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DEPARTMENT OF FISH AND GAME

NATURAL RESOURCES

of the

COASTAL WETLANDS

of

HUMBOLDT AND DEL NORTE

COUNTIES

Mattole River

Bear River

Mad River

Little River

Big Lagoon

Stone Lagoon

Freshwater Lagoon

Redwood Creek

Klamath River

Miscellaneous wetlands

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**NATURAL RESOURCES
OF
COASTAL WETLANDS
OF
HUMBOLDT & DEL NORTE
COUNTIES**

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INTRODUCTION

Information contained in this report concerns a number of wetlands along the coasts of Humboldt and Del Norte Counties. Although of smaller size and lesser known than some of the other more prominent estuaries and lagoons covered in previous reports of this series (Humboldt Bay, Eel River Delta, Lake Earl and Smith River), they are, nevertheless, important segments of California's remaining coastal fish and wildlife habitat.

These wetlands vary in size from a few acres to several thousand acres (including adjacent agricultural lands which may be periodically flooded). Some are classed as lagoons, others as ponds or marshes and several are estuaries formed by the mouths of major coastal streams. Although differing in size and character each of these wetlands is significant in providing habitat vital to the maintenance of many fish and wildlife species. Collectively these wetlands support thousands of birds and mammals as well as untold numbers of fish and other aquatic organisms.

The value of these wetlands regardless of size and character can only be measured in relation to the total amount of such habitat which still exists. Man's activities over the past hundred years have reduced the State's estuarine habitat by at least 70 percent. The fish and wildlife resources effected by this loss have declined in numbers correspondingly. The continuation of wetland destruction will lead inevitably to drastic reductions in fish and wildlife numbers and the complete elimination of some species.

Consequently the Department of Fish and Game has initiated a high priority inventory of coastal wetlands in order to bring about a better understanding of the values involved and to provide assistance in planning for the preservation of coastal resources. This publication is an integral part of that program.

The authority for the preservation and management of California wildlife has been charged to the Department of Fish and Game. The responsibility, however, rests with the people of the State, for the Department cannot do the job alone. Only through a common effort by citizens, planners, private business and public agencies can we insure the continued existence of our wildlife legacy for future generations to enjoy.

SUMMARY

A number of wetland areas are situated along the 167 mile coast line of Humboldt and Del Norte Counties in northern California (see Plate 1). They occur in many forms including stream estuaries, lagoons, ponds and marshes. The wetlands described in this report, along with the other north coast wetlands covered in previous reports of the Department of Fish and Game's Coastal Wetland Series, constitute an important part of the States remaining wetland habitat.

This section of the coast is one of the least developed coastal areas in the State. It is typified by rocky headlands extending from the Coast Range, broken occasionally by canyons and flood plains of stream drainages. Forests of redwood and douglas fir cover much of the area. Flood plains are devoted largely to agriculture and are composed primarily of pasture lands. Most of the wetlands are located in or near these floodplains.

Settlement of the North Coast began about 1850. In the early period the area served mainly as a supply point for mining activities farther inland. After the mining boom period timber production, farming, ranching, commercial fishing and tourism became the leading industries.

Land reclamation in the coastal marshlands and estuaries for agricultural and commercial development led to a substantial reduction in wetland habitat. This, along with stream degradation, caused by logging, road building and other upstream land use changes resulted in a drastic reduction of fish and wildlife numbers. In spite of this reduction the north coast area is still comparatively

rich in marine life resources.

Land ownership within the immediate coastal zone is mixed. A number of wetlands are partly or entirely within the boundaries of State or National Parks. Others are mostly in private ownership except for State owned tidal and submerged lands.

Each wetland area is different in many respects from the others and not all habitat types are found in each area. Collectively, however, the wetlands provide a wide variety of habitats including woodlands, coastal forests, riparian, grassland, upland, agriculture, sandy beach, sand dunes, intertidal flats, channels, open water, salt marsh and freshwater marsh.

The kinds and numbers of fish and wildlife utilizing these areas are directly dependent on the type and quantity of habitat available. Each species has its own habitat requirements and utilizes those areas to which it is best suited. Some may use a number of different habitat types while others are completely dependent on only a single type.

Over 250 species of birds and at least 50 species of mammals are found in the coastal areas of Humboldt and Del Norte Counties. Not all species are found in each of the wetlands discussed in this report, but all are represented in one or more of these areas. Many species are not specifically dependent on wetland habitat but at least 100 species are.

Each of these wetlands plays an important role in providing habitat necessary to support migratory waterfowl, shorebirds and other water associated birds using the coastal segment of the Pacific Flyway.

In addition the ponds, lagoons, estuaries and streams involved support large numbers of king salmon, silver salmon, steelhead and coastal cutthroat trout.

Many other fresh and saltwater rivers flow through Humboldt County. The river systems of the Klamath, Little River, Redwood, Mad, Bear and Mattole are major producers of anadromous fish which support coastal sport and commercial fisheries important to the north coast economy.

In terms of economic values these coastal wetlands contribute significantly to the people of Humboldt and Del Norte County in many other ways. Tourism is the second most important local industry. Most of the tourism is related to recreational uses dependent on the areas scenic qualities and biological resources. Any significant degradation of these resources will most certainly detract from the recreational potential.

There are many forms of recreational opportunities available including fishing, hunting, boating, camping, sightseeing, nature study and photography.

Insofar as appropriative uses are concerned sports fishing is the greatest recreational activity. North Coast waters support hundreds of thousands of angler days use annually. Collectively these waters are second only to the Sacramento-San Joaquin river systems in terms of their contribution to the statewide anadromous fishery.

Hunting use, although of lesser magnitude, is a significant recreational activity in these coastal wetlands. Waterfowl hunting, particularly in the lagoons and the lower Mad River provides several thousand user days of recreation each year. Other forms of hunting, including upland game and big game, takes place on adjacent lands. One of the few areas in California where elk hunting is offered lies in the coastal strip of northern Humboldt County.

By far the greatest recreational uses are those that are non-appropriative. This includes nature study, wildlife observations, photography and other related

outdoor pursuits. Visiting the town and the visit this area do so because of the scenic and biological resources.

These same wetlands receive a great deal of scientific and educational use. They are popular areas for field trips by grade school, high school and college classes. At the same time they offer many opportunities for scientific study.

Coastal wetlands, particularly the river systems, also contribute significantly to the commercial fishing industry. Salmon taken commercially at sea are produced in these waterways. The estuaries are important holding areas for anadromous fish when they move from salt water into freshwater to spawn, and when the young fish return to the sea. These same estuaries are also used as nursery areas for marine species such as market crabs and sole.

Whether or not these many natural resource benefits will continue to be available will depend largely on man's influence on the area's lands and waters. Past human uses have already caused reductions in resource production.

Habitat destruction and degradation come about in many ways. One of the most serious threats comes from sedimentation accelerated by logging, road building, excessive grazing and other soil disturbing activities. Pollution and contamination can also have serious effects on biological productivity and human use. In addition, direct habitat destruction through stream channelization, levee construction, land reclamation and urbanization have already caused serious losses in the past and pose significant threats for the future. Great care must be taken to protect the ecological integrity of the remaining coastal wetlands and their tributaries by wise land use planning and enforcement. Only in this way can the people of California derive the fullest benefits provided by these irreplaceable resources.

Collectively the wetland areas described in this report provide habitat necessary to support a wide variety of fish and wildlife. These wetlands also support high potential recreational use and have potential for sustaining even higher future use. Their importance can be measured in terms of meeting the needs for increasing outdoor recreation and in their contribution to the North Coast's tourist-related economy.

To maintain the natural resources and aesthetic quality necessary to insure full realization of the intrinsic and economic benefits the Department of Fish and Game recommends that:

1. Land use plans be developed for all coastal drainage basins in order to insure protection and enhancement of water quality and to minimize downstream siltation.

The maintenance of water associated resource productivity in the streams, estuaries and lagoons is dependent on upstream land use activities to a large degree. Consequently, it is essential that logging, road construction and other land use activities be conducted in such a way as to reduce adverse impacts on fish and wildlife to the extent possible.

2. Existing land uses of agricultural and undeveloped lands in and around stream deltas, estuaries and lagoons be maintained through appropriate zoning.

The present pattern of agricultural, forestry and recreational land use which is common to most of these coastal wetlands is compatible with fish and wildlife habitat requirements. Maintaining these use patterns also insures

continued... with... agriculture, timber
production and... industry.

3. Wherever possible public fishing access be provided to the lower reaches of the Mattole River, Bear River, Mad River and Little River through public easements.

Private land ownerships along these streams with little or no provisions for public access prevents full recreational utilization of a valuable public resource.

4. Flood plain zoning be implemented along coastal streams where necessary.

Structural devices for flood protection such as levees and stream channelization cause extensive damage to fish and wildlife resources. Flood plain zoning can help to reduce flood losses without damaging aesthetic and biological values.

5. The lease of State lands in Big Lagoon by the Department of Fish and Game be continued to insure protection of natural resources and to provide diversified public recreational opportunities.

State lands in Big Lagoon are leased to the Department for a period of ten (10) years. At the end of this time it will be necessary to renew the lease agreement.

6. Private lands within the marsh area east of Highway 101 on Big Lagoon be acquired by the Department of Fish and Game.

In order to provide adequate protection for the Big Lagoon marsh and to achieve the most efficient management

opportunities. The Department of Fish and Wildlife would
desirably manage the lands. The Department could then
realized and the productivity of the lands would be insured.

7. State lands in the lagoon be leased by the Department of Fish and Game and managed for fish, wildlife and diversified recreational opportunities.

Such action would guarantee the maintenance of fish and wildlife resources and continued fishing and hunting recreational activities.

8. Destruction of any fish and/or wildlife habitat resulting from public or private projects or land use changes within or immediately adjacent to a coastal wetland be fully compensated for by the project sponsor.

By providing adequate mitigation measures in cases where activities leading to habitat destruction are determined to be necessary and unavoidable fish and wildlife losses may be minimized.

9. Wetlands within state, national and county parks be protected by the appropriate agency and managed for their natural amenities.

The importance of our dwindling wetland resources should be fully recognized by public agencies in whose jurisdiction they occur, and management plans should be developed by such agencies to insure their protection. No projects or activities which would jeopardize their biological productivity should be considered.

10. No filling, dredging or draining of any existing coastal marsh either public or private be permitted.

The loss of California's original coastal wetlands through human activities has greatly increased the importance of the remaining wetlands. Even very small areas of habitat play an essential role in maintaining our dwindling fish and wildlife resources.

11. All existing osprey nests and heron rookeries be protected and sufficient numbers of old growth trees be preserved in streamside zones and timbered areas adjacent to coastal lagoons to insure future nesting sites. All known osprey and heron nests are shown in Plate 21.

Provisions for preserving existing nests and suitable future nest sites in all logging operations and other habitat altering activities will be necessary to maintain existing populations of these birds.

12. The California Coastal Zone Conservation Commission recommendations for the protection of coastal resources through public acquisition and zoning be implemented.

Plans for the protection of the natural resources of the coastal zone developed by the Commission provide the means by which many of the other recommendations included in this report may be carried out.

COASTAL WETLANDS OF HUMBOLDT
AND DEL NORTE COUNTIES

GENERAL DESCRIPTION

The wetlands discussed in this report are located along 167 miles of the northern California coast extending from the Mendocino-Humboldt County line to the Oregon border (Plate 1). Several of the major wetlands including the Eel River Delta, Humboldt Bay, Lake Earl and the Smith River Delta have been covered in separate reports and are therefore not considered here (see Coastal Wetlands Series #6, #9 and #10). This publication is intended to describe the remaining coastal wetlands found within the two counties.

This section of the coast is one of the least developed coastal areas in the State. With the exception of urban centers such as Eureka, Arcata, Trinidad and Crescent City, the coastal zone is sparsely populated. Land uses are primarily associated with timber production, agriculture or recreation.

The mountains of the Coast Range extend to the sea where they form rocky headlands broken only by canyons and flood plains of stream drainages. These mountains are not a continuous chain but rather a series of irregular ridges running northwest to southeast. As a result the stream watersheds usually lie well south of their mouths. The Klamath River and Smith River are the only major exceptions.

Forests of redwood and Douglas fir cover most of the mountains and foothills although open grasslands and brush occur at some locations especially near the sea.

Most of the wetlands are associated with flood plains formed at the mouths of coastal streams. They may occur as estuaries, lagoons, ponds or marshes and are often surrounded by agricultural land reclaimed from former wetlands.

The original inhabitants of the north coast were American Indians. At the beginning of the 19th century at least four tribes including the Mattole, Wiyot, Yurok and Tolowa were occupying lands close to the sea in what is now Humboldt and Del Norte Counties. Nature provided an abundance of fish, wildlife and edible plants upon which they subsisted.

The first recorded sighting of the north coast by European man occurred in 1595 when the Spanish Ship San Augustin commanded by Sebastian Ceremeno passed off Trinidad on a return trip from the Orient. Trinidad was again visited in 1775 by Spanish ships. Later, vessels from other nations including Russia began to ply the coastal waters hunting and trading for furs with local Indian tribes. This fur trade lasted until about 1850.

Jedediah Smith and his party of 18 men became the first to journey overland to the coast from the interior. Following the waters of the Trinity and Klamath Rivers they reached the sea in the spring of 1828 and moved north into Oregon.

In 1840 a search was begun to find a harbor to open northern California and southern Oregon for settlement. Although Humboldt Bay had been entered in 1805 by Captain Jonathan Winship, it was not until 1849 that it was rediscovered by Dr. Josiah Gregg's party.

Settlement actually began in 1850 at Trinidad and on Humboldt Bay. Originally these settlements served as staging areas and supply bases for the mines located inland. As overland transportation improved other towns began to spring up to serve the ranches and small farms that were being homesteaded in outlying areas.

The most productive agricultural lands were found in the rich alluvial valleys of the coastal streams. The extensive marshes

associated with the process. Eventually the dikes and drainage systems were left. The process still continues today. As a result the large numbers of fish and wildlife which formerly utilized these areas declined drastically.

Likewise the increasing upstream mining and logging caused changes in coastal streams which resulted in a long term decline in stream productivity, consequently runs of anadromous fish became much reduced.

For many years the north coast was dependent on ocean shipping for survival. This along with a growing commercial fishery led to a thriving ship building industry. Eventually, the major commerce shifted to the export of lumber as the mines to the east began to decline in productivity.

By 1900 logging was by far the leading industry. The completion of the Northwestern Pacific Railroad in 1914 and the "Redwood Highway" a few years later provided new avenues of transportation for export of lumber and the import of necessities. As time passed, maritime shipping became less important. Many port facilities were abandoned and others became primarily commercial fishing facilities.

Today lumber is still the leading industry followed by tourism, commercial fishing and agriculture. Man's activities have left their mark on the land, although not so extensively as in many other areas of the state. The north coast is still rich in fish and wildlife resources.

CLIMATE

The climate of the north coast is typically cool Mediterranean in character, with very wet winters and dry summers. Low coastal fog

... in the ... annual ... ranges from 60 ... inches and comes ... as rain from October through April. Snow is rare at sea level but does occasionally occur.

Temperatures are generally cool with extremes that seldom exceed highs of over 80°F or lows below 30°F. Average summer and winter temperatures seldom vary over 10°F.

The prevailing winds are from the north and northwest but winter storms often bring winds from the south and southwest. Wind velocities of over 75 miles per hour are often recorded during such storms.

GEOLOGY

The geology of the north coast is complicated by the presence of no less than eight different geologic formations. The oldest is the Galace formation dating from pre-Silurian to late Jurassic which is restricted more or less to the Klamath River drainage. It consists of volcanic, granitic and metamorphic materials. Near the mouth the rocks are primarily sandstone, shale and conglomerate of probable cretaceous age.

A younger but closely related formation, the Kerr Ranch Schist is found in both the Klamath River and Redwood Creek drainages. It is dark gray, thinly foliated and contains alternate layers of sericite and aggregates of quartz and plagioclase. Soils in the Redwood Creek drainage and around the lagoons south of Redwood Creek have a dark gray color and an abundance of micaceous minerals derived from the parent material of Kerr Ranch Schist.

The Franciscan and Yager formations are similar rock formations which cover approximately 60% of Humboldt County. Both are of fault block structure that tilts to the northeast. The Franciscan

used for grayhacke, greenstone, chert and volcanic rock with sandstone intrusions. The Yaquina is of similar mineral composition but is predominantly shale containing large bodies of conglomerate and grayhacke.

The softly consolidated sediments of the Wildcat and Hookton formations are common along sections of the coast, particularly around Humboldt Bay. They range in age from upper Miocene to mid-Pliocene. The Hookton materials are found overlying the Wildcat formation from the Van Duzen to Little River.

Farther north near Crescent City are the Saint George and Battery formations. The oldest, the Saint George, was created during the Pliocene period and later overlain by the younger Battery formation.

The alluvial deposits associated with the coastal valleys and plains are composed of a variety of soils derived from the parent material found upstream. The type of soil formed is a product of many factors including parent material, climate, relief, location, living organisms and the length of time the deposits have been in place. Slight changes in any of these factors will influence the soil ultimately created. Consequently many different soils are often found in the same general area forming a mosaic of soil patterns.

MATTOLE RIVER AREA

Drainage

The headwaters of the Mattole River lie near the Humboldt-Mendocino County line. The river travels north and northwesterly for approximately 50 miles before it swings to the west and enters the sea about forty miles south of Eureka near the small community of Petrolia. Its drainage basin covers approximately 278 square miles (Plate 2).

The annual runoff as measured 6.5 miles upstream from the mouth (excluding the river's north fork) averages about 1,090,000 acre feet. The average flow is 1,351 cfs, with extremes ranging from as low as 20 cfs and as high as 90,400 cfs (U. S. Dept. of the Interior G.S. 1969 Part I). Fluctuations of such magnitude are typical of north coast streams. The steep upper canyons coupled with high periodic and seasonal rainfall results in rapid runoff.

The low summer flows are not sufficient to overcome the effects of littoral drift in the sea. Consequently sediments dropped at the river mouth build up to form a temporary barrier of sand creating a lagoon that may extend for a mile upstream. Much of the upper drainage is covered by forests of mixed conifers and hardwoods. Foothills of the lower river valley are largely grasslands interspersed by brush fields and patches of timber. Most of the grass and brushlands were formerly forest that has been converted for grazing purposes.

Pastures and orchards are often found along the river wherever sites with suitable slopes and soils are located.

Land Ownership

Virtually all lands bordering the river are privately owned. The only public lands are state tidelands located in the lower river and along the beach. A

county road extends from the south of the river. No other public road is available.

Land and Water Uses

In the upper drainage timber production is a major land use along with livestock grazing. At one time the river was used to float logs to ships waiting offshore near the river mouth. This practice was discontinued many years ago when better forms of transportation became available.

On the lower river agriculture is the major industry. The open grasslands are used for livestock grazing, both cattle and sheep. Pastures are located on the flood plain and some hay is produced. Some orchard crops are also grown. Water from the river and its tributaries is used to some extent for irrigation.

In the mid 1800's oil was discovered near Petrolia (hence its name). For a short period of time oil was produced and shipped from the area to San Francisco. Commercial use of the field ended many years ago and has not been renewed.

Other than providing a limited amount of irrigation and domestic water, the river is probably most important for recreational purposes. Considerable angling use for salmon and steelhead occurs each year in areas where access is available.

Water Quality

Water quality in the Mattole is generally good. The absence of large communities in the drainage has kept the river relatively free of direct waste discharges. Sewage facilities in the area are of the individual septic tank type. Some leaching may enter the river but the extent is not known.

Upstream logging coupled with high seasonal rainfall results in some turbidity and siltation during the winter and spring but the problem is not as severe in the

as it is in many other coastal streams.

Natural Resources

Habitat

A variety of habitats are found along the lower river but wetland types are limited. The river channel and lagoon formed by the sand closure of the mouth make up most of the total. A small seasonal marsh south of the lagoon is the only other wetland area.

The lagoon and river waters fluctuate considerably in size depending on tides and runoff. During the dry season the river occupies only a small portion of the wide rocky channel. The river channel and the lagoon are virtually free of vegetation other than green algae. Tidal influence in the estuary extends about one mile upstream.

Low sand dunes and sandy beaches and river bars surround the lagoon and extend north and south from the river mouth along the ocean front. Some sparse vegetation composed of knotweed, dune tansey, blue grass and bush lupine is found on the higher dunes near the beach. Farther up river brass buttons, clover, rabbits-foot grass and mares tail commonly grow in sandy areas.

There is no clear definition between woodland and upland habitat types. For the most part trees and brush are found growing together in mixed stands in ravines and canyons. Common plants of this community are blueblossom, poison oak, coyote brush, blackberry, current, grand fir, douglas fir, bay, buckeye and maple.

Agricultural areas are primarily grasslands used for livestock grazing. The plant composition is a complex mixture of grasses and forbs, mostly introduced species, including oatgrass, rye grass, wheat grass, fescue, soft chess, orchard grass, brome and clover.

has most of the char
some distance inland. The overstory is composed of alder, willow and
black cottonwood. The thick undergrowth includes elderberry, thimbleberry,
blackberry and bay berry.

Map of the vegetative patterns is included in Plate 3. Habitat acreages
are shown in the following table:

Table 1

Habitat Acreages

Woodland and Brush	1715
Riparian	263
Grasslands (Agricultural)	420
Open Water	77
Marsh	5
Sand and River Gravel	220

List of plants commonly found in the North Coastal area is included in
Appendix A.

Wildlife

Water Birds

The Mattole River Delta has neither large acreages of wetlands nor
a broad array of habitat types. Consequently the number and variety of
water associated bird life is not extensive. The lack of aquatic vegetation
limits use primarily to those species that feed on animal organisms or that can
find food in adjacent pastures.

The lagoon area is used by small numbers of waterfowl, particularly during the
winter months. Most are transients moving between other areas of habitat
along the coast. Mallards, pintails, widgeon, greenwing teal scaup and scoters
are the most common. A few mallards and mergansers are year round residents.

Canada geese were fairly common but

On rare occasions swans have also been observed.

Shorebirds are numerous in the lagoon where they feed in the intertidal area. Several thousand birds can be seen during peak population periods in the fall and winter. Species most frequently observed include sandpipers, dunlin, willets, plover, yellowlegs, godwits and killdeer. These birds periodically also use the nearby pastures. A few species including killdeer and spotted sandpipers nest locally.

Great blue herons are the most common wading birds but bitterns and common egrets also use the area. Coots are the only regularly seen member of the rail family although the sora rail & Virginia rail may at times use the small marsh south of the lagoon.

Other water birds that frequent the delta include kingfishers, grebes, cormorants, loons, pelicans and a variety of other coastal and pelagic species.

Land Birds

The predominant forms in terms of numbers and varieties are the songbirds. Sparrows, thrushes, flycatchers, wrens, larks, warblers, finches and juncos are examples of this group. Most are migratory but many are residents.

A wide variety of other land birds including crows, ravens, jays, woodpeckers, flickers, swallows, hummingbirds, quail, grouse, mourning doves and band-tailed pigeons are common residents or migrant visitors. Also included are the raptors. Turkey, vultures, red-tailed hawks, rough-legged hawks, marsh hawks and kestrels are common. Less often seen are the golden eagle, osprey, red-shouldered hawk, cooper's hawk, sharpshinned hawk and goshawk. Bald eagles, white-tailed kites, prairie falcons and peregrine falcons are much rarer but are seen from time to time.

General

The Mattole River supports five species of anadromous fish, two species of freshwater non-game fish, and several euryhaline species (Appendix D).

All utilize the brackish or estuarine habitat with the possible exception of the freshwater non-game species. The anadromous and euryhaline species are all dependent upon the ocean for a segment of their life history.

Anadromous species

The term anadromous refers to fish which spend part of their lives in the ocean, then move into freshwater to spawn. In the Mattole River, these species include the king and silver salmon, steelhead rainbow trout, pacific lamprey and threespined stickleback.

Salmon and steelhead migrate into the Mattole River after heavy fall storm flows have opened the sand bar which typically forms across the mouth. The fish ascend to tributary streams on rising and dropping flows and spawn in areas with clean gravel and adequate water flows. The eggs are deposited in redds, or nests, dug by the female. The young fish, called alevins, wiggle their way up through the gravel shortly after hatching. Young king salmon migrate to the estuary or brackish water zones soon after emerging. Young silver salmon and steelhead typically spend one or two years in freshwater before migrating downstream, although steelhead may remain in freshwater for up to three years. A very small portion may never out-migrate and resemble resident rainbow trout. Earlier out-migration of silver salmon and steelhead as young-of-the-year fish can occur, but survival of these fish is considerably less than that for the older age groups.

physiological changes to cope with the salt concentration in the ocean. Likewise, the adult fish returning to complete their life cycle similarly utilize the same brackish water environment, although it may not be as critical as for the juvenile fish.

In the Mattole River, high flows from September or October storms often stimulate king salmon into entering the lower 1.5 miles of river. As flows quickly drop, many of the fish are stranded and trapped in the pools. The fish, which are vulnerable to many predators, including man, remain in the pools until sufficient flows allow them to resume their upstream migration.

The Pacific lamprey is not a true fish and belongs to a primitive class of fish-like creatures called cyclostomes. Lampreys utilize freshwater streams for spawning and enter the Mattole River in the late winter or early spring. Circular nests are constructed by removing rocks and pebbles with the disk-like sucking mouth. After hatching, the young lampreys, or ammocoetes, distribute themselves in the gravel and silty stream areas where they feed upon micro-organisms. The ammocoete remains in freshwater for several years and migrates out of the freshwater environment to the ocean at a size of five - six inches.

Three-spined sticklebacks are fairly common in the lower Mattole River and estuary and may be found in fresh or saltwater. Anadromous subspecies enter the river and spawn within a few miles of the ocean. Spawning takes place in the late spring and early summer in areas with aquatic or submerged vegetation. The male constructs a nest made from bits of organic material and then forms a tunnel like entry opening. The female lays the eggs in the nest which is then guarded by the male until the young are self-dependent.

The anadromous form of the three-spined stickleback is present in the Mattole River in upstream areas. Both forms feed upon detritus and small aquatic organisms, and in turn, are eaten by larger animal predators.

Freshwater species

There are three known species of freshwater fish which inhabit the lower Mattole River. These include the Humboldt sucker, coastrange sculpin and rainbow trout.

The Humboldt sucker cannot tolerate saltwater, but is commonly distributed throughout the river above the tidewater zone. This zone fluctuates considerably and as such, suckers may be found as far down as the estuary during the late summer when saltwater intrusion is absent or during heavy winter flows. Suckers spawn in the main river and tributaries in the spring and broadcast their eggs over gravelly riffles. The young hatch in about one month and move to the stream margins and quiet water habitats.

The coastrange sculpin is the only sculpin species recorded from the lower Mattole River, however, three other species, the prickly sculpin, riffle sculpin, and Pacific staghorn sculpin may also be present in the Mattole River. Sculpins are unobtrusive fish which inhabit the stream bottom feeding on detritus, aquatic insects and small fish. The eggs are laid in the spring under flat rocks or logs and guarded by the male. Often utilized as an important forage species in some rivers, they are probably not heavily preyed upon by fish in the Mattole River. A few exceptions may be large silver salmon or steelhead juveniles which might consume sculpin fry and young.

...trout are found... but
...occur predominantly in... streams or above anadromous
fish blockages. The steelhead is considered a subspecies of rainbow trout
which demonstrates a greater tendency for an anadromous existence.
Because of similar physical characteristics, it is usually impossible to
differentiate between juvenile steelhead and rainbow trout.

Euryhaline species

Euryhaline refers to fish which are able to live in waters with a wide
range of salinity. These are predominantly inshore ocean fish which
occasionally enter the river estuaries or brackish water lagoons.

The starry flounder is the only fish in this group which has been observed
in the Mattole River. Several other species have been observed in rivers
to the north and may possibly enter the Mattole River. Starry flounder
frequently utilize the brackish and nearby freshwater zones of the Mattole
River for nursery areas, feeding upon annelid worms, small copepods,
crustaceans, and aquatic insects. The adult fish typically seeks shallow
areas near river mouths, estuaries or sloughs for spawning in December and
January. Small starry flounders occur on the mud and sand flats in the
lower 2.0 miles of river and may be the product of estuarine spawning.

Invertebrates

numerous species of invertebrates seasonally abundant in the lower river estuary. Many species, including aquatic insects and strictly marine invertebrates will be found in the estuary only when conditions are suitable.

The Dungeness crab, an important commercial species, may utilize the estuary as a nursery area although seasonal bar opening and closings possibly restrict their entry. Soft shell clams, introduced to California accidentally with oyster seed, are found in areas with low salinities. Bay shrimp, amphipods, and isopods may be found in the estuary and provide forage for many fish species. Numerous species of polychaetes are common in the estuary but are poorly known.

Amphibians and Reptiles

Amphibians and reptiles, although secretive and seldom seen, are common residents of the coastal wetlands. The amphibians are represented by frogs, toads, salamanders and newts. The reptiles by lizards, snakes and turtles.

The Mattole River and its associated ponds and freshwater marsh seasonally abound in Pacific tree frogs and red-legged frogs which breed in these waters. The salamanders and newts of which there are numerous species inhabit the woodland areas around the river. Some species must enter freshwater to breed while others lay their eggs in damp forests bordering wetlands.

Of the reptiles, the snakes are the most common and although they are not usually thought to be aquatic, species like the western aquatic garter snake are frequently found in the waters of the coastal wetlands. Other terrestrial species like the western rattlesnake are found around the mouth of the Mattole River.

Three species of lizards including the common western fence lizard inhabit the high dry areas. The only turtle in the Mattole River area is the western pond turtle which frequents permanent freshwater ponds and streams where there is adequate depth to provide shelter.

Sport Fishing

Three species of anadromous fish are the majority of the sport fishing use in the Mattole River. In 1966, the Department estimated that 600 and 700 angler-days were expended each year to catch 400 salmon and 500 steelhead, respectively. The majority of the salmon taken are king salmon.

Resident trout and juvenile steelhead support small summer fisheries in the Mattole River. The majority of the use is expended by local residents.

Hunting

Some waterfowl hunting effort is expended in the river delta but the hunter success is low. The lack of extensive waterfowl habitat to attract birds in high numbers severely limits any future potential. Upland game and deer hunting contribute more insofar as total hunter use opportunity is concerned. Virtually all hunting is limited to landowners and their guests except for a few areas near the river mouth.

Nature Study

Opportunities for nature study and other non-appropriative uses are provided to some extent along Light House Road on the south bank of the river. In most cases, however, viewing must be done from the road. Only at a few locations can the public actually leave the right-of-way.

Past scientific study has been primarily expended by public agencies such as the Department of Water Resources and the Department of Fish and Game. The isolated location of the river has inhibited use by private researchers, colleges and universities. The same is true for educational uses. Only local schools are known to use the area for field trips and outdoor studies.

Problems and Conflicts

Sedimentation

As in other north coast rivers, sedimentation is one of the major problems. Upstream logging and road building are the major contributors but land subdivisions and heavy livestock grazing can also increase silt loads. The magnitude of the problem is not known but stream conditions have declined in quality to the extent that anadromous fish runs have been reduced. Sedimentation affects aquatic life by compacting spawning gravels, filling pools, raising water temperatures, lowering dissolved oxygen levels and reducing food chain organisms. Not only is the main river affected but also its tributaries. Many streams which once supported anadromous fish no longer do so according to local residents.

Access

The full recreational potential of the river cannot be realized without provisions for public access. Private ownership of virtually the entire delta precludes most uses of the areas fish and wildlife resources. Only the beach and state lands in the tidal portion of the river are reachable by the general public without trespassing.

Land Subdivision

As in all scenic coastal areas land development for recreational homesites is one of the greatest threats to wildland habitat. Proposals for such development along the lower Mattole have been made but to date none have actually been developed. Appropriate zoning of agricultural and open space lands will be necessary to protect important natural resources.

BEAR RIVER

The mouth of the Bear River is located thirty miles south of Eureka (Plate 1). It is rather small compared to other north coast rivers. Its entire length is no more than 20 miles and its drainage basin encompasses only about 33 square miles (Plate 4).

Like other coastal streams water run-off fluctuates greatly. This is reflected in stream bed physiography. The headwaters are typified by deep v-shaped canyons with little or no flood plain while mid and lower sections have gentle to moderate gradients with relatively wide flood plains. Water flows reach high levels during winter storms but decline in summer months to very low flows.

The upper drainage is heavily timbered with forests of fir, madrone, oak and tanoak. The lower drainage is largely grassland interspersed by brush and patches of timber. The floor of the flood plain is similar but with occasional cultivated farm and ranch lands.

Land Ownership

Virtually all of the lower river area is in private ownership with the exception of state lands in the river channel and along the beach.

Land and Water Uses

The primary land use is agriculture. Along the flood plain there are about 500 acres of pasture, hay and grain lands, some of which are irrigable. The surrounding grass covered hills are used for grazing of beef cattle and sheep.

Wherever commercial quality timber is found logging is the major land use. However, most current activity is in the upper drainage since little timber of harvestable age remains along the lower river.

Habitat is sparse within the Bear River Basin. Consequently no water quality problems associated with domestic wastes have been recorded. Siltation and turbidity resulting from logging, road building and, to some extent, grazing pose the greatest threats in terms of water quality. Increased siltation has reduced the stream's productivity for anadromous fish (Dept. of Fish and Game 1965).

Natural Resources

Habitat

The amount and variety of wetland habitat is extremely limited. The estuary portion of the river is nothing more than a widening of the stream channel screened from the sea by sand spits. The water surface area is only slightly affected by the rise and fall of the tides. Sand and gravel bars formed near the mouth are constantly changed by tides, surf and stream flow.

Vegetation other than green algae is completely lacking in the tidal zone and the stream channel. During all but the winter months the stream occupies only a small part of its channel. The remaining area is composed of bare river rock, gravel and sand. The meandering water course changes frequently.

Riparian cover exists at some locations along the river banks. It is composed of willow, alder and cottonwood with an understory of blackberry, thimbleberry and other shrubs. Almost solid stands of red alder cover the hillsides south of the river near the mouth.

Agricultural lands are scattered along both sides of the river. Most are pastures but some oat hay is grown on suitable sites. The uplands are primarily grassland with occasional brush patches and pockets of mixed hardwoods and conifers.

The vegetative patterns of the lower river valley are shown on Plate 5. Acreages of habitat types are as follows:

... of ... include ...
... burrowing owls, screech owls and ... owls are residents or regular visitors.

Mammals

The only big game species common to the lower river valley is the blacktail deer. Black bear were regularly seen many years ago but are now found primarily in the upper drainage. The mountain lion is also a resident of the upper drainage but individuals may still pass through the lowlands on rare occasions.

Weasels, mink, river otters, skunks, badgers, bobcats, gray foxes and coyotes are all residents of the delta. In addition seals and sea lions frequently enter the lagoon and sometimes travel upstream to the extent that water depths permit.

A wide variety of other mammalian species including blacktail jack rabbits, brush rabbits, mountain beaver, porcupines, gray squirrels, flying squirrels, ground squirrels, mice, rats, gophers, moles and shrews occupy various habitat types throughout the area. Lists of birds and mammals found in the coastal areas of northern California are included in the Appendices B and C.

Table I
Habitat Acreages

Woodland and Brush	272
Riparian	47
Grassland	420
Agriculture	155
Sand and River gravels	32
Open Water	22

Wildlife

Water Birds

The limited wetland habitat does not support substantial numbers or varieties of water associated wildlife. Small numbers of merganser ducks and mallards utilize the river periodically all year. Other waterfowl occasionally stop over for short periods near the river mouth in the fall, winter and spring months.

Shorebirds including sandpipers, dunlin, willets, yellowlegs and killdeer are common along the sand and gravel bars but do not occur in large numbers. Great blue herons, cormorants, grebes and several species of gulls frequent the area regularly.

Land Birds

Terrestrial species are much more numerous. Because of their mobility and migratory habits, species and numbers change with the seasons. The small song birds are predominant in both kinds and numbers. Some of the more common varieties are sparrows, thrushes, flycatchers, wrens, larks, warblers, finches, and juncos. Populations are usually greater in the riparian habitat or the borders between woodlands and open grasslands or pasture.

Other common land birds of the area include crows, ravens, jays, woodpeckers,

quail and songbirds. The open grass country interspersed by woodland is particularly attractive to raptors. Golden eagles, red-tailed hawks, rough-legged hawks, red-shouldered hawks, cooper's hawks, sharp-shinned hawks, kestrels and turkey vultures are seen regularly. Sightings of the rare bald eagle and peregrine falcon are also recorded. Because of their nocturnal feeding habits the owls are less often seen but nevertheless are regular residents and visitors. The most common species include the great horned owl, barn owl, short-eared owl, screech owl, saw-whet owl and burrowing owl.

Mammals

A number of marine mammals such as the California sea lion, Steller sea lion, harbor seal and common dolphin are found offshore but as far as is known do not normally pass into the river. The only truly aquatic mammal that regularly uses the stream is the river otter, although a number of others including the mink, weasel and raccoon are associated rather closely with riparian areas because of the cover and food sources provided.

Deer, blacktail jack rabbits, brush rabbits, striped skunks, spotted skunks, badgers, gray fox, coyotes and bobcats are common. Black bear and mountain lions are found in the drainage but have become rare locally.

In addition many small rodents including mice, rats, gophers, moles, ground squirrels and shrews occupy a variety of habitat types within the vicinity of the lower river.

General

The fish fauna of the Bear River is very similar to that of the Mattole River (Appendix D).

Important runs of salmon and steelhead rainbow trout utilize the Bear River for spawning and as nursery area. Openings and closings of the river's mouth allow entry of anadromous and euryhaline species in a manner similar to that discussed for the Mattole River.

It is well known that the Bear River
probably occurs in the Bear River estuary. Recorded
observations of specific species, however, are practically
non-existent.

Amphibians and Reptiles

The Bear River supports an amphibian and reptile fauna much like that of the Mattole River. The area around the mouth of the river is also inhabited by the western rattlesnake.

RESOURCE USE

Because of the general lack of public access resource use is extremely limited. Fishing offers the greatest potential but angling is currently limited to those who can obtain permission from local landowners.

The lower river below the county road bridge near Capetown is open to winter fishing for salmon and steelhead, and provides about 1.5 miles of access. Private property and resulting poor access limits the actual amount of fishing use. Resident trout and juvenile steelhead support a small amount of summer fishing use in the upper river and major tributaries. No estimates on total use are presently available.

Hunting is oriented more towards terrestrial species, particularly deer and upland game. Although ducks are occasionally taken they do not occur in sufficient numbers to attract many hunters. All hunting is restricted to the family and friends of the landowners.

Nature study opportunities are likewise limited. Some use does exist by persons travelling the Mattole Road, but very little of the delta area can be seen from it. The same is true for scientific and educational use, although permission to trespass for this purpose could probably be more easily obtained than for other uses.

Problems and Conflicts

Sedimentation

Sedimentation is the most significant factor currently affecting the Bear River. Logging activities within the drainage have caused increases in silt loads carried by river waters. The resulting siltation is known to cause damage to anadromous fish by compacting spawning gravels, filling pools, raising water temperatures,

...the reason ...
...siltation ... cannot be ... they are known to
be adversely influencing fish populations. (Dept. of Fish and
Game 1969).

Access

The public is denied virtually all use of the Bear River, particularly in the lower portion, because of the absence of legal access. Before any use of the available resources can be provided to the public some form of access will be necessary.

MAD RIVER

Drainage

The Mad River originates in the Coast Range of Southern Trinity County and flows northwesterly for almost 110 miles before entering the Pacific Ocean 13 miles north of the entrance to Humboldt Bay (Plate 1). At one time the river drained directly into the bay (Mad River Slough is part of the former channel), but sometime prior to 1850, it changed its course to the present location.

The drainage basin is long and narrow and covers approximately 447 square miles (Plate 6). Except for the coastal plain and a few small interior valleys the terrain is characterized by steep canyons and rugged mountains. Elevations range upward from sea level to about 5,000 feet. Much of the drainage is covered by mixed coniferous forest at higher elevations and redwood forest lower and closer to the coast.

Extremes in runoff are typical of the Mad as they are in other north coast streams. Water flow, as measured four miles upstream from the mouth, shows highs of over 77,000 c.f.s. (cubic feet per second) and lows of under 1.0 c.f.s. (U. S. Dept. of Interior G.S. 1935). High flows sometimes result in flooding of the coastal plain and lower valley.

Kuhn Reservoir is located on the upper river 97 miles from the mouth. Created for water storage, the reservoir is capable of storing 51,000 acre feet (Winzler and Kelly, 1967). This water is delivered for domestic and industrial use in the Humboldt Bay area.

Land Ownership

Most of the land in the delta area is privately owned. Approximately 150 acres of land south of the river mouth are in public

Land subdivisions for recreational home sites are always in demand in scenic coastal areas. Although no subdivisions have been applied for this area as yet such action may be expected at some time in the future. Consequently efforts should be made to insure appropriate agriculture and open space zoning to protect the areas natural resources.

ship and operated as a county park (park). The only other public lands are state lands in the lower river and its estuaries including parts of the Old Mad River Slough (Plate 7).

Land and Water Uses

Most of the lowlands in the delta are utilized as pasture for dairy cattle and other livestock. These lowlands were formerly salt and brackish water marshes prior to their reclamation by the construction of dikes and levees to prevent tidal intrusion. Because much of the land is below sea level, periodic flooding during the rainy season is common.

On somewhat higher ground agricultural uses are giving way to residential subdivisions and commercial development. This encroachment on agricultural lands has accelerated over the past ten years and is continuing to increase.

Water stored at Ruth Reservoir is used for domestic, commercial and industrial purposes in the Humboldt Bay area.

The Humboldt Bay Municipal Water District regulates flows from Ruth Reservoir depending on water requirement in the Service District while maintaining a minimum flow of 30 c.f.s. for maintenance of fisheries resources. The water is diverted at Egan, approximately six miles from the river mouth by five Ranney Collector wells. Water from wells No. 1 and 2 is filtered and transported to a one million gallon control reservoir from which it is delivered for domestic use to the cities of Arcata and Eureka, the Humboldt Community Services District and several smaller community service districts. The total filtered water delivered by the Humboldt Bay Municipal Water District in 1974 was 2.8444 billion gallons.

... from ... and 5 is un-
filtered and delivered to ... Simpson and Louisiana Pacific
pulp mill on the Samoa peninsula for industrial use. Total
unfiltered water delivered in 1974 was 17.246 billion gallons
(Humboldt Bay Municipal Water District, 1974).

Extensive recreational use is also made of the river, primarily
for fishing. Runs of salmon, steelhead and coastal cutthroat
attract many fishermen.

Several gravel extraction operations are located on the lower
river. These operations utilize aggregates from the river bed
during all periods of the year when weather and runoff conditions
permit.

Water quality

Tidal influence extends approximately three miles upstream from
the mouth. In this section of the river salt content varies accord-
ing to runoff and tidal stages. As a general rule the closer to
the mouth the greater the salt content. The entire estuary is
very close to pure sea water at high tide during low summer flows.

Sediment loads are high during heavy runoff periods but may not
reach levels recorded in some other coastal streams (Dept. of Water
Resources, 1969). The reason is basically the difference in up-
stream geology. Formations on the upper Mad are less erodible than
those found in some other areas. Nevertheless, logging, road
building and other activities are causing siltation problems.

The only direct discharge of domestic waste into the river occurs
below the town of Blue Lake. These wastes are passed through a
treatment plant before entering the river. No major pollution
problems are known to result from this discharge. High coliform
counts indicating extensive pollution by animal wastes have been

recorded in the lower river however pollution is believed to be at least partly from domestic septic system leaching. Other contributors are not identified at this time.

Natural Resources

Habitat

The habitat communities of the delta are composed of 10 basic types shown on Plate 8. Each type is categorized according to physical features and vegetative characteristics. The conditions provided by each community attract those species of other living organisms that find their life requirements met in that particular type.

Immediately adjacent to the ocean beach wind blown sand forms a band of dunes extending south from the river mouth to the entrance of Humboldt Bay. These dunes support sparse vegetation composed primarily of European dunegrass, beach strawberry, bush lupine, dune tansey, sand verbena and bluegrass. Plant density and diversity increase farther inland from the tide line. The dunes are fragile and easily damaged by vehicular activity or other mechanical disturbance.

On the inland side of the more stabilized dunes trees have taken root to form small patches of woodland. These woodlands are typically composed of beach pine, sitka spruce, monterey cypress and Douglas fir with an understory of low growing shrubs such as blackberry and salmonberry.

Riparian woodland is found along the river and tributary sloughs. The overstory differs from other woodlands in that the primary species are willow, red alder and black cottonwood. Understory plants include blackberry, salmonberry and Himalaya berry as well

as a number of grasses. A narrow band of cover between the river and the upland area however it still exists.

Upland habitat, typified by low growing shrubs, is present only in small amounts near the river mouth and a few other scattered locations. Common plants of these areas include willow, red alder, bayberry, black twinberry, coyote brush, silk tassel, Indian plum, bush lupine, blackberry and red-flowering currant.

Agricultural lands are primarily pastures for hay production and livestock grazing, although a small acreage of potatoes and/or other crops are occasionally grown. The plants found in pastures are largely introduced species. Some of the most common are ladino clover, salina clover, red clover, orchard grass, rye grass, wheat grass, bentgrass, bluegrass, foxtail, kdock, soft chess, plantain and dandelion.

Tidal flats and river bars are found in the river channel, the estuary and the tidal sloughs. Generally the true intertidal area is located only in the Old Mad River Slough and in the lower portion of the estuary. The bottom sediments in these areas are composed of soft mud, silt and sand. They are alternately covered and exposed by the changing tides. In the upper portion the river bars are composed of river rock, gravel and sand. They are covered by water only during periods of high water during the rainy season. Both tidal flats and river bars are free of vegetation other than algae.

Those areas which usually are not exposed by low tides or low water flows are classed as open water. This includes the river, some sloughs and the deeper portions of the estuary. These areas are also free of vegetation other than algae.

sal ... area ... river
slough ... formerly ... much of the ... lowlands
now used for pasture. The dominant plants are cordgrass, pickle-
weed, salt grass, marsh rosemary, gum plant, javana, arrowgrass
and salt marsh.

marshlands which contain fresh or brackish water are classed as
freshwater marsh for the purpose of this report. They occur as
small ponds, ditches, borrow pits and sloughs scattered throughout
the agricultural lands and other habitat types. Some are more or
less permanent while others contain water only during the rainy
season. Plant types vary from the more salt tolerant sago pond-
weed, widgeon grass, creeping spike rush and bullrush in brackish
water to silverweed, water buttercup, poison hemlock, duckweed and
attail in fresher waters. Although the acreage is relatively
small during much of the year the total is greatly increased by
seasonal flooding of the lowland pastures.

residential, commercial and industrial lands are located near
highway 101 and to the south near Arcata. Much of the wildlife
value of such lands has been destroyed. The acreage of developed
lands is increasing steadily at the expense of agricultural and
wild lands.

the habitat types and estimated current acreages are shown in
table III following.

Table III

Habitat Types and Acreage

Type	Acreage
Sand Dunes	673
Woodland and Coastal Forest	182
Riparian Woodland	212
Upland	110
Agriculture	3,000
Tidal Flats and River Bars	227

Type

Open Water
Salt Marsh
Freshwater Marsh
Residential, Commercial and Industrial

Wildlife

Water Birds

Although the Mad River Delta is home for many kinds of wildlife it is probably most important in terms of the habitat it provides for water associated species. Each year thousands of migrant waterfowl, shorebirds and other water-associated birds move south from the breeding grounds as far north as the Arctic Circle to winter along the California coast. Without the habitat provided by such areas as the Mad River these migratory populations would cease to exist.

Not only is the area important to migratory species but also to residents as well. Many birds nest and spend the entire year locally.

The water-associated birds include many orders with over 100 species represented within the Mad River-Humboldt Bay area. They show great diversity in size, form and habits but they all share a common need for water related habitat.

Waterfowl of many kinds visit the delta area as wintering birds or transients during winter migrations. Some, including the mallard, cinnamon teal and common merganser nest here and may be seen the year round. Some waterfowl prefer shallow water areas where they feed largely on aquatic vegetation. These, the so-called puddle ducks, include widgeon, pintails, mallards, gadwalls, shovelers, teal and wood ducks. Others, the diving ducks, prefer deeper water where they obtain vegetable and animal food items by diving under water. Common divers are the canvasback, redhead, ring-necked

duck, sculpin, and salmon. The scoter, however, is also a diver and feeds on small fish almost exclusively. Unlike other waterfowl they have long narrow serrated bills for capturing prey rather than the spatulate bills typical of most ducks.

Occasionally both geese and swans are also seen in the coastal flood plain but neither are regular visitors. Swans are common to the south of Humboldt Bay and along the Eel River but geese, other than black brant occur only in small numbers along the north coast.

At least 31 species of shorebirds are known to occur locally. The most common species are the dunlin, western sandpiper, black bellied plover, killdeer, dowitcher, sanderling, willet, marbled godwit, northern phalarope and common snipe.

Shorebirds, like waterfowl, are present in the greatest numbers during the fall and winter when migrant birds arrive. A few species like the killdeer and spotted sandpiper are local nesters but most others nest far to the north in Canada and Alaska. They feed on small invertebrate organisms in the mud flats, river bars, beaches, marshes and agricultural lands.

Egrets, herons and bitterns are classed as wading birds. They feed on small fish, crustaceans, amphibians, reptiles and even small mammals. Although they prefer the shallow bay waters, marshes and streamsides, several species also feed extensively in pasture lands.

Most species found in the delta are local nesters in the Humboldt Bay area. The common egret nests only on Indian Island as far as is known, but blue herons, green herons, night herons and bitterns nest at other sites. The introduced cattle egret also probably nests locally but the snowy egret, an occasional visitor, is not known to do so.

A number of other marsh birds including coots, grebes and kingfishers are also common, as well as coastal birds such as gulls, terns, cormorants, pelicans, murres, albatrosses, puffins, petrels, fulmars, shearwaters, albatrosses and jaegers. Some of these species are not normally seen inland but do occur offshore.

Land Birds

Resident and migrant terrestrial birds are present in large numbers and a wide variety of species. The songbirds are most numerous. This group includes sparrows, thrushes, flycatchers, wrens, larks, warblers finches and juncos. Crows, ravens, jays, woodpeckers, flickers, swallows, valley quail, pheasants, doves and band-tailed pigeons are also common.

In addition at least 22 species of raptors including red-tailed hawks, coopers hawks, sharp-shinned hawks, American kestrels, marsh hawks, golden eagles, bald eagles, peregrine falcons, prairie falcons, osprey, white-tailed kites, turkey vultures and several kinds of owls have been recorded. Many, including the extremely rare peregrine falcon are believed to nest within the vicinity of the Mad River Delta.

The magnitude of bird use in the delta can be demonstrated only for the water associated species. Population data expressed in terms of bird days use gathered by aerial census is shown in Appendix C.

Mammals

Species variety and numbers are high even though most mammals are nocturnal and not easily observed. During the day they tend to remain in areas with protective cover. The riparian woodlands, woodlands and upland habitat are therefore essential to the continued existence of many mammals within the delta.

most mammal common in the area is the
rally, the coastal plain was occupied by
cently sightings have been quite rare. Black bears were also
esent in the past but these animals are now confined to less
pulated forested areas of the nearby foothills.

aver, mink and otter are found in the river and many of the
oughs and tributaries. Other furbearers include weasels, skunks,
coons, ringtail cats and foxes. Both coyotes and bobcats are
sidents of the drainage but are not often seen in the open
stures of the delta.

e many smaller mammals such as mice, gophers, ground squirrels,
ush rabbits and blacktail jackrabbits provide the food necessary
support the larger carnivores and raptors.

Fish

Sixteen species of fish have been identified from the lower Mad River. These include four species of salmon, two trout, two anadromous nongame fish, five freshwater nongame fish and four euryhaline fish. Additional species may infrequently drift downstream from the upper drainage but are not included in this text.

Anadromous Fish

King and silver salmon are the principal species comprising the annual salmon runs, although chum and pink salmon individuals have been observed on rare occasions. King salmon are first observed rolling in the estuary in early September and often move in and out with tidal changes. They migrate to upstream spawning areas with the advent of increased stream flows from early storms and have usually completed spawning by the first of January. The major silver salmon run usually follows the king salmon and spawning may continue through January.

The Mad River Salmon and Steelhead Hatchery, completed in 1971, is located 10 miles upstream from the mouth and contributes heavily to the natural salmon runs. The migrating adult fish are attracted and diverted into the hatchery where they are artificially spawned. The young fish are raised in concrete raceways and released at a size to optimize returns of adult fish. Most of the fish raised by the hatchery are released into the Mad River during the spring although sometimes fall releases are made.

entire life in fresh water or optionally
All size ranges utilize the estuary for feeding nursery
cially where streamside vegetation provides protection and cover. Although
the full importance is not completely understood, this riparian cover
appears to be a very critical factor in maintaining anadromous cutthroat
trout runs. While in the estuary, the trout feed heavily upon small crustaceans
and other fish. Predation upon fish appears to be more developed in cutthroat
trout than in either steelhead or silver salmon. After entering the ocean,
it is believed that the fish remain fairly close to the river mouth and when
conditions permit, move in and out with tidal changes.

Rainbow trout are found throughout the Mad River drainage, although most fish
in the lower drainages with access to the ocean are probably juvenile steelhead.

Pacific lamprey occur in the Mad River and are commonly observed in the river
during the spawning season in the early spring.

The three-spined stickleback is a common inhabitant of the Mad River and has
a similar life history as described for the Mattole River.

Freshwater Fish

Suckers are represented by one species, the Humboldt sucker, which is found
throughout the drainage.

Several sculpin species, locally called "bullheads" inhabit the Mad River
and include the spickly, riffle and coastrange sculpin.

Small individuals of all species provide an important food source for the
coastal cutthroat trout.

... were first imported into California in 1941. They have become an important minnow in some areas, but are considered a pest in others. They have been observed in the lower Mad River and particularly in a log pond located near Lindsey Creek, a major tributary of the Mad River. They may have a detrimental effect upon salmonids through competition for food and space. Green sunfish have also been observed in this log pond but are probably not a common resident of the river.

Euryhaline Fish

Four euryhaline fish species have been reported from the Mad River estuary and include the starry flounder, red-tail surfperch, Pacific staghorn sculpin and eulachon. Starry flounder extensively use the shallows and flats of the estuary for nursery habitat and probably as spawning areas. Often in the spring, large schools of red tail surfperch enter the river for the first few hundred yards and provide excellent sport fishing. The Pacific staghorn sculpin is an inshore ocean inhabitant which frequently enters brackish water areas. The Mad River is believed to be the southern limit for eulachon, commonly called candlefish. They enter the river to spawn during the late spring.

Invertebrates

In recent years, the Mad River estuary has expanded, creating additional habitat for estuarine invertebrates.

Noteworthy species include the Dungeness, or market crab, which utilizes the area for nursery habitat; Bay shrimp, amphipods, and isopods seasonally occur in the estuary and provide food for many fish species. Polychaete worms are found in the estuarine mud flats and form an important link in the food chain.

Aquatic and terrestrial insects associated with freshwater streams and the estuarine riparian vegetation are an important food source for many fish and wildlife species.

The mouth of the Mad River is subject to considerable tidal action and thus is unsuitable for most species of reptiles and amphibians which generally avoid saline environments. The associated marshes and wetlands of the Mad River however, support a fauna similar to that described for the Mattole River.

Resource 3
Recreational 3

The Mad River is a popular recreational attraction to North Coast residents and visitors alike. Because of low water and air temperature recreational pursuits popular in warmer climates are not common here. Consequently most recreational opportunities are tied closely to the areas fish and wildlife resources.

Hunting

Waterfowl hunting is the most significant appropriative wildlife use. Public hunting is limited to the river and tidal sloughs traversable by boat. Landowners and local residents who can obtain permission to trespass on private lands have the best chance of success. Some lands are leased for hunting clubs. The total hunter use is not known but it is believed to be relatively high.

Quail, pheasant, dove, snipe and rabbits are also hunted but opportunities are limited. Occasionally deer are reportedly taken although very little deer hunting effort is expended.

Trapping

No estimate of trapping effort or take is available but some such activity does take place. Fur trapping is conducted by many local youngsters as well as by seasonally employed adults as a supplementary income.

Sport Fishing

Anadromous fish support the majority of the sport fishing in the Mad River. With the return of migrating king and silver salmon into the river during the early fall, a small boat troll fishery and bank fishery developes in the estuary and lower river. Most

King salmon are naturally produced move downstream to the Mad River estuary in fall with the peak of downstream migration occurring around the first part of June. Peak out-migration from the estuary occurs during the first half of July.

The young salmon feed predominantly upon small crustaceans, aquatic insects, and other benthic and drift organisms in the estuary until they reach out-migrant size.

The Mad River supports a native winter run of steelhead which is augmented by hatchery smolt releases. Due to the high turbidity of the river after storms however, sport fishing is usually limited. In addition to the winter run fish, a small spring run of native summer steelhead enter the Mad River and ascend to holding areas in the upper drainage. These fish support a small local fishery in that area during the summer.

Releases of Washougal River, Washington, strain spring run steelhead smolts made in 1972 created a heavy fishery in the lower river during the spring of 1974. Since the run is dependent upon hatchery operations, further returns will rely on additional releases.

Native and hatchery produced steelhead smolts move through the lower river and estuary on their way to the ocean during April and May. In addition, many juvenile fish utilize the area for important nursery habitat.

Coast cutthroat trout inhabit the lower Mad River and several tributaries as far upstream as the North Fork. Anadromous and resident fish are usually difficult to distinguish except in areas above barriers that restrict sea-run fish. The anadromous form enters the Mad River in the fall and spawns in the late winter and early spring in tributary streams. The young may spend their

of the angling pressure. Although the river is open to winter angling for an additional 14 miles upstream to the confluence with Maple Creek. Private property and poor access prevents greater use in the upper reaches.

Steelhead enter the river in mid-fall and the fishing effort during this time is directed towards the migrating adults. Winter flow conditions and river turbidity usually curtail fishing activity after the first major winter storm, but in some years, dry winter conditions permit winter steelhead fishing to continue through February.

A small local fishery develops in the summer for native summer (spring run) steelhead which ascend into holding areas in the upper river canyons. The majority of the fish are taken by anglers who have access through the several large ranches in that area. In the spring of 1974, returns of Washougal strain summer steelhead introduced by the Mad River Hatchery, created a significant sport fishery in the lower river. It is estimated that anglers may have caught as many as 500 adult summer steelhead. The hatchery trapped an additional 187 fish for egg cultural purposes during the same period. The Department is presently actively working to improve and augment this fishery with native summer steelhead stocks.

Juvenile steelhead and resident trout are caught by anglers during the summer sport fishing season throughout the main river and most of the significant tributaries. Estimates of the total use and harvest are not presently available but may be very significant.

Candlefish and redbtail surfperch are sought by anglers in the spring near the mouth of the river. Candlefish migrate as far upstream as three miles and are occasionally caught by anglers when significant concentrations can be located.

Non-appropriative use of the delta is probably the most common use with the possible exception of sportfishing. Many people, both local and tourists, visit the area purely for its esthetic values. The observation of wildlife under such circumstances is a valuable part of their experience. Other people visit expressly to view birds and other wildlife as well as photograph them. The Mad River Beach County Park provides public opportunities for many of these activities on the estuary.

Boating

Most boating is done in conjunction with fishing or hunting although a minor amount of pleasure boating may also occur. Open water suitable for boat travel is quite limited. Launching facilities are provided by a public ramp at Mad River Beach County Park.

Scientific and Educational Use

Because of the proximity of Humboldt State University and College of the Redwoods a great deal of scientific and educational use is made of the Humboldt Bay-Mad River area. Field trips and individual studies to fulfill class requirements are frequently conducted. High school and grammar schools also utilize the area for field trips and classroom work.

In addition many studies in the fields of fish, wildlife, ecology, botany, geology, and pollution have been carried out by government agencies, independent foundations and private industry.

Collectively the knowledge gained through scientific and educational programs helps us to better understand the world we live in and to find better ways of preserving and utilizing our natural resources.

Sedimentation

Sedimentation is a chronic problem typical of most North Coast rivers. The unstable geological formations along with extensive upstream logging and road building lead to accelerated erosion and high silt loads in runoff waters.

Unfortunately, little is known about current siltation rates or the ultimate effects on natural resources. However, it is known that siltation reduces fish productivity by compacting spawning gravels, filling pools, raising water temperatures, lowering dissolved oxygen content and smothering food organisms. It is also known that high turbidity levels adversely influence angling success and effort.

The solution to sedimentation control lies in better land use controls, particularly in the area of logging, road building, land subdivision and livestock grazing. Until such time as better controls are implemented little can be done to solve the problem.

Flood Control

Periodic flooding of the lowlands by the Mad during winter storms has brought about many proposals for flood control. The recent consideration of a dam at Butler Valley by the Corps of Engineers is an example. Any structural devices on the river would most certainly effect fish and wildlife adversely. The extent of damage would depend on the type of project constructed. Any project considered should take into consideration the fish and wildlife involved and provide for full compensation of habitat lost to insure protection of the resource.

A better solution to flood control problems would be flood plain management. This involves non-structural methods of reducing flood damage, such as zoning land uses compatible with periodic inundation, building regulations and differential flood insurance rates favoring agriculture and other compatible uses.

The Mad River has not had a recent history of major pollution problems. From Blue Lake there is little human habitation over most of its length and no industrial activities which discharge into the river. There are, however, occasional discharges of harmful waste products below Blue Lake.

Several instances of fish kills resulting from the leaching of wood preservative chemicals from lumber mills have been recorded. As long as such chemicals are used without adequate measures to prevent them from entering streams periodic fish losses can be expected.

is a sewage treatment plant located below Blue Lake. The treated wastes are not known to be causing pollution at this time. High coliform counts have been registered downstream but the source is obviously not the treatment facility. The highest coliform levels were recorded at the mouths of Mill Creek and Warren Creek (Wood, 1972). At least part of the pollution probably is derived from septic system leaching. The source of the remainder has not been identified.

Efforts should be made to identify and stop pollution at its source to insure the maintenance of the highest possible water quality in the river and its tributaries.

Urban Expansion

The conversion of agriculture and wild lands to urban uses is probably the greatest threat to fish and wildlife. Subdivision and commercial development has accelerated rapidly over the past 20 years and shows no sign of stopping. The encroachment has moved outward from the City of Arcata along Highways 101 and 299. If the trend continues at the same rate severe adverse effects on fish and wildlife will result.

... it is too late the ... of the ...
... agricultural and wildlife ... proper zoning and adequate enforcement.
... lands and waters thus protected will guarantee continued production of much
... farm products and at the same time maintain open space and wildlife for
... esthetic, recreational and economic benefits.

Access

Access to the estuary is provided by Mad River Beach County Park and the public
boat launching ramp constructed by the Wildlife Conservation Board. Boat access
is also possible in portions of the old Mad River Slough. A 7.4 acre parcel of
county lands provides access near the old Canal School site on Mad River road.
Another county parcel of 3.36 acres provides river access near Azalea Reserve
State Park.

Fishermen can reach the river at several other locations on unposted private land.
This access, however, is not guaranteed and could be closed at any time by the
landowner. Legal access is not available on the majority of agricultural lands.

Access through easement or acquisition could be provided on both sides of the
river at the old railroad crossing. This would insure permanent access on the
river at locations which provide reasonable access and are used currently by
landowner consent on a temporary basis.

All legally navigable waters of the river and tidal sloughs should be identified
to allow maximum public use of areas which they are legally entitled to use.

LITTLE RIVER AREA

Drainage

Little River is a relatively small coastal drainage that enters the Pacific Ocean about six miles north of the Mad River in Humboldt County (Plate 1). The drainage basin is only 17 miles long and covers an area of approximately 40 square miles (Plate 9). Average annual runoff is estimated at 95,000 acre-feet/year. (Baruth^{and} Yoder 1971).

The terrain within the basin is not as steep and rugged as some of the other North Coast Drainages. The highest point in elevation is about 3100 feet. Most of the basin is covered by redwood forest, much of it second growth. Past logging activity beginning in the late 1800's has been heavy.

About three miles upstream from its mouth the river canyon opens into a flat coastal flood plain covering about 900 acres. This land is used primarily for livestock grazing and hay production. A sand spit separates the plain from the ocean.

Land Ownership and Access

The entire valley floor and upstream drainage are privately owned. Most of the timber land is owned by major lumber companies. The valley farmland is divided among several landowners (Plate 10).

The only public lands, excluding road and highway rights-of-way are the State tidelands of the river delta and the sand spit south of the mouth. The spit is part of Little River State Beach, managed by the Department of Parks and Recreation.

Access other than on the beach and by boat in the tidewaters is not available to the public. Use of the agricultural lands is largely restricted to those who can obtain permission of the owner. Some parts of the commercial timber lands are open to public use by written permit under certain conditions. Locked gates and use restrictions discourages much public use, however.

The valley lands are used for agriculture. The surrounding forest lands are devoted to timber production. Some residential and commercial developments are located near the beach and Highway 101 north of the river. Land use on the sand spit is entirely recreational.

The only direct use of river water is for irrigation. Approximately 325 acre feet are diverted from the river and its tributaries annually for this purpose (Baruth and Yoder 1971). Most other water uses are related to recreation, particularly sports fishing.

Water Quality

Samples taken at Crannell between December 1967 and April 1968 have shown Little River water to contain bicarbonate and some silica and an extremely low percentage of dissolved solids. Although little data is available regarding coliform bacteria it would be expected to be low because the drainage is sparsely inhabited. Cattle grazing on the flood plains could be a contaminating factor.

Natural Resources

Habitat

Compared to many of the other coastal wetlands the habitat variety of the Little River Delta is limited. The limit of habitat variability is reflected by similar limits in wildlife species numbers and variety. Although supporting less total numbers of wildlife than some other wetlands, the area is important to those species which use it.

Each of the habitat types represented supports those kinds of living things that prefer the environmental conditions it provides. In most cases a combination of habitat types is required.

of forest predominates in the surrounding foothills to the valley floor. These forests are typified by an overstory of sitka spruce, beach pine, douglas fir and red alder with an understory of salmon berry, red-flowering currant, salal and sword fern. Logged over areas may temporarily be in other stages of plant succession but will ultimately return to their former state in time.

Riparian woodland is found along the river and in a few isolated patches scattered through the agricultural lands. This differs from the other woodlands in that the dominant overstory is composed of willow and red alder. A dense understory of thimbleberry, salmon berry, blackberry and Himalaya berry is present in some locations.

The agricultural lands are mostly used for livestock grazing. Typical plant species are clover, fescue, brome, orchard grass, sweet vernal grass, rye grass, juncus and a variety of forbs. Many of these plants have been introduced by man.

The sand dunes of the spit are vegetated in some areas but bare in others. Where vegetation exists it includes such plants as European dune grass, bush lupine, dune tansey, sand verbena and beach strawberry.

The intertidal area is relatively small and confined to the river mouth west of Highway 101. The substrate is sandy and free of vegetation other than algae. This zone is covered by sea water during high tide periods.

The river channel itself is the only open water habitat. Except for the last mile it is quite narrow.

Permanent marshlands are virtually non-existent in the Little River flood plain. It is probable that some marsh did exist until man began reclamation activities. Today only seasonal marshes occur as a result of temporary flooding of low ground within the agricultural land.

A map showing the pattern of habitat is shown in Plate 11. The habitat types and acreages are shown in the following table.

Table IV
Habitat Acreage

Type	Acreage
Coastal Forest and Woodland	200
Riparian Woodland	87
Agriculture	380
Sand Dunes	135
Open Water	37

Wildlife

Mammals

The Little River basin is within the present range of the Roosevelt elk. Their tracks and signs can be found upriver but they seldom venture onto the floodplain. Black bear also occur in the forested areas but are not normally seen in open agricultural lands. Blacktail deer are the only big game mammals that regularly use the delta.

River otter are residents of the river, and mink, weasels, skunks, raccoons and ringtail cats use the woodland and riparian woodland. Bobcats and coyotes are less common locally but do occur particularly in the adjacent foothills.

Black-tailed jackrabbits, brush rabbits, tree squirrels, ground squirrels, mice, gophers and many other small mammals are numerous within the different habitat types.

and Birds

The variety of songbirds, upland game birds, raptors and other land birds found in the Little River delta is basically the same as that found in the nearby Mad River delta. A few species which commonly use the Mad River area may not be common at Little River because of habitat deficiencies. Otherwise the only real difference is in total bird day's use.

Water Birds

Because of the limited aquatic habitat available the use of water associated birds using the area are not high. The greatest use occurs in the lower estuary where a small intertidal area exists.

Waterfowl use the river and seasonally wet sites on agricultural lands to a limited extent. Scaup, buffleheads, ruddy ducks, mergansers, wood ducks and occasionally small groups of mallards, pintails, widgeon and teal are most common. The riparian cover along the river and its tributaries supports a small nesting population of wood ducks and some mallard nesting probably also takes place.

Shorebirds use the ocean beach and intertidal flats as well as the agricultural lands. Usually they are seen only in small flocks near the estuary. Some species, particularly killdeer, nest locally, while others are seasonal migrants.

Egrets and herons are regular users of the agricultural lands and the river. Common egrets and great blue herons are most often seen but black-crowned night herons and green herons are also residents. Both of the latter species probably nest in the riparian growth.

Other local species include coots, grebes, loons, murres, gulls and terns. Many additional species have been recorded but are not considered to be regular visitors.

Fishes

Anadromous Species

King and silver salmon, steelhead rainbow trout, coast cutthroat trout and Pacific lamprey are the principal anadromous fish species occurring in Little River. The three-spined stickleback is also present and may either be an anadromous or resident subspecies.

The salmon enter Little River at approximately the same time as they do other northcoast rivers which have sand bars that block the mouth in the summer. The fish appear to move fairly rapidly through the lower river, probably because of a lack of deep holding pools. They ascend to the upper main river and several tributaries for spawning. The juvenile fish follow similar life histories as that described for the Mattole River.

Cutthroat trout and juvenile steelhead use the river and estuary throughout the year, although a lack of cover in the tidal area probably reduces the value of the estuarine habitat. Areas above river mile 1.5 are protected by excellent riparian vegetation and fish numbers are probably greater. The adult fish spawn in areas similar to that used by salmon although they can utilize smaller sized gravels.

Freshwater Species

Little River supports two known freshwater fish species, the Humboldt sucker and coastrange sculpin. As with the Mattole River, other sculpin species may occur in the river but as yet, they have not been observed and identified.

Euryhaline Species

A variety of euryhaline fish have been observed in Little River including red-tail and barred surfperch, starry flounder, eulachon, night smelt, top smelt and pipefish. Most of these, with the exception of the starry flounder, are probably transient visitors to the estuary.

The small estuary of Little River supports most of the species of invertebrates mentioned in the Mad River section. One important addition is the razor clam, a very popular sport species, which occurs in the sandy beach areas near the river's mouth.

Amphibians and Reptiles

The amphibian and reptile fauna of the Little River is subject to the same limitations described for the Mad River and the species encountered in this area would be similar to those described for the Mattole River.

Virtually all coastal areas are attractive to recreation seekers. Little River is no exception. The publicly owned sand spit receives thousands of visitors each year. Most of this use is a direct result of the availability of biological resources and scenic beauty.

Hunting

Little River supports very little hunting use because of the private land trespass problem and the State Park status of the sand spit. Even if access was available the low populations of waterfowl and other game species would not attract many hunters.

Sport Fishing

Annual runs of salmon and steelhead are lightly fished in Little River due to poor winter water conditions. The first major storms which stimulate the entry of fish into the lower river usually muddies the water and eliminates potential angler use. Dry periods during the winter occasionally allow the river to clear sufficiently and permit a small bank fishery to develop consisting primarily of local residents. Summer resident trout fishing for rainbow and coast cutthroat trout occurs throughout the drainage. In the lower river, juvenile steelhead and yearling silver salmon are occasionally taken by anglers.

Surfperch, eulachon (Candlefish) and various smelt species are occasionally fished for near the river mouth. The actual angler use expended in these fisheries varies greatly from year to year depending upon availability and abundance.

Boating

The amount of water area suitable for boat traffic is extremely small. Consequently, the boating use is almost non-existent except for a few fishermen. No launching facilities are available.

Nature Study and Sightseeing

Some visitor use can be attributed to persons who are specifically looking at or photographing wildlife. By far the greatest use, however, is by persons who are enjoying the total scenic experience. The viewing of wildlife under these conditions is an integral part of this experience. The location of Highway 101 enables all travellers an easy opportunity to view the area even if they don't stop.

Scientific and Educational Use

Although both scientific and educational use is made of Little River the opportunities are not as great as those offered in other nearby areas. The greatest potential scientific use probably is in the invertebrate beach organisms, particularly razor clams. This beach, of which the Little River sand spit is a part, is one of the most productive razor clam habitats in the State.

Problems and Conflicts

Sedimentation

As in other coastal streams sedimentation increases brought about by heavy upstream logging is a threat to the maintenance of anadromous fish runs. The compaction of spawning gravels, filling of pools, destruction of food organisms, raising of water temperatures and lowering of dissolved oxygen content has resulted in the reduction of habitat quality and adversely affected fish populations.

Better controls of man caused erosion will be necessary if the resource is to be protected.

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The sand spit and tidewater zone are the only areas which currently provide for public use. The river upstream from Highway 101 does have potential for angling use if access could be provided. The best method would probably be through an easement for foot traffic along the river channel with at least one access point where vehicles could be parked.

Urban Expansion

This has not been a problem up until this time but the possibility of development is always present. To avoid destruction of scenic and biological resources agriculture and open space zoning with adequate provisions for enforcement should be initiated as soon as possible.

BIG LAGOON AREA

Drainage

Big Lagoon, as well as Stone and Freshwater Lagoons, were probably formed by a combination of forces including tide, wind and littoral sand drift. The barrier sand spits that were thus created act as dams across the mouths of coastal valleys and hold stream runoff waters much in the same way as a reservoir. In the case of Big Lagoon the barrier spit is periodically breached by high stream runoff and high tides. When this happens the lagoon water level drops and an interchange with sea water takes place.

The lagoon is located about 24 miles north of Arcata in Humboldt County (Plate 1). It is the southern most of three lagoons situated in the same general area.

The lagoon is fed by three tributaries known as Tom Creek, Pitcher Creek and Maple Creek. The largest is Maple Creek which has two forks one about six miles in length and the other about 14 miles. Pitcher Creek is four miles long and enters Maple Creek some two miles above the lagoon. Tom Creek, the smallest tributary, is only a little over two miles long. It enters the lagoon directly 1.5 miles north of the Highway 101 bridge. The total drainage basin of the three streams is approximately 57 square miles (Plate 18).

The highest point in the upper drainage is about 2000 feet. The entire area is densely forested with redwood and douglas fir, most of which is second growth. Logging activity is heavy as it has been for many years.

The lagoon is about 3.5 miles long and 1.3 miles wide at its widest point.

Although the water surface area fluctuates depending on whether or not the spit is breached it generally covers about 1,470 acres. The sand spit which separates the lagoon from the sea is 3.2 miles long and averages 700 feet in width at mean low tide.

A cross section of lagoon is somewhat saucer shaped with a maximum depth of 24 feet. The depth is quite variable because of the draining effect following breaching of the sand spit. The greatest depths occur when runoff water has filled the lagoon and before any opening of the spit has taken place. Shortly after draining maximum depth may be as little as 21 feet. The bottom is composed of soft mud except along the sandy spit and an area of clay on the southern shoreline.

Land Ownership and Access

Most of the lagoon is State owned and leased by the Department of Fish and Game for fish and wildlife management and related recreational uses. The acreage of these leased lands totals 1746 acres. The sand spit is also public land administered by the Department of Parks and Recreation. Some 270 acres are involved. About 50 acres in the southwest corner of the lagoon are part of the Humboldt County Park System. A small Indian Rancheria of about eight acres is also located on the south shore of the lagoon. The remaining land, except for road and highway rights-of-way, is privately owned, most of it by the Louisiana Pacific Corporation.

Because of the large amount of public land, including portions of the shoreline, access is well provided for. A land ownership map is included in Plate 19.

Land and Water Uses

The lagoon and much of its shoreline is used primarily for recreational purposes including boating, hunting, fishing and sight seeing. Picnic facilities and a boat launching ramp are available at Big Lagoon County Park. A boating club also has a site on the north shore near Highway 101 for use by its members.

A small residential community is located inland on the south side and a recreational sub-division has been developed nearby.

Situated east of Highway 100 are the residences and other facilities of the Louisiana Lumber Corporation, in operation. A mill and corporation yard with roads and an unused mill pond are located along the east side of the Upper Lagoon marsh.

Virtually all of the remaining lands within the drainage are devoted to timber production and harvest.

Water from Maple Creek is used to some extent for operations connected with the mill. At one time water was diverted into the mill pond for log storage. Although the pond is no longer used for this purpose it still contains water.

Water Quality

The water quality of the lagoon is generally good. No direct domestic waste discharge to the lagoon or its tributaries is known but some leaching of septic systems may occur. Upstream logging and road building have increased sedimentation and turbidity but the extent is not known. The sedimentation is visually apparent in the rapid silt buildup in the lagoon in the past ten years, however.

It is probable that industrial wastes occasionally pass into the drainage from the mill operation either from corporation yard runoff or accidental chemical spills, although no records of recent fish kills or other indications of such problems are known at this time.

Surface water temperatures of the lagoon range from 48°F to 70°F (McGie and Hayes, 1959). Lows are reached in February and the highs in June and July. The annual fluctuation is about 22 degrees.

Salinities range from 3.75 to 10.79 depending on time intervals following

breaching of the spit and Hayes. Highest salinities occur in the western portion of the lagoon during the time sea water enters.

Low salinities occur when stream runoff is high and before the spit is open to the passage of sea water. A vertical salinity stratification also exists. The more dense saline waters tend to resist mixing with less saline water except during breachings.

Natural Resources

Habitat

The significance of Big Lagoon in terms of wildlife lies primarily in the aquatic and marsh habitat it provides for water associated species. In a world where such habitat is rapidly being altered and destroyed each remaining unit increases in importance as other areas are lost.

The variety of habitat within the area is not as diverse as some other areas but the character of this and the other two Humboldt County lagoons is unique. No other coastal wetlands in the State are quite the same.

Each of the different habitats, including the adjacent forests, play an important role in maintaining many different kinds of wildlife both resident and migrant. They are categorized into nine different types according to physical and vegetative characteristics for the purposes of this report.

The largest single type is open water. This includes the deeper portions of the lagoon which are usually covered by water even when water levels are lowest.

Second is the submergent vegetation category, which involves the shallower water areas which are periodically drained by breaching of the spit. This type of habitat covers a large area in the eastern part of the lagoon and a narrow band around most of the remaining shoreline. Conditions are favorable

For growth of submergent vegetation which is quite common.

Sago pondweed and widgeon grass are the dominant plants.

Freshwater marsh is found only in the old mill pond which is separated from the lagoon by a man made dike. It contains water throughout the year and provides suitable conditions for such plants as cattail, silverweed, mares tail, sagittaria and duck weed.

The seasonal marsh covers a rather large area east of Highway 101, and a narrow band of shoreline along the northern and southern edges of the lagoon. It contains water when lagoon levels are high but periodically is left dry when waters are low. Because of the brackish nature of the lagoon the plants that grow here are more salt tolerant. The dominant plant species are bullrush, spike rush, silverweed, juncus, carex and three square. Large dense stands of bullrush cover much of the area east of highway 101.

Some smaller areas to the east and south of the lagoon are open grasslands. These areas support a number of grass and forb species including sweet vernal, orchard grass, bent grass, salt grass, clover and dock.

Vegetation on the sand spit is sparse. Along the waters edge some pickleweed is evident and salt grass, dune tansey, sand verbena, strawberry and morning glory occur on higher ground. Otherwise the area is typified by bare sand and driftwood.

Most of foothills surrounding the lagoon are covered by dense coastal forest of redwood, douglas fir, sitka spruce, beach pine and red alder. The understory is typically thick with such plants as salmon berry, salal, red flowering currant, elderberry, sword fern, coyote brush and blueblossom.

Urban areas are located to the south of the lagoon and along the north shore east

of the area. The only industrial site is also east of the highway. This includes a lumber mill and supporting facilities.

The habitat pattern is illustrated in Plate 20. A summary of habitat types and acreages is shown in the following table.

Table VII
Habitat Acreages

<u>Habitat Type</u>	<u>Acreage</u>
Open water	912
Submergent vegetation	558
Freshwater Marsh	75
Seasonal Marsh	345
Grassland	375
Sand Spit	280
Coastal Forest	
Urban and Industrial	225
Riparian	35

* Covers virtually all other lands in the drainage basin.

Wildlife

Big Lagoon and the surrounding forests support many different kinds of wildlife. Some are residents that live most of their lives within the immediate area. Others are seasonal migrants that spend varying periods of time locally and then move on. Winter is the peak season in terms of both numbers and varieties. Summer populations tend to be much lower, particularly for water associated species.

Water Birds

Between the months of August and May thousands of birds visit Big Lagoon on their annual winter migrations from northern breeding grounds. Some use the area only temporarily for feeding and resting on their long flights south. Others may spend the winter on this and nearby areas of habitat, constantly trading back and forth. Whether used for short periods or long periods, Big Lagoon is one of many key wetlands along the Pacific Flyway without which the survival of many birds would not be possible.

A small local population of waterfowl nest in the lagoon. Broods of both mallards and cinnamon teal have been observed in the marshes east of the highway, most often in the mill pond. The northern arrivals in the fall may increase the daily numbers to several thousand birds. Pintails, widgeon, mallard, greenwing teal, shovellers, scaup, canvasback, scoters, mergansers and ruddy ducks are the most common.

The puddle ducks primarily use the marsh and shallow water areas where they can reach submergent vegetation from the water surface. Most of their diet is vegetable matter although some do take small invertebrate organisms from the substrate as well. Most diving ducks, on the other hand, use the deeper waters to a greater extent since they can dive well below the surface in search of food. As a group they consume more animal matter than do the puddle ducks. Some species, scoters for example, feed almost entirely on marine invertebrates, while mergansers take small fish. Canvasbacks and ruddy ducks are exceptions. Like puddle ducks much of their food is vegetable matter.

few geese are seen in the lagoon but brant do pass offshore in large numbers and they occasionally rest on lagoon waters. Other species which have been recorded, though rarely, are Canada geese, snow geese and whitefronted geese.

Shorebirds are not as numerous here as they are in other coastal wetlands because of the lack of intertidal waters. When the water is high only limited feeding areas are available in the upper marsh and along the shoreline. When water levels drop to expose large areas of the lagoon bottom shorebird use increases substantially.

Those most commonly seen include western sandpipers, dunlin, sanderlings, dowitchers, yellowlegs, willets, godwits, killdeer and avocets. These birds feed on invertebrate life which they obtain by probing the mud and sand with their characteristically long narrow bills. Like waterfowl most nest far to the north. Only a few including the spotted sandpiper and killdeer nest locally.

The wading birds, egrets, herons and bitterns, are year long residents for the most part. The blue herons, green herons and night herons nest at a number of locations along the Humboldt and Del Norte County coast. As far as is known the common egret nests only on Indian Island in Humboldt Bay. The influx of these birds to the rookery and the coinciding reduction of birds elsewhere indicates most egrets return to Indian Island during the nesting season.

Food habits of all wading birds are similar to some extent. They feed largely on small fish, crustaceans, amphibians and reptiles. Some, including the common egret and blue heron often take mice, gophers and other small mammals.

During the day egrets and blue herons can be seen feeding in marsh and shallow water areas. Night herons do most of their feeding after dark and roost during the day. Bitterns tend to stay in heavy cover of tules and cattails where they are well camouflaged.

Many other water birds including coots, rails, grebes, loons, murres, cormorants, gulls, terns and pelicans use the lagoon regularly. Others like auklets, puffins,

petrels, albatross and terns are primarily offshore species but may sometimes be seen in or near the lagoon. Each species has its own particular preference for certain habitat types and food. Accordingly they will be found in those surroundings which provide them with the living conditions they require.

In order to determine water associated bird use on the lagoon, aerial census counts were conducted monthly between 1970 and 1973. The results are included in Appendix H.

Land Birds

Although too difficult to census, large numbers and varieties of terrestrial bird species are found in the vicinity of Big Lagoon. For the most part they are not dependent on aquatic or marine environments. Consequently they occupy the other types of habitat - forests, upland, grassland and, to a lesser extent urban areas. Like the water birds each species has its own habitat requirements and will be found in those ecosystems to which it is best suited.

Songbirds are the most numerous. This category includes over 80 species of sparrows, thrushes, flycatchers, wrens, larks, warblers, vireos, finches, juncos and others. Crows, ravens, jays, woodpeckers, flickers, swallows and hummingbirds are also represented. Many are residents but most are migratory to one degree or another.

Quail, blue grouse, ruffed grouse, mourning doves and band-tailed pigeons are upland game birds which inhabit the Big Lagoon area. All but doves and pigeons are permanent residents. These birds provide sport hunting opportunities during the appropriate season.

Predators are at the top of the avian food chain. All are flesh eaters and feed on a variety of small mammals and insects as well as other birds.

The osprey is a bird of prey dependent on the specific conditions provided by the large bodies of water they feed on fish. These birds nest only in larger streams and lakes that are capable of supplying fish in sufficient quantities to support them. North Coast osprey nesting sites are shown in Plate 21. (Plate 21 also locates heron rookeries).

Mammals

The only mammal of Big Lagoon that is strictly aquatic is the river otter. They are frequently seen near the Highway 101 bridge. The otter feeds on fish and other aquatic life and is a resident of most coastal bays, lagoons and streams. Mink, another member of the weasel family, are also found close to water but are not as dependent on aquatic habitat as the otter. Other local furbearers include weasels, skunks, raccoons, ringtail cats, coyotes, gray fox and bobcats.

The largest resident is the Roosevelt elk. Once widespread throughout the Coast Range, they are now confined to northern Humboldt County and Del Norte County. The highest populations occur between Big Lagoon and the Klamath River. A herd ranging between 30 and 40 animals uses the marsh and grassland east of Highway 101. This herd is especially important because they can be viewed regularly by persons travelling on the highway.

Deer are common in the foothills adjacent to the lagoon and bear sign is regularly seen. The mountain lion is much rarer but probably is present within the drainage basin.

Brush rabbits, tree squirrels, ground squirrels, gophers, mice and other small mammals are found throughout the different habitat types. Although less noticeable these smaller creatures are an indispensable part of the food chain that supports the larger carnivores and raptors.

known to occur in Big Lagoon and also species of anadromous, freshwater and euryhaline fish.

The anadromous fish include silver salmon, steelhead rainbow trout, coast cutthroat trout, Pacific lamprey, green sturgeon and threespined stickleback. Historically king salmon were planted in the lagoon but an annual run is not believed to presently exist. Silver salmon and trout utilize Maple Creek and the lower section of Tim Creek for spawning. The fish enter the lagoon directly from the ocean when a combination of high water levels and low tides break open the bar at the northern end. After spawning, the trout migrate back down into the lagoon and thence the ocean if the bar is open or later reopens. In years when the lagoon bar remains closed after a short open period, the outmigrating fish become trapped.

Juvenile salmon and trout migrate out of Maple Creek in a manner similar to other northcoast streams. However, a closed lagoon bar often prevents entry into the ocean and the fish are forced to take up residence in the lagoon and migrate out the following season.

Resident forms of both steelhead (rainbow trout) and coast cutthroat trout probably occur in the lagoon although it is difficult to distinguish these from the juveniles of sea-run fish.

Mult Pacific lamprey pass through the lagoon on their spawning migration into Maple Creek. The young may utilize the lagoon after their freshwater residence period prior to entering the ocean.

Threespine stickleback is a common inhabitant of the lagoon. It is an important forage fish for many larger fish and bird species. It is uncertain whether they are an anadromous or resident subspecies but the population probably contains both types.

Several green sturgeon have been observed. These probably entered the lagoon when the bar opened and were ultimately trapped. It is doubtful there are any sturgeon spawning in the lagoon or tributaries.

Two sculpin species, the riffle sculpin and the euryhaline Pacific staghorn sculpin, have been recorded from the lagoon. Both prey heavily upon young fish and in turn are consumed by large predators.

A myriad of euryhaline fish species have been observed in Big Lagoon during many investigations. Most of these fish are transient species which only occasionally enter the lagoon when it is open to the ocean. Some invariably become trapped and may take up residence if salinities do not significantly decrease and cause mortality. In addition, there are several species which can utilize the lagoon a significant portion of the year for nursery and possibly spawning habitat. These include the starry flounder, redbait surfperch, shinner perch and the previously mentioned Pacific staghorn sculpin.

Of special interest is the estuarine lagoon goby, found only in fresh and brackish water lagoons of California. A recent distribution and status report identified the lagoon goby from Big Lagoon but was not able to evaluate the present population status. It was felt however, that its restricted distribution in California and narrow habitat requirements make it particularly vulnerable and deserving careful attention.

lensate... occurring in... Large numbers of Foraminifera, protozoans, nemertea, molluscs, isopods, amphipods, copepods, cladocera, and polychaete worms have also been identified from the lagoon.

The amphipods, commonly referred to as scuds, are an important dietary item for fish in the lagoon and appear to favor sand bottoms.

the marshes and redwood forest surrounding Big Lagoon support an abundant amphibian and reptile fauna. The fauna is similar to that described for the other coastal wetlands.

Resource Use

Big Lagoon is a popular recreation site for both tourists and residents. Most of this use is directly related to the areas fish and wildlife resources. The abundance of these resources in conjunction with the high esthetic qualities attracts thousands of visitors annually. The local economic benefits derived from recreationists is second only to forest products in Humboldt and Del Norte Counties. To maintain and enhance these benefits will require the protection of the resources, both biological and scenic, on which this use depends.

Hunting

Waterfowl hunting is the most significant appropriate use of wildlife on Big Lagoon. It is one of the few wetlands remaining in California where unrestricted public access for hunting purposes is still available. The total hunting pressure is limited primarily by success. When hunting pressure gets too high the birds tend to stay offshore in the ocean during the day or move to other nearby areas of habitat. The lagoon supports an estimated 671 hunter days annually.

Most waterfowl hunting takes place in the marsh east of the highway or along the shoreline. Occasionally temporary blinds are constructed in the shallow water of the lagoon proper. Others hunt from boats, a few with skiff boats, one of the most efficient hunting methods.

Big game and upland game hunting is permitted on some lands adjacent to Big Lagoon owned by the Louisiana Pacific Company. Written permission is required. These lands may be closed to hunting at any time because of fire hazard or other reasons as may be determined by the company.

Fig. 1 provides a unique opportunity for Columbia anglers where steelhead salmon and trout can be caught in a lake or lagoon environment. Because of the closed bar situation anadromous fish access into the lagoon relies on a variety of environmental factors. When the bar is open, migrating salmonids apparently move rather quickly through the lagoon and into the tributary streams for spawning. As a result, fishing opportunities for fresh run fish are very spotty. Spent adult steelhead and coast cutthroat trout however, are often forced to take up summer residence when access to the ocean is blocked by a closed bar. The survival rate of these fish in the lagoon is unknown, but they do support minor, although constant, fishing pressure during the spring and summer months. In addition, juvenile fish migrating downstream from the tributaries into the lagoon contribute to this summer sport fishery.

Several of the euryhaline species provide a limited fishery, mainly for local residents who are aware of the seasonal timing of the bar openings.

Boating

Although most boating activity is associated with either fishing or hunting some pleasure boating does occur. The public launching ramp at Big Lagoon County Park provides sufficient access to meet any foreseeable demands for both sports and pleasure use. A yacht club situated along the north side of the lagoon provides some facilities for use by members.

The cold water and air temperatures are not conducive to many water sports popular in warmer climates. In addition the shallow depths over much of the lagoon and increasing siltation rates limits areas of use. As a result pleasure boating is not expected to increase a great deal beyond present levels.

Nature Study and Sightseeing

The existence of the three lagoons in an area of unique scenic beauty, and in close proximity to state and national parks creates an attraction of high magnitude for the thousands of tourists who travel each year on Highway 101. Redwood National Park recorded over 116,000 visitor days in 1974. Prairie Creek State Park recorded 341,944. Virtually all of these visitors would also have passed through Big Lagoon and had the opportunity to enjoy its scenic

beauty and natural life which can be seen from the highway.

It is also known that many visitors stop to fish, picnic, collect driftwood and otherwise use the area for varying periods of time. Although accurate estimates of user days are not available the total use is known to be substantial.

Many people are attracted to the area specifically to observe wildlife. The thousands of water birds and other wildlife that use the lagoon offer excellent opportunities for such use. The Roosevelt elk herd which can often be seen from the highway is especially popular. Management of the area by the Department of Fish and Game as a State Wildlife Area will probably result in increased use for wildlife observation purposes.

Scientific and Educational Uses

The unique nature of the North Coast lagoons make them particularly valuable for purposes of science and education. They are easily reached by a short drive from Humboldt State University and College of the Redwoods. Consequently they are used extensively by students and faculty for both educational field trips and studies necessary to fulfill class requirements. Some use by grammar and high school classes is also known to occur.

Problems and Conflicts

Sedimentation

All coastal estuaries and lagoons are gradually being filled by sediments carried by tributary streams. Under natural conditions this process is extremely slow and takes place over thousands of years. Man's activities which accelerate erosion many times above normal levels have hastened the filling process alarmingly. In only a few years the eastern part of Big Lagoon has aggraded substantially by siltation, and the water surface area has been much reduced

as a result. If the marsh is continued the marsh and aquatic habitat available for water associated wildlife will be greatly diminished.

In the case of Big Lagoon, logging and road building are the activities responsible for increased erosion. Logging practices used in the harvest of redwood forests cause a great deal of soil disturbance. When vegetation is removed by clear cutting, the heavy winter rains carry the eroded material into the streams and eventually the lagoon where it is dropped by the reduced water velocity.

The problem has been compounded by the Highway 101 causeway which acts as a dike and tends to cause retention of more silt on the upstream side.

The only hope of reducing the problem lies in better erosion control measures and changes in logging practices which would give more attention to the protection of other resources.

Urban Expansion

At the present time there does not appear to be an immediate threat from urban expansion. However, such development could be a real possibility in the future. The subdivision south of the lagoon is an indication of what could happen in other areas.

Although most of the lagoon proper is in public ownership much of the adjacent forest land is privately owned. At any time these lands could be converted from timber production to recreational homesites given the right economic incentive. Proper zoning and enforcement will be necessary to insure maintenance of the lagoons biological and scenic resources. The only other answer would be public acquisition of a protective strip surrounding the lagoon.

Protection of Osprey Nests

Ospreys require relatively large snags or live trees in close proximity to feeding areas for nesting purposes. The clear cutting of forests surrounding the lagoon may eliminate suitable nesting sites if steps are not taken to preserve some old growth habitat. All existing nest trees and a buffer zone around each of them should be identified and given permanent protection to insure continued osprey nesting opportunities.

Pollution

The greatest potential pollution problem comes from residential septic tank leaching.

Urban and commercial developed sites are limited to a few industrial homesites and a couple of recreationally oriented enterprises.

Habitat acreages by type are shown in the following table:

Table VIII
Habitat Acreages

<u>Type</u>	<u>Acreage</u>
Open Water	385
Submergent Vegetation	136
Marsh	80
Agriculture and Grassland	364
Riparian Woodland	20
Woodland and Coastal Forest	537
Sand Spit	157
Urban and Commercial	8

Because of the migrant habits of many species the populations of wildlife using Big Lagoon fluctuate from season to season and even day to day. Winter is the peak period when the large flights of waterfowl and other water birds arrive from northern breeding grounds. Mammals are largely resident species that are present year round.

For most species of mammals and land birds it is very difficult to obtain accurate information on total numbers. For this reason no population data is available on those species. Most water associated birds, however, can be censused by airplane since they spend much of their time on open water or other areas where they can be seen. Population data expressed in terms of bird days use is included Appendix I (Wildlife use is shown separately for Dry Lagoon).

STONE LAGOON

Drainage

Stone Lagoon is located on Highway 101 38 miles north of Arcata (Plate 1). It lies between two other lagoons; Big Lagoon to the south and Freshwater Lagoon to the north. It covers an area of 521 surface acres when full and has an average depth of 15.5 feet (Pogue and Johnson, 1956). It is about 1.5 miles long and 0.6 miles wide. A sand spit about one mile in length with an average width of approximately 600 feet separates the lagoon from the sea. The unique sedimentary rock formation of the shoreline was probably the result of upheaval from subterranean pressure. This rock, known as Kerr Ranch Schist, was probably laid down prior to the late upper Jurassic period (Manning and Agle 1950). Much of the lagoon bottom is composed of this material.

The drainage basin includes about 12 square miles of steep mountains terrain covered largely by coastal forests of redwood and douglas fir (Plate 22). Elevations range from sea level to 1850 feet.

Several small streams drain into the lagoon. All but one, McDonald Creek, are intermittent and dry up during the summer.

The sand spit occasionally is breached by tidal and wave action when lagoon water levels are high. When this happens the lagoon drains rapidly until only the deepest portions contain water. The breach usually lasts only for a day or so at a time before sand buildup closes the opening (Pogue and Johnson 1956).

Just south of Stone Lagoon is a small side drainage that contains a marshy area known as Dry Lagoon. This site was probably a former segment of Stone Lagoon which has somehow been separated from the larger body of water and gradually filled with silt.

Land Ownership and Access

Dry Lagoon, the sand spit, and a large part of the shoreline is State owned land administered by the Department of Parks and Recreation. The lagoon is State tideland controlled by the State Land Commission. Except for road and highway rights-of-way the remaining lands surrounding the lagoon are privately owned (Plate 13).

Public use of Stone Lagoon is assured by the ownership pattern. Inland access to portions of the shoreline is restricted by intervening private lands but this is not considered to be a real problem. Boat launching facilities are available along Highway 101. This boat ramp is in private ownership but permission to use it can usually be obtained from owners at Red Hen Cafe. Small car top boats can be launched at the north end of the lagoon from park lands.

Land and Water Uses

Water use of the lagoon proper is strictly recreational. Some water is diverted from McDonald Creek and other tributaries for agricultural use. No other use of basin waters is known.

The public lands are devoted to recreational use. Most of the private lowlands east of the lagoon are pastures used for livestock production. Several residences are also located in these lowlands along with a private campground and recreational vehicle park. The surrounding forests are intensively managed for timber production except for a few open areas where grazing is possible

Water Quality

The absence of urban centers or industries in the drainage has helped to maintain relatively good water quality in the lagoon. Some livestock wastes probably enter lagoon waters through its tributaries, although the quantity and its effects are not known.

Logging and grazing activities in the drainage have probably caused some increases in sedimentation but the tributary streams suffer more from the effects than the lagoon since the waterflow is relatively small.

Salinities vary as a result of the periodic interchange with sea water.

Generally the lagoon is more saline near the spit and less saline close to the mouth of McDonald Creek. Salinity readings range from seven parts per thousand to 30 parts per thousand with lows coming with increased precipitation until such time as the spit opens to the sea. A rapid increase in salinity occurs immediately after breaching (Dawson, 1969).

Water temperatures range between 8°C (46°F) to 22°C (72°F) with lows during periods of high precipitation between December and March and highs during the summer months of July and August. (Dawson, 1969).

Natural Resources

Habitat

Several distinct habitat types are found within the immediate area of Stone Lagoon. Each of these types, or the combination of several, provides the conditions necessary to support the various kinds of fish and wildlife that occupy them. Plants, soils, water and many other factors are all components that influence environmental situations which may exist at any site. The quantity, quality and variability of habitat is directly related to the kinds and numbers of other living things the area will support.

The Stone Lagoon area has been divided into eight habitat categories for discussion. The pattern of their occurrence is shown in Plate 14.

Much of the lagoon is classed as open water. This area includes the deeper waters

which do not support bottom rooted vegetation to any great

The shallower waters in the eastern and a narrow band of shoreline are classed as submergent vegetation. In this shallow water zone aquatic vegetation, largely widgeon grass and sago pondweed, is abundant. In terms of waterfowl use, it is this area that is most productive.

Also along the shore is a band of edge vegetation classed as marsh. Typical plants include great bullrush, spike rush, three square and juncus. In many areas plant densities are low and confined to a very narrow strip along the waterline. The upper part of the lagoon is an exception. Here the marsh is rather extensive and is densely covered by bullrush.

Agriculture and grasslands are located east of the lagoon and in a few scattered locations to the north and south. Most of the grass and forb species have been either intentionally or accidentally introduced by man. Typical species include orchard grass, salt grass, rye grass, brome, fescue, sweet vernal grass, clover, plantain, dandelion and a host of others.

Riparian woodland separates the marsh from the agricultural land east of the lagoon. Land clearing for additional pasture space has greatly reduced original stand. It is typified by an overstory of alder and willow with an understory of salmon berry, thimbleberry, salal, rhododendron and sword fern. The woodlands south of the lagoon are interlaced with dense stands of brush including such species as coyote brush, blueblossom, red-flowering currant and other woody species.

The sand spit is sparsely vegetated with salt grass, pickleweed, dune tansey, morning glory and other more salt tolerant plant species. Driftwood in all shapes and sizes litters much of the area.

Water Birds

The greatest use recorded on the lagoon is by waterfowl. Over 670,000 waterfowl of use is sustained annually with the largest numbers occurring between October and April. Scoters, scaup, ruddy, ducks, canvasbacks, buffleheads and other diving ducks are most numerous. This is a reflection of the predominant habitat type. Puddle ducks are less abundant but mallards, pintails, widgeon, shovellers, teal, gadwalls and woodducks are regular users.

At least some nesting takes place as indicated by observations of both mallard and gadwall broods recorded during July and August (Helmke, 1969).

Shorebird use is low, probably because of the absence of intertidal flats or other suitable feeding habitat. Much of the use is noted on the sand spit, particularly along the ocean beach. Western sandpipers, dunlin and sanderlings are most frequently seen.

Blue herons, night herons and common egrets are regular visitors but they are not numerous. Dry Lagoon and the tule marsh east of Stone Lagoon provides suitable habitat for bitterns, Anthony's green herons and occasionally cattle egrets and snowy egrets may also be seen. The available habitat in and around Stone Lagoon is apparently not sufficient to attract high wading bird use.

The lagoon supports a wide variety of other water birds including rails, coots, grebes, loons, cormorants, kingfishers, pelicans, gulls and terns.

In addition a number of offshore and pelagic species such as auklets, puffins, murres, petrels, albatross and jaegers are sometimes seen.

Land Birds

The forests, uplands and agricultural areas surrounding the lagoon provide habitat that harbors a variety of land birds. This category includes

songbirds, upland game birds, raptors and . . . with a few exceptions, such as the osprey, they are not dependent on aquatic habitat but may periodically use such areas.

Mammals

The mammals of Stone Lagoon include the same species found at nearby Big Lagoon.

Fishes

Stone Lagoon has a fish complement similar to Big Lagoon although many of the euryhaline species have not been verified from Stone Lagoon. Presently, a total of 12 fish species have been observed and recorded (Appendix D).

Silver salmon, steelhead rainbow trout, coast cutthroat trout, and Pacific lamprey all rely on openings in the bar to gain entry into the lagoon and thence McDonald Creek for spawning. Openings do not occur as frequently as in Big Lagoon, possibly because of a smaller drainage. Because of this, the anadromous fish populations are subject to greater year to year fluctuations. Juvenile silver salmon and trout utilize the lagoon as a nursery area and probably migrate out when the lagoon opens in the late spring or fall.

Both Pacific lamprey and threespined stickleback occur in Stone Lagoon and fill ecological niches similar to those in Big Lagoon.

The fact that only four ocean or euryhaline fish species have been recorded from Stone Lagoon as compared to 18 from Big Lagoon probably reflects the intensity of past investigations at the two lagoons. Undoubtedly, many of the species recorded from Big Lagoon could and probably do occasionally occur in Stone Lagoon and future studies may verify this fact.

The presence of the lagoon goby was recently verified by the collection of a single adult from near the mouth of McDonald Creek. Further collections may indicate the presence of a larger population.

A wide variety of invertebrates were found in the lagoon. An unidentified bryozoan was the most abundant. Other invertebrates included foraminifera, protozoans, nemerteans, isopods, amphipods, mysids, decapods, and mollusks of various species.

The amphibian and reptile fauna of this area would be subject to the same limitations as those described for Big Lagoon but would otherwise support similar species.

DRAFT

Resources

The scenic qualities and proximity to other important North Coast recreational areas make Stone Lagoon a popular tourist attraction. Highway 101, which passes along the lagoon's shoreline, provides the opportunity for travelers to enjoy the area even though they may not stop. For those who do choose to stop the biological resources offer many hours of enjoyment under a variety of circumstances.

Hunting

Waterfowl hunting is the most significant appropriate use of lagoon wildlife. Most hunting is done from boats, particularly scullboats; some hunting is done from the shore but this method is much less successful. The total use is not known but a few hunters can be found on the lagoon on most days during the season. Because of the nature of the lagoon and the methods of huntings, there is little potential for increased opportunity.

Some deer and upland game hunting is done by local residents in the adjacent foothills. No significant increase above present levels is expected.

Sport Fishing

Openings in the sand bar at Stone Lagoon allow anadromous fish access in a manner similar to Big Lagoon, but because of a smaller drainage, they occur less frequently. Sport fishing pressure for salmon and trout is heaviest after sand bar openings, although like Big Lagoon, a light amount of pressure occurs throughout the year.

Boating

Although some pleasure boating does occur, most activity is associated with either hunting or fishing. Boats can be launched near the highway on the northeastern corner of the lagoon. From the standpoint of protecting wildlife

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resources and fishing quality, increases in pleasure boat use would not necessarily be desirable.

Nature Study and Sightseeing

The lagoons greatest potential for public use is non-appropriative activities related to natural history and esthetic qualities. At the present time thousands of people enjoy the outdoor experience, including the observation of wildlife, offered by visiting this area. Dry Lagoon State Park received 116,653 visitor days in 1974. Many people visit specifically to observe the wildlife. Such uses are expected to increase substantially in the future.

Scientific and Educational

The North Coast lagoons and other wetlands are frequently used for educational purposes. Grammar schools, high schools, College of the Redwoods and Humboldt State University conduct field trips for outdoor class work. In addition a number of studies have been made by college and university students to fulfill undergraduate and graduate class requirements. Public agencies and private researchers have also utilized these wetlands in the search for knowledge relating to fish, wildlife, natural resources, ecology, geology and other fields. As our world gets more complex and greater demands are placed on our resources the availability of such areas for research will become increasingly important.

Problems and Conflicts

Urban and Recreational Development

There does not appear to be an immediate threat of urban development but the possibility is always with us. Private lands now used for agriculture or timber production could be sub-divided for recreational homesites if the economic incentive is favorable. This kind of activity would destroy wildlife habitat and impair the esthetic quality. Because of the important biological resources

and high economic value. The area is a prime place for the area's protection and, therefore, requires planning and enforcement.

Ecological damage could also result from recreational development on State Park lands. Proposals have been made to construct a boat launching ramp, parking lot, roads and campgrounds on the southeastern portion of the lagoon shoreline near the mouth of McDonald Creek. Such action would destroy marshland and other habitat in a very fragile area. The resulting human use on this site would also reduce wildlife use on adjacent habitat.

An important part of the State Park function is to preserve natural resources with this in mind it would seem improper to consider development that would destroy wildlife habitat of very high value. Every effort should be made to direct development into areas where the least damage to ecological systems will result.

Removal of Riparian Woodland

Recently land clearing activities aimed at increasing pasture acreage have caused the loss of part of the remaining riparian cover east of the lagoon. Without controls more habitat may be destroyed in the future. Perhaps the best assurance of protection would be acquisition of the remaining cover.

Pollution

The major source of pollution in Stone Lagoon is McDonald Creek and its tributaries. Livestock wastes enter the creek and are then transported downstream to the lagoon. Other sources such as septic system leakages or direct discharges may occur but are not well documented.

FRESHWATER LAGOON

Drainage

Freshwater is the smallest of the three Humboldt County lagoons. It covers an area of about 245 acres, is a little over one mile in length and is about 1/4 mile wide. It is located 40 miles north of Arcata on Highway 101 (Plate 1).

The lagoon is bowl like and fairly uniform in depth with a soft muddy bottom. The average depth is 14 feet with a maximum of 17 feet. Only one tributary, Owl Creek, enters the lagoon and it is intermittent.

The 2.2 square mile drainage basin is composed of low foothills of the Coast Range (Plate 23). The area is mostly covered by redwood forest that has been heavily logged in the past. Dense brush is typical of some areas close to the beach and in areas that have been recently logged.

Unlike the other two lagoons, Freshwater Lagoon does not periodically open to permit water exchange with the sea. A water control device located in the northeast corner prevents breaching of the sand spit.

Land Ownership and Access

The lagoon is publicly owned as state tidelands. The sand spit is also in public ownership. Much of the remaining land is in private ownership (Plate 13).

Land and Water Uses

The primary use on the lagoon and adjacent sand spit is recreation. Freshwater Lagoon receives greater use than either of the two other

1. At of the lagoon is water with average depth of 14 feet. This zone can actually be divided into two habitat types. The deeper center portion is free of vegetation and is classed as open water. Surrounding this deeper water is a wide strip of shallower water that contains submerged vegetation in varying densities. The dominant plant species involved is elodea.

Freshwater marsh occurs in the southeast corner of the lagoon at the mouth of Owl Creek, and as a narrow strip extending along most of the remaining shoreline. Typical plant species include bull-rush, rush, spike rush, silver weed, pond lily and duckweed..

The only grassland habitat of any size is found on hillsides north and east of the lagoon. Sweet vernal grass, orchard grass, bent grass, clover and dandelion are common representative plants although many other grasses and forbs occur. A few other small areas of grassland exist within other habitat types.

The sand spit is largely bare sand littered with driftwood but some sparse vegetation including salt grass, dune tansey, beach strawberry and pickleweed is present above the high tide line.

Large brush fields cover portions of the adjacent hillsides to the north and east. For the most part these areas are typified by dense growths of blueblossom, elderberry, huckleberry, willow and coyote brush.

Coastal forests are composed of typical coastal forest overstory species such as redwood, Douglas fir, Sitka spruce and red alder, usually accompanied by a dense understory of salal, huckleberry, blackberry and sword fern. Differences in successional stages are common as a result of logging.

The urban classification includes several residences along the eastern shore. The acreage involved is relatively small.

Habitat acreages are shown in the following table:

Table II

Habitat Types and Acreage

Type	Acres
Open Water	110
Submergent Vegetation	135
Freshwater Marsh	15
Grassland	55
Sand Spit	55
Coastal Forest and Brush Fields	1,022
Urban	8

Wildlife

Wildlife use of Freshwater Lagoon is inhibited to some extent by the heavy recreational activity. This, along with habitat limitations, probably has reduced the value of the area for wildlife compared to what it was in years past. In spite of these limitations the lagoon is still important as a coastal wetland for many water associated species.

Census data for water associated bird use is included in Appendix J. No population data is available for other species.

Water Birds

Most waterfowl use is by diving ducks. Except for the shallow marsh along the shore the habitat is not attractive for puddle ducks. Ruddy ducks, scaup, canvasbacks, buffleheads, scoters and mergansers are most frequent users. Only small numbers of mallards, pintails, teal and shovellers were recorded during census flights.

Some nesting of mallards and cinnamon teal may take place but no records of broods are available. If nesting does occur it is probably very limited since suitable habitat is in short supply.

Shorebirds are the most common birds in the area. Because of the high water level or flooded producing habitat, Freshwater Lagoon does not attract large numbers of birds. Only a few blue herons, black-crowned night herons, and bitterns are known to use the area. Most of this use is recorded in the marshy perimeter.

The greatest bird use comes from a variety of other water birds including coots, grebes, loons, cormorants and gulls. In addition, a number of offshore species such as auklets, puffins, murres, petrels, terns, albatrosses and jaegers may be observed occasionally.

Land Birds

The songbirds, upland game, raptors and other avian groups of which this category is composed include basically the same species found in adjacent areas already discussed. With few exceptions, notably the osprey, these birds do not require large bodies of water or marshland. For the most part they occupy various habitats in the surrounding areas although they may be seen from time to time about the lagoon.

Mammals

The river otter and mink are the only aquatic species which use the lagoon regularly. The many other mammals found locally are not directly dependant on the environmental conditions provided by the lagoon. The species involved are the same as those described in the Big Lagoon, Stone Lagoon and Redwood Creek sections of this report.

Fish

Freshwater Lagoon may have historically supported anadromous fish but because of present inadequate passage into the lagoon and lack of suitable spawning tributaries, does not currently support any runs. The lagoon has been the recipient of many fish introductions although only six species are believed to presently exist (Table).

Chemical treatment of the lagoon was conducted in 1965 and probably eliminated several native species. Natural reintroductions from a tributary, Owl Creek, probably included threespined stickleback, riffle sculpin and coast cutthroat trout. Catchable rainbow trout have been annually planted in the lagoon which has also historically received plantings of cutthroat trout, Eastern brook trout, Atlantic salmon and kokanee. A single large brown trout was taken in a gill net in 1972 and was probably inadvertently included in a catchable trout plant.

Surplus juvenile steelhead from the Mad River Hatchery have also been recently stocked in the lagoon.

Gold smelt were introduced in 1959 as a forage fish for salmonids and were not totally eliminated in the 1965 chemical treatment. The smelt appear to be an important item in the diet of larger trout.

The lagoon goby was identified from Freshwater Lagoon in 1951 but recent attempts to locate other specimens have been unsuccessful. Additional collecting may discover the presence of a small population.

This freshwater lagoon supports a diverse
ing primarily of freshwater insects, and
Fish are the primary predators on these
wildlife species, especially birds, which
adult aquatic insects.

Freshwater lagoon... influence... ocean waters and thus offer
breeding habitat for amphibians in the marsh and at the south end of the
lagoon. The amphibian and reptile fauna encountered in this area is
similar to that described for the Mattole River and other coastal wetlands.

Resource Use

Freshwater Lagoon receives intensive recreational use. Its location, proximity to a major highway, easy access and sportsfishing opportunities attracts thousands of visitors annually. It is expected that this use will continue to increase in the future.

The scenic quality and natural resources make the north coast area an important tourist attraction. Tourism is second only to the lumber products industry in Humboldt and Del Norte Counties local economy (Greater Eureka Chamber of Commerce, 1964). In order to maintain and enhance economic values protection of these resources should be a high priority in making land use decisions.

Both appropriate and non-appropriative uses of biological resources are involved in relation to recreational visits. Hunting and fishing are examples of appropriate use. Non-appropriate uses include photography, nature study and sightseeing.

Hunting

Hunting is not an important activity on Freshwater Lagoon although

it does take place to a minor extent. Waterfowl are the species most often sought. Hunting is done primarily from boats but a few hunters do hunt from shore. The lack of large numbers of ducks and the resulting poor success is the limiting factor.

Some upland game and deer hunting probably is done within the drainage but again opportunities are limited. No figures on hunter days use are available.

Sport Fishing

Catchable rainbow trout support an estimated 10,000 annual angler days at Freshwater Lagoon. Anglers harvest approximately 11,500 fish each season, the majority of which are caught in the summer and fall months.

Boating

Probably more recreational boating occurs on Freshwater Lagoon than on either of the other two lagoons. The uniform water depths and other characteristics are more suitable for boating and such activities as water skiing. The lagoon size, however, limits the degree of boating that can safely take place on a given day. In all probability it will not support much increase in use without serious conflicts with fishermen and other users.

Nature Study and Sightseeing

Unquestionably the greatest total use involves this category of non-appropriative recreation. Large numbers of passing tourists stop on the sand spit adjacent to Highway 101 to walk along the beach, camp, picnic and enjoy the scenery. This use is encouraged by parking space and public rest rooms. Whatever the reason for stopping, the visitors total recreational experience is enhanced by the ability to see and enjoy wildlife in its native habitat.

In addition to the passive users, many visits are made by persons expressly for wildlife observations and photography. Many are willing to travel great distances to see birds or mammals which they cannot see closer to home.

Scientific and Educational Use

As with other coastal wetlands the opportunity for both scientific and educational uses is always present. The extent of actual use for such purposes up until the present time has not been great however. Part of the reason is probably the presence of more attractive wetlands, in terms of plant and animal diversity, closer to Humboldt State University and other schools in the Eureka-Arcata area.

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Problems and Conflicts

Urban Development

Several homes are now located on the east shore of the lagoon. Additional development could occur at any time since these lands are privately owned. Further construction would detract from the scenic beauty, destroy wildlife habitat and pose potential water quality problems through septic system leaching. In order to prevent such damage the area should be zoned for uses compatible with open space and conservation.

Excessive Use

The location of the lagoon makes it very accessible to large numbers of people. The present high use is believed to be a major factor inhibiting use of the lagoon by many kinds of water associated wildlife. As human activity increases wildlife use can be expected to decline accordingly and since wildlife is an important part of the recreational value, part of the enjoyment of visiting the lagoon would be lost.

Conflicts between types of use are also certain to arise. An obvious example is pleasure boating and fishing. Fishermen are not happy with fast moving ski boats and water skiing becomes hazardous with the presence of many anchored or trolling fishing boats. In some way these conflicts will have to be resolved at sometime in the future.

REDWOOD CREEK

Drainage

Like most other major coastal streams in Humboldt County, Redwood Creek has its beginning far south of the mouth. It flows northwesterly on a course roughly paralleling the Mad River for approximately 61 miles before entering the sea near the town of Orick, some 40 miles north of Eureka (Plate 1).

The Redwood Creek drainage basin covers 276 square miles (Plate 12) of steep mountains and canyons ranging to over 5,000 feet in elevation. For the most part the entire area is heavily timbered with Douglas fir and mixed conifers at higher elevations, and redwoods in lower coastal forests. A narrow flood plain extends upriver from the mouth for approximately four (4) miles. The flood plain is primarily used for agricultural purposes.

Redwood Creek produces the high stream flows during winter storms typical of north coast streams. Highs of over 50,000 c.f.s. (cubic feet per second) have been recorded 2.5 miles from the mouth. During dry periods the stream flow may be as low as 10 c.f.s. (U.S. Dept. of Interior G.S., 1969).

Land Ownership

Most of the lands within the study area are privately owned with a few exceptions. An extension of Redwood National Park includes a quarter mile wide strip running completely through the flood plain adjacent to the beach. Parts of this strip are still being used by former landowners under agreement with the Park Service. This use will eventually be phased out over a period of years.

Parts of the lower creek and its estuary are state tidelands. In addition the county owns a small parcel at Huffords Road. Land ownership is shown on Plate 13.

Within the flood plain the dominant land use is agriculture. Most of the lands are used for livestock grazing or hay production. Commercial and residential uses are centered in the town of Orick and along Highway 101 to the north and south.

The surrounding drainage is used primarily for timber production. These lands have been subjected to heavy logging for many years. Two lumber mills are located on the flood plain.

Redwood Creek and the beach areas are used extensively for recreation. The proximity of the National and State Parks attract large numbers of summer visitors. Although some water from the basin, mainly small tributary streams, is used for irrigation and industrial purposes, the heaviest use is also associated with recreation.

Water Quality

Because of logging and road building activities upstream Redwood Creek carries heavy silt loads during high run-off periods. Otherwise the stream is relatively free of pollutants. No direct sewage outfalls are located on the stream and no significant centers of human habitation exist above Orick. Some minor leaching of septic systems may reach the creek waters but the extent is not known.

Natural Resources

Habitat

The study area can be divided into a number of habitat types based on vegetative communities and other environmental factors. For the purpose of this report, 10 categories have been identified. These include open water, intertidal flats and river bars, sand dunes, salt marsh, freshwater marsh, riparian woodland, woodland,

upland, and some of the agricultural areas. Some of the urban, commercial and industrial areas have lost their value for wildlife. The remaining areas are all of importance to wildlife in varying degrees. Plate 14 illustrates the various habitats within the delta.

The open waters of the stream and its estuary are free of vegetation other than algae. The water surface area is not constant because of daily tidal fluctuations and seasonal stream flows. Redwood Creek itself is relatively shallow (except during periods of high run-off) but it gradually deepens near the mouth.

During most of the year the stream occupies only a small part of its channel. The exposed portion is composed of sand, gravel and river rock with little vegetation of any kind. The bottom sediments become finer in the estuary to form intertidal flats of sandy silt. These flats are alternately covered and exposed by the changing tides. The amount of this habitat type, particularly in the estuary has been greatly reduced by the construction of levees for flood control.

The sandy beach is bare of vegetation below the high tide line and is littered with logs and other debris. Vegetation on the dunes above high tide changes with the degree of sand stability. Closer to the sea dunes of dune grass, sand verbera and strawberry are common. Plants such as lupine, purple beach pea, dune tansey, plantain, bur clover and blackberry become dominant farther inland.

Salt marsh is extremely limited and occurs only as a fringe area between the intertidal flats and the higher ground. Salt grass is the primary plant cover.

Freshwater marsh is also limited and occurs only in a few locations. Plant species which are characteristic of these marshes are sedges,

willow, salal, skunk cabbage and huckleberry. During winter flooding, the pasture lands may also become flooded to form seasonal marsh.

Riparian woodland is found in only a few remnant stands near old stream channels and tributaries. Only one stand remains on the main Redwood Creek channel. The channeling of the stream for flood control destroyed much of this habitat type. That which remains is typified by an overstory of red alder, black cottonwood and willow. The understory is composed of salmon berry, thimble berry, elderberry, black twinberry, blackberry and cow parsnip.

In contrast other woodlands are dominated by redwoods, Sitka spruce and alder with an understory of salal, thimble berry, elderberry, huckleberry and sword fern. These woodlands are found on the foothills adjacent to the valley floor.

Upland vegetation composed of, coyote brush, silktassel, poison oak, thimble berry and lupine, is rare and occurs mainly in small patches within or adjacent to other habitat types.

The most extensive vegetative type is agricultural. Most of the valley floor and large areas in the surrounding foothills are used for livestock grazing and, to some extent for hay production. Most of the plants are introduced species. Some of the most common are clover, blue grass, sweet vernal, brome, ryegrass, velvet grass, sheep sorrel and dandelion.

A summary of the various habitat types and acreages is shown in Table V.

Invertebrates

Natural invertebrates of the same bar

can be found in the creek

probably reflects the value of the estuary to marine invertebrates. Combinations of high stream flows from fall storms and tides open the bar which typically remains closed in the summer and early fall. Mudflat inhabiting polychaete worms, amphipods and isopods can probably be found in the estuary throughout the year.

Amphibians and Reptiles

The amphibian and reptile fauna of Redwood Creek is all described for the Mattole River Area except that this area is the southern range limit for the Del Norte salamander which inhabits southern Oregon and northern California.

Habitat

Intertidal Flats and River B	125
Sand Dunes	67
Salt Marsh	trace
Freshwater Marsh	30
Riparian Woodland	1,520
Upland	trace
Agriculture	1,415
Urban/Industrial	197

Wildlife

Water Birds

Shorebirds are the most numerous water associated species found in the Redwood Creek Delta. They utilize the intertidal zone of the ocean beach and estuary as well as adjacent pasture lands. Their numbers are highest between the months of September and May.

Sandpipers, dunlin, willits, yellow legs, godwits and killdeer are most common.

A small number of waterfowl, mallards and mergansers primarily, are present all year. Small numbers of other species including pintails, widgeon, teal, scaup, ring-necked ducks, ruddy ducks and scoters use the area frequently in fall and winter. The absence of extensive marshes or aquatic vegetation limits waterfowl use to comparatively low levels.

Other common but not numerous water associated birds present are coots, grebes, cormorants, murres, loons, pelicans, blue herons, night herons, common egrets, bitterns and kingfishers.

Several kinds of gulls are common and a number of other coastal or pelagic species including terns, petrels, guillemots, puffins, auklets, fulmars, shearwaters, albatrosses and jaegers may occasionally be seen.

birds are associated with the agricultural lands, woodlands, uplands and in some cases residential areas. They comprise the largest number of species within the avian class. Songbirds including sparrows, thrushes, flycatchers, wrens, larks, warblers, finches and juncos are the predominant form. Others include crows, ravens, jays, woodpeckers, flickers, swallows, hummingbirds, quail, grouse, doves and pigeons.

Raptors are also usually associated with land environments. One exception is the osprey which nests on Redwood Creek and is often seen fishing along the stream. Both the golden and bald eagle are rare visitors. Red-tailed hawks, rough-legged hawks, marsh hawks, coopers hawks, sharp-shinned hawks, American kestrels, great horned owls, short-eared owls, barn owls, screech owls and turkey vultures are among the most often observed species.

Mammals

A number of marine species such as porpoises, dolphins, seals and sea lions frequent the offshore area and the harbor seal, Stellers sea lion and California sea lion are known to enter the estuary frequently. The river otter, mink and beaver inhabit the creek and many of its tributaries. Other areas of habitat support a variety of mammals including gray fox, coyotes, ringtail cats, raccoons, bobcats, striped skunks, spotted skunks and weasels. The most numerous forms are the small shrews, mice, rats, moles, gophers, ground squirrels, squirrels, brush rabbits and blacktail jackrabbits which provide food for the predatory species.

Roosevelt elk frequent the pastures and hillsides of the lower valley and blacktail deer are numerous. Black bears are less common but regularly reported. The mountain lion is a resident of the upper drainage and may pass through the study area at times.

General

Redwood Creek supports a composition of fish similar to that of the Mad River although pink and chum salmon have never been recorded (Appendix D).

Anadromous species

The natural anadromous fish runs are enhanced by plantings of juvenile king and silver salmon, steelhead rainbow trout and coast cutthroat trout from the Humboldt County Prairie Creek Fish Hatchery. This is the only hatchery in California which raises and releases anadromous coastal cutthroat trout, principally an Alsea River, Oregon, strain.

Salmon often enter the river in the early fall after well meaning sportsmen open the bar which forms across the mouth. These early fish move in and out of the estuary and are usually unable to migrate to upstream spawning areas due to low stream flows. The salmon are often subjected to heavy illegal snagging and poaching activities.

Steelhead enter the creek beginning around mid-November and the run continues through March. Winter sport fishing, however, is almost always prohibited by high water turbidities.

Coastal cutthroat trout, both anadromous and resident forms, utilize Redwood Creek and its tributaries as far upstream as Captain Creek, located at the upstream end of Redwood Valley. Habitat destruction in the river by man activities and aggravated by storms and floods has had a deleterious impact upon the anadromous populations throughout the river. Channelization and levee projects along the lower river have reduced the value of the estuarine habitat to fishery resources. Prairie Creek, entering Redwood Creek 3.5 miles upstream from the mouth, and its tributaries, are probably the most important anadromous cutthroat spawning and nursery area in the drainage.

Additional anadromous fish include Pacific lamprey and three-spine stickleback. Non-anadromous sticklebacks also probably occur in the lower river.

Freshwater and Euryhaline species

Resident rainbow trout and coastal cutthroat trout, several sculpin species, Humboldt sucker, starry flounder, retail surfperch and eulachon all inhabit Redwood Creek and follow life histories and habits as previously described for the Mad and Mattole Rivers. The trout are usually found in the upper drainages above anadromous fish barriers, although they may occasionally drift to downstream areas. Eulachon, sometimes classed as an anadromous species because of its freshwater spawning activities, have been observed as far upstream as 15 miles during spawning migrations.

Resource Use

As in other areas of the north coast recreation plays an important role in local economics. The proximity of County, State and National Park lands attracts many visitors to the area. The fish and wildlife resources are an important factor in making the area attractive to recreational users.

Hunting

Waterfowl hunting opportunities are limited by the lack of suitable habitat necessary to hold birds in the area, and by the availability of access. Much of the estuary is inside the National Park and hunting is prohibited. Adjacent lands are privately owned and usually posted against trespass. Consequently hunting is largely restricted to a few local residents. The same is true for other types of hunting.

Elk hunts have been held within the area because of agricultural degradation. The most recent hunt was held in 1976. Public hunting has been permitted by the landowners under certain circumstances. Although the potential is limited in terms of hunter numbers the success is high and it is the only part of the state where the opportunity to hunt Roosevelt elk is available.

Sport Fishing

Redwood Creek supports an estimated annual use of 2,000 angler days directed towards salmon and steelhead. In 1969, the Department estimated that annually, fishermen caught 7,000 salmon and 6,000 steelhead. This figure probably reflects the catch during an especially good year when water conditions would be highly favorable. The estimate could be expected to be much lower during a normal year.

A small number of juvenile steelhead and cutthroat trout are caught during the summer months, the majority of which come from Prairie Creek. This beautiful tributary receives heavy pressure from both local fishermen and vacationists seeking summer trout fishing opportunities.

Gulachon, locally called candlefish, support a very important and often intense local fishery during their spring spawning migrations. Starry flounder and redbait sunperch are occasionally caught in the the river's mouth in the early summer months, but do not support a significant fishery.

Nature Study

Opportunities are limited to the beach and lower estuary within the National Park for the most part. Vehicular access is provided only to the end of the levee on the creek's north side. Some wildlife, including elk, can be seen from county roads and sometimes from Highway 101. The present magnitude of use is not known.

Boating

Water deep enough to support boating activity is restricted to a small area near the mouth. Almost all present boat use is believed to be associated with sports fishing. There is very little potential for other types of boating activity.

Scientific and Educational Use

Scientific use has generally been confined to public agencies but opportunities are available to colleges, universities and private researchers as well. No quantitative information is available for either scientific or educational use at this time.

Problems and Conflicts

Sedimentation

The production of anadromous fish is probably one of the most important functions of Redwood Creek in terms of natural resources and the north coast economy. Unfortunately, this production has been greatly reduced by siltation accelerated by upstream logging and road building. This siltation reduces fish production and survival by compacting spawning gravels, filling pools, raising water temperatures, lowering dissolved oxygen content and destroying food organisms.

Flood Control

In 1968 the Corps of Engineers completed a project of stream channelization and levee construction on the lower 3.4 miles of Redwood Creek. This project materially reduced the area's capability to support both fish and wildlife by the destruction and degradation of habitat.

Such channelization destroys pools and bank vegetation associated with natural meandering streams and leaves a wide sterile channel devoid of vegetation. Aquatic food production is much reduced and water temperatures are increased.

Riparian vegetation necessary to support a large number and variety of wildlife is lost. Those species closely associated with this kind of habitat are virtually eliminated and many others are adversely affected.

In addition, the character of the intertidal area is altered. Bottom sediments are changed and invertebrate production supporting higher forms of fish and wildlife is much reduced.

protection from flooding, also stimulates the expansion of urban, commercial and industrial development into agriculture and wild lands eliminating or degrading more habitat. The net result is less habitat and less fish and wildlife.

damage to
No mitigation for/fish and wildlife was provided. Little can be done now to rectify the situation. In the future, however, careful consideration of resource values involved should be made before any flood control project is authorized and full compensation should be provided to offset or reduce adverse impacts on fish and wildlife

Elk Depredation

Periodically elk from the foothill areas cause depredation problems in agricultural lands. They compete with livestock for pasture forage and damage fences. The greatest damage occurs when elk numbers build up to higher levels. To alleviate damage special controlled hunts have been held in the past to reduce the size of local elk herds. Such hunts have usually been initiated by land-owner complaints.

KLAMATH RIVER

Drainage

The Klamath River is the only major California stream emptying the Continental River that has its origin outside of the State. Its source is Upper Klamath Lake in southern Oregon. Its mouth is located 65 miles north of Eureka (Plate 1).

The river flows generally southwestward for over 260 miles on its way to the sea. For the most part it is located in steep rocky canyons where its descent may be as much as 100 to 200 feet per mile. After entering Humboldt County it is joined by the Trinity River at the town of Weitchpec some 42 miles upstream from the mouth. Three other major tributaries, the Scott, Salmon and Shasta Rivers, enter the Klamath farther upstream. The total drainage basin encompasses approximately 15,000 square miles (Plate 15).

The upper drainage in Oregon includes large acreages of farm land and marsh surrounded by forested mountains. In California the terrain is typified by rough rocky canyons and high mountains covered by brush and conifer forests. The mountains become less precipitous as the river nears the ocean and the forests of pine and fir give way to redwoods. Much of the basin has been subjected to heavy logging.

The average annual runoff, as measured near the mouth, is over 13,100,000 acre feet. The average discharge is 17,060 cfs (cubic feet per second), (Dept. of Interior G.S. 1969)

The California Oregon Power Company maintains three major hydroelectric power plants in the Klamath River drainage. Two of these plants are on the Klamath River near the town of Copco and the third is on Fall Creek near its confluence with the Klamath River.

Land Ownership and Access

Redwood National Park lands, a narrow coastal strip approximately 1/2 mile wide,

... the north of the ... side of the
... holding of Indian land is ... park boundary south
of the river. Public lands outside the park are confined to tidelands and the
river channel. Most other lands are privately owned. Land ownership patterns are
shown on Plate 16.

Park lands provide some access opportunities south of the delta. North of the
river access is also available on some private lands although fees for trespass
are charged at some locations.

Land and Water Uses

The majority of land adjacent to the lower Klamath River is used for recreational
purposes. Access fees are charged for river fishing and several concessions
offer boat launching facilities and rental, boats, camping grounds and
recreational vehicle parks are located north and south of the river. Commercial
areas extend along Highway 101 north of the river. Most of the remaining lands
are in either residential, agricultural or timber management uses.

~~Water Quality~~

The Department of Water Resources has secured thirteen points on the Klamath and Trinity Rivers and their tributaries between 1951 and 1959. In almost all cases they found the waters to have acceptable mineral content. Areas of excessive mineral content were diluted by downstream waters. Data collected in the Klamath River at three stations from Copco, downstream of Klamath during the period 1950 through 1955 showed that the water is of the alkaline earth bicarbonate type.

Coliform counts varied widely at the DWR monitoring stations but were determined to have acceptable ranges set for health standards.

Pollution

The most significant pollution in the Klamath River is sedimentation resulting from man's activities in the watershed. Road construction and its associated side-cast materials are major contributors to the factors which increase erosion. Soil disturbance, coupled with high seasonal rains, create localized mass movements of earth and result in increased river turbidity and sediment deposition.

Although not a major problem in the Klamath River, minor chronic pollution results from many sources, including direct discharge of untreated wastes, inadequately treated domestic wastes, septic system leakage and livestock wastes.

Upstream agricultural wastes originating in Oregon and the Scott and Shasta River drainages contribute to the pollution of the Klamath River.

Natural Resources

Habitat

The Klamath River Delta does not have a wide flood plain as do many other coastal rivers, nor does it have an extensive estuary. Much of the lower river channel, when not covered by water, is typified by sand, gravel and river rock. Islands of riparian vegetation are located on the higher ground of sand and gravel bars.

A low sand spit covers the south side of the river's mouth. To the north the terrain rises steeply from the channel's edge. Small areas of pasture are situated in lowlands adjacent to the river and on the more open hillsides. The surrounding hills are largely covered by redwood forest or brush fields except where grasslands have been cleared for grazing. Urban areas of houses, trailer parks and commercial buildings are found along Highway 101.

The water surface area varies with stream flow and tide stages but averages about 500 acres in the summer months. Aquatic vegetation other than algae is absent. The bottom sediments range from river rock upstream to sand near the mouth.

The expanse of sand and gravel bars is also influenced by tide and water flow. The only vegetation present is on higher ground. Much of the delta's riparian cover is found in islands on the river bars. Typical plant species include alder, willow, cottonweed, thimbleberry, elderberry, blackberry and salmonberry. Other riparian cover is found along the river's edge and along small tributaries of the river.

Vegetation on the river spit is sparse. Bare sand littered with wood debris is typical on the ocean side. On the inland side sweet clover, lupine, yarrow, strawberry and dandelion are the most common plants.

There is some small amounts along Hunter Creek, north of the mouth, and the pool on Richardson Creek south of the river. Vegetation associated with this habitat type includes cattail, spike rush, water hyacinth, and skunk cabbage.

Pasture vegetation is composed of a wide variety of grasses and forbs, most of which are introduced species. Velvet grass, sweet vernal grass, meadow fescue, orchard grass, rib grass, dandelion, cow parsnip, wild cucumber, mustard and clover are among the most common species. Lower pastures often contain scattered clumps of juncus, sword fern and bracken fern. Coyote brush and scotch broom is common on higher ground as is bracken fern.

Redwood is the dominant conifer in the forest type with a lesser amount of Douglas fir and Sitka spruce. On outcrops sites dense stands of alder, salal, salmonberry, huckleberry and blackberry are common. Forest habitat occurs only in areas surrounding the flood plain and is therefore not included in the habitat acreages listed here.

Habitat acreages are shown in the following table:

Table VI

Habitat Acreages

Agricultural and Grassland	730
Sand and River Rock	340
Fresh and Brackish Water Marsh	82
Riparian	650
Urban and Commercial	507
Open Water	545

Plate 17 shows the habitat pattern in the lower Klamath River area.

Birds

The most numerous water associated birds of the delta are shorebirds. The exposed tidelands of the estuary provide feeding areas which attract many varieties including sandhills, willets, dunlin, sandpipers, yellow-legs, plover and killdeer. Several thousand birds may be seen during peak population periods in the fall and winter.

Smaller numbers of waterfowl, particularly scoters, mergansers, scaup, ruddy ducks, widgeon, pintail, mallards, bufflehead and greenwing teal, use the area between late August and April. Mergansers, mallards and occasionally others may be seen year-round. Because of the lack of aquatic vegetation for waterfowl food production the area does not attract large numbers.

Great blue herons are common, and Anthony's green herons and common egrets are sometimes seen. Coots, grebes, loons, cormorants and murres are regular visitors. Many others including gulls, terns, petrels, guillemots, auklets and puffins are also present either as residents, common migrants or casual visitors.

Land habitat types support a wide variety of terrestrial birds. The greatest number in terms of both species and populations are classed as song birds. Sparrows, thrushes, flycatchers, warblers, wrens, larks, vireos, finches and juncos are examples of this group. Other types of land birds include crows, ravens, jays, woodpeckers, flickers, swallows, hummingbirds, doves, pigeons, quail and grouse. Many land birds are resident and others are migratory. They occupy all forms of habitat according to the preference of each species.

Several species of raptors are common on the lower Klamath River. Red-tailed hawks, rough-legged hawks, marsh hawks, kestrels, turkey vultures, great horned owls, barn owls, short eared owls and screech owls are examples. Less commonly seen species include red-shouldered hawks, golden eagles, cooper's hawks, sharp

red hawks, merlins, ospreys, white-tailed kites, owls, spotted owls, pygmy owls and burrowing owls. The bald eagle, falcon, and prairie falcon are much rarer.

The osprey is directly dependent on the river and on the availability of the fish on which it feeds. Several nest sites are located upstream from the highway 101 bridge.

Mammals

Marine mammals such as harbor seals, steller sea lions and California sea lions often enter the river and travel some distance upstream. Others including dolphins and porpoises are common offshore but rarely enter the river.

Water associated mammals that inhabit the river include the muskrat, beaver, river otter and mink. Other furbearers such as weasel, spotted skunk, striped skunk, ringtail cat, raccoon, gray fox, coyote and bobcat occupy various habitat types in and around the delta. Marten and fisher inhabit parts of the drainage but may no longer occur along the lower river.

The largest land mammal of the area is the Roosevelt elk which ranges generally through northern Humboldt County and Del Norte County in a coastal strip a few miles wide. Other common big game mammals are the black-tailed deer and black bear. The mountain lion is also present but much less common.

Many species of small mammals such as rabbits, squirrels, ground squirrels, chipmunks, rats, mice, gophers, moles, shrews and bats inhabit the various habitat types within the area.

General

There have been 28 species of fish reported from the lower Klamath River (appendix D). Additional species inhabiting the upper drainages may infrequently drift downstream, but are not included in the text and table.

Anadromous species

The Klamath River supports excellent runs of king and silver salmon with occasional reports of individual pink and chum salmon. The first king salmon usually appear in the estuary in late summer where a significant sport fishery develops. Runs continue through late fall, although most of the sport fishing is over by the end of September. Silver salmon usually enter the river later than the king salmon and the runs may continue through January or February. Early run fish probably ascend to the higher tributaries and are observed at Iron Gate Hatchery on the upper Klamath River and Trinity River Hatchery during late October and November.

Steelhead rainbow trout migrate into the Klamath River on almost a year around basis. Spring run steelhead enter during the period of late spring runoff and migrate to upstream holding areas in a few selected tributaries. These fish remain in freshwater for 6-10 months and are believed to spawn in the late winter. Steelhead continue to enter the river throughout the summer, although the large runs which have made the Klamath River a world famous fishing river do not commence until late August. A large portion of these late summer and early fall migrants are "half-pounders", a local name given to immature or

recocious steelhead. These fish have returned to the river spending only a few months in the ocean. Larger, mature adult fish, actually the survivors of previous "half-pounder" runs, also enter the river during this period and will migrate to upstream spawning tributaries. The fall runs may continue through November, after which winter run steelhead begin their upstream migration. Spawning usually takes place from February through March. In actuality, there is overlap in the timing of the steelhead runs and it is sometimes difficult to distinguish the different stocks by physical appearance.

Coast cutthroat trout are found in the lower Klamath River and most of the tributaries as far upstream as Tectah Creek (approximately 20 miles). The lower river and estuary are important nursery and feeding areas for juvenile and adult fish.

Introduced brown trout occur in small numbers in the Trinity River, a major Klamath River tributary. An occasional fish is taken by anglers in the lower Klamath River and may or may not have previously entered the ocean.

American shad, first introduced on the West Coast in 1871, have become established in the Klamath River. Upstream migration usually commences in May and continues through early July. Spawning takes place over areas with gravel or sand bottoms and a good current. The eggs are not adhesive and are slightly heavier than water. They drift downstream with the current and usually hatch in four to six days, or longer depending upon water temperature. Some young shad drift downstream immediately after hatching into the estuary, but the majority remain in freshwater until the following fall. By December, most of the juvenile fish have migrated out of the freshwater environment.

Both white and green sturgeon occur in the Klamath River, although the green sturgeon is much more numerous. The most recent verified observation of a white sturgeon was during the summer of 1974 when a Department of Fish and Game creel census clerk observed and photographed a sport caught fish. Very little is known of the life history of either species in the Klamath River. Fish tagged during a study near Orleans, approximately 54 miles upstream from the mouth, were recovered 53 miles farther upstream at Happy Camp, and as far away as Wilapa Harbor, Washington. This information suggests the Klamath River green sturgeon has a tendency to "wander", or migrate great distances.

Small numbers of introduced striped bass are present in the lower Klamath River in the spring. Most of the observed fish are taken by the Indian gill net fishery although a few fish are caught by sport anglers. Apparently, the Klamath River and estuary are not ideally suited for striped bass and a large population has not become established.

The final two anadromous fish inhabiting the Klamath River are the Pacific lamprey and the threespined stickleback. Lampreys migrate as far upstream as Iron Gate Dam while the sticklebacks are predominantly confined to the creek and slough habitats of the lower river. The non-anadromous form of stickleback probably also occurs in the same area.

Freshwater species

There are many species of freshwater fish which inhabit the

extensive Klamath River drainage. Those which are known to occur in the lower river and estuary include the Klamath large scale and small scale suckers, Klamath speckled dace, Klamath blue chub, brown bullhead, white catfish, prickly sculpin, and coast range sculpin. Resident rainbow, coastal cutthroat, and brown trout may also inhabit the river although it is difficult to distinguish these from juvenile sea-run fish.

Euryhaline species

Redtail surfperch and shiner perch are found in the Klamath River estuary although their distribution is seasonal. Starry flounder is a common and numerous estuarine inhabitant and utilizes the river for nursery and probably spawning habitat. The Pacific staghorn sculpin frequently enters the estuary and often preys upon smaller fish. Two species of smelt have been recorded from the Klamath River estuary, the surf smelt and eulachon. Although not a common estuarine visitor, surf smelt enter the river mouth on feeding forays when conditions are favorable. The eulachon, however, are known to migrate at least 25 miles upstream from the mouth during spawning runs. These migrations commence in March and April and the newly hatched young drift downstream to the ocean. Smelt are an important forage fish for many larger animals when they congregate at the river mouths prior to upstream migration.

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The river provides habitat for many different species of fish. A permanent mouth opening allows many marine species access to the sheltered estuarine waters. One of the most important species is the market crab which utilizes the estuary as a nursery area. In addition, river outflow contributes many essential nutrients to the ocean which are necessary for the development and survival of nearby ocean crab populations.

Small populations of soft shell clams are present in the mudflats along with polychaete worms. Although usually associated with the marine environment, unidentified barnacles have been observed in the river.

Bay shrimp, isopods, and amphipods are found along the bottom, especially among algae covered rock and gravel substrates.

Resource Use

Recreational use is the most significant factor in the economy excluding lumber production. Large numbers of recreationists are attracted by the scenic beauty, proximity of National and State parks and the quality fishing. The preservation and proper use of the area's biological and scenic values is therefore of the utmost importance.

Hunting

Hunting opportunities are limited by several factors. The National Park Service does not permit hunting on the coastal strip under its jurisdiction and public hunting is not generally allowed on the private lands. Consequently only State owned tidelands and navigable waters are available for the unattached hunter.

The absence of suitable habitat to attract high numbers of ducks or geese limits the potential for waterfowl hunting. Only a few local residents use the area for this purpose. Hunting for other species including quail, band-tailed pigeons, rabbits and deer is similarly restricted largely to local residents.

Sport Fishing

The Klamath River system ranks first among California's coastal rivers in the amount of habitat available to salmon and steelhead. The large annual runs provide excellent fishing opportunities for these species throughout most of the year. A total of 116,000 annual angler days were estimated in 1965 to be expended in the salmon and steelhead sport fishery with an estimated harvest of over 200,000 fish. These figures, however, have probably increased significantly in recent years. In a recent review of available literature on the Klamath River steelhead sport fishery, Boydston (unpublished manuscript) estimated that effort during the fall steelhead fishery may amount to as much as

129,000 angler days, which is 50 percent greater than the 1965 total annual estimated use estimate. Winter steelhead fishing in the upper river and salmon fishing throughout the river have probably also comparatively increased.

A study conducted by the Department in 1968 through 1969 revealed that summer trout fishing for juvenile steelhead in the main river from Iron Gate Dam to the Salmon River (124 river miles) amounts to approximately 10 percent of the total angling pressure. This figure would vary considerably through out the drainage and would amount to 100 percent of the fishing use on tributaries where all angling pressure is directed towards resident trout.

A conservative estimate of summer trout fishing use in the main Klamath River below Iron Gate Reservoir would probably be around 35,000 angler days annually. Considerable additional fishing use is expended throughout the drainage on the various tributaries.

American shad and sturgeon support small fisheries of local importance. Shad are taken by anglers during May and June with the majority of effort concentrated in the area from Weitchpec to the Salmon River. Sturgeon fishing develops on the river during the spring and is over on the upper river by summer. Fish are also occasionally taken in the estuary during the summer and early fall months.

The seasonal distribution of the many euryhaline species which are available to sport anglers determines the actual fishing use. Redtail surfperch and shiner perch are caught in the estuary in the late spring and summer months. Eulachon make annual spring spawning migrations into the river but because of the high river flows are not readily available for sport netting.

Nature Study

The scenic qualities and the presence of a wide variety of wildlife make the area very attractive for people who enjoy observing, studying and photographing wildlife in their natural settings. The use opportunity is enhanced by the area's accessibility from Highway 101. The magnitude of such use is not known but is suspected to exceed all other uses associated with fish and wildlife.

Boating

Most boating activity is a direct result of angler use but some pleasure boating does occur. The lower river does not offer a large water surface area to support a great deal of boating activity. It is also rather hazardous for those who are not experienced. Water skiing is discouraged by both the hazard and cold water temperatures.

One local enterprise offers river trips by jet boat as far upstream as Weitchepc. A number of local guides are also available for river trips although usually their services are related to fishing.

Scientific and Educational Use

The Klamath River system offers many opportunities for scientific use. Many studies related to anadromous fish have been conducted by state and federal agencies. The same opportunity exists for colleges, universities and private researchers.

Educational use is made of the area also but the magnitude is not known.

Sedimentation

As in most coastal streams sedimentation is probably the greatest threat to biological resources. Logging, which is very extensive in the Klamath drainage, is the major contributor but road building and other activities which cause increased erosion are also factors. The problem is compounded by the steep slopes and unstable soils of the region.

Unfortunately little is known about current siltation rates or about the ultimate effects of increased siltation on natural resources of the delta. However, it is known that siltation adversely affects fish life by compacting spawning gravels, filling pools, raising water temperatures, lowering dissolved oxygen and smothering food organisms. It is also known that the productivity of salmon and steelhead in the river has been much reduced as a result of the problem.

Flood Control

Floods are a natural process of river systems that can be expected regularly depending on precipitation and weather conditions. There have been major floods on the Klamath in 1861, 1881, 1890, 1927, 1953, 1955 and 1964. The floods in themselves are not necessarily bad. Flood waters help to clean gravels of silt and tend to deposit fertile soils in delta areas, thus benefiting agricultural production. Problems arise mainly because man builds on flood plains with full knowledge of the hazard and then demands protection from the high water he knows will come.

The communities of Klamath and Klamath Glen were inundated in the floods of 1953, 1955 and 1964. After the 1964 flood a control project was authorized under the Flood Control Act of 1966, Public Law 89-789. The project provided for construction of a new townsite at standard project flood elevation for the community

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Levee projects cause destruction of wildlife habitat and often change river bed characteristics adversely for fish life. In addition, protection of land behind the levee encourages development that destroys more habitat.

Developments are also again taking place in the flood plain where the town of Klamath was destroyed. Eventually more flood control measures will be sought to protect these developments. The same process on other rivers has led to the virtual elimination of riparian habitat, marsh and tidelands as well as severely reducing fish production.

A plausible alternative that would not destroy irreplaceable natural resources is available through a program of flood plain management. Such management would involve the zoning of land to uses compatible with periodic inundation and the prevention of uses or structures which would be subject to flood damage.

This would be accompanied by flood insurance rates favoring compatible uses.

Development

The gradual expansion of homes, businesses and other developments into wetlands of the delta is taking place but at a slower rate than in many other coastal areas. Too much development can destroy the natural resources and the economic benefits they bring to the area. In order to protect the resources and preserve the local economic base governmental bodies at local state and national levels should make every effort to provide controls on land use and prevent incompatible developments.

MISCELLANEOUS WETLANDS

Crescent City Marshes

A series of small marshes and seasonal wetlands extend south of Crescent City along the east side of Highway 101 (Plate 24). They are fresh or brackish water in character and total about 55 acres in size, including seasonally flooded portions. The surrounding lands are largely forested or cleared for grass and pasture land. The strip of land between the highway and marsh is used for commercial purposes. The entire marsh and adjacent lands are privately owned.

For the most part the marsh is very shallow and densely covered by water associated vegetation such as carex, cattails and tules interspersed with clumps of willows, red alders and small areas of open water. Within the open water areas waterlilies and water parsley are common.

Wildlife use of the area includes species which are usually associated with more heavily vegetated marsh lands. Waterfowl which commonly use the area are mallards, teal, shovellers, godwall, widgeon, pintails and ring-necks, ruddy ducks and wood ducks. They are usually found only in small groups in the more open areas. Some nesting by mallards, teal and probably wood ducks takes place in and near the marsh.

Shorebird use is highest around the perimeter of the marsh, particularly in pasture or grassland. Both sora and virginia rails frequent the areas where emergent vegetation provides the proper cover. Bitterns, night herons, blue herons, green herons and occasionally egrets utilize the marsh and adjacent pastures. Other water associated species commonly seen here are coots, pied-billed grebes, horned grebes, eared grebes and kingfishers.

Common land birds and mammals which occupy the area include most of those species found in other similar areas of habitat along the north coast.

Crescent Beach Marshes

Five miles south of Crescent City and west of Highway 101 a series of marshes extend for about 1 1/4 miles along the coast (Plate 25). A public access road to the beach divides these freshwater marshes, totaling about 40 acres, into a north marsh and a larger south marsh. The marshes, which are national park lands, are bordered by private lands cleared for pastures.

The north marsh is mostly overgrown with cattails, sedges, and Juncus. Water hemlock, water buttercup and Elodea are common in open water areas and in nearby flooded pastures. Numerous willows and a grove of Sitka spruce border the north marsh. The south marsh is larger, contains more open water and is characterized by the same plant species as well as blackberry and European dunegrass.

Among the types of wildlife that utilize the area waterfowl are the most common and include hooded mergansers, ring-necked ducks and wood ducks. The dense aquatic vegetation offers habitat for rails and the riparian habitat supports numerous songbird species. Many other water associated birds commonly occur including coots, grebes, herons, egrets, kingfishers and marsh hawks.

Lagoon Creek Pond

Lagoon Creek Pond is approximately five miles north of the town of Klamath in Del Norte County (Plate 26). It was originally created as a mill pond by damming Lagoon Creek about 150 yards upstream from its mouth. The mill was abandoned many years ago and the area surrounding the pond has returned to a relatively natural condition except for the recreational facilities located adjacent to Highway 101 on the north side of the pond. These recreational facilities were constructed and maintained by the County. The entire area is within the authorized boundary of Redwood National Park and will be

owned and managed by the National Park Service in the future.

The lagoon is about 2,000 feet long and 300 feet wide at its widest point and covers an area of approximately 15 acres. The headwaters of Lagoon Creek begin some two miles south and east of the pond and serve a total drainage basin of only about two square miles.

The deeper portions of the pond are typified by open water interspersed with dense mats of water lily. Dense stands of cattails are found along the shore in the lower part of the pond. In shallower waters upstream water lily, water parsley, and bulrush form dense vegetative cover that completely hides the waters surface.

Wildlife use is rather limited, primarily because of the pond's small size and heavy fishing pressure. Coots are rather common on the area and a few waterfowl, such as mallards, widgeon and teal are regular visitors. Some water fowl nesting may also occur. Blue herons, night herons, green herons, bitterns, rails and grebes also utilize the pond. River otters and mink are found in the drainage as well as a number of terrestrial mammals.

The pond is regularly stocked with catchable trout by the Department of Fish and Game.

Although the lagoon area is quite large, open water areas permitting fishing access are small. Annual plants of catchable rainbow trout, and a small remnant population of coast cutthroat trout support the fishing pressure at this roadside lagoon. Because of easy angler access, Lagoon Creek Pond receives a moderate amount of pressure

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during the spring and summer months. A federally maintained parking area and rest stop help make this a popular area.

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Espa Lagoon

This small coastal pond is located in Prairie Creek State Park adjacent to Gold Bluffs Beach about 13 miles south of the Klamath River (Plate 27). It lies just above the beach and is about two acres in size. The entire lagoon is publicly owned and is part of Prairie Creek State Park. Land and water uses are strictly recreational.

Most of the lagoon is open water with submergent vegetation including pond weed and wigeon grass. Much of the perimeter, particularly in the northern end, is covered by dense stands of tules, cattails, spike rush and water parsley. Upland vegetation of willow, alder and conifer species with a dense understory of coastal shrubs covers much of the surrounding hillsides.

Water associated wildlife which utilize the lagoon includes several species of waterfowl, shorebirds, grebes, coots, loons, herons, bitterns and rails as well as mink and river otter. Because of the lagoon's small size the magnitude of wildlife use is not high in terms of total use days.

Three species of fish are known to inhabit Espa Lagoon. These include coast cutthroat trout, rainbow trout, and threespined stickleback. There is a good possibility that sculpin also exist but their presence has not been verified. The trouts and stickleback are non-anadromous forms although there was probably historical access to the ocean.

The lagoon's inlet stream provides limited amounts of spawning area for the few cutthroat trout that exist in the lagoon and possibly the rainbow trout. The majority of the rainbow trout however, are planted by the Prairie Creek Fish Hatchery. The sticklebacks spawn during the spring months in the weedy shallows around the lagoon edges and provide forage for numerous wildlife species.

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Espa Lagoon receives light fishing pressure, probably due to its remote location. This small coastal lagoon is planted with catchable rainbow trout and has a small population of coast cut-throat trout, both of which support the sport fishery. Bank access is limited and most anglers utilize small boats. Fly fishing in the spring during aquatic insect hatches has been gaining in popularity in recent years.

Clam Beach Lagoon

This lagoon, rather a series of narrow ponds, is located just south of Little River between Highway 101 and a parallel county road to the east (Plate 28). The total acreage is less than three acres. Originally they were somewhat larger in size but were partially filled by highway construction. They lie partially within the highway easement but are otherwise privately owned. Historically the public has been allowed access for fishing and other recreational uses.

The ponds are very narrow and for the most part surrounded by dense thickets of willow and other woody shrubs. They contain aquatic growths of pondweeds, water lily and other species.

Wildlife use is not high because of the small acreage, proximity of the highway and heavy fishing pressure. Grebes and coots are most commonly seen but some use by waterfowl, herons and other water associated species is known to occur. The riparian vegetation does support use by a variety of song birds and small mammals.

Catchable rainbow trout planted by the Humboldt County Prairie Creek Fish Hatchery, and occasional plants of surplus trout from the Humboldt State University Fish Hatchery support the sport fishery of this lagoon area. Sport fishing pressure is heaviest following publicized fish plantings but with a year-round open fishing season, the lagoon receives constant pressure throughout the year. Increased use does occur during the pleasant late spring and summer months and with the advent of larger summer planting allotments.

Shore Acres

Located along the beach 100 yards from the present mouth of the Mad River, the Shore Acres marshes comprise about 20 acres of coastal wetlands (Plate 29). These marshes, which are filled by Widowwhite Creek as it enters the Pacific Ocean, includes seven ponds of various sizes which were originally constructed for fish culture and have since been abandoned. Three of the ponds are completely grown over and almost dry while the others contain open water. The marshes, nearby dunes and riparian vegetation are grazed by a few cattle but are not severely disturbed. Surrounding lands have been cleared for pastures. The marshes and all bordering properties

are privately owned.

The area is characterized by small stands of Sitka spruce, redwood and ferns on the nearby slopes while willows, alders and blackberry border the creek in the lower areas. Cattails, sedges, Juncus, water-hemlock, elodea and water buttercup are found in the ponds. As the creek passes through the dunes it is bordered by European dunegrass, coyote bush, bush lupine and strawberry.

Among the types of water associated wildlife that utilize the area, waterfowl shorebirds, rails, herons and egrets are the most common. Numerous songbirds including chickadees, kinglets, finches, wrens, sparrows, phoebes, and warblers utilize the dense riparian vegetation. The ponds are inhabited by several species of fish, frogs and garter snakes.

ECOLOGY

The origin of life on earth is shrouded in mystery that may never be fully understood by man. Perhaps this was meant to be. In any event, what we do know is that the first spark of life was struck millions of years ago and its birthplace was the sea. The first simple forms were probably nothing more than organic chemical compounds that somehow were capable of utilizing energy from the sun to grow and reproduce. As countless centuries passed these compounds became more complex and diverse. Nurtured by their mother sea they developed into organisms of many kinds, their structure and habits molded by their surroundings.

From these simple beginnings all life as we know it today was formed. As the world changed the organisms changed through evolutionary processes. Those that were not capable of adapting to environmental changes were lost along the way and are known only through fossils locked in stone. In whatever form, plant, fish, amphibian, reptile, bird or mammal all living things share two things in common --their origin and their dependence on an environment suitable to their needs.

Ecology is the study of the environmental conditions in which organisms live. An ecosystem is a given unit of habitat in which organisms live and interact with their physical and biological surroundings. The world is an ecosystem in itself, but, in turn is composed of countless smaller ecosystems. Likewise each of the coastal wetlands considered in this report is an ecosystem composed of many smaller ecological units which, combined, give the area its particular character.

Each wetland has certain similarities and basic differences in relation to the other wetlands. Both similarities and differences are based on the physical and biological conditions found in each area. The kinds and numbers of fish, wildlife and vegetation present are a direct reflection of these conditions.

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The interrelationships between the living organisms themselves and the physical features such as temperature, moisture, soil, sunlight and space form a very complex system that may remain quite stable if not disturbed by outside influences. Each organism takes from the system to maintain life and in turn gives to the system to support other life.

The life processes are sustained by energy derived initially from sunlight. Only plants are capable of converting the sun's rays to usable energy. They do so through a process known as photosynthesis. This energy is converted to proteins, fats and carbohydrates within the plant and passed on through the system in these forms. Grazing animals from tiny single celled organisms to large vertebrates obtain this energy from plants for their own needs and pass it on by becoming prey for predatory animals including man.

Energy is returned to the system by decomposing bacteria. As plants and animals die their remains are broken down by these bacteria to basic organic compounds which can be re-utilized within the never ending cycle.

Whether considering a single ecological unit or the entire world the process is the same. No organism can survive alone and each, including man, is entirely dependent on the continuity of the energy production system.

The productivity of each of the north coast wetlands in terms of fish, wildlife and other biological resources is initially related to its soils and waters. Coastal zones are among the most biologically productive areas of the world for two basic reasons; First, the sea itself is rich in plant and animal life, particularly in the shallower waters along the shore. Second, the coastal flood plains contain excellent soils high in organic content washed

be seen in adjacent marshes or agricultural lands. Egrets and herons wade the shallow waters looking for small fish, crustaceans or amphibians. At other times they move to pastures where they feed on small reptiles and mammals.

In areas of heavy marsh cover more secretive species like rails and bitterns can be seen. Waterfowl, depending on the species, are found in virtually all of the wetland habitat types. Ruddy ducks frequent the shallow waters and marshes where vegetation is at or near the surface. Diving ducks use more open, deeper waters. Wood ducks prefer riparian streamsides and mergansers dive for fish in the rivers and open waters of the lagoons and estuaries. Wet pasture lands are also used extensively by many waterfowl during the rainy season. Loons, grebes, cormorants, pelicans, murrelets, terns, gulls and other water-associated birds can be seen, often in large numbers, feeding, resting and moving about from area to area each seeking to fulfill its own needs in its own way.

In suitable areas the presence of beaver and muskrat is revealed by their cuttings and lodges. The tracks and other signs left by mink and river otter are usually evident along the edges of marshes ponds and streams for those who look. Occasionally, even seals and sea lions may move far upstream in larger coastal waters.

Adjacent terrestrial habitats likewise support their own variety of living things each occupying the area to which it is best adapted. Songbirds, quail, grouse, ravens, jays, hawks, owls, mice, rabbits, raccoons, foxes, bobcats, deer and elk, big or small, each creature has its own place in the ecosystem and each is no more or less important than any other.

Each plant and animal form has developed its own particular environmental requirements, therefore, each habitat type has its own combination of plants and animals. At the same time all are

interdependent and cannot exist in isolation. The removal of any segment of the ecosystem, whether plant, animal or physical feature will effect all other segments of the ecosystem.

The earth is constantly changing as it always has and probably always will. Perhaps many living things will disappear forever as many have in the past. Even man is not immune to the evolutionary process. In nature the process of change is slow, however, and provides time for adaptability. Unfortunately, man caused environmental changes are not the same. Man has caused the extermination of more life forms in the last one hundred years than were lost through evolution over the past 10,000 years (Greenwood and Edwards 1973).

If we are to prevent such destruction in the future and preserve a world environment capable of supporting a wide diversity of life, including man himself, we must develop a better understanding of the earths ecological system. We must also accept the fact that we are a part of that system and must learn to live in harmony with it. The fate of man is tied closely to the other living things with which we share this planet. What we do to protect them, we do to protect ourselves. What we do to destroy them may well lead to our ultimate destruction.

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