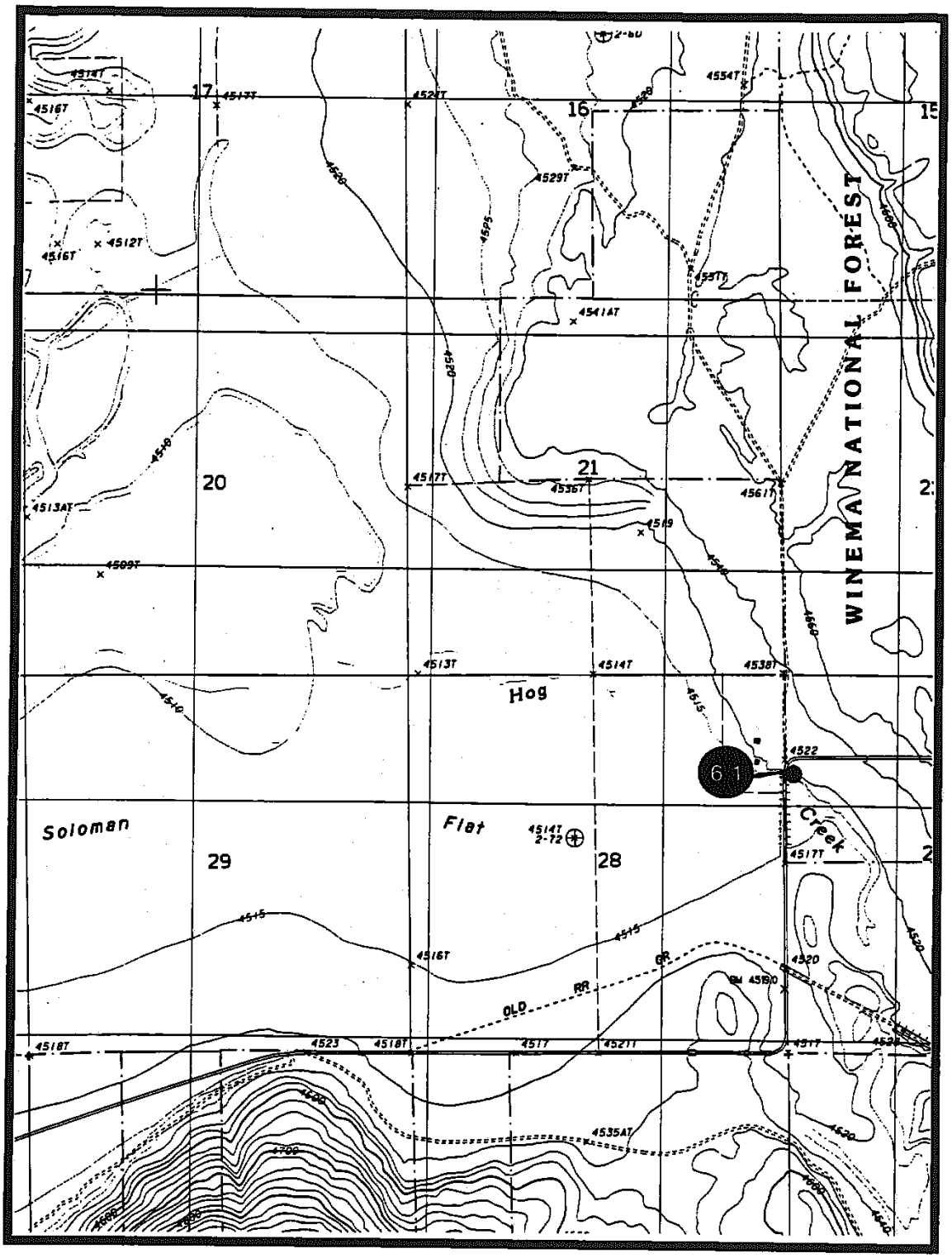
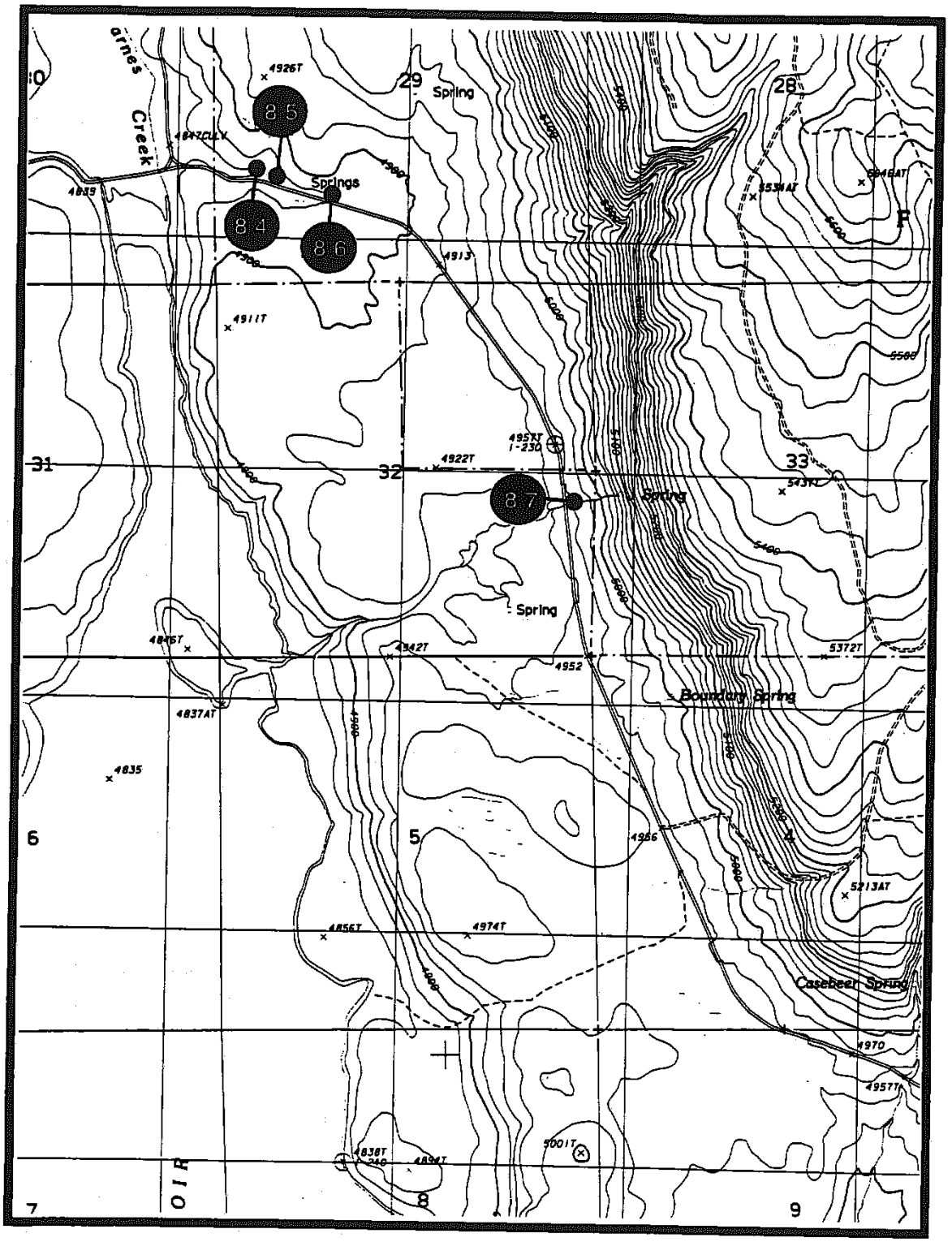
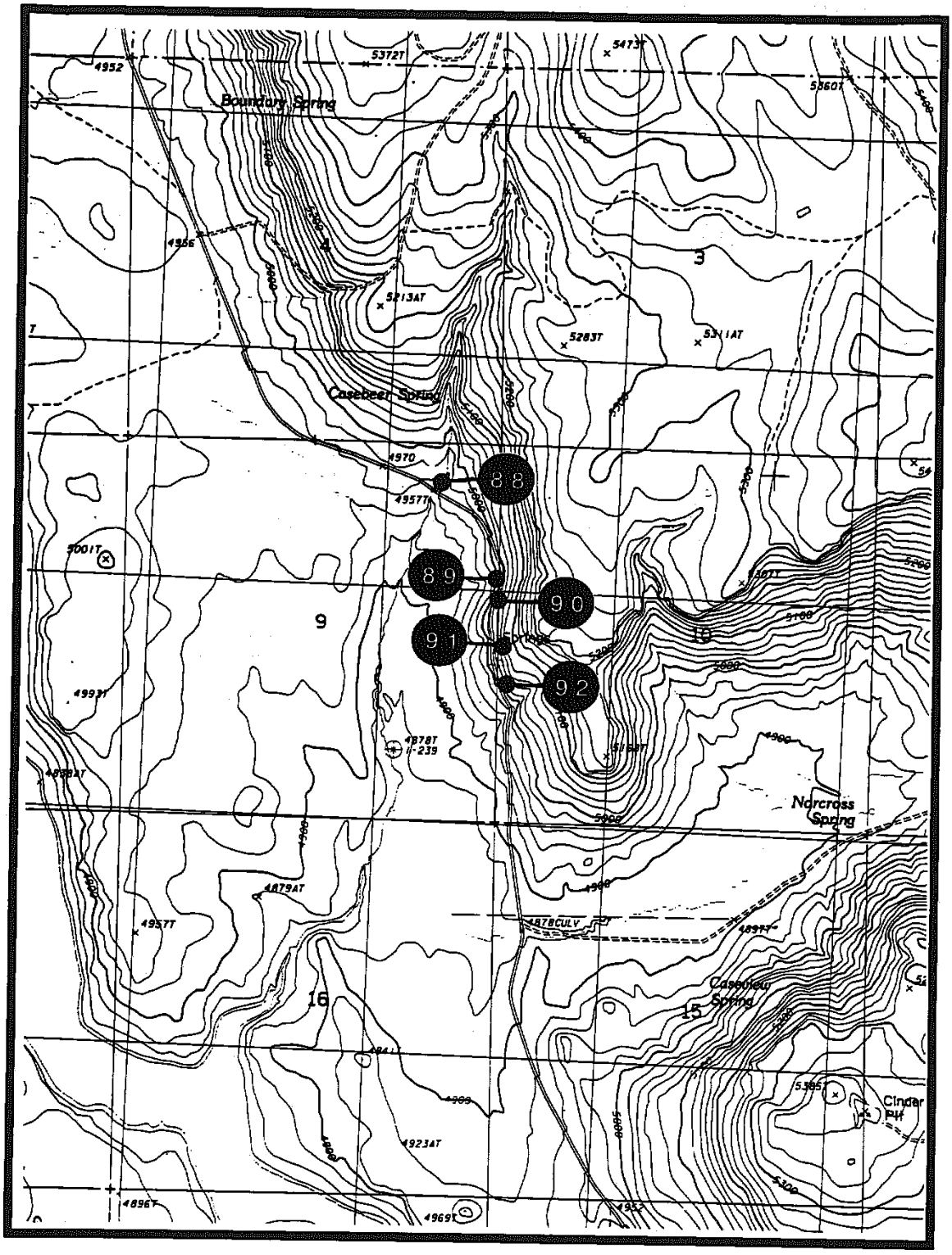
SITES 65, 95



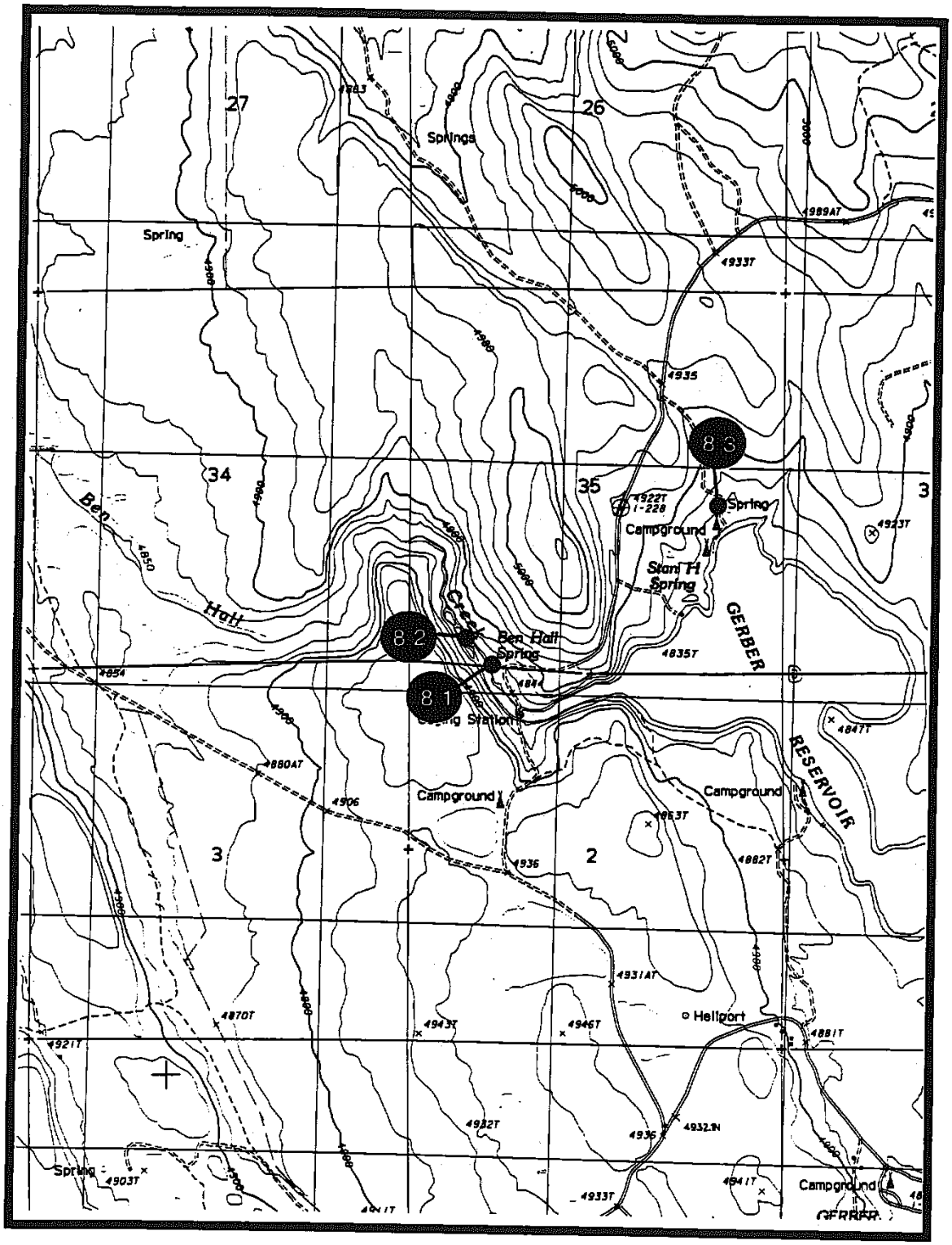
FUEGO QUADRANGLE, KLAMATH CO., OR
SITE 61



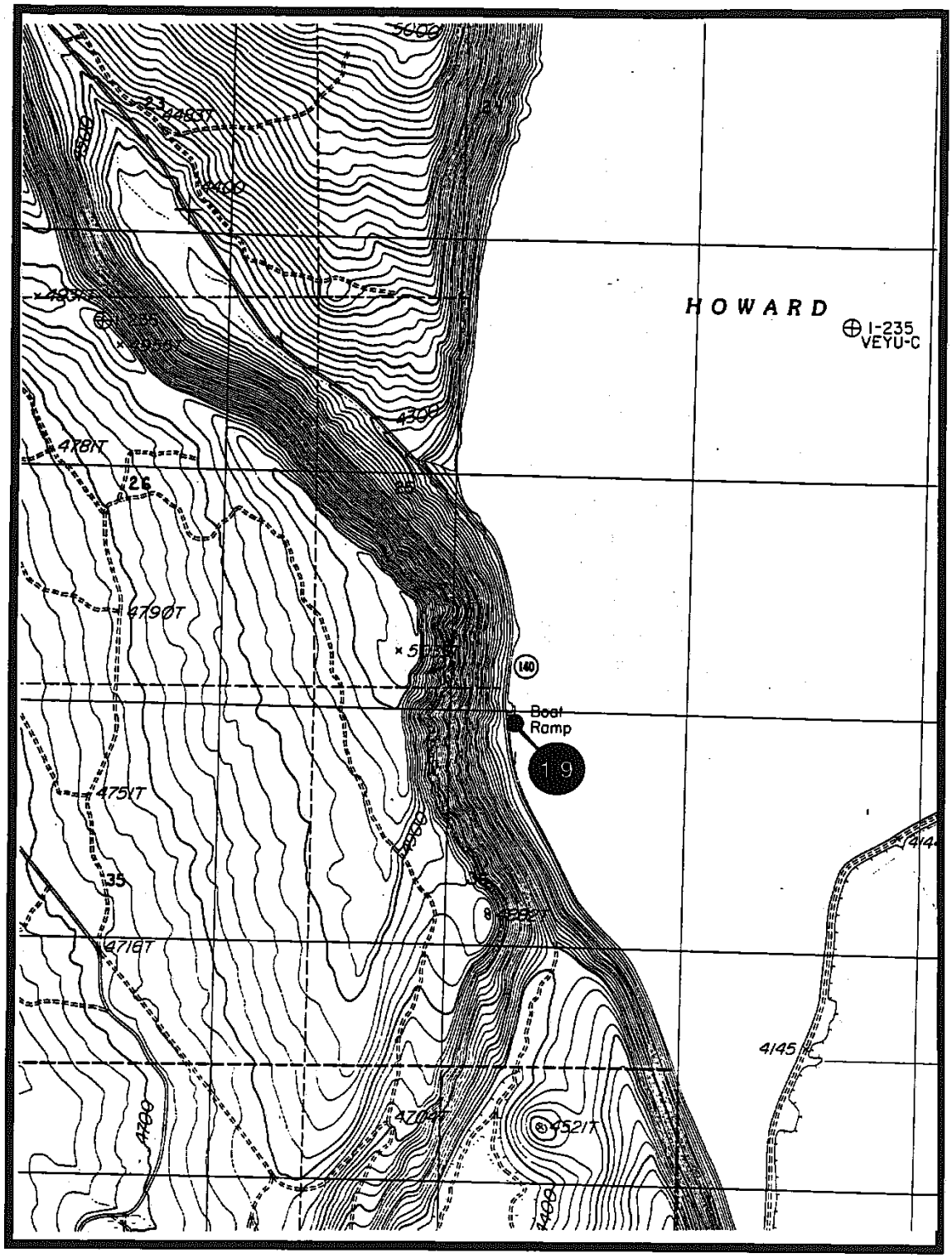
GERBER RESERVOIR QUADRANGLE, KLAMATH CO., OR
SITES 84, 85, 86, 87



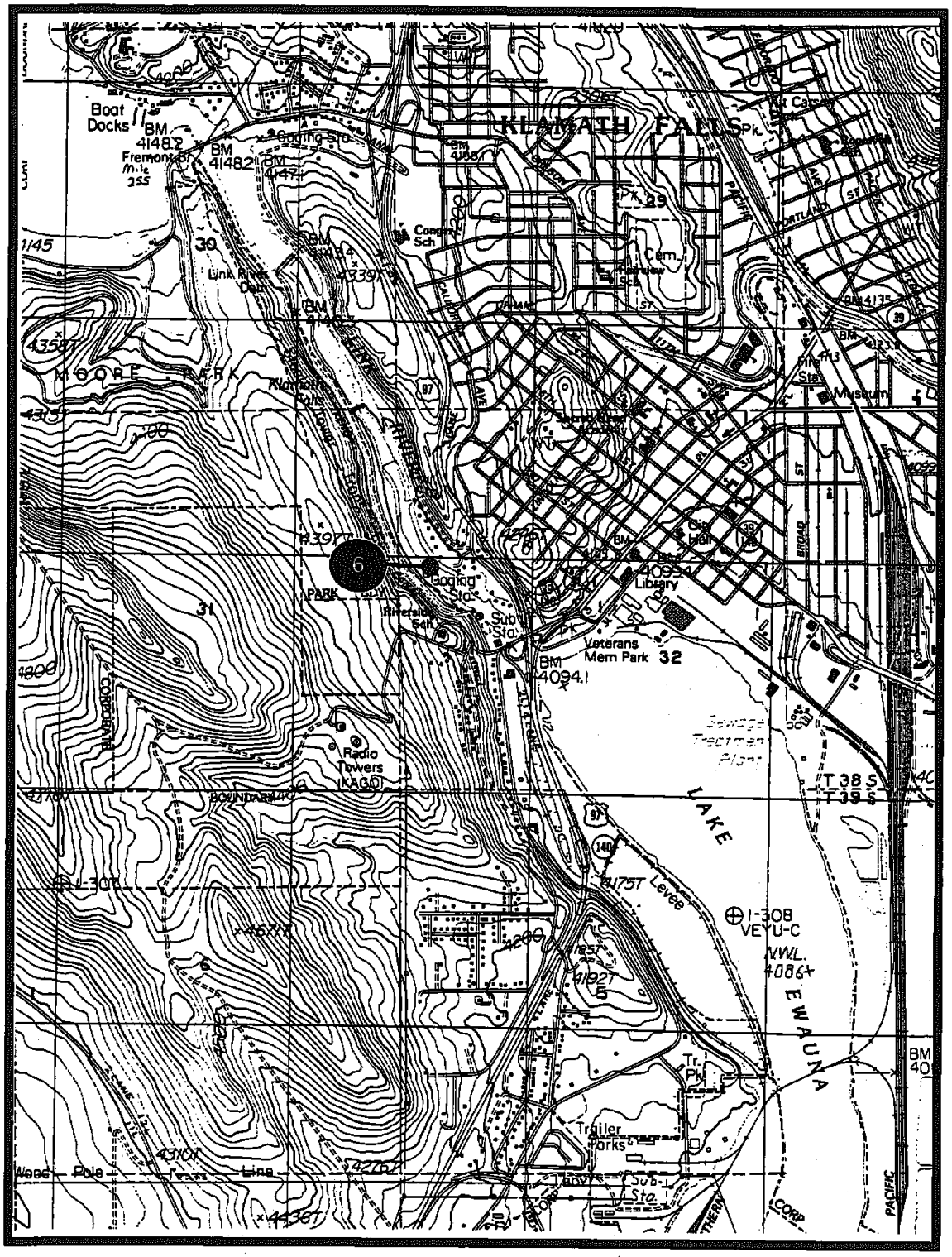
GERBER RESERVOIR QUADRANGLE, KLAMATH CO., OR
SITES 88, 89, 90, 91, 92



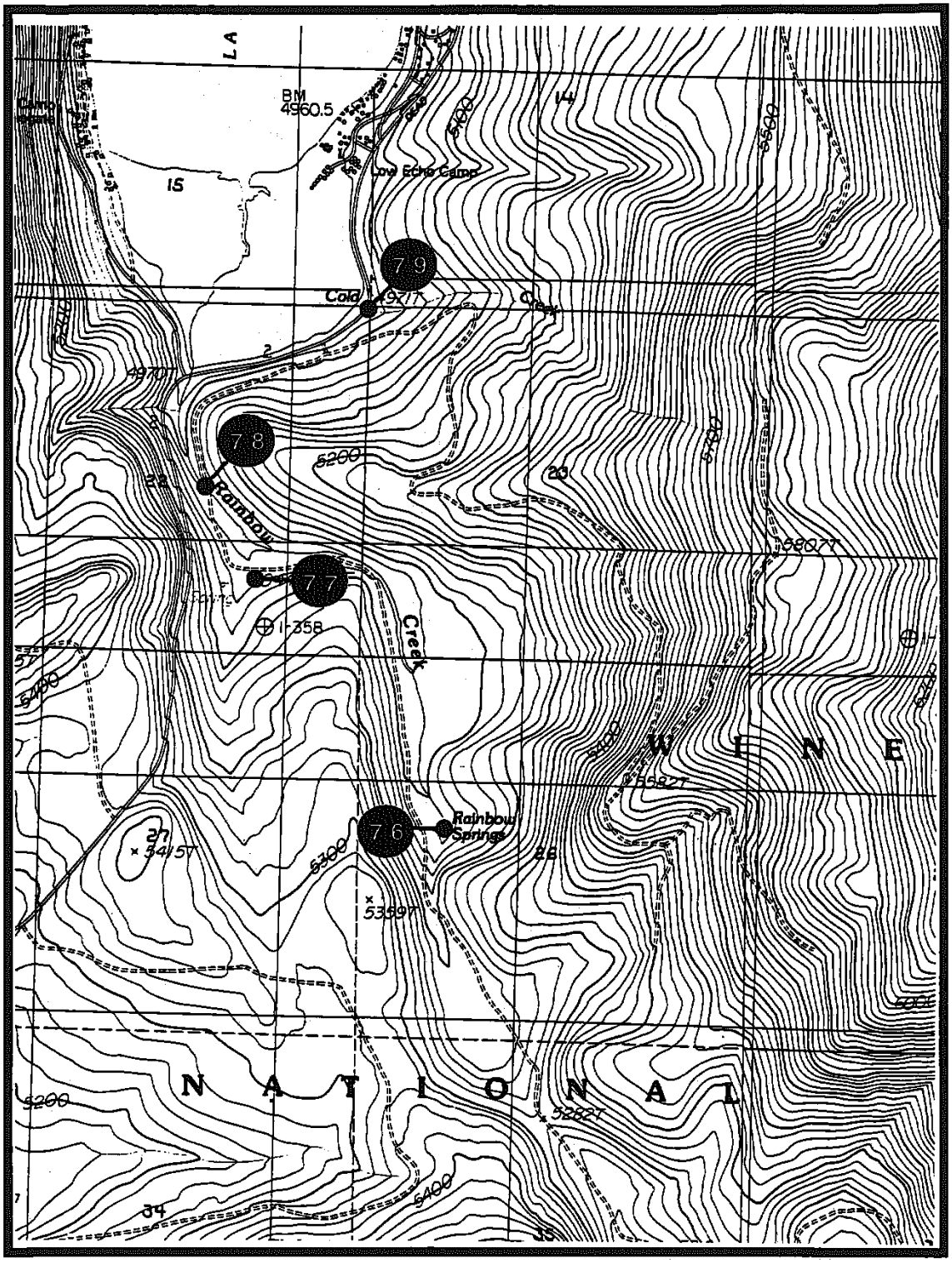
GOODLOW MOUNTAIN QUADRANGLE, KLAMATH CO., OR
SITES 81, 82, 83



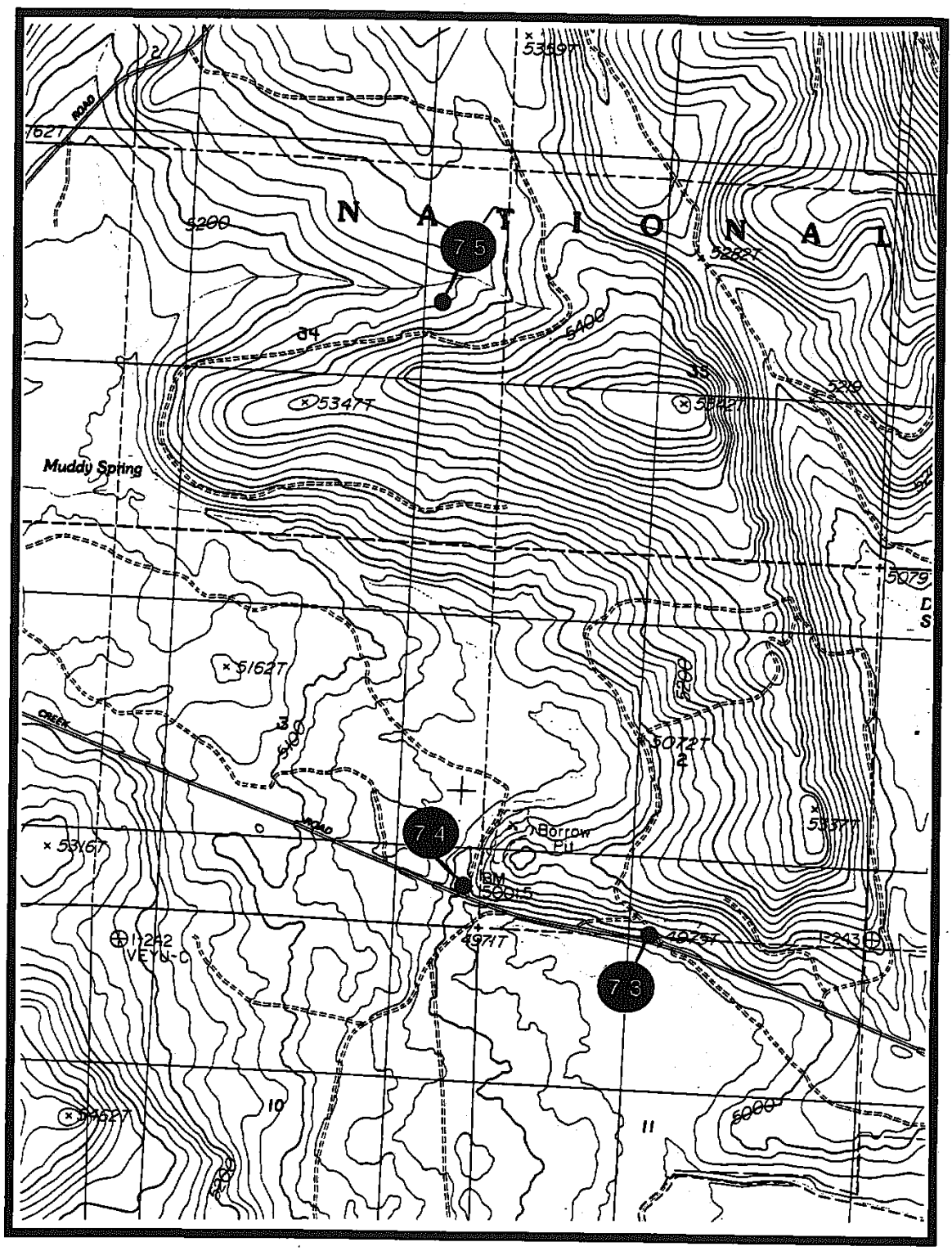
HOWARD BAY QUADRANGLE, KLAMATH CO., OR
SITE 19



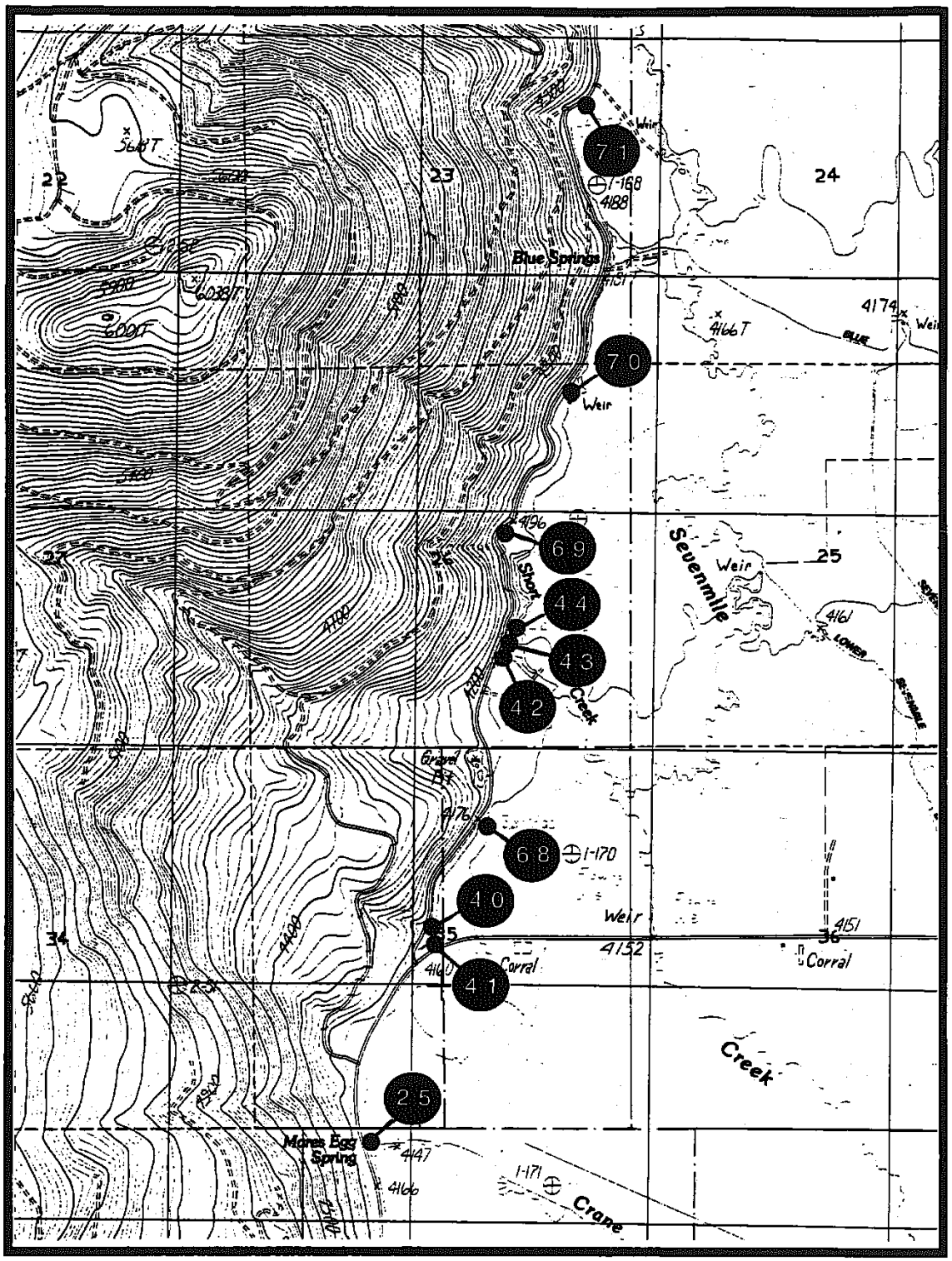
KLAMATH FALLS QUADRANGLE, KLAMATH CO., OR
SITE 6



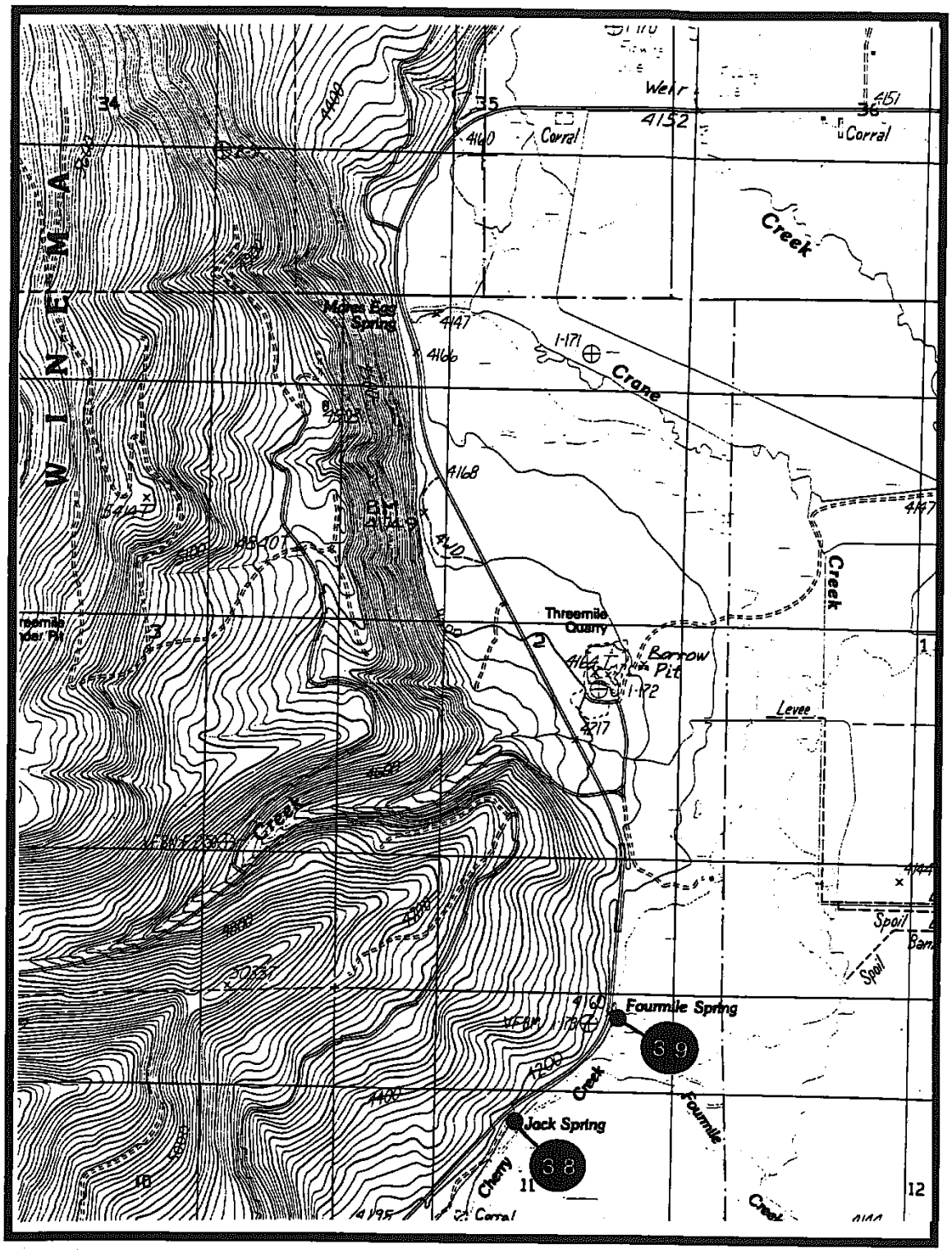
LAKE OF THE WOODS SOUTH QUADRANGLE, KLAMATH CO., OR
SITES 76, 77, 78, 79



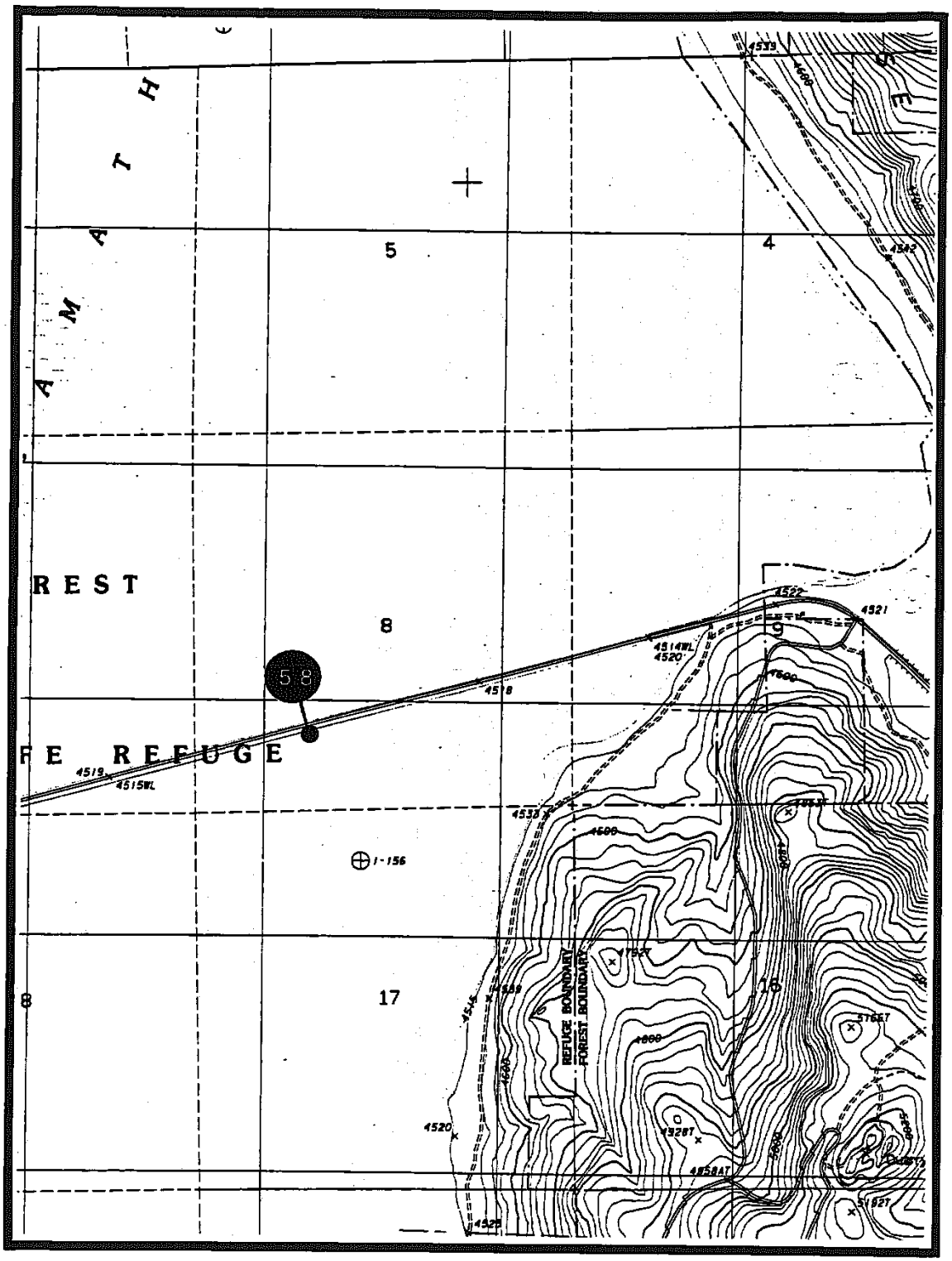
LAKE OF THE WOODS SOUTH QUADRANGLE, KLAMATH CO., OR
SITES 73, 74, 75



MARES EGG SPRING QUADRANGLE, KLAMATH CO., OR
SITES 25, 40, 41, 42, 43, 44, 68, 69, 70, 71

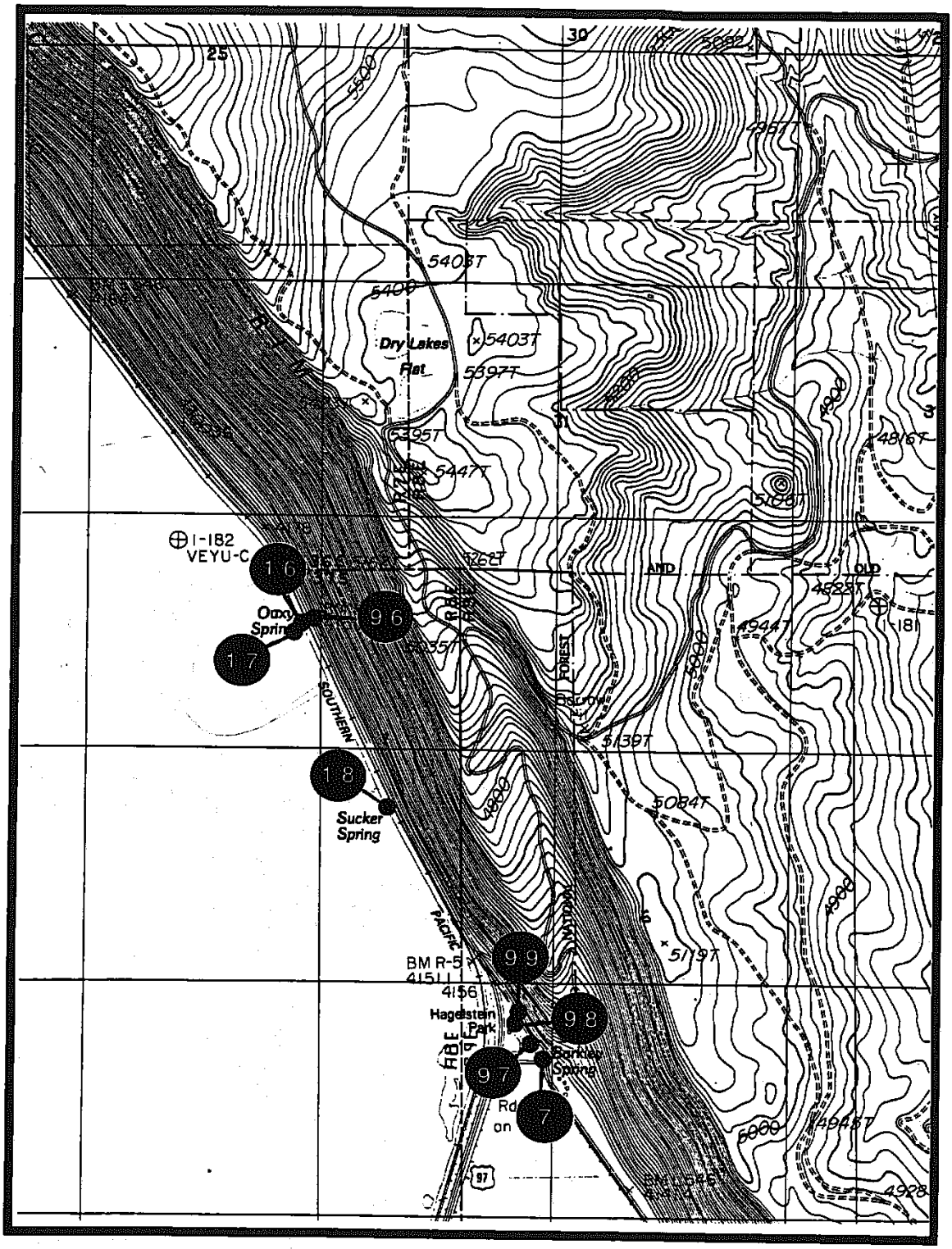


MARES EGG SPRING QUADRANGLE, KLAMATH CO., OR
SITES 38, 39



MILITARY CROSSING QUADRANGLE, KLAMATH CO., OR
SITE 58

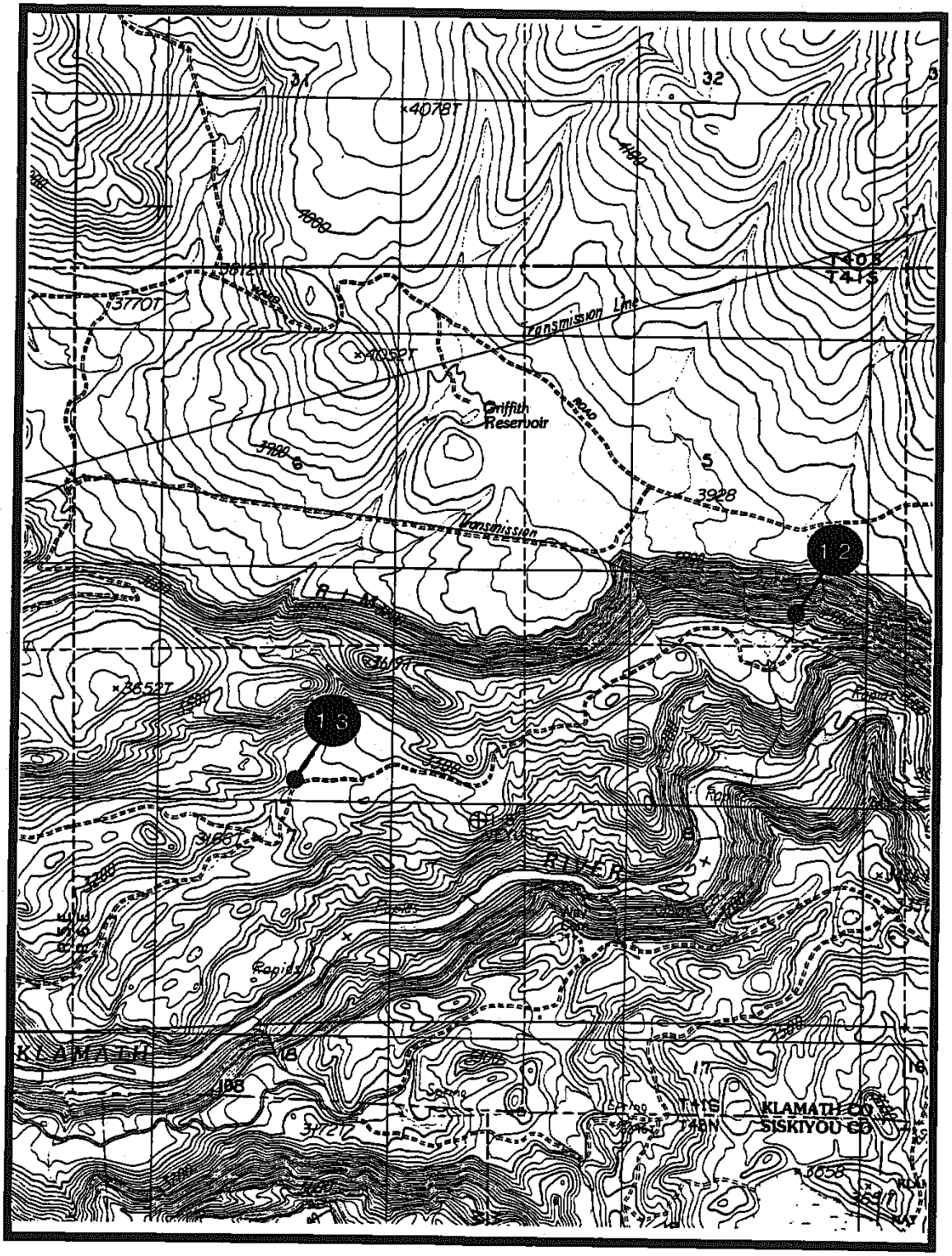
B26



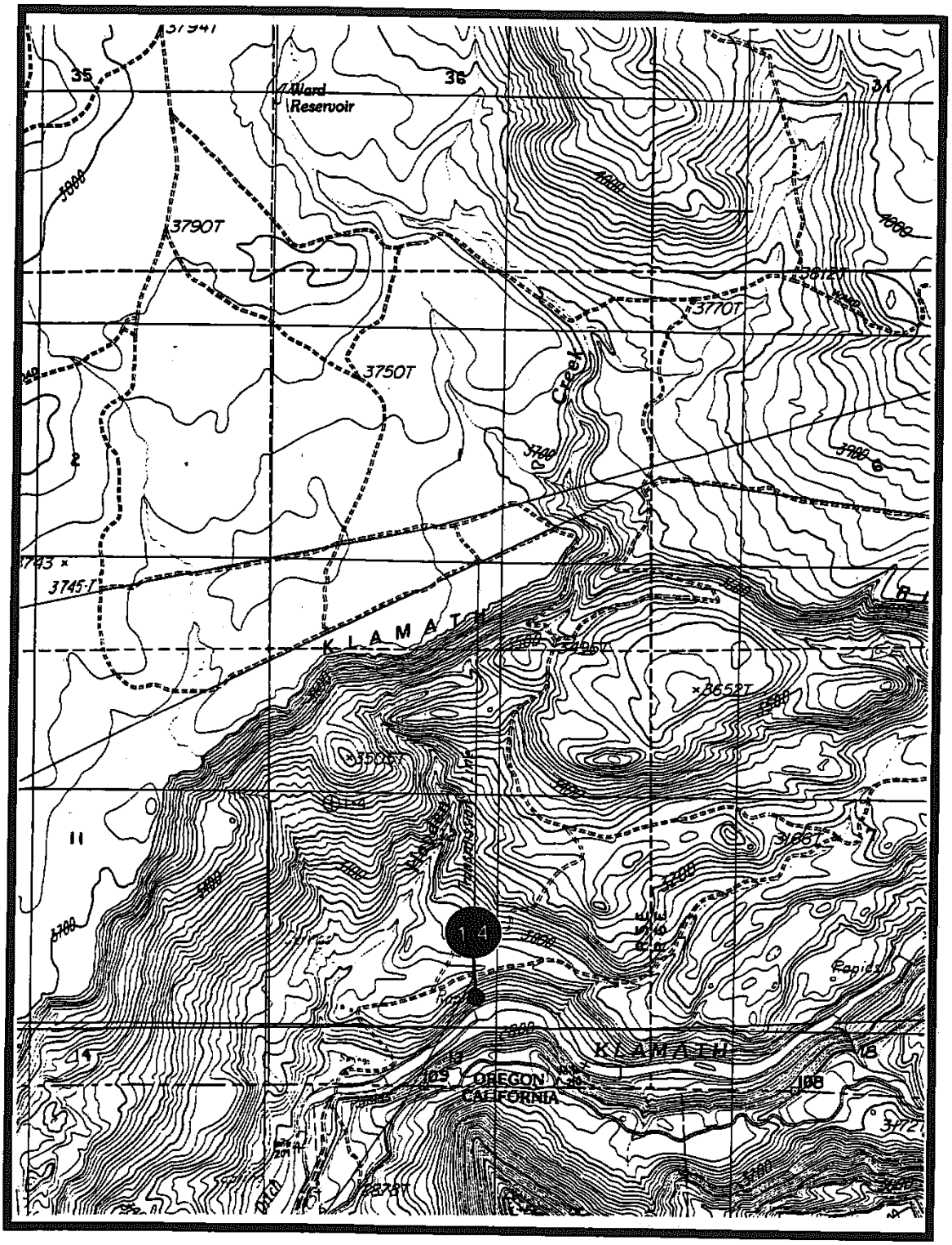
MODOC POINT QUADRANGLE, KLAMATH CO., OR
SITES 7, 16, 17, 18, 96, 97, 98, 99

Jump Jump Jump

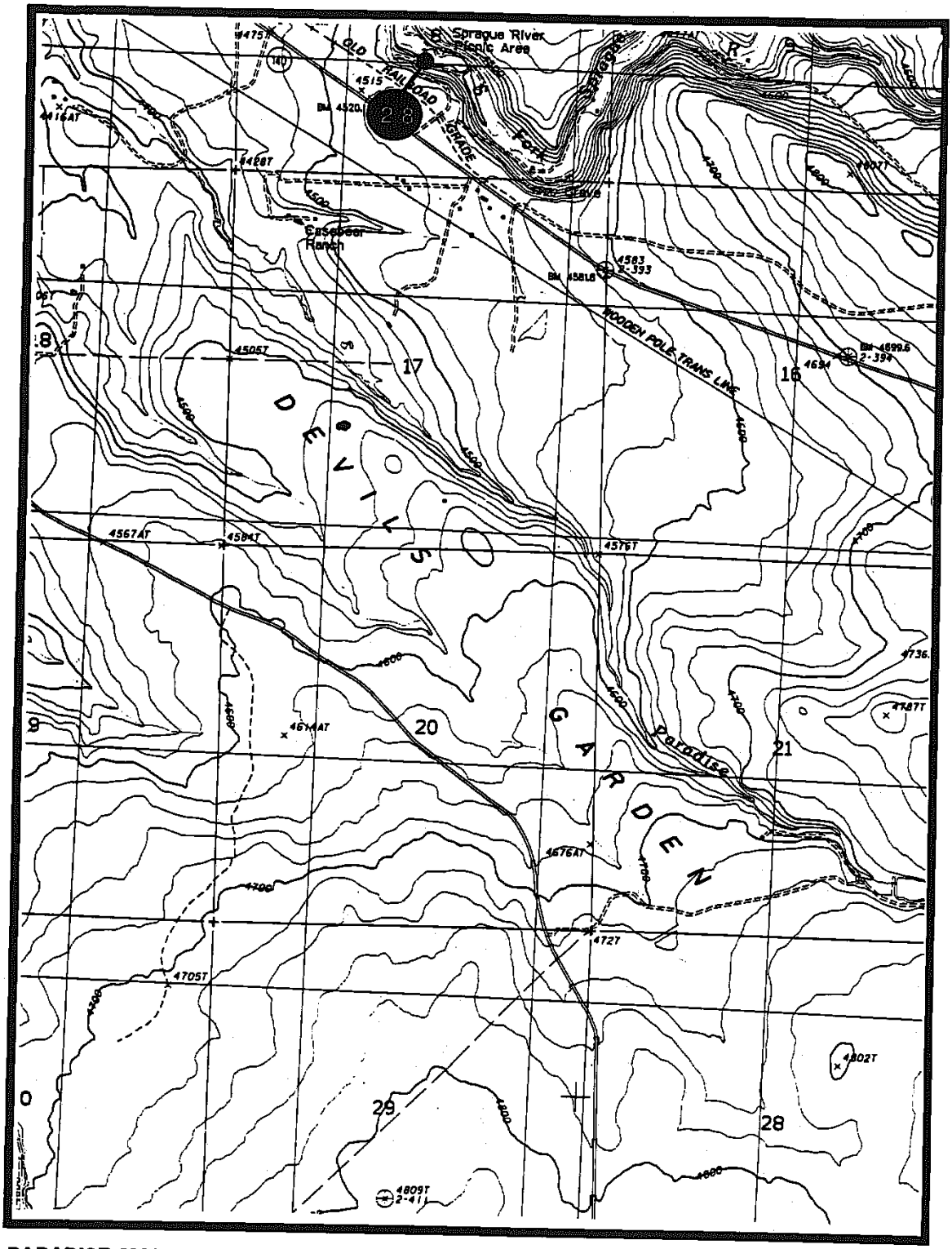
B27



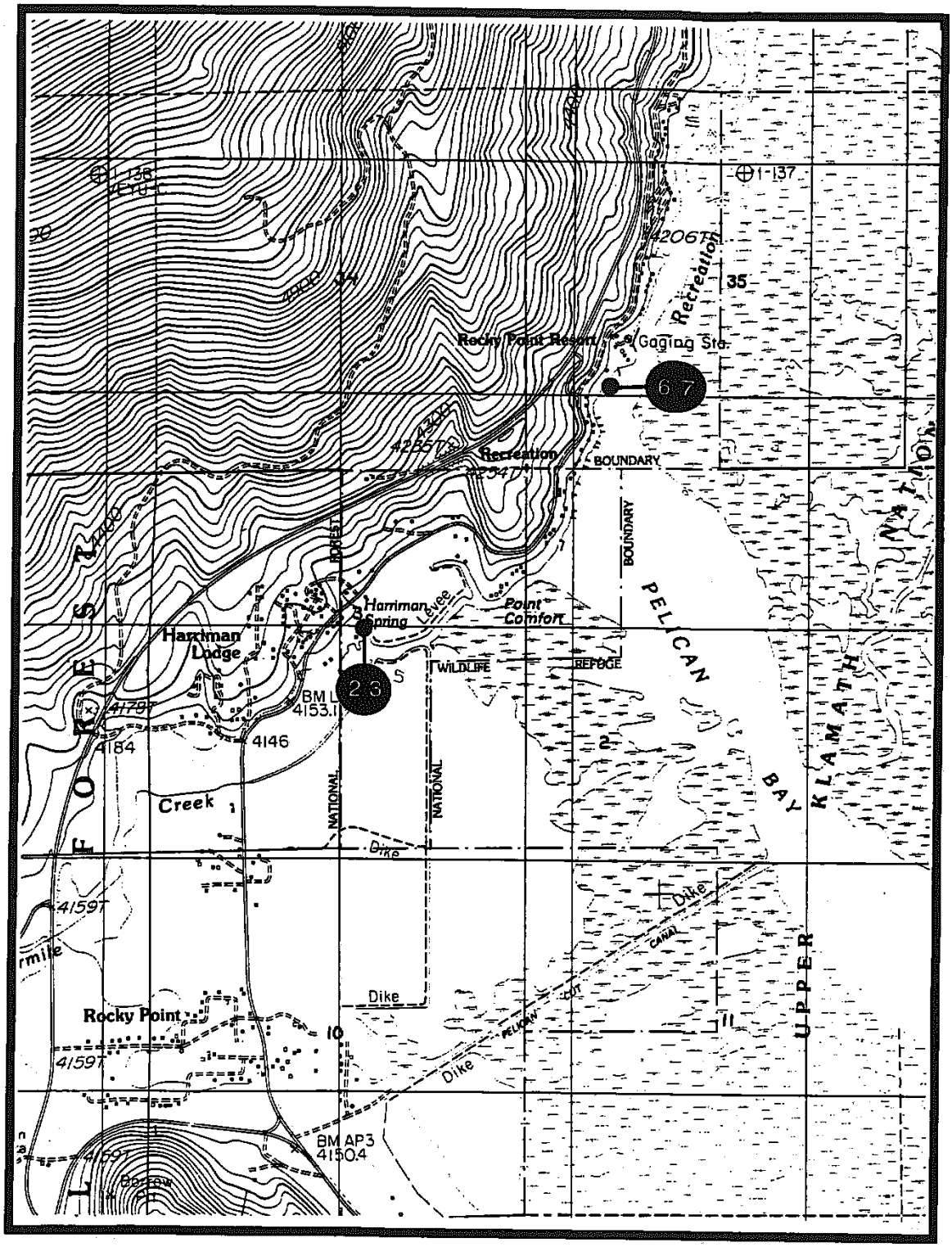
MULE HILL QUADRANGLE, KLAMATH CO., OR
SITES 12, 13



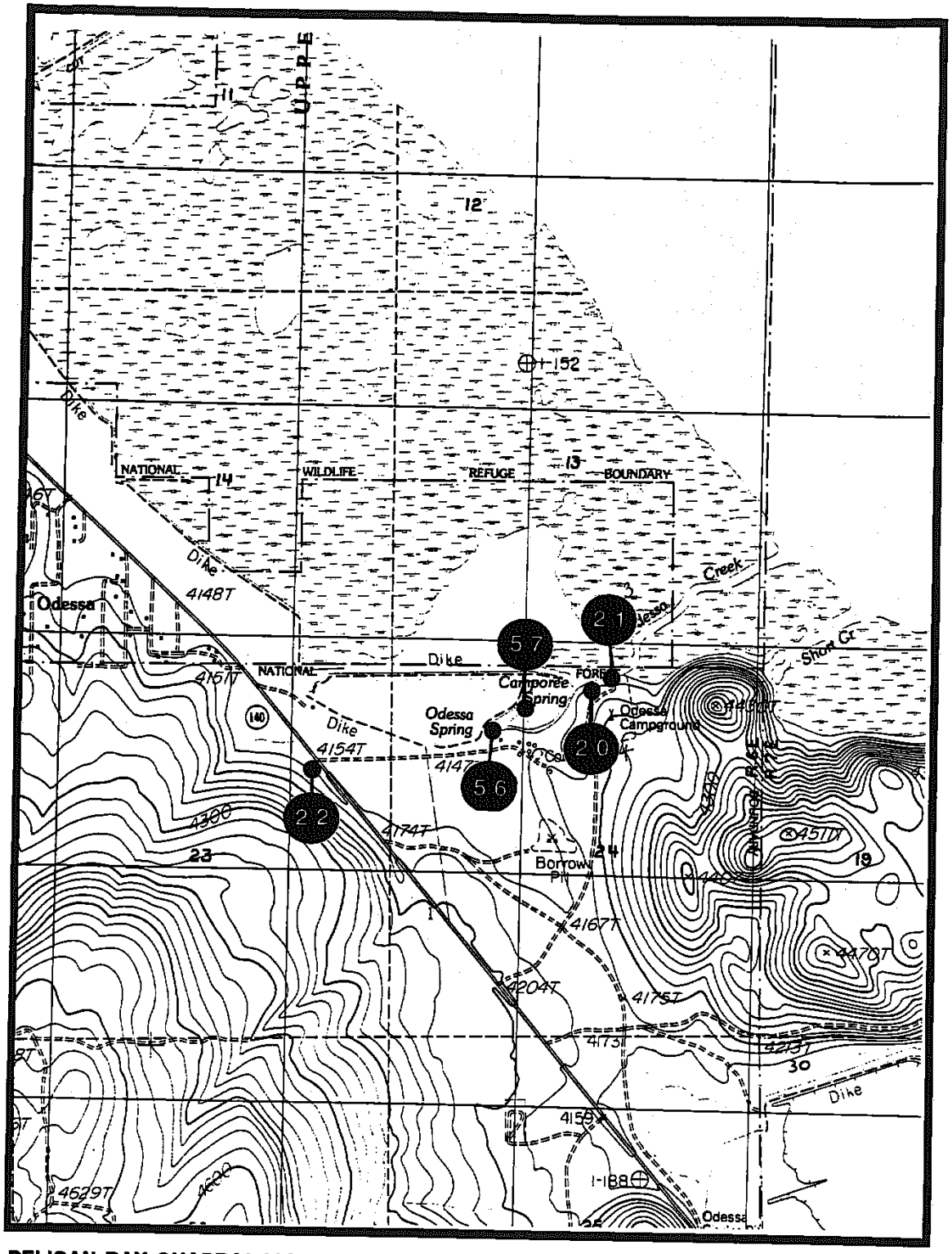
MULE HILL QUADRANGLE, KLAMATH CO., OR
SITE 14



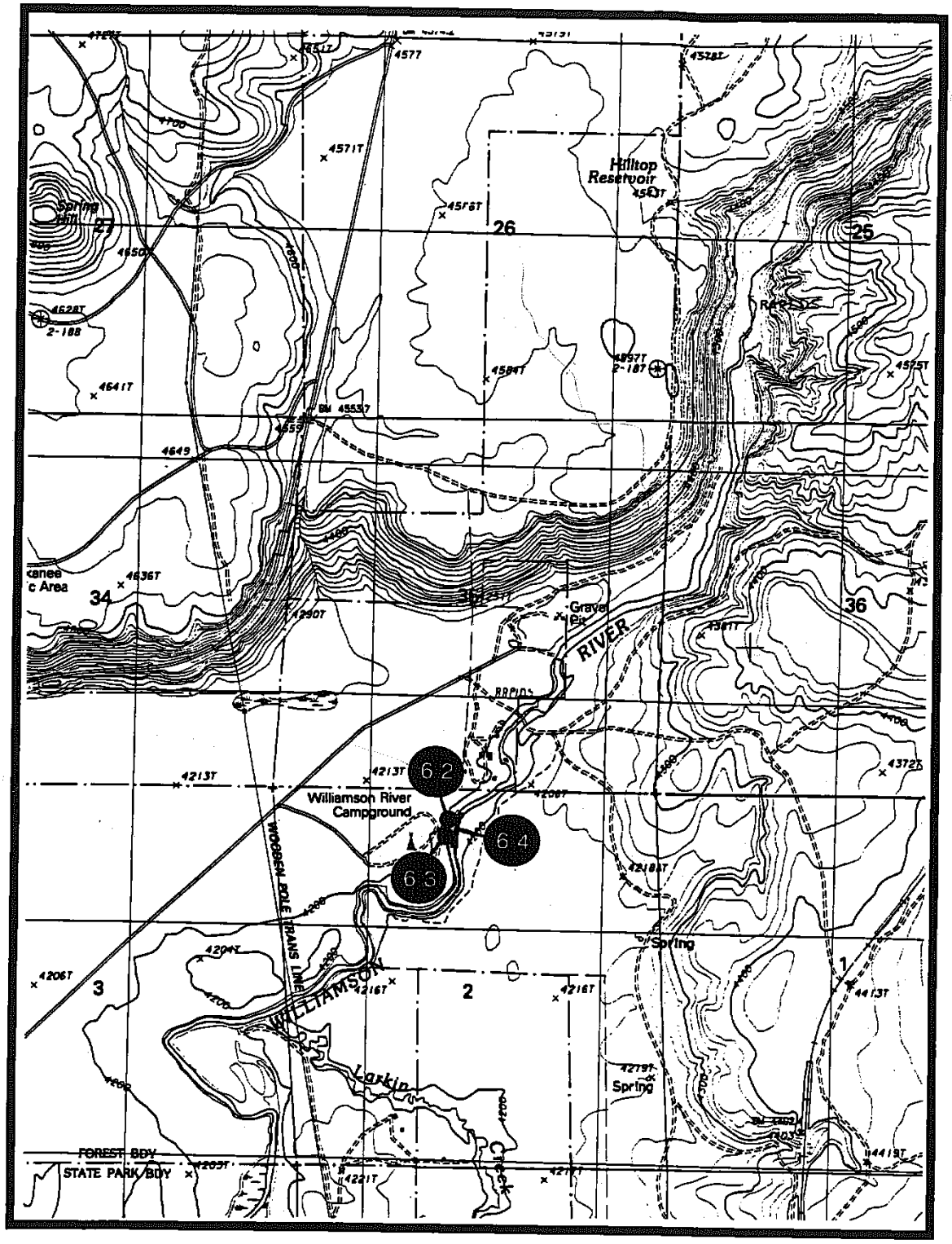
PARADISE MOUNTAIN QUADRANGLE, KLAMATH CO., OR
SITE 28



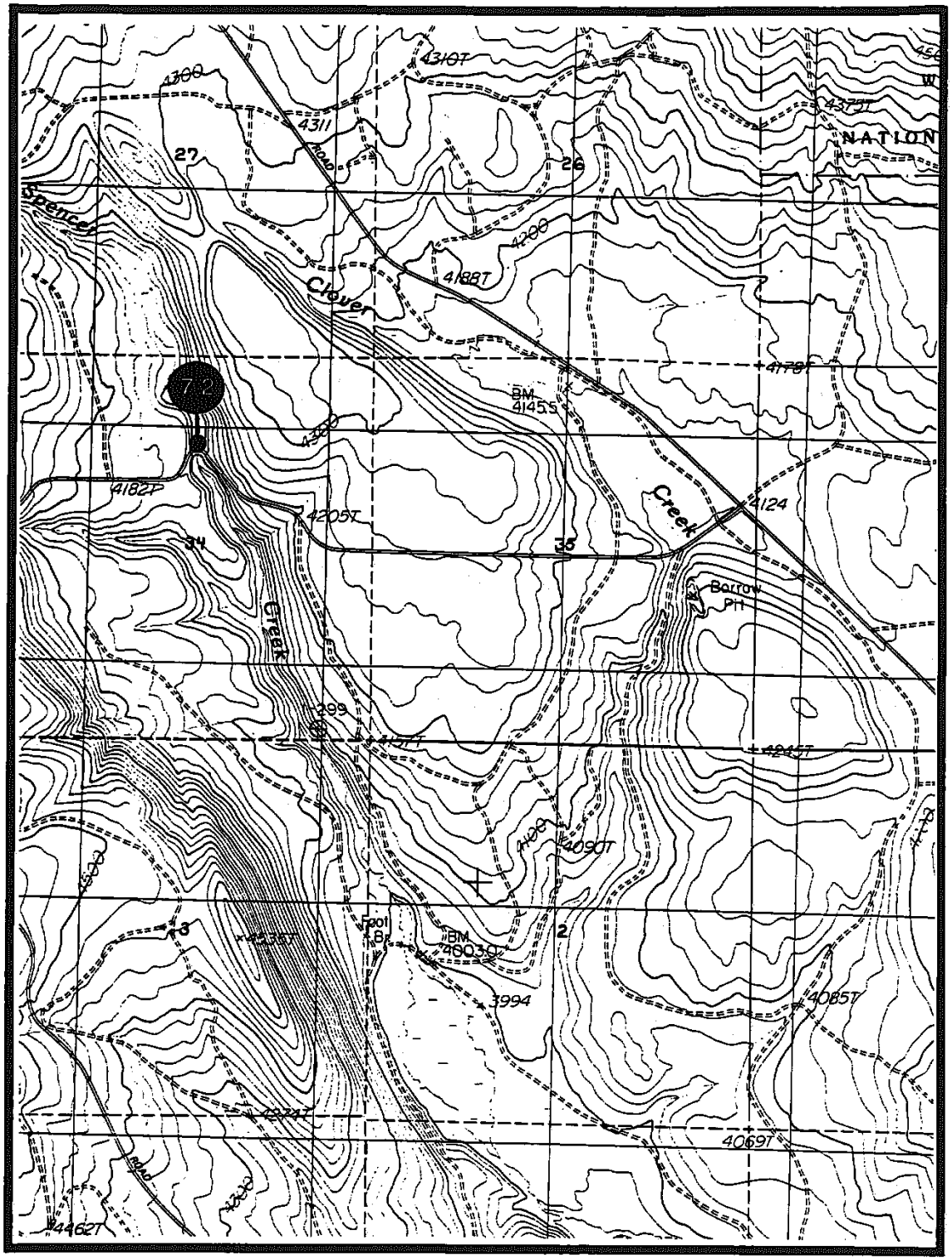
PELICAN BAY QUADRANGLE, KLAMATH CO., OR
SITES 23, 67



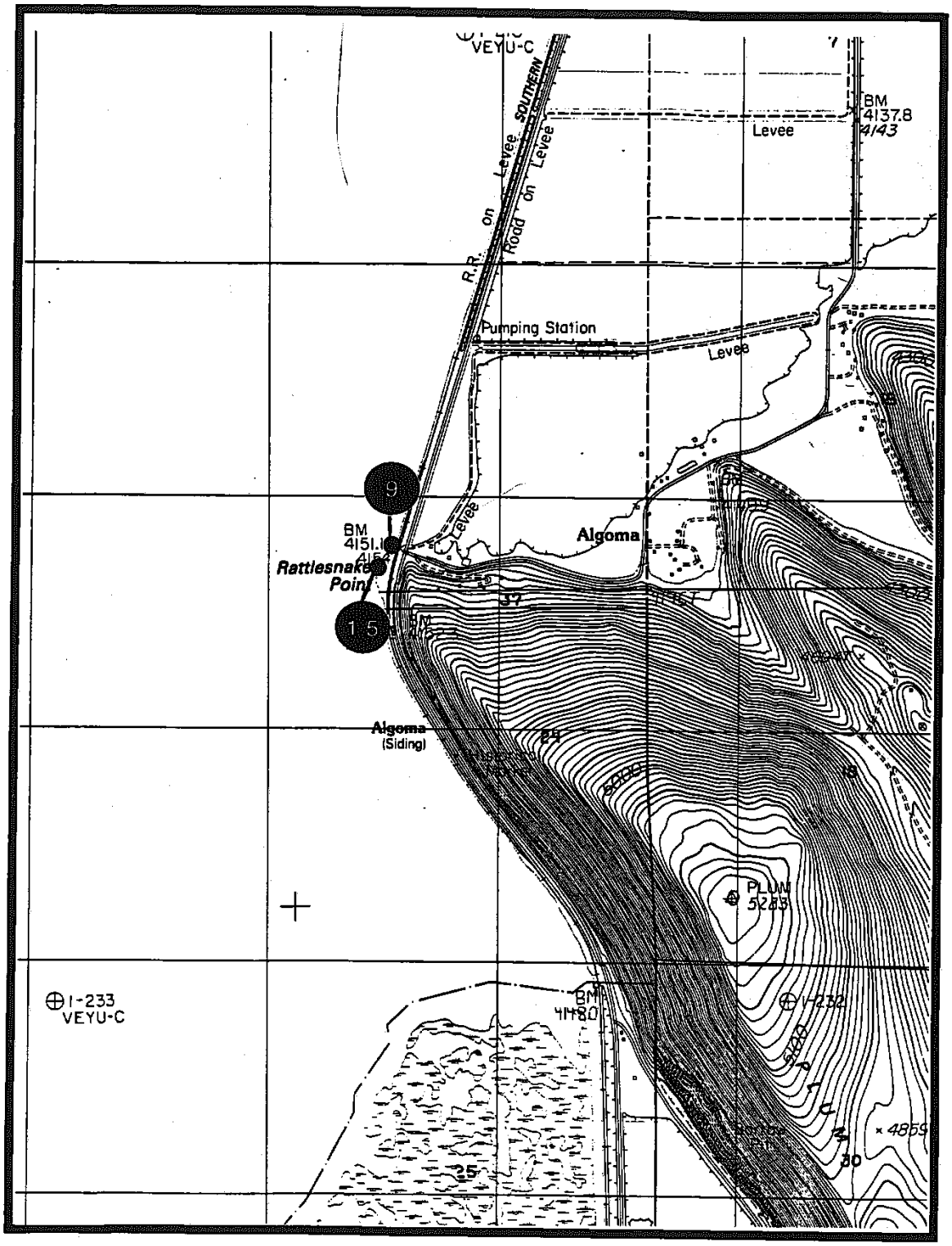
PELICAN BAY QUADRANGLE, KLAMATH CO., OR
SITES 20, 21, 22, 56, 57



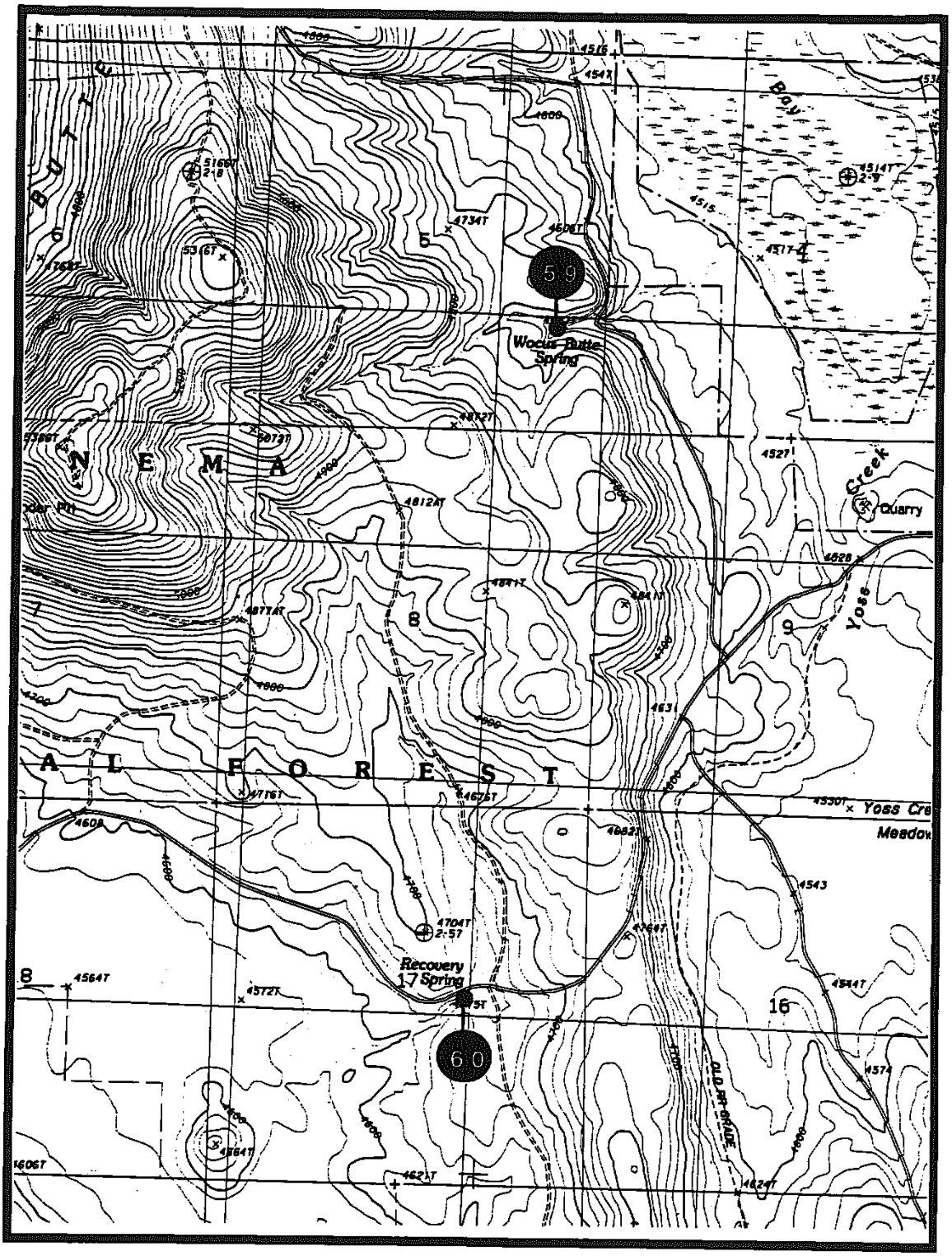
SOLOMAN BUTTE QUADRANGLE, KLAMATH CO., OR
SITES 62, 63, 64



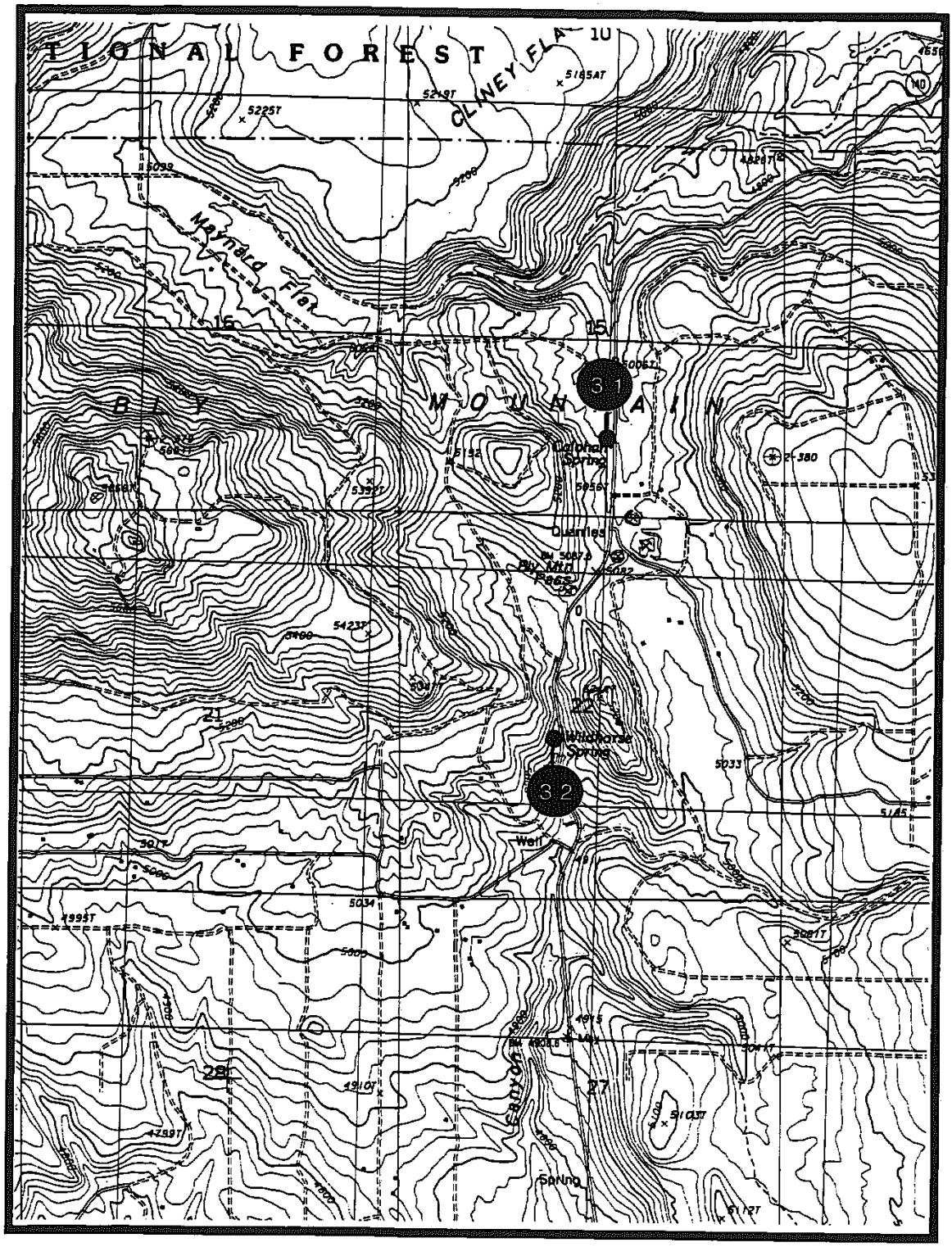
SPENCER CREEK QUADRANGLE, KLAMATH CO., OR
SITE 72



WOCUS QUADRANGLE, KLAMATH CO., OR
SITES 9, 15



WOCUS BAY QUADRANGLE, KLAMATH CO., OR
SITES 59, 60



YONNA QUADRANGLE, KLAMATH CO., OR
SITES 31, 32