THE JACOBY CREEK WATERSHED

PAST, PRESENT, AND FUTURE

by

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and

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REDWOOD COMMUNITY ACTION AGENCY

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INTRODUCTION

The 1987–88 RCAA project to improve fish and wildlife habitat on Jacoby Creek, had the following objectives:

- to curtail soil erosion in the Blue Slide area;
- to stabilize two eroding streambanks;
- to remove two failing road crossings;
- to remove a rock falls barrier to fish migration;
- to compile a comprehensive salmonid habitat improvement plan;
- to evaluate fish habitat improvement work accomplished between 1977 and 1986 on Jacoby Creek;
- to present a final report summarizing background information pertinent to fish and wildlife conservation in the watershed and documenting work accomplished;
- and to create a slide show program for use in local schools telling the story of the watershed and its fisheries.

This report updates background information contained in *A Study of the Jacoby Creek Watershed* (Murray and Wunner,1980); provides a summary of fish habitat restoration projects undertaken from 1977 to 1988; presents a plan for improvement work; and makes recommendations for the benefit of fish and wildlife of Jacoby Creek watershed and Humboldt Bay.

Technical background material has been included to give the reader a context in which to view today's situation in regard to the fish and wildlife of the watershed. This project is focused on the improvement of the salmonid fisheries; however, improvements of fish habitat will promote biological diversity and have benefits for many other species of native plants and animals as well.

OVERVIEW OF THE WATERSHED

LOCATION

The Jacoby Creek watershed is located (see Fig.1) in the coast ranges of northern California between the cities of Eureka and Arcata. The watershed is 16.6 sq. miles in area (Tuttle and Dickert, 1987) and empties into the northeastern portion of Humboldt Bay. The main stream channel is 11.1 miles long.

GEOLOGY

This watershed, situated on the edge of the eastern Pacific Ocean, is part of a large upheaval of the earth's crust. Recent studies of the Pacific Ocean floor indicate that it moves approximately 2 inches per year from the mid-Pacific ridge toward and under the continental marginal trench. The sea floor moves in a series of gigantic rigid segments that slide past each other along great faults. The Coast Ranges are the products of these faults, and were formed by the elevation and folding of off-shore marine sediments (Franciscan Formation) deposited directly on an oceanic crust about 160 million years ago (Cooper, 1975).

The stream drainage patterns of the Coast Ranges began on islands which gradually emerged from the Cenozoic sea. Increments of drainage were added downstream as the land arose (Christensen, 1966). As streams cut into the Franciscan Formation landforms, typically bearing from northwest to southeast, thick layers of Cretaceous sediments (the Falor Formation) were formed (see Fig. 2).

Franciscan Formation

This formation is an assemblage of characteristic rocks (Page, 1966): deep water sediments, marine volcanic material, and serpentine. No base for the assemblage has been found, even at a depth of 25,000 feet (North Coast Area Investigation, 1966). The Franciscan Formation in the Great Valley of California has been postulated to be a minimum of 50,000' thick (Bailey et al., 1964).

Common components of the assemblage are: greywacke sandstone (a coarse, dark gray sandstone of firmly cemented materials), shale (mostly gray to black, silty and brittle), serpentinite (green rocks often mottled by patches of black and invariably seamed in a criss-cross pattern of closely spaced fractures that have polished surfaces and feel soapy), and chert (closely jointed rocks composed of chalcedonic quartz with a distinctive red or green color). On earthflows the Franciscan Formation is expressed as a melange, or mixture, of the above components in a matrix of clay. This parent material gives rise to Atwell soil.

Atwell soil usually occurs in swales or draws. Minor ridges and higher elevations between these areas are usually occupied by Hugo or Melbourne soils which

Figure 2
Jacoby Creek Watershed Place Names

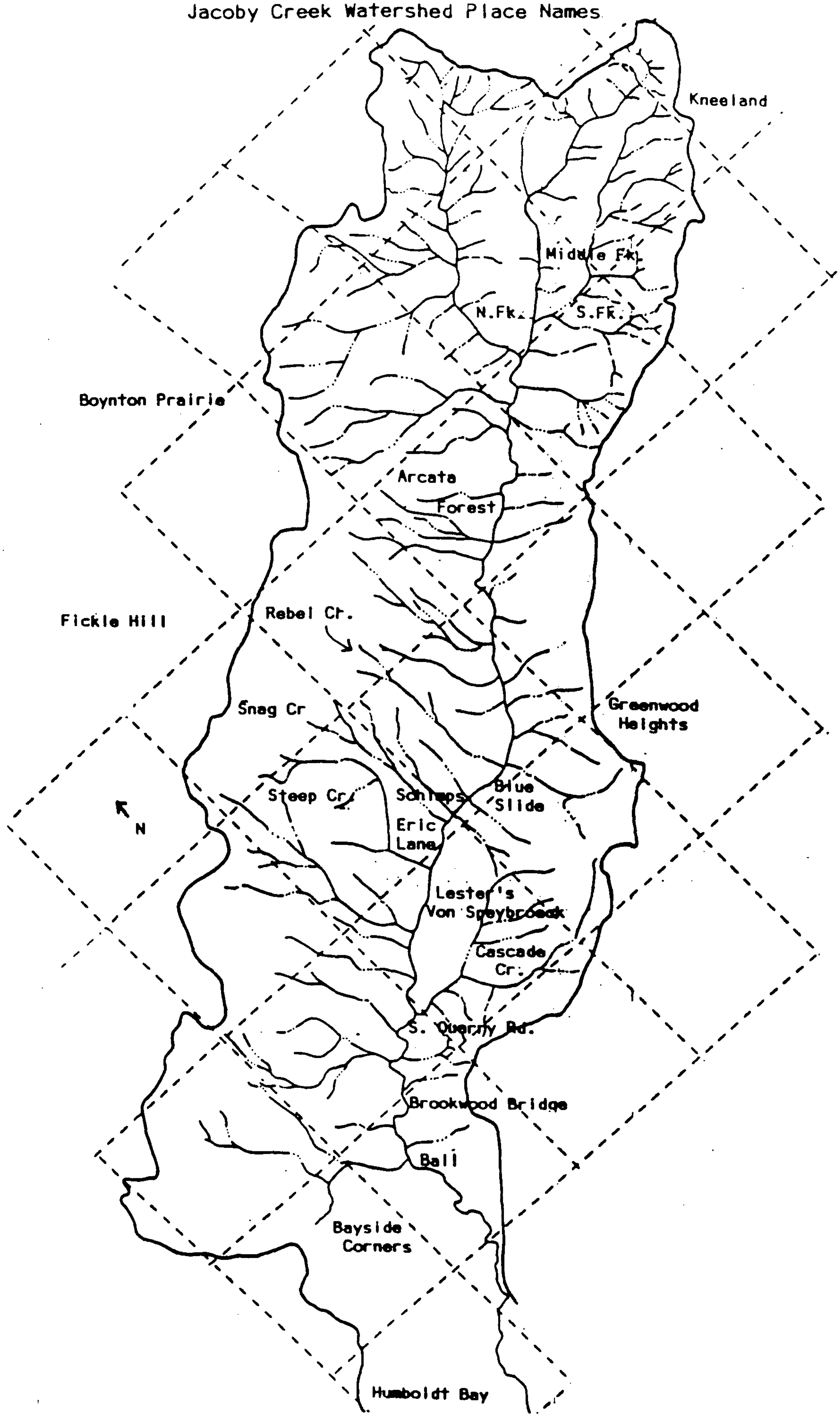
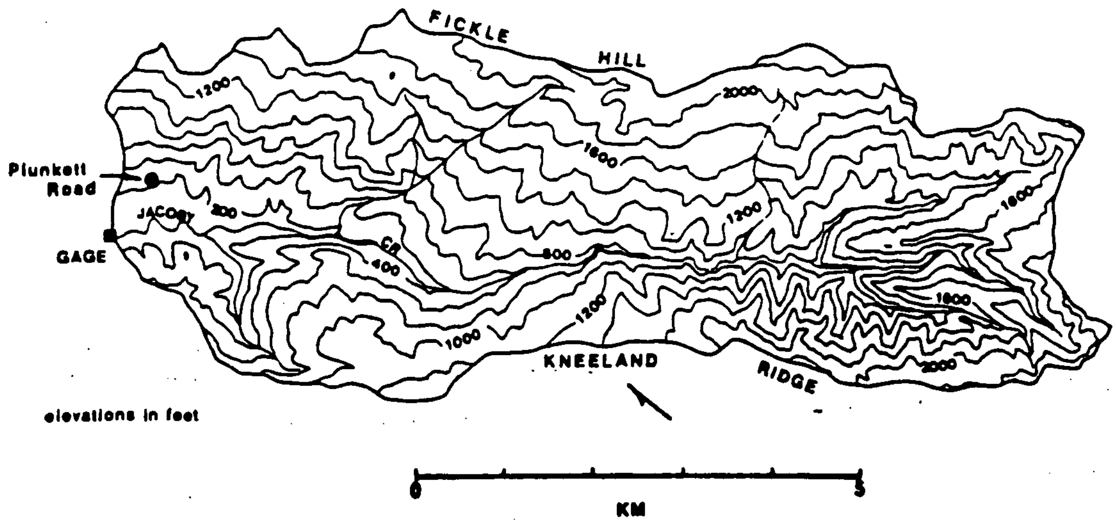


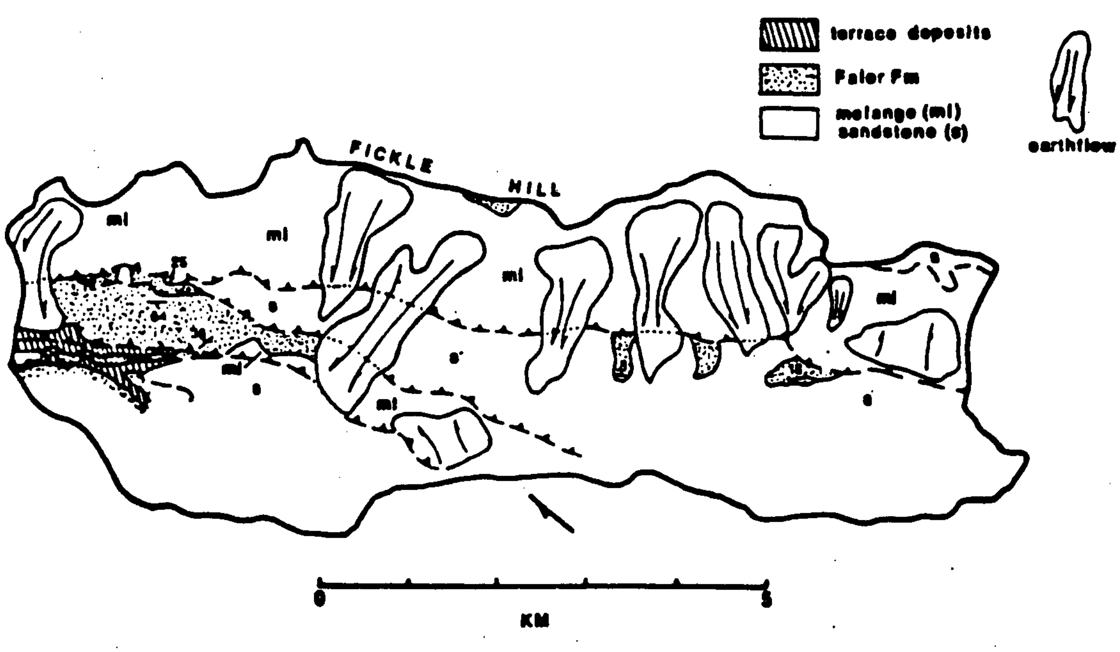
Figure 3

Topographic and Geologic Maps of Jacoby Creek Basin

(From Lehre & Carver, 1985)



Topographic map of Jacoby Creek drainage basin above Tom Lisle's gage at Brookwood bridge, compiled from Arcata South, Korbel, and Iaqua Buttes 7.5' quadrangles. Gage is located 4.7 km SE of Arcata, CA. Note that elevations are in feet.



Geologic map of Jacoby Cr basin, simplified from mapping of Carver and Stephens (1985). Melange (ml) and greywacke sandstone (s) belong to the Franciscan group. Only active earthflows are indicated.

are derived from hard Franciscan sediments. Atwell is composed of an expansive clay which swells in the presence of water and shrinks and cracks on drying. Clay, by definition, has a particle size of less than 0.02 mm in diameter. This small size makes it readily suspended in runoff.

Clay particles are in the form of small, flat, plate-shaped crystals called platelets, with many small pore spaces between them. The rate at which the pore spaces can absorb water is slow, but large amounts of water can be held between the platelets. When the soil becomes saturated, the capillary attraction between the platelets is destroyed. The clay soil becomes plastic as the platelets slide over one another. Disturbance or compaction of wet clay causes packing of the platelets, creating a nearly impervious or puddled soil. The clay properties of Atwell soil contribute to its low shear strength, low infiltration rate, tendency to instability and susceptibility to severe gully erosion. When clays are eroded and carried off by water, they remain in suspension until reaching water rich in calcium or sodium, such as salt water, at which time they flocculate or aggregate.

Falor Formation

The Falor Formation (Manning and Ogle, 1950) includes poorly consolidated, interbedded, shallow Pleistocene marine sands and pebbly sands; estuarine sands, silts and clays; and fluvial gravels, sands and silts. The deposits were laid down in a slowly subsiding depositional basin. The fluvial sand and gravel sequences possibly represent ice age sea level fluctuations (Lehre and Carver, 1985). Subsequent faulting has thrust Franciscan rocks over the Falor deposits. The age of the Falor Formation is constrained by a well-preserved volcanic ash layer present near its depositional base. This ash has been correlated on the basis of chemistry to the Huckleberry Ridge Tuff from the Yellowstone caldera in Wyoming.

GEOMORPHOLOGY

The upper slopes of Fickle Hill (see Fig. 3) consist largely of Franciscan melange and greywacke which have been thrust southward over the Falor Formation. Falor sediments form much of the lower slopes of Fickle Hill. Kneeland ridge consists chiefly of Franciscan rocks with a thin veneer of northeast - dipping Falor Formation present locally near the creek. The average slope of the Fickle Hill side of the basin is 11 degrees; that of the Kneeland Ridge side is 14 degrees.

Two major thrusts crop out on Fickle Hill about 1/3 of the way between the creek and the watershed divide. These faults, which are no older than about 1 million years, have a total offset of around 2,400' and are estimated to have faulting recurrence intervals on the order of 5,000-10,000 years. for offsets of 16' to 33' events (Carver, 1985).

Lehre and Carver (1985) suggest that tectonism and erosion in the Jacoby Creek drainage are not in equilibrium and that Fickle Hill continues to grow in relief and bulk. Earthflows originating in Franciscan melange of the upper thrust plate redistribute thrust material downslope. They conclude that earthflow material, which covers 20% of the basin, is moving through tributary channels and overshadows the contributions of surface erosion and shallow debris slides.

Tuttle and Dickert (1986) have found that surface erosion on bare sites such as roads and driveways is 1.8 times higher than on forested sites, and 1.4 times higher than on residential sites. Also, the incidence of surface debris slides as measured from aerial photographs has more than doubled between 1941 and 1978, with 3 times more slides associated with roads than with unroaded sites.

Physical Characteristics of the Jacoby Creek Estuary

The following is from a 1971 report by R.W. Thompson (unless otherwise cited). Humboldt Bay is the largest estuary between San Francisco and Coos Bay, Oregon. It is composed of three coastal estuaries linked together by a sand spit to form one continuous bay. Arcata Bay, the northernmost of these estuaries, occupies the low seaward end of several valleys which have been filled by floodplain and tidal flat deposits.

Jacoby Creek flows into the Arcata Channel System, the main tidal artery of Arcata Bay. There are three morphological subdivisions to the bay: tidal channels (located almost entirely below mean lower low water [MLLW]), tidal flats (1' to 2' below MLLW to 4' to 5' above MLLW), and salt marsh (5.5' to 7' above MLLW or approximately at mean high water level).

Tidal flats are classed as high or low. On the bay, tidal flat soil particle size generally decreases with elevation, except near the mouth of Jacoby Creek. Here, 2,000' from the marsh edge out into the bay, core samples show sand layers between layers of fine clay marsh bottom. The embedded layers of different sized soil particles are called laminations. At 1,500' from the marsh edge, core samples show that interbedded and interlaminated silty sands and clayey silts predominate. At 500', silty sand with some gravel and thin interbeds of clayey silt occur. Jacoby Creek is one of the very few areas in the bay where lamination of sediments occurs. This is evidence of a relatively rapid rate of sediment accumulation.

The channels of the former tidal marsh, visible on early maps and aerial photographs of the Jacoby Creek wetlands, give evidence that there was once an intricate and diverse channel system. Since Wiyot Indians were not recognized as owners of the land, "swamp and overflow lands" were sold by the government on the condition that the land be "improved" for agricultural purposes. Tidal marshes were considered an eyesore (Arcata Union, 1893) and valueless. By 1853, the same year that the Jacobys filed for their land, most of these lands were claimed, Of 8,738 acres of Humboldt Bay wetland existing in 1871, only 1,108 acres remained in 1978 (Shapiro and Associates, 1979).

Some bends, meanders, and side channels were cut off by the construction of levees and dikes. There was a drawbridge at Gannon Slough so freight could be floated up to as far as 5th and F Streets in Arcata. The Flannigan and Bronson Railroad which ran up Jacoby Creek beginning in 1882 necessitated the construction of an embankment from Gannon Slough to Bayside Corners. The Harpst and Spring Dike construction began in 1892 (Arcata Union). It ran from Butcher Slough to the railroad, then to the drawbridge at Gannon Slough, then to the mouth of Jacoby Creek, then up the bank of the creek until it was beyond the tidal influence. The dike was 10' wide at the base, 4 1/2' wide at the top, and 5' high. The Northwestern Pacific Railroad line along Humboldt Bay between Arcata and Eureka was built in 1901. This embankment blocked more of the tidal influence to the Jacoby Creek floodplain.

The Washington Gulch creek was cut off from the Jacoby Creek wetlands by being rerouted along the southwest side of an embankment built in 1875 by the Dolbeer and Carson Lumber Co. for its railroad which ran from Washington Gulch to the Bay. This embankment later became the Bayside Cutoff road.

At the mouth of Jacoby Creek the established Northern Coast Salt Marsh is separated from the adjacent high tidal flat by a wave-cut cliff 2' to 3' high. This marsh area has remained intact at least since 1931, the date of the earliest aerial photographs. The delta extending beyond the established marsh has grown by 18 acres, of which nearly 8 acres have become vegetated. The development of the lobes of the delta, coarse materials carried downstream by winter runoff and spread on an outwash fan, corresponds with the 1955, 1972 and 1975 storms (Tuttle and Dickert, 1986).

HYDROLOGY

Precipitation arises from fog-drip (fog condensing on vegetation) rain or snow. Most rain in the North Coast region falls between November and April. A ten year average of 60.65 inches has been reported from Sunnybrae (John Borgerson, personal communication). A rain gauge located three miles upstream from the mouth of Jacoby Creek (160' elevation) caught 44.39, 26.68, and 54.09 inches for the 1975-76, 1976-77, and 1977-78 years (Bill Lester, personal communication). Snow occurs on the ridgetops occasionally during cold winter storms and rarely over the entire watershed.

In the dry season the climate is moderated by summer fogs which reduce solar radiation and create an ideal habitat for a temperate rain forest. Harris (1987) has compiled evidence for the idea that the precipitation from fog drip has probably been considerably reduced by the removal of old growth forest stands in the watershed.

Rain or snow is intercepted by the vegetation or falls directly on the ground. Some of the intercepted water evaporates, and the rest flows down tree trunks or falls to the ground. If vegetation is absent, rain drop impact on bare soil results in erosion. Undergrowth and forest litter are important in protecting the soil.

As water reaches the forest floor, depending on its rate of arrival and the soil's capacity to allow water to enter, infiltration occurs. In undisturbed forest soils, infiltration capacities far exceed maximum rates of rainfall, so that all water enters bends create the downstream end of bars by causing scour across the entire channel. Bars are terminated upstream or directly opposite of the largest obstructions, or in the upstream limbs of bends.

The spacing of bends and large obstructions apparently controls the length of many bars. Many of the bars in Jacoby Creek are less than four channel widths long (an important fact in spacing pool forming habitat structures). Bars in Jacoby Creek are in dynamic equilibrium with bedload transport and with the stable bends and large obstructions that give bars their form, position, and relative volume.

A Jacoby Creek streamflow gauging station was operated by the U.S.G.S. from 1954 to 1965. The lowest recorded flow was 0.6 cfs on September 24, 1957. High flows recorded were: December 30, 1954— 1,670 cfs; December 21, 1955— 1,490 cfs; and December 22, 1964— 1,530 cfs.

Approximately 90% of the runoff occurs between November and April. (Environmental Science Services Administration, 1969-1970). The mean annual maximum flow is estimated to be 737 cfs with a range of peak flows between 380 cfs and 2,510 cfs. Analysis of recurrence intervals (Tuttle and Dickert, 1986) show the largest recorded discharge (March, 1972) had a 20 – 38 year return period. An ungauged storm in March, 1975 probably exceeded the 1972 event. Although the 1955 and 1964 storms are considered major events on the Northcoast, on Jacoby Creek they were only moderate storms with computed return periods of 5 and 8 years, respectively! The discharge of the stream recorded at lowest flow during the 1977 drought was 1.25 cfs on October 4, 1977 at the flat near the end of South Quarry Rd. (Humboldt Co. Dept. of Public Works).

VEGETATION

The history of the vegetation is discussed in detail to give a perspective on the time periods and the complexity of the processes which have resulted in the present-day vegetation.

The History of the Vegetation (Axelrod, 1970 and 1977)

In the early Eocene, fifty million years ago, a warmer ocean allowed a subtropical climate to prevail along the Pacific Coast into southern Alaska. The climate was one of heavy rainfall, at least 80" during the warm season, and dry frost-free winters, a climate today typical of southeastern Mexico, Panama and southeastern China.

A shallow tropical sea covered the Coast Ranges, lapping up against the Klamath Mountains (Dunn, 1988). Fossil floras indicate that tree ferns, palms, cycads and numerous large–leaved evergreen dicots of tropical and subtropical families were dominant, including species similar to modern day fig, avocado, cinnamon, palmetto, oak, acacia and pecan. At the same time redwoods were found in more northern latitudes: what is now Canada,Wyoming and Greenland.

As the eastern Pacific Ocean cooled and the continent was gradually uplifted, a colder climate developed inland, leeward of the Sierra-Cascade axis. This climate change allowed a northern forest (the Arcto-Tertiary Geoflora) composed of ancestors of present day species (for example, redwood, Douglas-fir, red cedar, spruce, hemlock, maple, dogwood, tan oak, barberry, rhododendron, red huckleberry, and salal) to begin to invade what is now the northern Sierra Nevada and central Nevada by early Miocene times, thirty million years ago.

The Antarctic ice sheet melted thirteen million years ago (Axelrod, personal communication, 1986), resulting in a further cooling of the climate. Subtropical species were forced coastward and southward and gradually eliminated from the region. As summer rains lessened, species similar to those still typical of the eastern deciduous forest of North America (hickory, beech, witch hazel, sweet gum, tupelo, chestnut, elm, and swamp cypress) were eliminated from the Pacific Coast flora. Also eliminated were species no longer native to North America but still found in Asia: tree of heaven, gingko and dawn redwood.

The fossil evidence shows that from the beginning of the Miocene invasion of the northern California area, two distinct vegetation elements developed from a common ancestorage: the Arcto-Tertiary Geoflora and the Madro-Tertiary Geoflora, have given rise to our present day flora. Madro-Tertiary species similar to California bay, madrone, cream bush, manzanita, silk tassel shrub, oak, and poison oak evolved in the cold, dry Sierra Madre Mountains of northern Mexico.

Present Plant Communities

A plant community is a group of plants which associate in a common environment. Salinity, soil moisture, soil type, exposure and disturbance are important factors determining where plant communities occur. The following native plant communities (Holland,1986) have been identified in the watershed and are discussed below: Northern Coastal Salt Marsh, North Coast Riparian Scrub North Coastal Coniferous Forest, Redwood Forest, Douglas-Fir Hardwood Mixed Evergreen Forest, and Bald Hills Prairie.

The Northern California Salt Marsh

The salt marsh at the mouth of Jacoby Creek covers 37 acres (Tuttle and Dickert, 1986) and is characterized by pickleweed (Salicornia virginica), cordgrass (Spartina densiflora), salt grass (Distichlis spicata), Carex lyngbyei, arrow-grass (Triglochin maritima), Jaumea carnosa, mousetail (Myosaurus minimus), marsh rosemary (Limonium californicum), bird's-beak (Cordylanthus maritimus), Humboldt Bay owl's clover (Orthocarpus castillioides, var. humboldtiensis) and Humboldt Bay gumplant (Grindelia stricta ssp. blakei). In the late spring, slender orange threads of the parasitic dodder (Cuscuta salina) twine over the pickleweed.

Bird's beak, owl's clover and gumplant are rare and endangered throughout their range (Smith and Berg, 1988). The latter two species are endemic to the salt marshes surrounding Humboldt Bay. A white form of owl's clover, which usually has purple-tipped bracts, has been found along the Jacoby Slough (Newton, 1987).

The North Coast Riparian Scrub Community

The riparian community begins at an elevation of nine feet near the Highway 101 bridge. In lowlands behind levees, where the land is no longer subject to normal tidal influence, vegetation zones correspond to the extent of soil drainage. Typical species are: cinquefoil (Potentilla egedii), sedge, cattail (Typha latifolia), rush (Juncus Lesueurii and J. effusus), brass buttons (Cotula coronopifolia), and spike-rush (Eleocharis macrostachya). Willow (Salix spp.) provides much of the overstory of the lower reaches of the stream. To date, S. parksiana, S. lasiandra, and S. sitchensis have been identified. Two species of horsetail are common: Equisetum hymale on perennially wet sites, and E. telmateia on sites which become dry during the summer.

Between the Highway 101 and Old Arcata Rd. bridges, scattered groves of black cottonwood (Populus trichocarpa) occur. An isolated redwood tree approximately 50 to 60 years old is found on the levee 1/4 mile upstream from the mouth.

Common shrubs are: ninebark (Physocarpus capitatus), twinberry (Lonicera involucrata), salmonberry (Rubus spectabilis), thimbleberry (Rubus parvifolius), stink currant (Ribes bracteosum) and vines of bearberry blackberry (Rubus ursinus).

From the Old Arcata Rd. bridge to the headwaters forks, as large conifers have been removed, the riparian zone has become dominated by willow and alder (Alnus oregona). Big leaf maple (Acer macrophyllum), with licorice fern (Polypodium scouleri) epiphytes, is frequent from the Covered Bridge upstream. Stink currant and salmonberry form dense thickets in many places. Common understory herbs are figwort (Scrophularia californica), bearberry blackberry (Rubus ursinus), hedge nettle (Stachys arvensis), nettle (Urtica lyalli), and wood rush (Luzula subsessilis).

North Coastal Coniferous Forest Community

Just downstream from the Old Arcata Rd. bridge, a rise in topography and the presence of Sitka spruce (Picea sitchensis) and grand fir (Abies grandis) represent the remains of the North Coastal Coniferous Forest. Other common species are: canoe cedar (Thuja plicata), western hemlock (Tsuga heterophylla), Douglas-fir (Pseudotsuga menziesii), Nootka cedar (Chamaecyparis nootkatensis), big-leaf maple and cascara (Rhamnus purshiana). This plant community can be found along Jacoby Creek into the headwaters tributaries.

Redwood Forest Community

Humboldt and Del Norte Counties contain the finest development of the coastal

Redwood Forest, a forest which once covered much of the northern hemisphere. The oldest fossil redwoods, about 150 million years old, are from the upper Jurassic of France (Arnold, 1947). Petrified wood from the lower Cretaceous, 125 million years ago, has been found on the Isle of Wight. More recently, during the Pleistocene, redwoods extended 200 miles southward from the present range limits to Carpenteria and Santa Cruz Island.

The trees are among the world's tallest (112 m.) and grow at rates near the world's maximum. Accumulation of wood mass in the Redwood Forest in unequaled in any other place (Zinke, 1977). The Redwood (Sequoia sempervirens) Forest ranges from the Chetco River near Brookings, Oregon to San Luis Obispo County, California, a range of about 450 miles, and an area corresponding directly to a summer fog belt along the northern and central coast ranges.

It is difficult to know for certain how close to the bay along Jacoby Creek redwood trees once grew. In 1978, redwood stumps were observed along the creek about 1 1/2 miles upstream of the Old Arcata Rd. bridge near the 40' contour interval. Here on the left bank about 10' above the highest detectable channel, several massive stumps were seen where the geologic parent material changes from recent alluvial deposits to Falor Formation. It is not until a mile further upstream, just above the Brookwood Bridge, that large old-growth and second-growth redwood trees are found.

Large clearcuts have a subtle but important detrimental impact on all plant and animal species in the watershed Extensive clearcutting of the redwood forest may produce areas where warm convection plumes lead to the dissipation of the fog layer with resultant significant reductions in the incremental growth of all species in adjacent undisturbed forests (Harris, 1987).

Depending on soil moisture, three common understories occur in the Redwood Forest: in dry areas, the Redwood-Swordfern association; in moderately drained areas, the Redwood-Oxalis association; and along watercourses and around springs and alluvial flats, the Redwood-Salmonberry association.

The following species compose the Redwood-Swordfern association: swordfern (Polystichum munitum), redwood violet (Viola sempervirens), salal (Gaultheria shallon), rhododendron (Rhododendron macrophyllum), black and red huckleberry (Vaccinium ovatum and V. parvifolium), and wax myrtle (Myrica californica). This association is common on well-drained soft Cenozoic marine sediments and Melbourne and Hugo soil types of the Franciscan Formation.

The Redwood-Oxalis association is noted for the absence of a shrub layer. The following species commonly occur: redwood sorrel (Oxalis oregona), redwood violet, trillium (Trillium ovatum), fetid adder's tongue (Scoliopus bigelovii), anemone (Anemone oregona), vanilla grass (Hierochloe occidentalis), fairy lantern (Disporum smithii), woodland star (Trientalis latifolia) and queen's cup (Clintonia andrewsiana). Species of the association occur on soils of soft Cenozoic marine sediments and the Franciscan soils: Hugo and Atwell.

Shrubs dominate the Redwood-Salmonberry association. In addition to the species listed for the North Coast Riparian Scrub Community, the following occur: red-flowering currant (Ribes sanguineum), red elderberry (Sambucus callicarpa) and lady fern (Athyrium filix-femina). Spike moss (Selaginella oregona) occurs on fallen trunks and deep-shaded banks.

When the Redwood Forest is clearcut, there is a reinvigoration of the understory shrubs in the Redwood-Swordfern and Redwood-Salmonberry associations and an invasion of both native and introduced pioneer species. Most native invaders come from the Hemlock Phase (Sawyer, et al., 1977) of the Douglas-Fir Mixed Evergreen Forest and the North Coast Riparian Scrub Community.

Common native invader shrubs and herbs include coyote brush (Baccharis pilularis), ceanothus (Ceanothus thyrsiflorus), yarrow (Achillea millefolium), thistle (Cirsium vulgaris), and western coltsfoot (Petasites palmatus).

Douglas-Fir Hardwood Mixed Evergreen Forest

This forest type is characteristic of the Franciscan Formation parent materials of the North Coast Ranges (Sawyer, et al., 1977). Douglas-Fir is the major species. In locations that have been free from fire for a considerable length of time, hemlock occurs as a codominant with Douglas-fir and tan oak (Lithocarpus densiflora). On recently cutover lands the following species become important: tan oak, California bay, madrone (Arbutus menziesii), and wax myrtle. The shrub layer on northern slopes is salal, salmonberry, rhododendron and black huckleberry. On southern slopes salal, poison oak (Rhus diversiloba), bearberry blackberry, Oregon grape (Mahonia aquifolium), cream bush (Holodiscus discolor), and ceanothus characterize the shrub layer. Swordfern is common throughout the community.

The herb layer on moist slopes includes: redwood sorrel, redwood violet, inside out flower (Vancouveria hexandra), and fairy bells (Disporium smithii). On drier slopes yerba de selva (Whipplea modesta) and red-flowered honeysuckle predominate.

Species which are rarely or infrequently encountered in the watershed include: calypso orchid (Calypso bulbosa), rattlesnake plantain (Goodyera oblongifolia), lycopodium (Lycopodium clavatum), and burning bush (Euonymus occidentalis). Old growth forms of common trees, such as redwood, red cedar, grand fir, and hemlock are becoming rare.

The Bald Hills Prairie Community

The prairie community is represented on Boynton Prairie and other prairies on Fickle Hill. These prairies have been heavily grazed and are now largely converted to introduced European species such as oatgrass (Avena sativa), velvet grass (Holcus lanatus), orchard grass (Dactylis glomerata) and dogtail (Cynosurus echinatus). Before the arrival of European culture, these prairies were probably similar floristically to the Oregon white oak woodland and prairies of the Bald Hills of Redwood National Park (Sugihara and Reed, 1987). These prairies were most likely composed of

(Carex tumicola), California oatgrass (Danthonia californica), Idaho fescue (Festuca idahoensis), Melic grass (Melica sp.), and needlegrass (Stipa pulchra).

Exotic Plants

A number of non-native plant species, exotics, have escaped from cultivation or have been unintentionally carried to this area. Almost all exotic species have become established only because the native vegetation has been removed. Most introduced species would probably be replaced by the native vegetation when disturbance ceases and canopy closure begins. Exotic plants are generally undesirable because they disrupt the balance between native plants, soil, climate, and energy cycling upon which native plants and animals depend.

Some species which have been successful in dominating native vegetation are Scotch broom (Cytisus scoparius), Portuguese broom (C.striatus), French broom (Genista monspessulana) English ivy (Hedra helix), South American cordgrass (Spartina densiflora), and Andean pampas grass (Cortaderia jubata)

Broom species are becoming more prevalent along roadsides and they are beginning to invade the sandy ridge in the headwaters of the middle fork. English ivy grows up tree trunks, displacing native woody vines, and eventually kills the host trees. Understory native plant species are also displaced. Ivy can be seen on both sides of the road near the Eric Lane junction, 3.3 miles up Jacoby Creek Rd. and along Fickle Hill Road.

South American cordgrass is a brackish water wetland species which now characterizes Humboldt Bay. Its Chilean origin has only recently come to light (Spicher,1984). It is speculated to have arrived in the 1850's in ship ballast. It seems that Chilean cordgrass excludes pickleweed from higher tidal elevations.

Andean pampas grass, a perennial, is solidly entrenched throughout most of the northcoast as well as this watershed. Called jubata grass by some, the plant produces small, very light, wind-dispersed seeds without pollination. To live, the seeds must land on a sunny, moist site soon after dispersal in order to germinate. When established pampas grass dominates its site until shaded out by a forest or ceanothus canopy.

Other invader grasses are: Italian wild rye grass (Lolium multiflorum), orchard grass (Dactylis glomerata), wild oats (Avena sativa), and sweet vernal grass (Anthoxanthum odoratum).

Common invader herbs are: New Zealand fireweed (Erectites minima), hawkbit (Leontodon taraxacoides, milkweeds (Lactuca biennis, L. canadensis, and L. ludoviciana), cat's ear (Hypochaeris radicata), dandelion (Taraxicum officinale), sow thistle (Sonchus asper), pearly everlasting (Anaphalis margaritacea), common groundsel (Sencio vulgaris), digitalis (Digitalis purpurea), pineapple weed (Matricaria matricarioides), tarweed (Madia sativa), common mullein (Verbascum thapsus), lupine (Lupinus sp.), lotus (Lotus corniculatus), clover (Trifolium repens), and sweet clover (Meliolotus alba).

Influence of the Riparian Zone on the Stream

Headwater streams are the collectors, processors and conveyors of products from upland ecosystems. These small streams, Order 1 and 2, contain life forms highly sensitive to inputs of light, sediment and runoff.

As small tributary streams unite, the channel widens and the forest canopy separates. The increased light penetration results in the establishment of a distinctive riparian vegetation. In response to increased light, benthic (bottom) algal communities become an important energy base for the ecosystem, and large particle detritus (organic debris) plays a lesser role in sustaining stream productivity. The trees comprising this vegetation provide a canopy important in cooling the stream during the warm season; and tree trunks which defend watercourses from erosion, define stream channels and create deep pools.

Most organic materials enter small streams as litterfall from the overhead canopy. In coastal Oregon small streams were found to receive 170 to 200 lbs. of organic material per 100' per year, mostly from litterfall (Triska and Sedell, 1976). Storm flows form these materials into "debris dams". At these places debris is sieved from the stream during high flows and fine organics are filtered during low water times. Debris dams serve as the principal places where microbial colonization of litter occurs. Litter colonized by bacteria is used for food by invertebrates.

When leaves enter the stream the soluble compounds in them are leached in a manner similar to a teabag in hot water. Bacteria then invade the leaves and oxygen consumption increases. Alder leaves, because of their high fiber content, are leached and invaded by bacteria more rapidly than the needles of Douglas-fir. Fir needles, slowly consumed initially in the fall become more rapidly used in the spring. Higher water temperatures speed up the bacterial colonization process.

FISH

Species

Seven species of fish have been identified in Jacoby Creek. The four salmonid species are: chinook salmon (Oncorhynchus tshawytscha), coho salmon (O. kisutch), steelhead trout (Salmo gairdnerii), coastal cutthroat trout (S. clarkii). Other species identified are: three-spined stickleback (Gasterosteus aculeatus), Pacific lamprey (Entosphenus tridentatus) and sculpin (Cottus sp.).

Upstream migration of salmonids was monitored during the 1977-78 season using a weir and trap located 1/4 mile upstream from Humboldt Bay. There fish were caught, tagged and released to continue their migration upsteam. Fish were recaptured upstream with electro-fishing equipment. Population numbers were estimated by determining the ratios of tagged to untagged fish (modified Peterson method). The populations were estimated to be 123 ± 41 coho and 217 ± 95 steelhead (Harper, 1980).

Fish were caught in the trap when flows were above 22 cfs. Over three spawning seasons, 95% of the coho were found between November and January. Records for steelhead show that during 1977-78, use of the stream by the majority of spawners was from December to June. The peak migration was from January to March, however adult spawners have been observed in May.

Sitings of chinook salmon are rare. A chinook smolt was caught at the fish trap located 1/4 mile upstream of the mouth (Harper, 1980). Roger Barnhart (U.S.Fish and Wildlife Service) found a 45" male chinook carcass at the Brookwood bridge in 1987.

Characteristics and Life Cycles

Harper (1980) found that steelhead spawned higher—from the flat downstream from the south quarry to the barrier to fish migration—in the stream system than coho. Salmonid redds, or nests are dug by the female in suitable spawning gravel. The construction of the redd is done in a manner which cancels out the effects of the streamflow so that eggs can be deposited and fertilized in relatively fast flowing water.

Steelhead may live after spawning. For example, a steelhead caught off the Alaskan Coast was judged from its scales to be eight years old and to have spawned four times (McNeil and Bailey, 1975). Harper (1980) found that 17% of the steelhead on Jacoby Creek were spawning for the second time.

The buried eggs depend on an intergravel water flow to provide oxygen and carry away carbon dioxide and ammonia. The eggs usually hatch in 50 to 60 days, depending on water temperature. After 3 to 4 more weeks, the young wiggle up through the gravel.

The emerged juveniles, called fry, live off their yolk sacs for 2 1/2 to 3 months after hatching and then begin feeding on plankton (Moyle, 1976). At first, fry school in the shallow stream edges. As they become parr (with appearance of oblong dark elipses on their sides), individuals establish territories, focal points in the stream where the most time is spent. Generally coho parr occupy the shallow glides at the tail of pools, while steelhead parr prefer the heads of pools and riffles. The diet consists of terrestrial insects, fallen or blown into the water, and aquatic insects, principally stone flies, caddis flies and mayflies. Ideal rearing habitat also consists of deep pools with abundant shelter from predators. For overwintering, young coho select quiet backwater pools and pools with woody debris. Steelhead appear to use boulder pools as well as woody debris pools for winter rearing. Coho and steelhead typically rear in nursery areas for one year before heading to the ocean or estuary.

Some characteristics and life history details (Kimsey and Fisk, 1964) of the non-salmonid fish species are as follows. Three-spined sticklebacks have small, spindle-shaped bodies covered with a few bony plates instead of scales. Three sharp erectile spines precede the soft dorsal fin. They are greenish or olive above and silvery on the lower sides and belly. Sticklebacks eat primarily insects, crustaceans and algae.

During spawning the males have a red throat and belly with blue eyes and greenish fins, and the females have a pinkish throat and belly. Breeding occurs in the late spring or early summer. The male builds a nest of grass and sticks bound together by a glue-like secretion in protected areas on the stream bottom. The male guards the nest until the eggs hatch.

Pacific lamprey, found in nearly all California coastal streams, are among the most primitive of living vertebrates. They are jawless with a skeleton composed of cartilage rather than bone. When lamprey become sexually mature in the spring and early summer, they move from the ocean to freshwater streams, sometimes attaching themselves with their buccal funnels (mouths) to a passing fish, whale or boat. If they attach to a fish or whale they rasp a hole with their teeth and inject an anticoagulant and the hosts blood flows to the lamprey. The funnel is also used to move stones to build a shallow nest in a riffle. During spawning the female attaches to a stone, and the male attaches to the female. Several pairs usually spawn close together. Lamprey die after spawning.

In a month or so, the minute larvae emerge from the gravel. When 12 to 15 mm long, they leave the nest area for quiet water and construct and inhabit a U-shaped tunnel, emerging periodically to filter stream bottom organisms. The larvae, blind and toothless, remain in this stage for 3 to 4 years. At the end of the larvae stage, strong teeth develop and lamprey move into the ocean.

Sculpins inhabit the lower part of the stream near the mouth. They are small and have flattened heads with eyes located high up. Their bodies are thin and tapered with large pectoral fins. Sculpin are commonly found in riffles. During spawning their eggs are deposited in clusters under large stones in flowing waters. They are opportunistic bottom feeders and feed on young trout and salmon when available.

Stocking

Records of the Calif. Dept. of Fish and Game show that Jacoby Creek has been stocked from 1930 to 1975 with coastal cutthroat and steelhead trout.

Year	Species	Number	Origin
1930	Steelhead	50,000	Unknown
1936	"	7,000	"
1938	"	5,000	Prairie Creek Hatchery
1939	"	10,000	" " "
1955	"	5,000	" " "
1962	Coastal Cutthroat	290	" " "
1963	" "	290	" " "
1964	" "	320	" " "
1965	" "	600	" " "
1966	" "	1,152	" " "
1975	Steelhead	200	Humboldt State University

Barriers to Anadromous Salmonid Migration

A waterfall at the Blue Slide located 5 1/2 miles from the bay in Section 24, just above the 20 Gallon Creek confluence, has under certain flow conditions, been a barrier to fish migration. The natural instability of this area has become aggravated as a result of road and railroad construction and logging.

One mile upstream from the Blue Slide another rock falls acts as a barrier to fish migration. It appears that this barrier was created when the natural channel on the right bank was filled with logs and soil to create the railroad right-of-way.

Many tributaries to Jacoby Creek such as Steep and Snag Creeks are blocked to fish passage by road culverts.

LAND USE

Near the end of the first logging around 1910, the land ownership and use pattern in the Jacoby Creek watershed was similar to that of today. A few owners, mostly companies, held the timberlands, while family ownerships and agricultural uses prevailed on flatlands in the lower watershed and on open prairies along the Kneeland and Fickle Hill ridges. Parcels along traveled ways became more valuable and smaller. Access often determined the shape of the parcel. For example, short property widths along access routes with and deep, long sides have allowed a maximization of property value.

Over 60% of the upper headwaters was clearcut prior to the 1973 revision of the California Forest Practices Act, resulting in severe soil and stream channel disturbances. A five-fold increase in residential development occurred between 1970 and 1978 (Tuttle and Dickert, 1987).

Future wetland impacts will resemble those of the past if human-related disturbances and natural processes occur at the same intensity as those over the historic record. Five of 13 subwatersheds are zoned at development densities which upon full build-out at the levels of the 1982 Jacoby Creek land use plan are expected to cause wetland sedimentation to accelerate beyond that experienced over the historic record (Tuttle, 1985).

Jacoby Creek falls under the California Resources Agency's wetland policy; and under general preservation policies of the Fish and Wildlife Service, the National Marine Fisheries Service, the Environmental Protection Agency, the California Dept. of Fish and Game, and the California Office of Planning and Research.

Jacoby Creek falls under both general and specific protection policies of the Humboldt County General Plan and Local Coastal Plan documents. Arcata's General Plan and Local Coastal Plan documents also specifically mention Jacoby Creek for protection and preservation of resources. Minimum stream flow requirements have been established by the California State Water Resources Control Board to protect salmon and steelhead runs.

Arcata Forest

The City of Arcata owns a parcel in the headwaters, about 1 square mile in size (Sec. 30). It is the largest unit of public land in the watershed. The City decided to log the forest to pay off a bond debt to pay for parklands it acquired. Logging of second growth timber began in 1985—most of the old growth logging terminated in 1912. Logging has been restricted to the Fickle Hill slope of Jacoby Creek. The Greenwood Heights slope, where a few pockets of old growth redwood occur, is considered to be a Forest Preserve. Two spotted owl nests have been located on the forest.

On the Fickle Hill slope, roading and timber harvest operations are proceeding upslope of the lower road along the stream. A permanent road system has been developed. Roads are rocked in most places. Some drainage problems occur as the road cuts through swampy areas. Generally the road is outsloped, facilitating drainage. A railroad flatcar, used to bridge a tributary, is an excellent demonstration of a widely needed type of stream crossing.

The City has logged more than annual sustained yield (growth) for the last two years. Harvests have proceeded at volumes greater than annual sustained yield because the unit price for logging is much lower for large volumes and paying off the bond debt early saves interest payments and means the cutting of fewer trees. Some of the forest management decisions regarding which areas should be cut, have overriden concerns of the City's Forest Advisory Committee. Logs have already been sold for a harvest of 2.3 mmBF in 1989 or 1990, after which no harvests are planned.

WATERSHED IMPROVEMENT WORK

This chapter contains brief descriptions and evaluations of the four previous Jacoby Creek fish and wildlife habitat improvement projects and describes work accomplished during the 1986–88 Wildlife Conservation Board-funded project.

PREVIOUS WATERSHED IMPROVEMENT PROJECTS

To our knowledge there have been no other projects for the improvement of fish and wildlife habitat besides the ones listed here by funding source: the Comprehensive Education and Training Act (CETA) in 1977–78; the California Division of Forestry (CDF) in 1983; the California Department of Fish and Game (DFG) in 1985; and the State Coastal Conservancy (SCC) in 1984-85.

CETA - 1977-78

The objectives of this project were to experiment with erosion control techniques—willow waddles, gully check dams, cross road drainages, a cribbing structure at the toe of the Blue Slide; to assess the extent of coliform bacteria contamination of Jacoby Creek; to assess salmonid populations and their habitat; and to present a report compiling results from the above experiments and assessments together with historical and other background material pertinent to the improvement of the watershed.

It was found that wooden terraces and log cribbing structures were not effective on the Blue Slide because of movement of the slide and erosion of the slope toe by Jacoby Creek. A block and tackle was not adequate to move logs and rocks necessary for stabilization of eroding slopes. A study of salmonid fish habitat showed that populations were limited by the shallowness of pools and the sparse cover which made juvenile fish vulnerable to predation.

A collection of samples of coliform bacteria from Jacoby Creek gave evidence that septic tank systems failed during the wet season and that the number of coliform bacteria reached high levels in the lower watershed.

Background information on physical features, vegetation, and fish and wildlife of the watershed was brought together with descriptions of the erosion control experiments, fish habitat study and coliform bacteria study in a final report made available to community residents. The report has been a resource for students and teachers in local schools from the elementary to the university level.

CDF - 1983

The objectives of this project were to reduce streambank erosion and road slumping. A slump in Jacoby Creek Rd., about 3.8 miles from the Bayside Grange, was believed to be associated with streamflow eroding the toe of the slump. Two 6' diameter redwood stumps along with much sediment, had been deposited into this low gradient reach downstream of the Blue Slide. These stumps, along with logs from a washed-out stream crossing of Jacoby Creek, formed a debris jam which blocked streamflow from a rock armored natural channel and instead deflected flows into the right bank. Work consisted of dismantling the stumps and removing part of the debris dam.

Not enough of the old road crossing debris was removed to allow the stream access to the old channel. It would have been better to remove the old debris dam rather than the stumps. Reduced slumping of the road resulted; however,after watching the area over several years it appears that the road slumping was due to the movement of the road fill which was placed placed in the drainage, rather than undercutting of the streambank. The fill was saturated during the storm season and the culvert installed to handle the drainage had an inadequate diameter. An important reason for the absence of road slumping in the last few years is the diversion of runoff across Lewis' driveway onto the Blue Slide– see Sediment Source Treatment Plan #21E.

Further removal of debris during the 1985 DFG project did allow the stream to flow back into the rock armored natural channel.

DFG - 1985

The objectives of this project were to allow access to spawning habitat and to improve rearing habitat for steelhead trout and coho salmon. Work consisted of removal of a road crossing, modification of an alder root channel obstruction on Cascade Creek, construction of a jump pool, and placement of 5 rootwads and 16 cover logs in Jacoby Creek. The road crossing removal site and selected log and rootwad placement sites were mapped to document the changes in the stream bottom shape and substrate composition A detailed final report of the project is available at the Natural Resources Division office of RCAA.

Road Crossing Removal

A dirt and log-filled road crossing, 30' long x 60' wide x 12' high, had been constructed over Cascade Creek in the 1950's. The site is located about 0.6 mile from South Quarry Rd.on the G-100 Simpson Rd. When first viewed in 1984, debris had collected upstream of the crossing, and a channel had eroded around the crossing on the left bank.

After the site was cleared of vegetation, a D-7 Cat moved about 100 cubic yds. of earth fill from the crossing area and all of the imbedded logs except those which stabilized the right bank. The site was then straw mulched. Several 6" steelhead were observed in the stream during the work.

An evaluation during the spring of 1987 showed that no erosion of the streambank had occurred.

Alder Root Channel Constriction

On Cascade Creek 40 yds. downstream from South Quarry Rd., an alder with six 80' tall trunks was established behind a sediment debris jam blocking fish passage and forcing high flows to erode the right bank.

PG&E employees felled the alder trunks which were in danger of falling onto power lines, and debris behind the root system was removed so that roots blocking the channel could be cut away. In 1988 an evaluation showed that debris again was trapped in the alder roots, and fish passage was blocked. It is recommended that an excavator remove the alder root mass from the channel of Cascade Creek

Blue Slide Jump Pool

Treatment to create a jump pool by moving rocks at the base of the Blue Slide falls was not effective. In December 1987 flood flows created a new channel bypassing the falls and creating a cataract which appeared impassable to fish. An HSU fisheries survey crew headed by Dr. Terry Roelofs did not see indications of spawning fish above the falls. During both the 1986-87 and the 1987-88 seasons steelhead spawners were seen only below the falls area on Schimps' property. However, electroshocking above the falls found young of the year in the fall of 1987 (Keith Barnard, pers. comm.). This does not testify to the effectiveness of the jump pool work as the rocks in the jump pool were too small to make a significant change in the barrier. It appeared that fish might pass the barrier by following the left bank during high streamflows, rather than up through the falls.

Root Wad and Log Cover Improvements

Redwood root wads were placed using heavy equipment at five sites: two at the end of South Quarry Rd. and three below the South Quarry Rd. bridge. The root wads were placed against the streambank with stem ends pointing downstream at an angle of 30 degrees. The purpose of the root wad placement was to create pool and fish cover by causing stream scour.

Sixteen logs were placed in pools devoid of cover and were cabled to trees growing on the streambank between South Quarry Rd. and the Brookwood Dr. covered bridge.

Fish habitat maps were made of the reaches in which the stumps and most of the logs were placed. The reaches were mapped on graph paper by the following method:

1) A tape was suspended down the center of the stream channel. Measurements were recorded from the tape perpendicularly to the wetted edge of the stream at the appropriate scale reduction.
2) Debris, bedrock, pool depth, and substrate were located on the resultant maps.
3) Reference stakes were installed on the streambank so that the maps could be replicated.

See the WCB 1988 section for the results.

SCC - 1984-85

The objectives of this project were to modify several long-standing debris dams which had blocked fish passage and caused streambank erosion; to clear sections of two tributary streams of logging debris, and to remove two large roadfill tributary crossings using hand tools. Future worksites were identified, and the Blue Slide was given a high priority for treatment.

Debris Jam 10 yds. above Rebel Creek Confluence

A large redwood cutlog 7' in diameter x 20' long formed a debris jam in Jacoby Creek resulting in erosion of the left bank, the toe of an earthflow. Debris was removed from the jam and the log was reduced in size; however, CCC crew time ran out before the log was removed–see Site 31 in the Treatment Plan.

Stump Jam

A 20' high boulder, located about 50 yds. upstream from the Rebel Creek confluence, buttressed a log jam which was causing flood flows to be diverted into a new channel on the right bank. The jam was 50' across x 35' wide x 20' high.

Two stumps were prominent features of the jam. One, located upstream of the boulder and measuring 18' high x 15' in diameter (DBH), was left in place. The other, jammed between the left bedrock bank and the boulder and measuring 6' in diameter x 6' long, was removed leaving an open channel 8' deep x 4' wide along the left bank. Debris was removed in 1984 and stored high on the left bank. This channel again plugged with debris in December 1987–see Site 23 in the Sediment Source Treatment Plan for further recommendations.

Rail Jam

About 1/4 mile downstream from the rock falls barrier to migration, a debris dam measuring 14' high x 30' long x 28' wide created a 16' falls by diverting Jacoby Creek over a flat sandstone outcrop on the left bank. Woody debris was being trapped behind large hewn logs and a bowed railroad rail.

Debris was removed so that the left bank falls was eliminated, leaving a 3' falls passable to salmonids. A pool has since developed at the base of these falls, and a series of pools is present upstream where a riffle formerly existed. The debris which was removed from the jam is still high up on the right bank.

Removal of Arcata Forest Road Crossings

Two large failing road crossings which were inaccessible to heavy equipment because of road washouts were removed by hand by RCAA, Work Fare (a Humboldt County Welfare Department work program) and California Conservation Corps (CCC) crews. Crossing "A" was located 50 yds. up the tributary which flows into Jacoby

Creek just above the former U.S.G.S. weir; Crossing "B" was located 1/3 mile further up the road from "A" on a tributary 15 yds. from Jacoby Creek.

Crossing A Approximately 70 cubic yds of material was removed. Two large quarry rocks beyond our capacity to move were left in the tributary channel.

An inspection of the site in March , 1988, found that the rocks in the channel have caused some bank sloughing; streamflow goes under and around them. These rocks could be removed by blasting to reduce the sediment contribution of the site, however,this site is no longer a major sediment source. The dark, cool conditions of a dense coniferous canopy have limited natural reproduction to a sparse growth of forbs: Galium sp., Equisetum telamentia, Oxalis oregona and Claytonia sibirica.

Crossing B Approximately 35 cubic yds. of earth was excavated by hand. Split planks resting perpendicularly on sill logs 5' apart were unearthed 3' above the streambed. The sill logs were left in place to stabilize the channel banks.

The site is no longer a sediment source. The slopes are stable, and the channel provided has been adequate to date (March 1988). The sill logs in the stream channel provide bank stability. The deciduous alder canopy affords increased light through the winter. A vigorous growth of the following species was observed: Epilobium angustifolium, Dentaria californica, Urtica urens, Sambucus callicarpa, Rubus spectabilis, Scropularia californica, Rumex spp., Oxalis oregona, Dicentra formosa, Stachys arvensis, Galium spp. Oeananthe sarmentosa, Carex spp., and Petasites palmatus. A duff layer, mostly alder detritus, is building up on the former bare soil area.

Logs which had been placed against the right streambank in an attempt to stabilize it in 1974 had washed into Jacoby Creek, resulting in lateral scour of the left bank and the formation of a pool, were removed. A straight run in the stream has resulted. Bank cutting no longer occurs, but the pool is now filled with sand and gravel.

Rebel Creek Tributary Clearance

Rebel Creek is a steep gradient, second order, non-anadromous tributary. Ten cutlog debris dams, composed largely of logging slash , which were causing bank erosion were removed from the stream between Jacoby Creek Rd. and the upper road above the quarry in Section 24. The debris removal allowed the stream to downcut to its rock-armored channel in the reaches treated, often eliminating newly cut channels and/or streambank erosion.

Cascade Creek Stream Clearance

The lower reach of this stream provides spawning habitat for coho salmon and steelhead is highly aggraded. Work consisted of removing cut logs and organic debris. Work occurred between the Jacoby Creek confluence and 1/2 mile above South Quarry

Rd. Six cutlog accumulations were blocking fish migration. In two areas, the stream flowed subsurface through accumulated soil, debris, and encroaching vegetation.

More work is needed in this area to remove sediment aggradation and to improve fish habitat. An excavator would be helpful in some places to remove accumulated sediments and obstructions.

Gauging Station Culvert Removal

In 1974 a culvert, 15' long x 3' in diameter, which formerly housed the U.S.G.S. gauging station, was washed 30 yds. downstream from its foundation adjacent to a concrete weir. In subsequent years the culvert became jammed in the stream channel and debris and sediments built up behind it, resulting in the formation of a riffle. Aggradation covered the weir, and the elevation of the stream channel was causing bank cutting. The culvert and log debris behind it was removed from the channel with a Griphoist.

In 1988 the concrete weir was completely exposed for the first time since 1974. The stream channel has downcut 3' to 6' from the weir to the falls and is contained in a bedrock-armored channel.

Logjams Above The Second Bridge

Two logjams about 30 yds. apart between the second bridge and the Arcata Forest boundary were causing streambank erosion in two different areas. Streamside landslides resulted, and the road washed out. Old hewn logs were found in the lower jam. Both landslides were also associated with drainage from a 1983 timber harvest. Removal of the stream debris and the construction of waterbars on the road reduced erosion of the sites.

The upstream site is located 100 yds. above the second bridge where the trail goes up and over a landslide–a failed roadcut. The slide is revegetating with alder, coltsfoot, horsetail, and beeplant. A logjam was removed from the stream channel at the base of the slide in 1985. The slope has been stable since that time.

The second landslide is located 30 yds. downstream. Significant blowdown of the riparian canopy left by the 1983 timber harvest occurred in the spring of 1986. The growth of vegetation: coltsfoot, red-flowering currant, and alder, has been much slower than on the upstream landslide, probably because of the site's more northern exposure and its greater angle of repose.

1986-88 WCB WORK

The work previous to this project was important in testing the applicability of a variety of restoration and monitoring techniques in the Jacoby Creek system. These projects allowed us to watch the results of 'improvements' over several years and set the stage for full scale restoration proscriptions.

The objective of the WCB project's erosion control work was to reduce soil erosion in the Blue Slide area and at two failing road crossings; and to remove a rock falls barrier to fish migration (not done, see text below).

The Blue Slide

In December, 1986, work first began on the Blue Slide, a Franciscan melange earthflow which was being eroded by Jacoby Creek and aggravated by road runoff. The culvert under Jacoby Creek Rd. at Rebel Creek had separated and it appeared that drainage escaping through the separation could mobilize the slide. Using a excavator, the culvert was exposed and the two sections were joined with a corrugated coupler to replace the failed, smooth one.

Three other areas affecting drainage to the slide were treated at this time. A new 60' long x 2' diameter culvert was installed to drain flow across the road from the edge of the Lewis' driveway. The pipe was placed in a natural draw so that discharge was directed away from the unstable slope of the Blue Slide; formerly it had discharged directly onto the slide.

A drainage swale 15 yds. long x 3' wide x 2' deep was excavated above Jacoby Creek Rd. to channel additional upslope drainage runoff into Rebel Creek.

Another culvert 50' long x 2' in diameter was installed 25 yds. down from the short cut road junction in the big quarry. This culvert directs most of the quarry runoff from flowing onto the Blue Slide and discharges into an existing sediment pond. The pond was observed during the storm season for any instability, but no problems were seen. Periodic observation of this pond is important and construction of a rock armored spillway would be a good precautionary measure.

In August 1987 the main work on the slide was accomplished. The right banks of both Rebel and Jacoby Creeks were riprapped with rock, 3' to 4' in diameter, approximately 10' up the bank. Several areas were not treated because they were out of reach of the excavator.

The 40' long x 4' diameter Rebel Creek culvert was replaced with one 50' long x 6' in diameter. The new culvert was aligned so that it discharged at ground level into the rock-armored channel. The culvert was then lined with reinforcing wire and rebar and covered with 6" of concrete to protect the galvanized coating from being worn away by the passage of rocks through it.

In September residents of the area and Bayside Grange members helped to spread straw mulch on the slide (at a rate of 2 tons per acre) after low rock terraces had been arranged along the slope contours to hold the soil and mulch in place. Chicken manure fertilizer was also spread over the slide.

In October, McKinleyville High School geology students cut and planted willow, salmonberry, and red-flowering currant sprigs on the slide. They also dug up all pampas grass plants in the immediate area.

An RCAA crew transplanted coyote brush, salal, alder, sedge, and iris plants to the slide from nearby locations. Plantings were made between rocks in the riprap areas to promote a streamside vegetative cover. Sweet clover and Lotus corniculatus seeds which had been collected on the slide were scattered over the slide area. Jute netting was placed over parts of the slide. (The jute netting was surprisingly effective in catching mudflows on the slide and giving some stability where no other treatment was possible).

In December 1987, serious erosion was occurring at the upper end of the riprap area near the rock falls. Gabions, wire baskets filled with rock, were recommended by the DFG advisor, Carl Harral. As this task was not included in the budget, CCC crews from the Del Norte Center and Eureka were assigned to the project. These crews, with RCAA assistance, drilled holes, anchored wire rope with Hilti adhesive, moved rock to the site and helped to fill the gabions.

In January 1988 the CCC crews could no longer assist, and 3 RCAA workers built a pipeline to convey the rock to the gabions. Four 20' sections of 1' diameter pulp loading pipe were used. When the initial row of gabions was completed, Carl Harral recommended putting in a second row to better protect the streambank from high flows. The Eureka CCC crew collected and delivered more rock to the site. The owner of the company which made the gabion baskets, Billy Hilfiker, demonstrated proper installation. RCAA personnel completed filling and wiring the second row of gabions.

In mid-March a 6th grade class from Jacoby Creek Elementary School planted 300 redwood seedlings on the slide. Students were encouraged to plant in among the riprap and in areas protected from direct sunlight. The trees were donated by the City of Arcata. By July a vegetative covering of the transplanted species, vetch, and barley covered the area. In August, coltsfoot, willow, conifer and alder seedlings still thrived.

Blue Slide Monitoring

A series of transects was established over the portion of the Blue Slide where improvement work has taken place, so that the long-term effectiveness of the project can be assessed. Transects which were placed 16.5' (5 m) apart were established. The first started near the newly installed culvert over Rebel Creek (Line 1-A). Along the transects wooden stakes, rebar or green paint spots on rocks were placed about 3.3' (1 m) apart. The actual distance between points was then measured. Stakes are marked with the transect line number and letter of the alphabet, each letter representing 1 m. When the length of the transect exceeded the letters of the alphabet, the alphabet was repeated and indicated as A-2, B-2, etc.

Four cross sections were established. The method was the same one used for the stream cross sections. The alphabetical points on the transect lines were used as data points until reaching the stream gorge, then elevations were recorded every 2'.

A stream channel longitudinal profile was made along the stream which included the slide area and a reach above and below it. A surveyor's level and stadia rod were used. Readings were taken every 25', unless an important feature occurred. The data from the cross-sections, transects, and longitudinal profile are on file at the

Natural Resources Office at RCAA.

Streambank Stabilization

Ball Site

This site is located on the left bank of Jacoby Creek about 1 mile upstream from the Old Arcata Rd. bridge, near the end of Graham Rd. The property owner had experienced a loss of land over the previous 10 years of about 5 linear feet as the stream eroded the left bank , located on the outside of a meander. Willows and alders, which occurred both up and downstream of the site, were absent. Cattle, sheep and horse grazing occurred on the site.

Work consisted of riprapping, fencing and planting alder. An excavator dug a trench 3' deep x 150' long at the base of the streambank in the stream channel. Large rock, 1--3' in diameter, was placed in the trench and layered up the bank to within 2' of the upper channel bank, 8' to 10' above the low water channel.

After this work was completed the landowner had a high tensile wire fence constructed to exclude grazing animals. An RCAA crew then planted 200 alder seedlings between the fence and the riprap. This work was accomplished during the winter of 1986-87.

Van Speybroeck Site

About 1/2 mile upstream from the South Quarry Rd. bridge on the Van Speybroeck property 60' of the left bank was eroding, and several large trees were in danger of falling into the stream. Redwoods on the left bank had been logged in 1978. A large stump was in the middle of the stream channel and formed the nucleus of a debris dam.

Work consisted of removing some of the debris. The large stump was left in place for juvenile salmonid cover. The bank was riprapped in a manner similar to the Ball site. Work was completed in the winter of 1986-87.

Road Crossing Removal

Two failing road crossings were removed using hand labor on a road on the Kneeland ridge slope located 1,000 yds. upslope from the second bridge. This site is on Arcata Redwood Co. property. Approximately 20 cubic yds. of material was removed, including 40' of corrugated metal pipe.

About 10 cubic yds.of material was removed from another small failing road crossing located in the Arcata Forest ± 200 yds. from the northwest forest boundary.

Rock Falls Migration Barrier Modification

The rock falls barrier to migration, which because of the land movement in the Blue Slide area one mile downstream is not the first migration barrier at this time, was surveyed by DFG personnel. DFG decided to use explosives on a rock ledge at the barrier to lessen the height of the jump. Some rock was blown off; however, the height of the jump was not lessened. After this effort it was decided that more should be known about the upper watershed fisheries before the barrier was eliminated.

Stream Reach Maps

These maps were first made during the 1985 DFG contract so that the effectiveness of habitat improvement structures, root wads and cover logs, could be assessed. Certain areas were remapped in 1986-87 during the WCB-funded project.

All structures were found to have moved downstream and were realigned parallel to flood flows. The larger root wads caused scour of the stream bottom in their immediate vicinity. However, the scale of the maps did not portray the scour depth changes in enough detail to distinguish between changes in the streambed resulting from larger stream dynamics or the effects of a particular structure. The placement of some cover logs in pools appeared to result in the sedimentation of the pools, probably as a result of reduced flow velocity. (see stream hydraulics and the Salmonid Habitat Improvement section of the Recommendations Chapter).

The stream reach maps are on file at RCAA Natural Resources Division Office. A detailed version of one of the maps (see Fig. 4) prepared as a student project, gives an example of the information contained on the maps.

Channel Cross Sections

Channel cross sections measurements were made so that the affect of riprap in the stream channel and streambank could be documented. The cross sections were made by establishing relocatable reference stakes above high water perpendicular to the stream and stringing a tape between the stakes. A stadia rod was placed perpendicular to each foot marker on the tape along the transect and the elevation was measured with an abney level. The data is at the Natural Resources Office at RCAA.

Ball Site

Comparison of the 1986 and 1988 transects showed that the riprap. The deepest part of the channel, the thalweg, had aggraded by about 0.5'. Approximately 1' of aggradation occurred along 6' of the right side of the channel cross-section.

Van Speybroeck Site

When the two cross-sections made in February, 1988, are compared to those made in October, 1986, it can be seen that the thalweg along the riprapped bank has deepened by about 1' while the right side of the channel has aggraded.

Slide Show

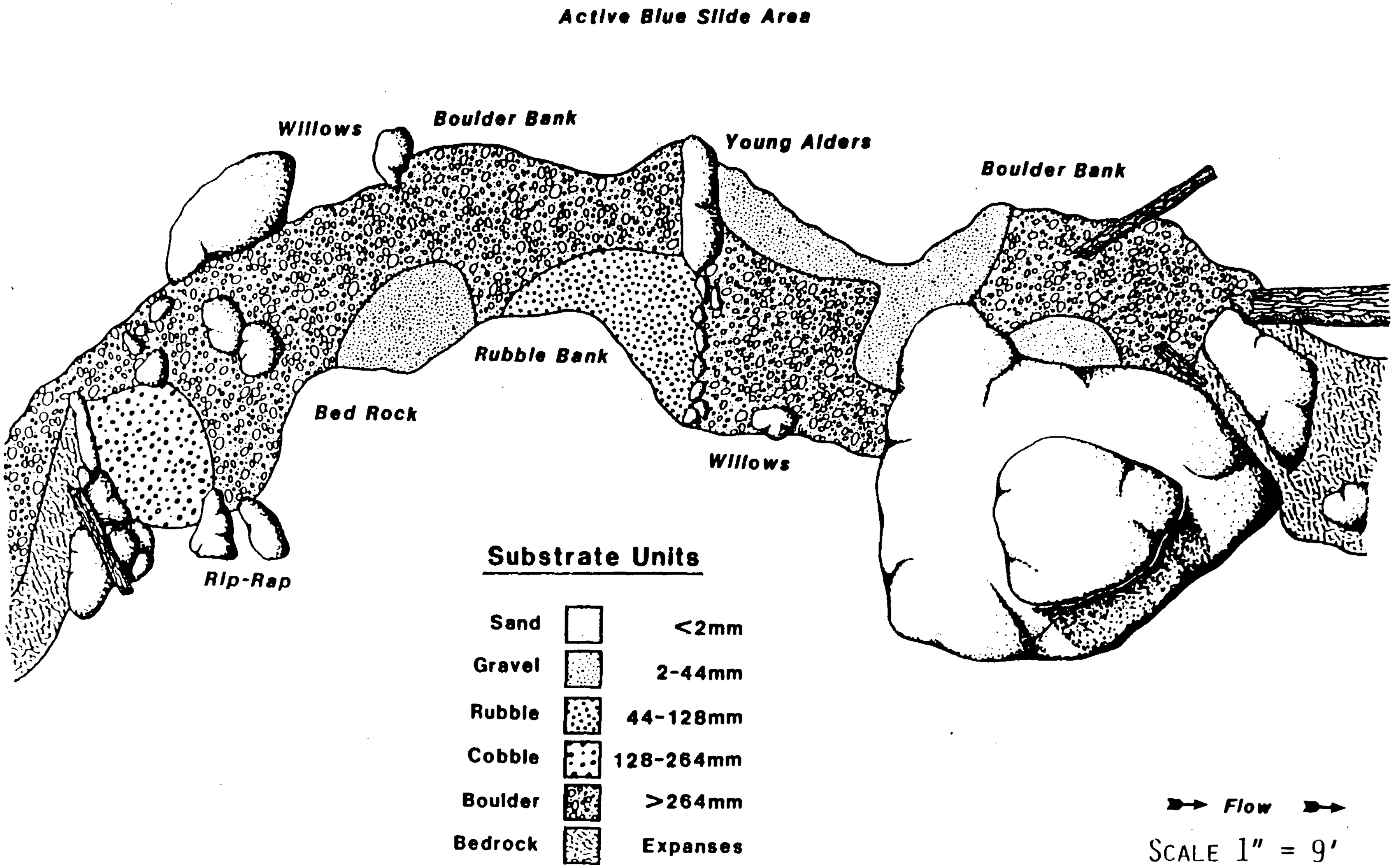
A copy of a slide show with a written narrative telling about the watershed and its salmonid fisheries was given to the Jacoby Creek School Library to spark further interests in study of the watershed.

Figure 4

JACOBY CREEK: Stream Reach Map

Blue Slide #1

Nov. 19, 1987



SALMONID HABITAT IMPROVEMENT PLAN

The salmonid habitat improvement plan has two parts: fish habitat analysis and identification of sediment sources. The objective of the fish habitat analysis is to determine factors limiting salmonid populations on Jacoby Creek. The second part of the plan identifies sediment sources impacting salmonid habitat and locates them on a map of the watershed. The objective of the Sediment Source Treatment Plan is to provide prescriptions to minimize sediment delivery to the stream system from watershed roads.

FISH HABITAT ANALYSIS

The stream was classified into its component habitat types. The types are based upon the location and the pattern of water flow through the habitat feature, and the nature of the flow-controlling structures (Decker, 1987). The following habitat types were recognized:

HABITAT TYPE

- RIFFLES
  - Low Gradient Riffle
  - High Gradient Riffle
  - Cascade
- RUNS
  - Glide
  - Run
  - Step Run
  - Edgewater
- POOLS
  - Secondary Channel Pool
  - Backwater Pool Associated with Boulder
  - Backwater Pool Associated with Rootwad
  - Backwater Pool Associated with Large Debris
  - Trench Pool
  - Plunge Pool
  - Lateral Scour Pool Associated with Large Debris
  - Lateral Scour Pool Associated with Rootwad
  - Lateral Scour Pool Associated with Bedrock
  - Lateral Scour Pool Associated with Boulder
  - Dammed Pool
  - Channel Confluence Pool
  - Corner Pool
  - Main Channel Pool Associated with Bedrock
  - Pocket Water

Methods

The habitat types occurring on Jacoby Creek in June and July, 1987, were assigned from the Highway 101 Bridge to nine miles (14,400 m) upstream (see Fig. 5) For each type the average length and width was measured using an optical rangefinder. The average and maximum depth was measured using a stadia rod. The data, separated into stream reaches roughly corresponding to stream gradient, are summarized for each study reach. The first three reaches are in habitat considered as available to anadromous fish at least occasionally, while the Headwaters Reach is thought to be limited to resident salmonids. The reaches are:

Lower, from Highway 101 to Lester's Ranch: 0 to 4.8 miles (7600 m)

Middle, from Lester's to the lower end of the Blue Slide: 4.8 to 6.3 miles (10,061 m)

Upper, from the lower end of the Blue Slide to the rock falls barrier: 6.3 to 7.1 miles (11,390 m)

Headwaters, from the rock falls barrier to the first fork in the headwaters area: 7.1 to 9 miles (14,400 m).

Results

The predominant general habitat types (see Fig. 6) in the anadromous section are the runs. Most of the spawning areas fall into this general category, and specifically, glides. Shelter was not rated in this procedure, however general observations and our previous study (Murray and Wunner,1980) indicate a lack of instream cover for all habitat types .

Lower Reach

This section includes the major coho habitat. Glides, averaging less than 0.2 m deep, are the most common type, comprising over 40% of the wetted surface area. (As the habitat typing crew gained more experience they believed the glides in the lower section would now be classified as runs). Glides in this low gradient section appeared to have more fine sediments than those in the upper reaches. All the riffles in this reach are low gradient (<3%), relatively wide, and some provide suitable spawning areas.

The predominant pool types are lateral scour pools associated with large debris and with rootwads. Average depths range from 0.2 m to 0.7 m, and the deepest are main channel pools associated with bedrock. The maximum depth was 2 m.

Figure 5
Jacoby Creek Fish Habitat

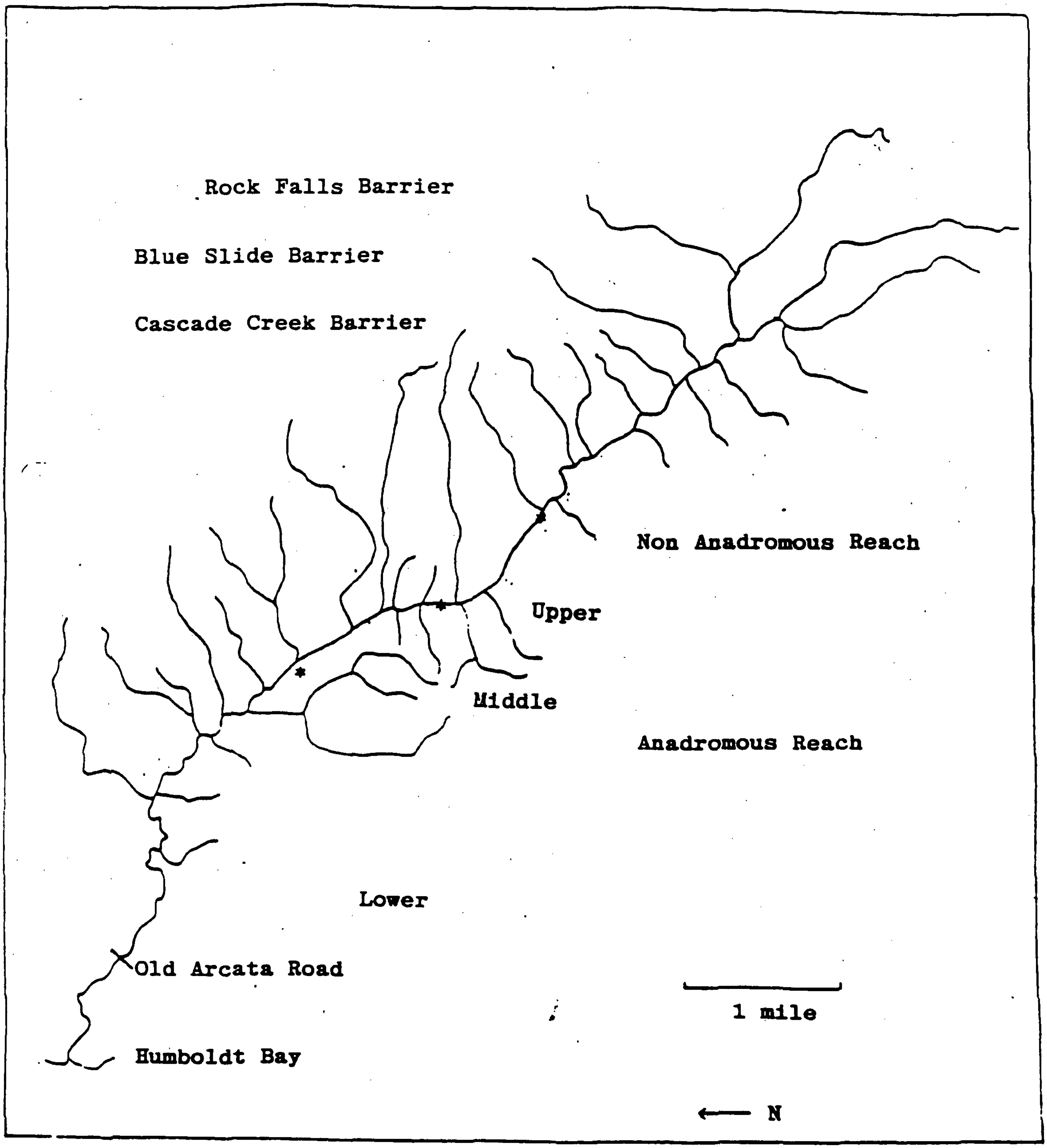
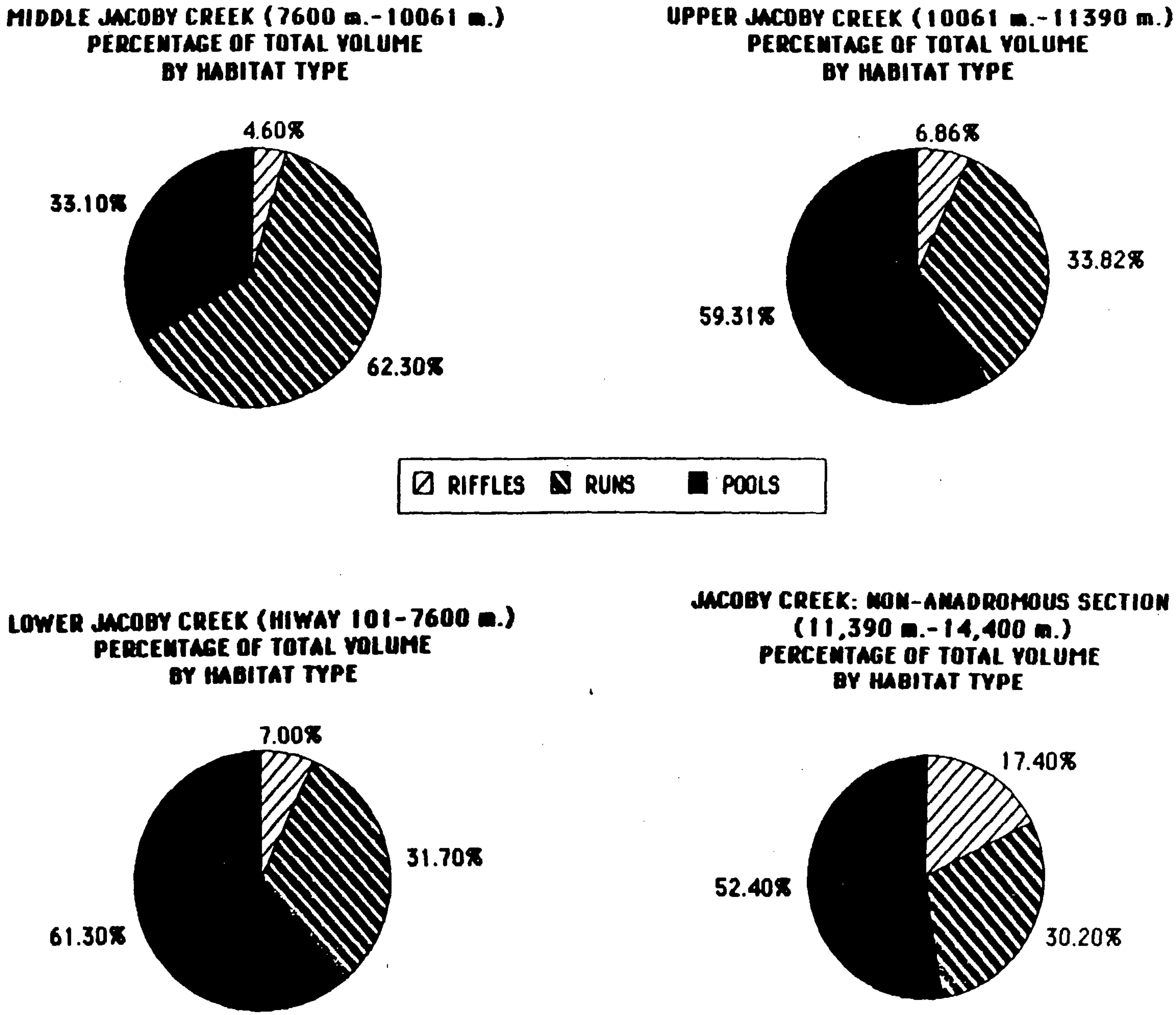


Figure 6

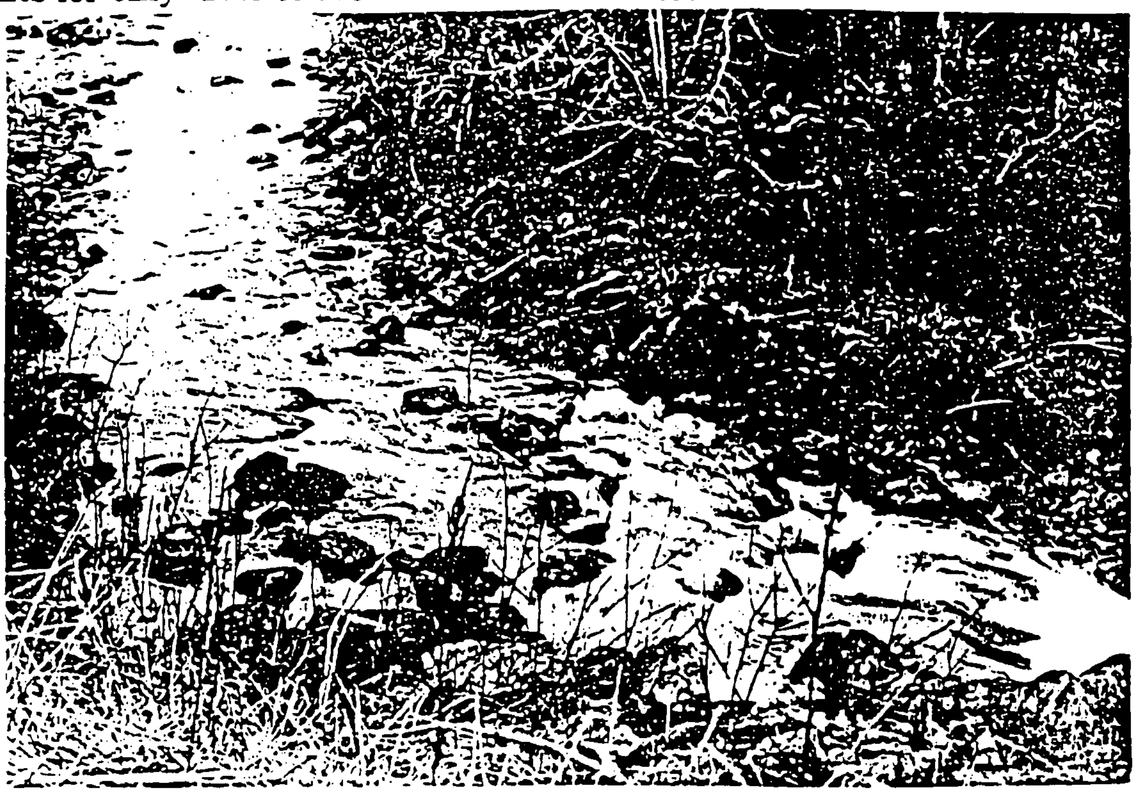
Fish Habitat Types



Middle Reach

This reach has a steeper gradient than the previous one with run types predominating 70% of the wetted surface area. Step Runs, long runs separated by short riffle sections, make up almost 75% of the run types in terms of area. The average run length was 37.6 m.

The predominant pool type here is the Lateral Scour Pool Associated with Boulder. These tend to be short (average length = 8 m) and shallow, with boulders providing instream shelter. Lateral Scour Pool Associated with Large Debris is the next most prevalent pool type here. Combined surface area of all pools in this reach accounts for only 17% of the wetted surface area.



Upper Reach

The beginning of the upper reach is at a steep, boulder-filled cascade below the Blue Slide which appears to be a migration barrier for coho salmon. Some steelhead managed to negotiate the cascade in the 1986-87 winter, as young- of-the- year steelhead were found during electrofishing upstream of the cascade. Runs make up over 40% of the surface area. Step Runs are the predominant type. Plunge Pools and Lateral Scour Pools with Boulders each comprise about 11 % of the area, despite the fact that the latter occurs twice as often.

Headwaters Reach

Upstream of the rock waterfall the stream gradient is less steep than the Upper Reach. Low gradient riffles predominate, accounting for 33.5% of the surface area.

Pools are uncommon and shallow. The average depth for the entire 3 km. of the reach was less than 1'.

IDENTIFICATION OF SEDIMENT SOURCES

From our experience of viewing the watershed erosion problems over the past 10 years the headwaters area was targeted for intensive investigation. Recent aerial photos were inspected and features which appeared to be sediment sources were noted. The major haul roads were then walked and erosion features identified (all of the erosion problems were associated with roads). Many features located during the ground check were obscured by vegetation on the aerial photos. Seeing the evidence of past and present sources of large sediment yield was very helpful in understanding the aggraded condition of Jacoby Creek and the downstream effects on anadromous fish habitat. Suggestions for the prevention of future problems are given in the following chapter.

Sediment sources were observed in March, 1988. The location of each site (see Fig. 7 & 8), a brief description of the problem, and recommended treatments are given in Appendix A. The sites are separated into two treatment categories: heavy equipment and hand labor.

The sites listed in the plan are places where erosion control is recommended as soon as possible to prevent further erosion. The priorities are those sites which are expected to yield the largest volume of sediment if not treated. The time needed to complete the work outlined is estimated as follows: An excavator and a D-8 tractor, 4 weeks; a 3 person crew, 12 weeks to set up projects, be on hand during heavy equipment work, and to monitor sites during the storm season.

Figure 7
Worksites on Upper Jacoby Creek

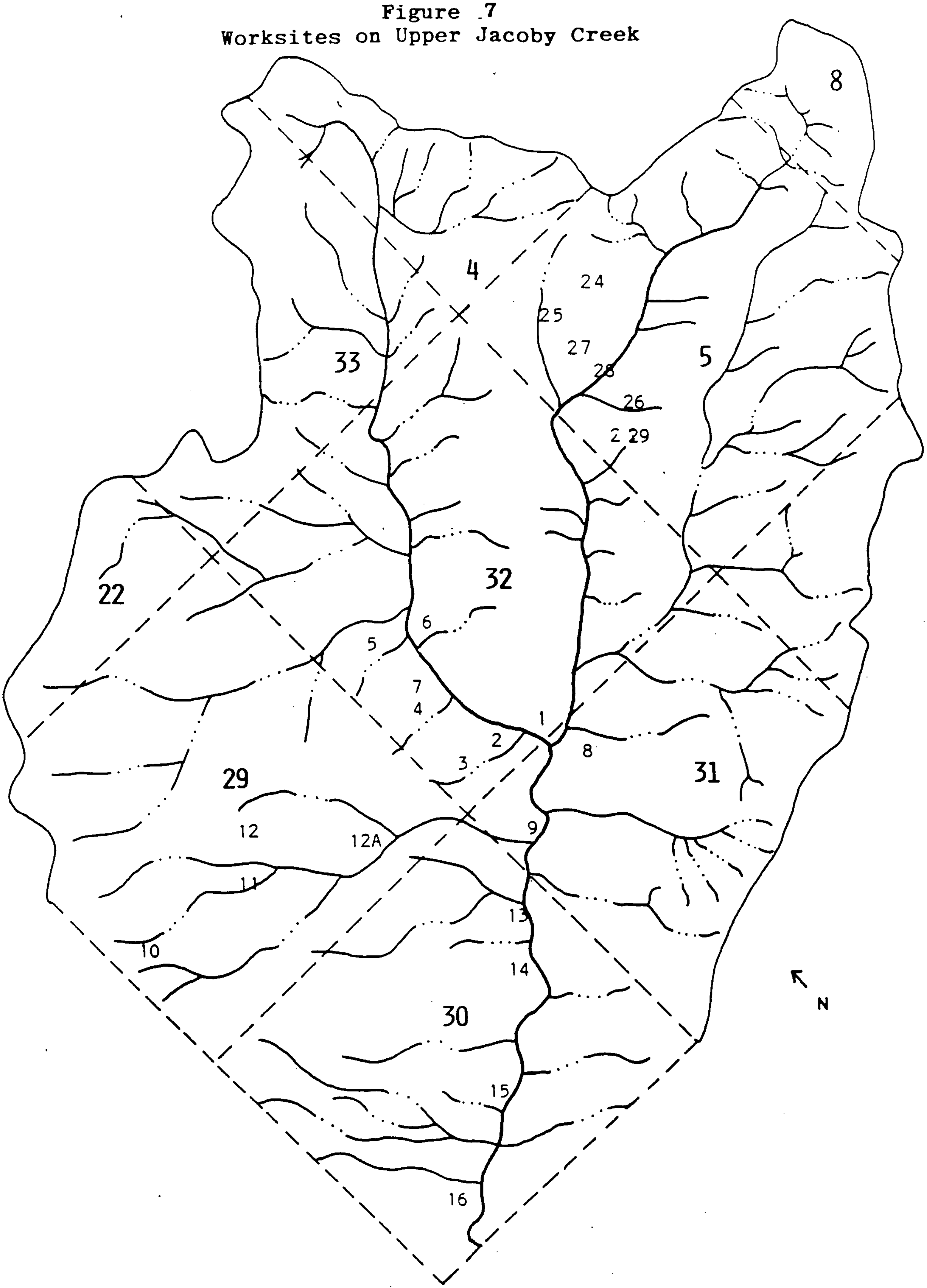
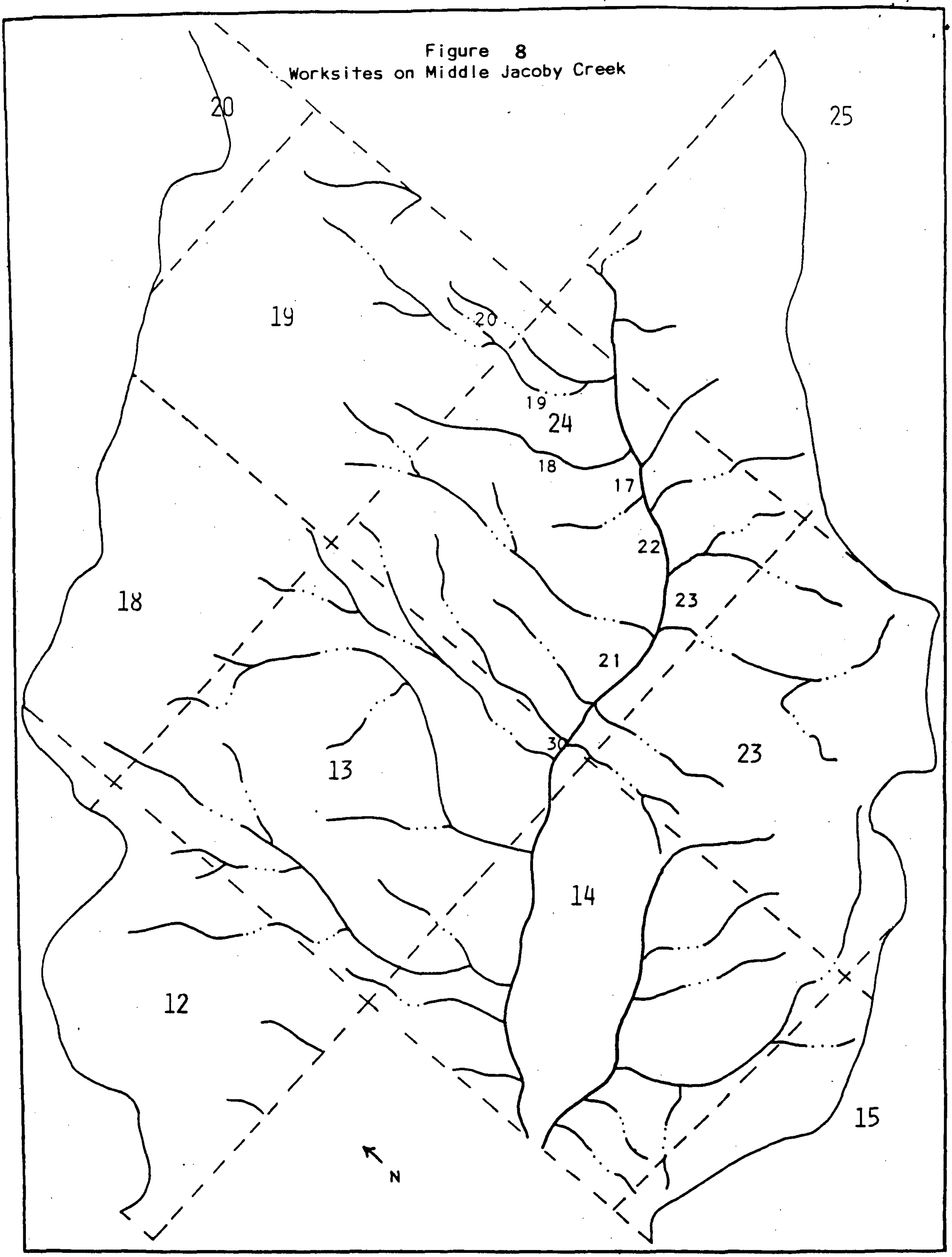


Figure 8
Worksites on Middle Jacoby Creek



RECOMMENDATIONS

This chapter gives recommendations and suggestions for fish and wildlife habitat improvement. The first recommendation is to carry out the erosion control measures outlined in the Sediment Source Treatment Plan (see Appendix A. Ideas for improvement presented in this section relate to the following topics: Salmonid Rearing Habitat, Stocking with Salmon, Estuary, Eelgrass and Oyster Beds, Road Erosion, the Recovery of Native Vegetation and Land Use Planning.

Salmonid Habitat Improvement

From the habitat typing data and observations on this and other northcoast watersheds we believe that the major factors limiting salmonid populations on Jacoby Creek are the scarcity of pools and cover and the reduction of the estuary area. The rarity and shallow nature of present day pools results in greater predation exposure and much lower fish numbers. Old timer accounts report greater pool depth and greater numbers of fish. A "no entry" natural streamside zone along Jacoby Creek which is wide enough so that trees upon falling, could contribute woody debris to the stream would greatly benefit salmonids..

In the short term nursery habitat might be improved by placing large woody debris or rootwads in some of the riffles, glides, or long step runs to convert them to Lateral Scour Pools and/or Backwater Pools. Most existing pools can be enhanced by adding woody debris in a manner which increases pool depth and provides shelter.

Comparing the data from the reaches upstream and downstream of the Old Arcata Rd., the latter reach shows more habitat in runs. Considering the lower gradient of this reach, its heavy sediment load, the levees confining the stream along most of its length, and livestock use, it seems that instream improvement efforts would be more effective if concentrated for the time being above the Old Arcata Rd.

The Stream Reach Maps document that the streambed is a dynamic system and that habitat improvement structures as well as sand and gravel have been moved, in a few cases out of the stream completely. To be successful in creating fish habitat with instream stuctures it is important to understand channel dynamics and to remember that the first function of the stream is to convey water and sediments. Even with the advice of a hydrologist who had intensively studied the reach, the effects on the stream bottom were not always possible to predict. The account of the removal of logs and the disappearance of a lateral scour pool (see Crossing B in the Arcata Forest -SCC Project) gives an example of the need to make conscious choices between bank stabilization and fish habitat improvement. When cover logs are installed it would be advantageous to be able to move around them depending on seasonal flow conditions and channel sediment changes.

Stocking with Salmon

Since both coho and steelhead require only 2.5 sq. m. of gravel per redd, spawning area is rarely a limiting factor on most streams. We believe Jacoby Creek is not spawner limited. Perhaps contrary to this point of view is the paucity of spawners, compared to other local streams, found by Terry Roeloffs and HSU fisheries students in a 2 day survey in early 1988. In spite of the low numbers found in the survey, we believe that, until conclusive evidence is presented otherwise, it must be assumed that salmonid populations are at carrying capacity for the present rearing habitat. Given the reproductive potential of salmonids, sufficient stock stray into Jacoby Creek from the Arcata Aquaculture project, (18 % was reported in Harper, 1980). The stocking record shows salmon have not been planted in Jacoby Creek. It is important to have one stream in Humboldt Bay not be stocked as a control for studies.

Estuary

It may be that the limited estuary of Jacoby Creek is an important reason for the rarity of Chinook salmon and for the lowered populations of other salmonids. The critical importance of the estuary in providing habitat for optimal growth and marine acclimation is being demonstrated on Redwood Creek (Anon. NPS, 1987). Juvenile chinooks usually migrate to the estuary when they are six months old. The present habitat allows only minimal transition between fresh and saline water with little cover from predators.

Restoring a portion of the Jacoby Creek bottomlands to brackish and freshwater marsh and allowing tidal action to influence an area upstream from Highway 101 would promote biological diversity and increase the estuary area renewing this important dimension to the stream's fish and wildlife habitat. Either the U.S. Fish and Wildlife Service or the DFG would be logical entities to carry out this plan. The Jacoby Creek wetlands are among those eligible for purchase from a willing seller under Proposition 70 passed in June, 1988.

Eelgrass and Oysters

The improvement of Jacoby Creek salmonid populations is linked to the biological productivity of Arcata Bay. Presently, large tracts of the bay's tidal lands are leased for oyster production. Much of this land is eelgrass habitat. Eelgrass is a key species in the dynamics of over 80 species of bay organisms (Roberts and Bott, 1986) to which it is important as a cover substrate or as a food. Eelgrass provides a habitat similar to a prairie on land.

Eelgrass is adapted to survive on a shallow layer of soil above anoxic sediments (Phillips, 1984). The common method of harvesting oysters in Arcata Bay involves a hydraulic dredge which disrupts sediments up to a depth of 2' and thus the conditions necessary for eelgrass survival. Eelgrass does not have time to reinvade the area before the reoccurrence of dredging 18 to 24 months later (Waddell, 1964). More research is needed to determine the importance of eelgrass to salmonids and the impacts of oyster culture on the bay's food chain.

Road Erosion

Implementation of the following measures would reduce road-related causes of erosion:

- The designation of earthflows (see Fig.2) as special use areas with specific standards for development.

- Annual inspections of road stream crossings, whether abandoned or not, and the removal of failing crossings. When culverts are installed a recorded responsibility is made part of the deed.

- The construction of road stream crossings so that the potential for diversion is eliminated. Wherever possible roads will be outsloped and the use of inboard ditches reserved for special, localized situations.

- Fines for motorcycles and all terrain vehicles users who damage drainage ditches on logging roads need to be sufficient so for road repairs and reestablishing waterbars.

Recovery of Native Vegetation

Implementation of these following measures will engender the recovery of native vegetation:

- Control of scotch and other broom species and english ivy.

- Removing vehicular access and revegetating abandoned areas in the two quarries (at the end of Eric Lane and along Jacoby Creek Road) in Section 24.

- Control of Andean pampas grass on recent timber harvest plans.

- Limiting the use of fire on timber harvests to only landing areas as large slash fires destroy soil humus and create habitat for exotic and native weed species.

Land Use Planning

General benefits to fish and wildlife would stem from a consideration of the following:

- An in-depth evaluation by the Humboldt County Planning Dept. of the cumulative effects of full build-out impacts across land uses and land use plans on Greenwood Heights, Kneeland, and Fickle Hill.

- A parcel-by-parcel assessment of buildable lot, lot split, and subdivision proposals on the effects of the proposed development on drainage, soil erosion, and use and disposal of ground and surface water (during both summer and winter) on the biology of the stream and the estuary.

- A pamphlet prepared by the JCWD and distributed to all watershed households listing chemical compounds and the names of products containing them which are toxic to aquatic organisms and which therefore should not be disposed of in septic systems.

- A study to determine the effects on stream and bay organisms of the use of water from Jacoby Creek for irrigation during low water periods . Also a determination of the minimum instream flow needed to protect fish and wildlife. We have seen Jacoby Creek stop flowing below irrigation diversions in the late summer and fall.

CONCLUSION

The major reason for decline of salmonid numbers appears to be the removal of the old growth forest. The canopy of this forest held millions of gallons of water over the ground layer creating local microclimates which buffered the forest floor from temperature extremes. In the stream zone where large tree trunks defended streambanks from erosion, defined stream channels, and created deep pools which gave protection from predators. In this sense today's numbers of salmonids are indicators of the quality of the vegetation which protects the soil.

More fish in Jacoby Creek depends on the recovery of their habitat. Habitat restoration occurs in most cases with the protection of the stream zone from disturbance. The treatment plan proposed here is to remedy locations greatly disturbed by removing earth from stream channels and stabilizing landscapes so that natural revegetation can occur.

Cause for hope is highlighted in the increasing awareness being fostered the Jacoby Creek Elementary School. The school participated in an aquarium-incubator project, raising steelhead funded by the Calif. Dept. of Education (Higgins, 1987). This led to the development of a watershed awareness curriculum unit in which students from kindergarten through 8th grade participated.

We encourage those who understand the concepts of the wise use of the Jacoby Creek watershed to bring these ideas to the attention of residents, landowners and the various political entities so that developments can take advantage of experience and knowledge.

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APPENDIX A

SEDIMENT SOURCE TREATMENT PLAN

Specific worksites are described on the following pages. Locations are illustrated in Fig. 7 & 8. Heavy equipment worksites are grouped, according to access, into three watershed areas. The areas are prioritized by estimated sediment yield if not treated. Within each group sites are listed in the suggested order of work. Treatment order is especially important for the lower North Fork area. The hand labor sites also are listed in order of priority.

Heavy Equipment Worksite Priorities

A. Lower North Fork (Sections 29 and 30)
B. Blue Slide - Quarry (Sections 24 , 19 and 14)
C. Headwaters (Section 5)

Lower North Fork Access is from Fickle Hill Rd. This road system was last used in the early 1970's, and, as some tributary crossings have washed out,they will have to be rebuilt and removed at the end of the work. The recommended order of site treatments is: 14, 13, 9, 8, 1, 2, 3, 4, 7, 5, 6, 9, 12, 11, 10.

Blue Slide Quarry This area is easily accessed from Jacoby Creek Rd. The suggested treatment order is: 20, 19, 18, 17, 22, 21, 30.

Headwaters This area is accessed by Fickle Hill Rd. and the Sierra Pacific road. Suggested treatment order is: 29, 26, 28, 27, 25.

Hand Labor Worksite Priorities

A. Arcata Forest: removal of two road crossings, 15(A) and 16(B).
B. Middle Fork Headwaters: repair of waterbars on steep slopes which have been breached by motorcycle traffic, 24(C).
C. Blue Slide Area: 31(D).

Site	Location	Description of Problem & Recommendation
1	Sec. 32 N. Fk. ± 50 yds. upstream from mainstem confluence.	An earth-covered log bridge not yet failed. 1/2 day excavator time to remove.
2	Sec. 32 N. Fk. main haul road crossing of 1st right bank tributary upstream from mainstem confluence.	Failed tributary crossing. 2 hrs. excavator time to remove logs and earth debris from stream channel.
3	Sec. 32 N. Fk., 25 yds. up 1st tributary.	The stream meanders through a landing constructed in the tributary channel. A 12' deep, 25 yds. long eroding gully with an actively eroding headwall. The area is a major sediment source. 3 days cat time to restore natural drainage through the area.
4	Sec. 32 N. Fk. main haul road crossing of 2nd tributary upstream from confluence.	A failing road crossing, 30' long x 20' wide x 15' deep; and 30' of failing landing on the right bank tributary's left bank. 1 day excavator time to remove.
5	Sec. 32 N. Fk. main haul road crossing of 3rd right bank tributary from confluence (wooden culverts).	An earth-log bridge has failed into the stream. 1 day cat time to remove debris and fill material.
6	Sec. 32 N. Fk. ± 500 yds. upstream from	The N. Fk. flows subsurface through a landing

	3rd right bank tributary.	125' long x 45' wide x 10' to 20' deep constructed in the stream channel. Active erosion of the fill material occurs at the upstream end. No holes are yet evident through the landing area. 4 days cat and 3 days excavator time to remove fill material. 20 bales of straw needed.
7	Sec. 32 N. Fk. between 2nd and 3rd right bank tributaries.	Raised roadbed prism dams upslope drainage, resulting in a swampy area and erosion of roadfill. 1/2 day cat time to remove roadfill.
8	Sec. 32 S. Fk. main haul road crossing 50 yds. upstream from mainstem confluence.	Active erosion is occurring. 1/2 day cat time to remove roadfill from tributary channel.
9	Sec. 31 Main haul road crossing of Bogs Creek, 1st right bank tributary upstream from Lucchesi cabin.	Culvert has insufficient capacity, drainage, escapes channel and runs down two long and deep gullies inthe road. 1/2 day cat time to remove stream crossing and obliterate gullies.
10	Sec. 29 Headwaters of Bogs Cr. First motorcycle plank bridge ± 1/4 mile down haul road from Fickle Hill.	Partially eroded Humboldt crossing. 1/2 day Cat time to remove 150 cu. yds.(mostly right bank).
10-A	Sec. 29 Headwaters of Bogs Cr. ± 1/8 miledown road from #10. Big blowout.	Failing tributary crossing which the stream has eaten away ±500-800 cu. yds. from crossing and 1000 cu. yds. in the ravine. 1/2 day excavator

		time to remove 150 cu. yds.
11	Sec. 29 100 yds. down haul road from #10A. Pink flagpost.	Two failing tributary crossings. 6 hrs. cat time to remove a total of 600 cu. yds.
12	Sec. 29 Down haul road from #11.	The road interrupts numerous waterbars and rechannels drainages. 2 days excavator time to repair waterbars and to remove fill.
12-A	Sec. 29. 40 yds. down road from landing.	Remove 2 road crossings.
13	Sec. 30 Main haul road crossing of 1st right bank tributary in the Arcata Forest downstream from the Lucchesi cabin.	Failing stream crossing. 2 days excavator time 1/2 day cat time to remove.
14	Sec. 30 Main haul road crossing of 2nd right bank tributary in the Arcata Forest downstream from the Lucchesi cabin 50 yds. down road from #13.	Failing stream crossing 2 days excavator time and 1/2 day cat time to remove.
15	Sec. 30 Right bank tributary in Arcata Forest 200 yds. up the main haul road from Crossing A.	Failing stream crossing: holes developing in road; culvert rusted out. The site is not equipment accessible so removal must be done by hand labor: 3 wks, 5 people.
16	Sec. 30 1st downstream-most right bank tributary in Arcata Forest.	Failing stream crossing: culvert rusted out. The site is not equipment accessible so removal must be done by hand labor: 3 wks, 5 people.
17	Sec. 24 Lower haul road along Jacoby Creek.	New watercourse flows 30 yds. down inboard ditch

	100 yds. downstream from rock waterfall barrier to migration and former locked gate.	and erodes streambank. 1 hr. cat time to construct waterbars along the road.
18	Sec. 24 An abandoned haul road crossing of Short Creek 300 yds. up the road which ascends from the upper quarry area.	Flow escapes the channel during storms and runs down the road because of an inadequate culvert capacity (18") with no trash rack. This has resulted in 600' of gullied road. 1/2 day cat time to remove fill and culvert, and to outslope the road.
19	Sec. 24 1/4 mile up haul road from #18.	Tributary impacted by roadfill, and waterbars along the road are dysfunctional. 1/2 day cat time to remove fill and to restore waterbars.
20	Sec. 19 Continuing up road from #19.	Waterbars have been breached by ORV's, and the road is markedly gullied. 1/2 day cat time; 10 waterbars.
21	Sec. 24 Jacoby Creek 4 miles from the Bayside Grange below the quarry: the Blue Slide.	A road-activated earthflow (see description of Blue Slide work). Treatment numbers are keyed to map of the slide area.
	Right Bank Treatments	
21-A	30 yds. downstream from Rebel Creek confluence.	Some riprap has fallen into the stream, leaving an area prone to erosion during storm flows. Griphoist crew needed (3 people, 3 days); or use crane in conjunction with left bank work. Use adhesive and cable to "tie" rock armor together.
21-B	Where "Rock Ridge" meets riparian	Slip out. Rock or gabion baskets needed to stabilize

	willows.	the slope toe. (5 people, 5 days).
21-C	Between middle and lower riprap areas jute netting location.	"Tie" rocks together as in 21A or install gabion baskets.
21-D	Immediately upstream from Rebel Creek	Riprap right bank of Jacoby Creek confluence.
21-E	Above Lewis' driveway.	Put runoff back into natural drainage toward Leiderman property and away from the Blue Slide. Runoff can be channeled with corrugated metal pipe if surface flow is inconvenient.
	<u>Left Bank Treatments</u>	
21-F	Opposite "Rock on Rock."	Create bank protection, using gabions, riprap, or logs.
21-G	The left bank of the Blue Slide area.	About 100 yards up left bank from Jacoby Creek, 20 Gallon Creek flows through a marsh. Down stream of the marsh several raw banks and deep cracks give evidence of recent erosion and slumping. Upslope of the marsh the remains of a road and washed out road crossing are apparent. It appears that 20 Gallon Creek upstream and downstream of the road has been channelized and that the stream's course has been changed so that

		the flow is away from a large (flat, graded) staging area. This explains why there is a discrepancy between the USGS map of 20 Gallon Creek which shows the stream to enter Jacoby Creek about 50 yds upstream of the present confluence. It also explains the apparent newness of the 20 Gallon Creek channel and the very active erosion and high soil moisture levels of the left bank of Jacoby Creek. Treatment to correct road -related problems and to drain the marsh is estimated at 3 days D-8 and 3 days excavator time.
	General Treatments	Resurvey established transects: longitudinal profile and cross sections. Continue revegetation and maintenance of slide and road to quarry. Straw mulch area after 1st winter storm. Have funds (± $1,500) available to address storm drainage problems.
22	Sec. 24 Jacoby Creek Rd. 100 yds. before the hairpin turn of the lower road in the quarry.±4.5 miles from the Bayside Grange	An earthflow, about 130 yds.long and 30 yds wide enters Jacoby Creek. Scarps 3' to 4' high have appeared below the road since 1985 when quarry overburden was put on the head of the slide. Toppled young alders, numerous cracks along the slide, bare soil, and observations of movement over the last 3 years testify to the instability of the area. Jacoby Creek is eroding the slope toe which is 30 yds. long. Quarry drainage is concentrated onto this slide. Heavy equipment work is needed upslope to divert flow

		from the slide and to armor the toe. This project has been submitted to DFG for funding.
23	Sec. 24 Stump Jam	Remove large logs from main channel. Crew of 5, 3 weeks.
24	Sec. 5 On ridge separating the N + S branches of the Middle Fork, 1/4 mile down the ridge top road which leaves Kneeland-Maple Creek Rd. at paddle marker #5J031-1°°	Waterbars along a extremely steep skid road have been breached by motorcycles, and gullies are forming. 10 person crew, 2 weeks hand labor to establish waterbars.
25	Sec. 5 Main haul road crossing of the N. branch of the Middle Fork.	A large log-earth bridge crossing, presently adequate. More investigation is needed.
26	Sec. 5 Main haul road crossing of the S. branch of the Middle Fork.	Culvert discharges onto roadfill, causing much sediment contribution to the stream. Excess roadfill needs to be excavated and a longer and larger diameter culvert is needed. 1/2 day excavator time.
27	Sec. 5 Main haul road from landing between the N. and S. branches the Middle Fork.	Waterbars are not functional; culvert receives too much flow and discharges on an unstable slope. 1/2 day cat time to remove the culvert and to outslope the road.
28	Sec. 5 Landing between the N. + S. branches.	Cracks in landing indicate fill along the edge of the Middle Fork Landing could fail into the

		stream. 1 day excavator time to pull back fill material.
29	Sec. 5 Middle Fork. landing 500 yds. down the road from the S. branch crossing.	Remove culvert marked "18-20", and pull back landing where cracks are apparent. 1 day excavator time.
30	Sec. 14 Jacoby Creek Road 3.3 miles from the Bayside Grange in the vicinity of the Eric Lane Junction.	Stabilize an earthflow being eroded by Jacoby Creek. The streambank needs to be protected with 3' to 5' diameter rock and a drainage plan for the area upslope needs to be developed in cooperation with landowners and users of Eric Lane. The culvert which conveys Eric Lane drainage discharges into an expanding gully which needs to be rock armored.