Revised Draft Environmental Impact Statement/
Environmental Impact Report

Truckee River Operating Agreement

Biological Resources Appendix

California and Nevada

August 2004

United States Department of the Interior
Bureau of Reclamation
Fish and Wildlife Service
Bureau of Indian Affairs

State of California
Department of Water Resources

Biology Appendix

PART A

COMMON AND SCIENTIFIC NAMES OF PLANT AND ANIMAL SPECIES IN THE TRUCKEE RIVER STUDY AREA

Common Name	Scientific Name
Plants	
Trees	
black cottonwood	*Populus balsamifera* spp. *trichocarpa*
Fremont cottonwood	*P. fremontii*
lodgepole pine	*Pinus contorta* ssp. *murrayana*
Jeffrey pine	*P. jeffreyi*
ponderosa pine	*P. ponderosa*
quaking aspen	*P. tremuloides*
red fir	*Abies magnifica*
Shrubs	
American dogwood	*Cornus sericea*
antelope bitterbrush	*Purshia tridentata*
low sagebrush	*Artemisia arbuscula*
big sagebrush	*A. tridentata*
buffaloberry	*Sheperdia argentea*
coyote willow	*Salix exigua*
dusky willow	*S. melanopsis*
greasewood	*Sarcobatus vermiculatus*
interior rose	*Rosa woodsii* var. *ultramontana.*
mountain alder	*Alnus incana* spp. *tenuifolia*
saltbush	*Atriplex confertifolia*
serviceberry	*Amelanchier alnifolia* var. *pumila*
shining willow	*Salix lucida* spp. *lasiandra*
tamarisk	*Tamarix* sp.
Truckee barberry	*Berberis (=Mahonia) sonnei*
yellow willow	*Salix lutea*
Grasses and Graminoids	
annual beard grass	*Polypogon monspeliensis*
beaked sedge	*Carex utriculata*
broad-leaved cattail	*Typha latifolia*
common reed	*Phragmites australis*
hardstem bulrush	*Scirpus acutus*
Kentucky bluegrass	*Poa pratensis*
least spikerush	*Eleocharis acicularis*
mannagrass	*Glyceria striata*
Olney's bulrush	*Scirpus americanus*
rusty sedge	*Carex subfusca*
slender wheatgrass	*Elymus trachycaulus*
slender-beak sedge	*Carex athrostachya*
soft rush	*Juncus effusus*
water sedge	*Carex aquatilis*

Herbs

altered andesite buckwheat	*Eriogonum robustum*
altered andesite popcornflower	*Plagiobothrys glomeratusa.*
bigleaf lupine	*Lupinus polyphyllus*
common horsetail	*Equisetum arvense*
Cup Lake draba	*Draba asterophora* var. *macrocarpa*
Cusick's speedwell	*Veronica cusickii*
Dog Valley ivesia	*Ivesia aperta* var. *canina*
Donner Pass buckwheat	*Eriogonum umbellatum* var. *torreyanum*
Dune sunflower	*Helianthus deserticola*
English sundew	*Drosera anglica*
Lemmon's clover	*Trifolium lemmonii*
long-petaled lewisia	*Lewisia longipetala*
Margaret's rushy milkvetch	*Astragalus convallarius* var. *margaretiae*
marsh willowherb	*Epilobium palustre*
marsh skullcap	*Scutellaria galericulata*
monkey flower	*Mimulus glutatus*
Munroe's desert mallow	*Sphaeralcea munroana*
Nevada dune beardtongue	*Penstemon arenarius*
Nevada oryctes	*Oryctes nevadensis*
Plumas ivesia	*Ivesia sericoleuca*
playa phacelia	*Phacelia inundata*
Ranger's buttons	*Sphenosciadium capitellatum*
russian thistle	*Salsola kali*
round-leaved sundew	*Drosera rotundifolia*
sagebrush pygmyleaf	*Loeflingia squarrosa* ssp. *artemisiarum*
sand cholla	*Opuntia pulchella*
scalloped moonwort	*Botrychium crenulatum*
Sierra Valley ivesia	*Ivesia aperta* var. *aperta*
starved daisy	*Erigeron miser*
steamboat monkeyflower	*Mimulus ovatus*
subalpine fireweed	Epilobium howellii
Tahoe draba	*Draba asterophora* var. *asterophora*
Tahoe yellow cress	*Rorippa subumbellata*
tall whitetop	*Lepidium latifolium*
Tiehm's rock cress	*Arabis tiehmii*
upswept moonwort	*Botrychium ascendens*
Washoe pine	*Pinus washoensis*
Washoe tall rockcress	*Arabis rectissima* var. *simulans*
western goblin	*Botrychium montanum*
white sweet-clover	*Melilotus alba*
white clover	*Trifolium repens*
whitetop	*Cardaria pubescens*
Williams combleaf	*Polyctenium williamsiae*
willow herb	*Epilobium ciliatum*

Aquatic

nodularia	*Nodularia spumigena*
blue green algae	*Aphanizomenon flos-aquae*
Common waterweed	*Elodea canadensis*
pondweed	*Potamogeton sp.*

Common Name	Scientific Name
Invertebrates	
California floater	*Anodonta californiensis*
Lake Tahoe benthic stonefly	*Capnia lacustra*
Nevada viceroy	*Limenitus archippus lahontani*
Fishes	
goldfish	*Carassius auratus*
carp	*Cyprinus carpio*
tui-chub	*Gila bicolor*
golden shiner	*Notemigonus crysoleucas*
Sacramento blackfish	*Orthodon microlepidotus*
fathead minnow	*Pimephales promelas*
speckled dace	*Rhinichthys osculus*
Lahontan redside shiner	*Richardsonius egregius*
mountain sucker	*Catostomus platyrhynchus*
Tahoe sucker	*C. tahoensis*
cui-ui	*Chasmistes cujus*
white catfish	*Ameiurus catus*
brown bullhead	*A. nebulosus*
channel catfish	*Ictalurus punctatus*
Lahontan cutthroat trout	*Oncorhynchus clarki henshawi*
rainbow trout	*O. mykiss*
kokanee	*O. nerka*
mountain whitefish	*Prosopium williamsoni*
brown trout	*Salmo trutta*
brook trout	*Salvelinus fontinalis*
lake trout	*S. namaycush*
western mosquitofish	*Gambusia affinis*
Paiute sculpin	*Cottus beldingi*
white bass	*Morone chrysops*
Sacramento perch	*Archoplites interruptus*
green sunfish	*Lepomis cyanellus*
largemouth bass	*Micropterus salmoides*
white crappie	*Pomoxis annularis*
black crappie	*P. nigromaculatus*
yellow perch	*Perca flavescens*
walleye	*Stizostedion vitreum*
Amphibians	
long-toed salamander	*Ambystoma macrodactylum*
Great Basin spadefoot toad	*Spea intermontana*
western toad	*Bufo boreas*
Yosemite toad	*B. canorus*
Pacific treefrog	*Pseudacris (Hyla) regilla*
mountain yellow-legged frog	*Rana muscosa*
northern leopard frog	*R. pipiens*
bullfrog	*R. catesbeiana*

Reptiles

northwestern pond turtle	*Clemmys marmorata marmorata*
long-nosed leopard lizard	*Gambelia wislizenii*
desert spiny lizard	*Sceloporus magister*
western fence lizard	*S. occidentalis*
northern sagebrush lizard	*S. graciosus graciosus*
side blotched lizard	*Uta stansburiana*
northern alligator lizard	*Elgaria coerulea*
southern alligator lizard	*E. multicarinata*
western skink	*Eumeces skiltonianus*
western whiptail lizard	*Cnemidophorus tigris*
rubber boa	*Charina bottae*
racer	*Coluber constrictor* ssp
coachwhip	*Masticophis flagellum*
striped whipsnake	*M. taeniatus*
gopher snake	*Pituophis catenifer*
common kingsnake	*Lampropeltis getula*
California mountain kingsnake	*L. zonata*
common garter snake	*Thamnophis sirtalis*
western terrestrial garter snake	*T. e. elegans*
western aquatic garter snake	*T. couchi*
ground snake	*Sonora semiannulata*
western rattlesnake	*Crotalus viridis* ssp.

Birds

common loon	*Gavia immer*
Arctic loon	*Gavia arctica*
Clark's grebe	*Aechmophorus clarki*
western grebe	*A. occidentalis*
red-necked grebe	*Podiceps grisegena*
horned grebe	*P. auritus*
eared grebe	*P. nigricollis*
pied-billed grebe	*Podilymbus podiceps*
American white pelican	*Pelecanus erythrorhynchos*
double-crested cormorant	*Phalacrocorax auritus*
least bittern	*Ixobrychus exilis*
American bittern	*Botaurus lentiginosus*
black-crowned night heron	*Nycticorax nycticorax*
green-backed heron	*Butorides striatus*
snowy egret	*Egretta thula*
great egret	*Ardea albus*
great blue heron	*Ardea herodias*
white-faced ibis	*Plegadis chihi*
sandhill crane	*Grus canadensis*
tundra swan	*Cygnus columbianus*
greater white-fronted goose	*Anser albifrons*
snow goose	*Chen caerulescens*
Ross' goose	*C. rossii*
Aleutian Canada goose	*Branta canadensis leucopareia*
Canada goose	*Branta canadensis*
mallard	*Anas platyrhynchos*

gadwall	*A. strepera*
green-winged teal	*A. crecca*
American wigeon	*A. americana*
northern pintail	*A. acuta*
northern shoveler	*A. clypeata*
blue-winged teal	*A. discors*
cinnamon teal	*A. cyanoptera*
ruddy duck	*Oxyura jamaicensis*
wood duck	*Aix sponsa*
canvasback	*Aythya valisineria*
redhead	*A. Americana*
ring-necked duck	*A. collaris*
greater scaup	*A. marila*
lesser scaup	*A. affinis*
surf scoter	*Melanitta perspicillata*
Harlequin duck	*Histrionicus histrionicus*
Barrow's goldeneye	*Bucephala islandica*
common goldeneye	*B. clangula*
bufflehead	*B. albeola*
common merganser	*Mergus merganser*
red-breasted merganser	*M. serrator*
hooded merganser	*Lophodytes cucullatus*
Virginia rail	*Rallus limicola*
sora	*Porzana carolina*
common moorhen	*Gallinula chloropus*
American coot	*Fulica americana*
American avocet	*Recurvirostra americana*
black-necked stilt	*Himantopus mexicanus*
snowy plover	*Charadrius alexandrinus*
semipalmated plover	*C. semipalmatus*
killdeer	*C. vociferus*
mountain plover	*Charadrius montanus*
black-bellied plover	*Pluvialis squatarola*
marbled godwit	*Limosa fedoa*
long billed curlew	*Numenius americanus*
willet	*Catoptrophorus semipalmatus*
greater yellowlegs	*Tringa melanoleuca*
lesser yellowlegs	*T. flavipes*
solitary sandpiper	*T. solitaria*
spotted sandpiper	*Actitis macularia*
Wilson's phalarope	*Phalaropus tricolor*
red-necked phalarope	*P. lobatus*
long-billed dowitcher	*Limnodromus scolopaceus*
common snipe	*Gallinago gallinago*
dunlin	*Calidris alpina*
sanderling	*C. alba*
western sandpiper	*C. mauri*
least sandpiper	*C. minutilla*
Heermann's gull	*Larus heermanni*
Bonaparte's gull	*L. philadelphia*
ring-billed gull	*L. delawarensis*

herring gull	*L. argentatus*
California gull	*L. californicus*
Forster's tern	*Sterna forsteri*
black tern	*Chlidonias niger*
caspian tern	*Sterna caspia*
turkey vulture	*Cathartes aura*
golden eagle	*Aquila chrysaetos*
bald eagle	*Haliaeetus leucocephalus*
northern harrier	*Circus cyaneus*
sharp-shinned hawk	*Accipiter striatus*
Cooper's hawk	*A. cooperii*
northern goshawk	*A. gentilis*
red-tailed hawk	*Buteo jamaicensis*
Swainson's hawk	*B. swainsoni*
rough-legged hawk	*Buteo lagopus*
osprey	*Pandion haliaetus*
American kestrel	*Falco sparverius*
merlin	*F. columbarius*
prairie falcon	*F. mexicanus*
peregrine falcon	*F. peregrinus*
blue grouse	*Dendragapus obscurus*
California quail	*Callipepla californica*
mountain quail	*Oreortyx pictus*
chukar	*Alectoris chukar*
ring necked pheasant	*Phasianus colchicus*
band-tailed pigeon	*Columba fasciata*
rock dove	*C. livia*
mourning dove	*Zenaida macroura*
yellow-billed cuckoo	*Coccyzus americanus*
barn owl	*Tyto alba*
short-eared owl	*Asio flammeus*
long-eared owl	*A. otus*
great horned owl	*Bubo virginianus*
California spotted owl	*Strix occidentalis*
western screech-owl	*O. kennicottii*
flammulated owl	*O. flammeolus*
northern pygmy-owl	*Glaucidium gnoma*
northern saw-whet Owl	*Aegolius acadicus*
burrowing owl	*Athene cunicularia*
common poorwill	*Phalaenoptilus nuttallii*
common nighthawk	*Chordeiles minor*
black swift	*Cypseloides niger*
Vaux's swift	*Chaetura vauxi*
white-throated swift	*Aeronautes saxatalis*
black-chinned hummingbird	*Archilochus alexandri*
Anna's hummingbird	*Calypte anna*
calliope hummingbird	*Stellula calliope*
broad-tailed hummingbird	*Selasphorus platycercus*
rufous hummingbird	*S. rufus*
belted kingfisher	*Ceryle alcyon*
northern flicker	*Colaptes auratus*

white-headed woodpecker	*Picoides albolarvatus*
Lewis' woodpecker	*Melanerpes lewis*
Williamson's sapsucker	*Sphyrapicus thyroideus*
red-breasted sapsucker	*S. ruber*
red-naped sapsucker	*S. nuchalis*
downy woodpecker	*Picoides pubescens*
hairy woodpecker	*P. villosus*
black backed woodpecker	*P. arcticus*
western kingbird	*Tyrannus verticalis*
ash-throated flycatcher	*Myiarchus cinerascens*
olive-sided flycatcher	*Contopus borealis*
western wood-pewee	*C. sordidulus*
black phoebe	*Sayornis nigricans*
Say's Phoebe	*S. saya*
gray flycatcher	*Empidonax wrightii*
dusky flycatcher	*E. oberholseri*
Hammond's flycatcher	*E. hammondii*
willow flycatcher	*E. traillii*
western flycatcher	*E. difficilis*
horned lark	*Eremophila alpestris*
tree swallow	*Tachycineta bicolor*
violet-green swallow	*T. thalassina*
purple martin	*Progne subis*
bank swallow	*Riparia riparia*
northern rough-winged swallow	*Stelgidopteryx serripennis*
cliff swallow	*Hirundo pyrrhonota*
barn swallow	*H. rustica*
western scrub jay	*Aphelocoma californica*
Steller's jay	*Cyanocitta stelleri*
Clark's nutcracker	*Nucifraga columbiana*
black-billed magpie	*Pica pica*
American crow	*Corvus brachyrhynchos*
common raven	*Corvus corax*
plain titmouse	*Parus inornatus*
mountain chickadee	*Parus gambeli*
bushtit	*Psaltriparus minimus*
brown creeper	*Certhia americana*
white-breasted nuthatch	*Sitta carolinensis*
red-breasted nuthatch	*S. canadensis*
pygmy nuthatch	*S. pygmaea*
house wren	*Troglodytes aedon*
winter wren	*T. troglodytes*
Bewick's wren	*Thryomanes bewickii*
marsh wren	*Cistothorus palustris*
canyon wren	*Catherpes mexicanus*
rock wren	*Salpinctes obsoletus*
golden-crowned kinglet	*Regulus satrapa*
ruby-crowned kinglet	*R. calendula*
blue-gray gnatcatcher	*Polioptila caerulea*
western bluebird	*Sialia mexicana*
mountain bluebird	*S. currucoides*

Townsend's solitaire	*Myadestes townsendi*
Swainson's thrush	*Catharus ustulatus*
hermit thrush	*C. guttatus*
varied thrush	*Ixoreus naevius*
American robin	*Turdus migratorius*
loggerhead shrike	*Lanius ludovicianus*
northern shrike	*L. excubitor*
northern mockingbird	*Mimus polyglottos*
sage thrasher	*Oreoscoptes montanus*
water pipet	*Anthus spinoletta*
American dipper	*Cinclus mexicanus*
Bohemian waxwing	*Bombycilla garrulus*
cedar waxwing	*B. cedrorum*
European starling	*Sturnus vulgaris*
Hutton's vireo	*Vireo huttoni*
solitary vireo	*V. solitarius*
warbling vireo	*V. gilvus*
orange crowned warbler	*Vermivora celata*
Nashville warbler	*V. ruficapilla*
yellow rumped warbler	*Dendroica coronata*
black-throated gray warbler	*D. nigrescens*
hermit warbler	*D. occidentalis*
yellow warbler	*D. petechia*
MacGillivray's warbler	*Oporornis tolmiei*
Wilson's warbler	*Wilsonia pusilla*
common yellowthroat	*Geothlypis trichas*
yellow-breasted chat	*Icteria virens*
black-headed grosbeak	*Pheucticus melanocephalus*
blue grosbeak	*Guiraca caerulea*
indigo bunting	*Passerina cyanea*
lazuli bunting	*P. amoena*
green-tailed towhee	*Pipilo chlorurus*
spotted towhee	*P. maculatus*
vesper sparrow	*Pooecetes gramineus*
savannah sparrow	*Passerculus sandwichensis*
song sparrow	*Melospiza melodia*
lark sparrow	*Chondestes grammacus*
black-throated sparrow	*Amphispiza bilineata*
sage sparrow	*A. belli*
chipping sparrow	*Spizella passerina*
Brewer's sparrow	*S. breweri*
dark eyed junco	*Junco hyemalis*
white-crowned sparrow	*Zonotrichia leucophrys*
golden-crowned sparrow	*Z. atricapilla*
fox sparrow	*Passerella iliaca*
Lincoln's sparrow	*Melospiza lincolnii*
western meadowlark	*Sturnella neglecta*
yellow-headed blackbird	*Xanthocephalus xanthocephalus*
red-winged blackbird	*Agelaius phoeniceus*
tricolored blackbird	*A. tricolor*
Brewer's blackbird	*Euphagus cyanocephalus*

brown-headed cowbird	*Molothrus ater*
Bullock's oriole	*Icterus bullockii*
western tanager	*Piranga ludoviciana*
house sparrow	*Passer domesticus*
pine siskin	*Carduelis pinus*
American goldfinch	*C. tristis*
lesser goldfinch	*C. psaltria*
red crossbill	*Loxia curvirostra*
purple finch	*Carpodacus purpureus*
Cassin's finch	*C. cassinii*
house finch	*C. mexicanus*
evening grosbeak	*Coccothraustes vespertinus*

Mammals

vagrant shrew	*Sorex vagrans*
Preble's shrew	*S. preblei*
Merriam's shrew	*S. merriami*
Trowbridge's shrew	*S. trowbridgii*
montane shrew	*S. monticolus*
water shrew	*S. palustris*
broad-footed mole	*Scapanus latimanus*
little brown myotis	*Myotis lucifugus*
Yuma myotis	*M. yumanensis*
long-eared myotis	*M. evotis*
fringed myotis	*M. thysanodes*
long-legged myotis	*M. volans*
California myotis	*M. californicus*
western small-footed myotis	*M. ciliolabrum*
silver-haired bat	*Lasionycteris noctivagans*
western pipistrelle	*Pipistrellus hesperus*
big brown bat	*Eptesicus fuscus*
western red bat	*Lasiurus blossevillii*
hoary bat	*L. cinereus*
spotted bat	*Euderma maculatum*
Townsend's big-eared bat	*Plecotus townsendii*
pallid bat	*Antrozous pallidus*
Brazilian free-tailed bat	*Tadarida brasiliensis*
white-tailed hare	*Lepus townsendii*
Sierra Nevada snowshoe hare	*L. americanus tahoensis*
black-tailed jackrabbit	*L. californicus*
mountain cottontail	*Sylvilagus nuttallii*
pygmy rabbit	*Brachylagus idahoensis*
mountain beaver	*Aplodontia rufa*
Sierra Nevada mountain beaver	*A. rufa californica*
yellow-bellied marmot	*Marmota flaviventris*
Townsend's ground squirrel	*Spermophilus townsendii*
Belding's ground squirrel	*S. beldingi*
California ground squirrel	*S. beecheyi*
white-tailed antelope ground squirrel	*Ammospermophilus leucurus*
golden-mantled ground squirrel	*Spermophilus lateralis*
least chipmunk	*Tamias minimus*

yellow-pine chipmunk	*T. amoenus*
lodgepole chipmunk	*T. speciosus*
Townsend's chipmunk	*T. townsendii*
long-eared chipmunk	*T. quadrimaculatus*
western gray squirrel	*Sciurus griseus*
Douglas' squirrel	*Tamiasciurus douglasii*
northern flying squirrel	*Glaucomys sabrinus*
Botta's pocket gopher	*Thomomys bottae*
northern pocket gopher	*T. talpoides*
mountain pocket gopher	*T. monticola*
little pocket mouse	*Perognathus longimembris*
Great Basin pocket mouse	*P. parvus*
long-tailed pocket mouse	*Chaetodipus formosus*
Merriam's kangaroo rat	*Dipodomys merriami*
Ord's kangaroo rat	*D. ordii*
chisel-toothed kangaro rat	*D. microps*
dark kangaroo mouse	*Microdipodops megacephalus*
American beaver	*Castor canadensis*
western harvest mouse	*Reithrodontomys megalotis*
canyon mouse	*Peromyscus crinitus*
deer mouse	*P. maniculatus*
brush mouse	*P. boylii*
pinon mouse	*P. truei*
northern grasshopper mouse	*Onychomys leucogaster*
bushy-tailed woodrat	*Neotoma cinerea*
desert woodrat	*N. lepida*
heather vole	*Phenacomys intermedius*
montane vole	*Microtus montanus*
long-tailed vole	*M. longicaudus*
sagebrush vole	*Lemmiscus curtatus*
common muskrat	*Ondatra zibethicus*
Norway rat	*Rattus norvegicus*
house mouse	*Mus musculus*
western jumping mouse	*Zapus princeps*
common porcupine	*Erethizon dorsatum*
coyote	*Canis latrans*
Sierra Nevada red fox	*Vulpes vulpes necator*
kit fox	*V. velox*
common gray fox	*Urocyon cinereoargenteus*
black bear	*Ursus americanus*
common raccoon	*Procyon lotor*
American marten	*Martes americana*
fisher	*M. pennanti*
ermine	*Mustela erminea*
long-tailed weasel	*M. frenata*
mink	*M. vison*
California wolverine	*Gulo gulo luteus*
American badger	*Taxidea taxus*
western spotted skunk	*Spilogale gracilis*
stripped skunk	*Mephitis mephitis*
northern river otter	*Lutra canadensis*

mountain lion	*Felis concolor*
bobcat	*Lynx rufus*
mule deer	*Odocoileus hemionus*

Scientific and vernacular names follow the checklists in:

American Fisheries Society. 1991. Common and scientific names of fishes from the United States and Canada, 5th edition. Spec. Pub. No. 20. Bethesda, Maryland.

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PART B. LIST OF SPECIAL STATUS SPECIES KNOWN OR LIKELY TO OCCUR IN THE STUDY AREA THAT ARE NOT LIKELY TO BE AFFECTED BY ALTERNATIVES UNDER CONSIDERATION.

SPECIES	SCIENTIFIC NAME	STATUS[1]	LOCATION AND HABITAT
Plants			
Altered andesite buckwheat	*Eriogonum robustum*	NNHP S2S3	NV endemic. Storey and Washoe Counties. Dry, shallow, highly acidic gravelly clay soils on ridges, knolls and steep slopes usually in stunted pine woodlands, 4,410-7,325 ft.
Altered andesite popcornflower	*Plagiobothrys glomeratus*	NNHP S2S3	NV endemic. Storey and Washoe Counties. Dry, shallow, highly acidic gravelly clay soils on ridges, knolls and steep slopes usually in stunted pine woodlands 4,850-6,650 ft.
Ames milkvetch	*Astragalus pulsiferae* var. *pulsiferae*	NNHP S1	Washoe County, NV, in CA from Lassen to Sierra Counties. Loose, porous volcanic gravels and sands in open ponderosa pine forests, sagebrush plains, or valley floors. 4,265-5,512 ft.
Cup Lake draba	*Draba asterophora* var. *macrocarpa*	FSS CNPS 1B	CA endemic, El Dorado County. Rocky soil in coniferous subalpine forest; 8,200-9,236 ft.
Dog Valley ivesia	*Ivesia aperta* var. *canina*	FSS CNPS 1B	CA endemic, known only from Dog Valley, Sierra Co.. Vernally wet, shallow rocky soil of volcanic origin in openings of yellow pine forest; 5,700-6,150 ft.
Donner Pass buckwheat	*Eriogonum umbellatum* var. *torreyanum*	FSS CNPS 1B	CA endemic from Placer, Nevada, and Sierra Counties, historic collection on Squaw Creek. Rocky meadows and outcrops, often on ridgetops and steep slopes, 6,000 to 8,000 ft.
Dune sunflower	*Helianthus deserticola*	NNHP S2	Churchill, Clark, Lyon(?), and Mineral Counties, NV; also in UT and AZ. Dry, open, deep sands, often on dunes, 1,345-4,880 ft.
English sundew	*Drosera anglica*	CNPS 2	Nevada, Sierra, and other northern CA counties; circumboreal; known from Sagehen Creek, a tributary to Stampede Reservoir. Bogs and fens, often on sphagnum; 4,264-6,560 ft.
Galena Creek rockcress	*Arabis rigidissima* var. *demota*	FSS CNPS 1B NNHP S2	Placer and Nevada Counties, CA and Washoe County, NV; Apparently restricted to northern Carson Range. Sandy to rocky soils, generally in forest openings; 7,020 to 10,020 ft.
Lemmon's clover	*Trifolium lemmonii*	NNHP S1 CNPS 1B	Nevada, Sierra, and Plumas Counties, CA and Washoe County, NV; dry soils near pine forests or sagebrush flats, 4,820-6,000 ft.

long-petaled lewisia	*Lewisia longipetala*	FSS CNPS 1B	CA endemic from Nevada, El Dorado, Placer, and Fresno Counties. Alpine boulder and rock fields; 8,200-9,595 ft.
Margaret's rushy milkvetch	*Astragalus convallarius* var. *margaretiae*	NNHP S2	NV endemic in Carson City, Douglas, Lyon and Storey Counties. Rocky slopes and flats among sagebrush in the pinyon-juniper and sagebrush zones. 4,700-7,800 ft.
marsh willowherb	*Epilobium palustre*	CNPS 2	Known in CA only from Grass Lake (El Dorado Co.) and Willow Lake (Plumas Co.), circumboreal. Bogs and fens; ~ 7,218 ft
Munroe's desert mallow	*Sphaeralcea munroana*	CNPS 2	Placer County, CA (Squaw Creek) to WA, MT, WY, and UT. Dry, open places usually with sagebrush, ±6,560 ft.
Nevada dune beardtongue	*Penstemon arenarius*	NNHP S2S3	NV endemic in Churchill, Mineral, and Nye Counties. Deep, loose soils of valley floors. Aeolian deposits, and dune skirts, often on dunes, 3,920-5,960 ft.
Nevada oryctes	*Oryctes nevadensis*	NNHP S2S3	Western NV including Washoe, Storey, and Churchill Counties; also in CA. Deep sands of stabilized dune washes, and valley flats. 3,900-5,960 ft
Nevada waterweed	*Elodea nevadensis*	NNHP SH	Originally described from a specimen along the lower Truckee River near Wadsworth. Now not considered to be a valid species.
playa phacelia	*Phacelia inundata*	NNHP S2?	Washoe and Humboldt Counties, NV; also in CA and OR. Alkali playas and seasonally inundated areas with clay soils. 5,030-5,640 ft
sagebrush pygmyleaf	*Loeflingia squarrosa* ssp. *artemisiarum*	NNHP S1S2	??? ??? ????
sand cholla	*Opuntia pulchella*	NNHP S2S3	Western NV including Washoe and Churchill Counties; also in AZ, CA, and UT. On deep sand dunes or deep sand in NV. 3,950-6,300 ft.
scalloped moonwort	*Botrychium crenulatum*	FSS CNPS 2 NNHP S1?	Widespread but uncommon in CA and possibly NV, where currently known only from Spring , Clark County, confined to western North America. Mainly in wet meadows. Not reported from Truckee River Basin.
Sierra Valley mousetails	*Ivesia aperta* var. *aperta*	CNPS 1B NNHP S1	Sierra, Plumas, and Lassen Counties, CA; Washoe and Storey Counties, NV, eastern base of Sierra Nevada; shallow, vernally wet meadows and along rocky streams. 4,500-6,600 ft.
starved daisy	*Erigeron miser*	FSS CNPS 1B	CA endemic in Nevada and Placer Counties. Known from Donner Pass Lake area. Rocky granite ledges. 8,200-9,236 ft.
Steamboat monkeyflower	*Mimulus ovatus*	NNHP S1S2	NV endemic in Storey, Washoe, Douglas(?), and Carson City(?) Counties. Dry, gravelly places in sagebrush or pinyon-juniper zones. 4,550-6,200 ft.

Steamboat buckwheat	*Eriogonum ovalifolium* var. *williamsiae*	E, NE	Steamboat Springs, Washoe Co., NV; hot spring soil deposits.
Subalpine fireweed	*Epilobium oreganum*	FSS CNPS 1B	CA endemic in Sierra, Mono, and Fresno Counties, CA. Meadows and seeps, subalpine coniferous forest 6,560-8,856 ft. Not reported from Truckee River Basin
Tahoe draba	*Draba asterophora* var. *asterophora*	FSS CNPS 1B NNHP S1	El Dorado, Alpine, Mono and Tuolumne Counties, CA, and Washoe County, NV. Decomposed granite near timberline. 9,000-10,200 ft.
Tiehm's rockcress	*Arabis tiehmii*	NNHP S1	Washoe County, NV, and Mono County, CA; subalpine to decomposed granite outcrops 9,820-10,560 ft
upswept moonwort	*Botrychium ascendens*	FSS CNPS 2	Eldorado, Butte, Tehema, and Shasta Counties, CA and Clark County, NV (Spring Mts.), confined to western North America. Grassy field coniferous forests near streams. 8,891-11,155 ft
Washoe pine	*Pinus washoensis*	NNHP S1	Washoe County, NV, much of northeastern CA, into PNW? Montane and subalpine coniferous forests 6,240(?)-8,500 ft.
Washoe tall rockcress	*Arabis rectissima* var. *simulans*	NNHP S1	Douglas and Washoe Counties, NV, possibly in CA; endemic to northern Carson Range. Dry, sandy soils in pine or fir forests 6,035-7,350 ft
Western goblin	*Botrychium montanum*	FSS	Butte, Plumas, and Tehama Counties, CA, and other western states. Shaded coniferous forests 4,920-6,248 ft. Not reported from Truckee River Basin.
Williams combleaf	*Polyctenium williamsiae*	NNHP S2	Western NV including Washoe County. Shoreline of vernal pools in sagebrush and pinyon-juniper zones 5,700-7,467 ft.
Invertebrates			
Western Lahontan springsnail	*Pyrgulopsis longiglans*	NNHP S2S3	Springs.
Lake Tahoe benthic stonefly	*Capnia lacustra*	NNHP G1 S1	Only at Lake Tahoe; 100-400 feet deep water
Carson Valley silverspot butterfly	*Speyeria nokomis carsonensis*	NNHP S1	Only in Carson River drainage in Alpine County, CA, and Walker River drainage in Mono County, CA
Birds			
common loon	*Gavia immer*	S CSSC NNHP S2 S3	BR, LT, LR, PCR, PL, SR; large bodies of water with fish, regular migrant
Sandhill crane	*Grus canadensis*	CT	Tahoe Basin, wet meadows and open areas; migrant, historic nesting UTR
Harlequin duck	*Histrionicus histrionicus*	CSSC	Rare sightings LT, PL, LTR; mountain streams; transient

golden eagle	*Aquila chrysaetos*	CSSC	SA: open terrain; resident
northern goshawk	*Accipiter gentilis*	FSS CSSC NNHP S3	Tahoe Basin: conifer and aspen forest, resident
prairie falcon	*Falco mexicanus*	CSSC	SA: open terrain; resident
mountain plover	*Charadrius montanus*	S	Great Basin, shortgrass prairies and arid plains, transient
California spotted owl	*Strix occidentalis occidentalis*	FSS CSSC NNHP S1	Tahoe Basin: coniferous forest; resident
western burrowing owl	*Athene cunicularia hypugaea*	CSSC NNHP S3	LOTR, LR, PL: open terrain, resident
black swift	*Cypseloides niger*	CSSC	Central to southern Sierra: nest near waterfalls, migrant in Tahoe Basin
rufous hummingbird	*Selasphorus rufus*	BCC	Common, often a transient in spring and fall, breeding range is Pacific NW north to Alaska.
Lewis' woodpecker	*Melanerpes lewis*	BCC	Resident breeder in isolated pockets of the Sierra Nevada and other areas of California and northern Nevada.
red-breasted sapsucker	*Sphyrapicus ruber*	S	Sierra Nevada; cavity nester in cottonwood, willow, aspen, alder, fir and birch trees, resident
gray flycatcher	*Empidonax wrightii*	S	Migrant and breeding species in Great Basin, inhabits sagebrush, pinon-juniper, very open pine woodlands
bank swallow	*Riparia riparia*	CT	LOTR, LR: nest in excavated burrows in vertical banks of fine textured soils
loggerhead shrike	*Lanius ludovicianus*	S	LOTR, LR, PL: open terrain with scattered shrubs; resident
hermit warbler	*Dendroica occidentalis*	S	Summer resident in the Sierra Nevada, uses upper canopies of scattered groups of tall trees
Virginia's warbler	*Vermivora virginiae*	CSSC, BCC	Pinyon-juniper woodlands, mountain mahogany thickets, and brushy areas along streams. No known breeding localities north of the Wassuk Range, NV, and Mono Co., CA
Brewer's sparrow	*Spizella breweri*	S	Summer resident throughout Nevada; inhabits open, shrub habitats
lark sparrow	*Chondestes grammacus*	S	Summer resident in Great Basin, open shrublands in valleys and foothills
sage sparrow	*Amphispiza belli*	S	Summer resident in Great Basin; sagebrush and chaparral
tricolored blackbird	*Agelaius tricolor*	CCE	Migrant throughout study area; nests in tall, dense cattails or willows, forages on muddy shores

Fish			
Lahontan lake tui chub	*Siphateles bicolor* ssp. *pectinifer*	CSSC FSS	Abundant in Pyramid Lake. Also in Lake Tahoe and Stampede Reservoir where threatened by kokanee and opossum shrimp which have deplete zooplankton on which tui chub feed and largemouth bass which prey on juvenile chubs in rearing areas (Moyle, 2002).
Mammals			
Preble's shrew	*Sorex preblei*	NNHP S2	Nearest known sightings NW Nevada (Sheldon NWR) and Warner mountains; montane sagebrush communities, and brushy riparian areas
Trowbridge's shrew	*Sorex trowbridgii*	NNHP S2	Common and widespread in Sierra Nevada in both wet and dry habitats at mid-elevations (3800-7500 feet). Optimal habitat is mature stages of ponderosa pine and mixed-conifer forests. Distribution not closely tied to availability of water.
Western small-footed myotis	*Myotis ciliolabrum*	NNEP S3	Western U.S.; roosts under rock slabs and crevices, eats flies and insects
western white-tailed hare	*Lepus townsendii*	CSSC	Crest and eastern slope of Sierra Nevada; sagebrush, meadows, and conifer forest
pygmy rabbit	*Brachylagus idahoensis*	NSSC	Northwestern, northern, and eastern two-thirds of the state of Nevada; in association with tall, dense sagebrush
Sierra Nevada mountain beaver	*Aplodontia rufa californica*	CSSC	Dense riparian-deciduous and open, brushy stages of most forest types in Sierra Nevada
Sierra Nevada red fox	*Vulpes vulpes*	CT	May occur within the upper Truckee Basin within coniferous forests
American marten	*Martes americana*	FSS	Tahoe Basin; coniferous forests
Pacific fisher	*Martes pennanti pacifica*	FSS CSSC	Tahoe Basin; high elevation coniferous forest
Wolverine	*Gulo gulo*	CT	Sierra crest, open terrain above timberline
American badger	*Taxidea taxus*	CSSC	Most of California and Nevada; open terrain

Federal - E = endangered, T = threatened, S = Fish and Wildlife Region 1 species of management concern, FSS = Forest Service sensitive species, FSW = Forest Service watch species

State - NE = Nevada endangered, NSSC = Nevada species of special concern; CT = California threatened, CCE = California candidate for endangered species; CSSC = California Department of Fish and Game species of special concern

Location BR = Boca Reservoir; LT = Lake Tahoe; IL = Independence Lake, LTR = Little Truckee River; LOTR = Lower Truckee River; LR = Lahontan Reservoir; PCR = Prosser Creek Reservoir, PL = Pyramid Lake, SA = Study Area, SR = Stampede Reservoir, UTR = Upper Truckee River

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

TRUCKEE RIVER RIPARIAN VEGETATION

AND

FLUVIAL GEOMORPHOLOGY STUDY

Final Report
September 30, 1993

REGION ONE

U. S. Department of the Interior Mission Statement

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

U. S. Fish and Wildlife Service Mission Statement

It is the mission of the U.S. Fish and Wildlife Service to provide leadership to achieving a national net gain of fish and wildlife and the natural systems which support them.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
Sacramento Field Office
2800 Cottage Way, Room E-1803
Sacramento, California 95825-1846

[illegible]

Memorandum

To: Field Supervisor, Ecological Services
Reno Field Office, Reno, Nevada (ES)

From: Acting Field Supervisor, Ecological Services
Sacramento Field Office, Sacramento, California (ES)

Subject: Truckee River Riparian Vegetation and Fluvial [illegible] Hydrology Study - Final Report

This memorandum transmits three copies of our final report on the Truckee River Riparian Vegetation and Fluvial Hydrology Study. An additional [illegible] copies will be hand-delivered at our next meeting, scheduled for [illegible] at the Sacramento Field Office. The attached report provides an overview of the methods and results of the study. It also includes a preliminary model to be used in assessing the effects of changes in hydrologic regime on riparian vegetation. Also included, under separate cover, is a set of cover type maps prepared for the entire study area.

Per our agreement, we will continue to assist the Reno Field Office in using the information provided in this report to prepare an Environmental Impact Statement for the Truckee River Operating Agreement. We look forward to continued cooperation. Should you have any questions regarding the attached report, please contact Steve [illegible] of my staff at (916) [illegible].

Dale A. Pierce

Attachment (1 report)

cc: [illegible]
ARD ES, Portland, OR

TRUCKEE RIVER RIPARIAN VEGETATION

AND

FLUVIAL GEOMORPHOLOGY STUDY

Final Report
September 30, 1993

Prepared for:
U.S Fish and Wildlife Service
Reno Field Office - Ecological Services
Reno, Nevada

Prepared by:
Steve Caicco, Mitchell Swanson, and Maria Macoubrie
U.S. Fish and Wildlife Service
Sacramento Field Office - Ecological Services
Sacramento, California

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INTRODUCTION

This report describes the results of an investigation of riparian vegetation and channel dynamics on the Truckee River in California and Nevada. The objectives of the study were to gain an understanding of the influence of geomorphology, hydrology, and land use on the character and distribution of riparian vegetation and wildlife habitat, and to develop a preliminary model of the relationship between riparian vegetation and fluvial dynamics.

Riparian vegetation and geomorphic processes in [illegible] and influence the development of channel morphology and rates of [illegible]. Riparian vegetation [illegible] where it is high enough on the channel to survive [illegible] but low enough to tap into [illegible] water supply. [illegible] typically occur on gravel bars, channel banks, and on floodplains. Dense, established vegetation is often a significant hydraulic feature in the channel and on the floodplain. By increasing hydraulic drag on flood flows, vegetation can reduce flow velocities and induce fine sediment deposition. This in turn enhances [illegible] conditions for the establishment of a [illegible] of more plant species, resulting in a "positive feedback" loop. The hydraulic roughness of vegetation [illegible] and woody debris [illegible] channel flow capacity, rates of lateral erosion and [illegible] the channel pattern. This [illegible] process, [illegible] referred to as the [illegible] riparian succession model, may destroy existing vegetation while [illegible] new [illegible].

The hydrologic [illegible] influences on riparian vegetation include water supply during the growing season, particularly [illegible], and surface [illegible] interaction. [illegible], the depth, [illegible], and frequency of flood flows are major factors in shaping the physical environment in which riparian vegetation [illegible]. The importance of these factors can be evaluated by statistical analysis of streamflow records, and by field observation and measurement of hydraulic factors. Such an analysis determines how much water is available at given times for the growth, establishment, and maintenance of riparian plants, and how often flood flows are sufficient to scour and destroy vegetation [illegible].

[illegible] affecting riparian vegetation include [illegible], the nature and mobility of channel sediments, the influence of the [illegible] of flooding and sediment transport on channel morphology (channel width, depth, shape and pattern), and floodplain topography, and [illegible] change through time. These factors are analyzed by the [illegible] of geomorphic features through field measurement and by map and aerial photograph analyses. A qualitative channel-vegetation response model is developed [illegible] and sediment [illegible] features in the field [illegible] flood events.

FLUVIAL GEOMORPHOLOGY

Overview

[illegible] drainage [illegible] from the [illegible] in the [illegible] Nevada into the Great Basin at Pyramid Lake, Nevada (**Figure 1**). From the outlet dam at Lake Tahoe, the River [illegible] canyons and [illegible] valleys [illegible] feet in elevation, [illegible] in and around the City of Reno, agricultural areas [illegible] with diverted flow, and arid desert canyons and valleys [illegible] feet.

The present Truckee River was formed [illegible] with the uplift of the Sierra Nevada [illegible] Quaternary period [illegible] years). The upstream boundary of the study area is Lake Tahoe, which [illegible] basin formed by [illegible] Range to the east from the Sierra Nevada crest to the west. [illegible] the Truckee River [illegible]

While the Sierra Nevada uplifting continues, the Great Basin [illegible] the primary force that has formed the [illegible] typical of Nevada, northeastern California and western Utah. [illegible] and the vicinity of Pyramid Lake [illegible] mountains [illegible]. Large lakes filled [illegible] during the glacial periods of the Pleistocene Era [illegible] million years [illegible] and early Holocene [illegible] 10,000 years [illegible]. Lake sediments of [illegible] Pyramid Lake [illegible] nearly 1,000 feet higher than the present [illegible] up the Truckee River [illegible] between Wadsworth and Reno. [illegible] the [illegible] Reno area, was also [illegible] lake, although it [illegible] extensive system of meadows and wetlands by the time the [illegible] settlers arrived in the early 1800s.

The headwaters of the Truckee River, located within the [illegible] Lake Tahoe Basin, [illegible] steep mountain [illegible] with [illegible] tributary streams and [illegible] lakes. After flowing [illegible] Lake Tahoe, water enters the Truckee River [illegible] the natural [illegible] at Lake Tahoe [illegible] the level of [illegible] feet [illegible] storage above the natural rim. In addition to Lake Tahoe Dam, [illegible] tributaries of the Truckee River [illegible] Donner Lake, Prosser Creek, the Little Truckee River [illegible] Stampede, Boca [illegible] and [illegible] Lakes), [illegible] (**Table 1**). [illegible] Dam, [illegible] and Marble [illegible] Dam impound waters on the main stem of the Truckee River downstream of Reno. Numerous smaller [illegible] structures [illegible] tributary [illegible].

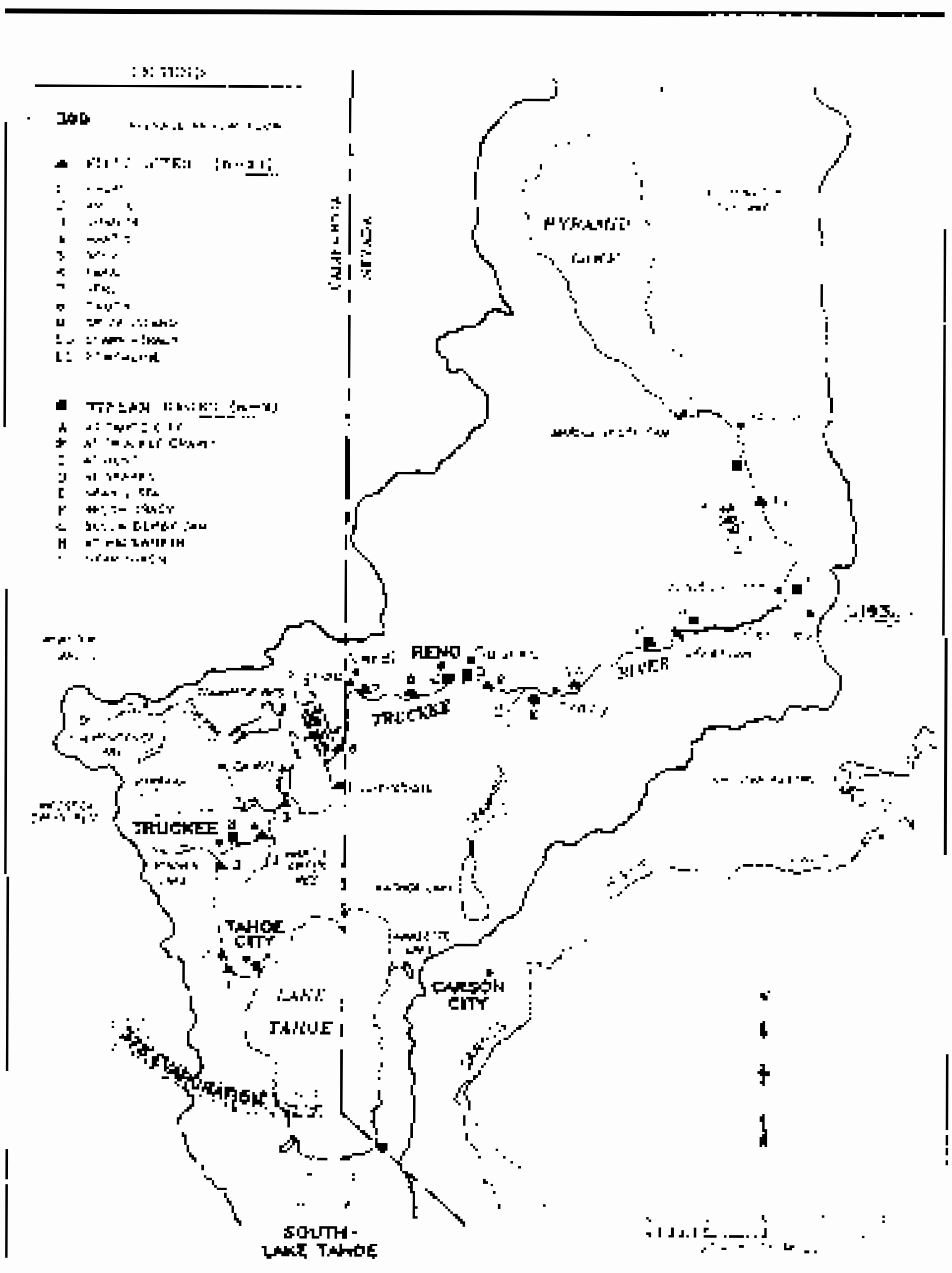
PYRAMID
LAKE
RENO
TRUCKEE
RIVER
TRUCKEE
TAHOE
CITY
LAKE
TAHOE
CARSON
CITY
SOUTH
LAKE TAHOE

Figure 2. [illegible]

Table I. [illegible]

Reservoir Name	Storage (Acre-feet)	Drainage Area	Date Closed	Elevation (Feet MSL)	Function(s)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Municipal supply[3]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

For Newlands Project operated by Truckee Carson Irrigation District.

Original dam was constructed in [illegible].

For Reno/Sparks, NV.

Small dam originally constructed in [illegible].

In general, the river [illegible] Lake Tahoe and the Reno-Sparks area (e.g., the Truckee Meadows) is [illegible] [illegible] and flanked with [illegible] adjacent floodplain areas for riparian vegetation. In the Truckee Meadows area, the river [illegible] meandered within a broad floodplain with extensive associated wetlands. These floodplain areas were initially converted to agricultural uses, but are now predominately urban and commercially zoned. [illegible] the Reno area and below Vista de-watered many wetland areas and confined the Truckee River to a single channel. The [illegible] has been [illegible] [illegible] through a combination of channelization and [illegible] [illegible] [illegible].

Downstream to the east of the Truckee Meadows, the river is confined within a narrow [illegible] valley. The floodplain areas have been highly altered by agricultural, commercial, urban and industrial developments. [illegible] upstream of Wadsworth at Derby Dam, much of the river's flow is diverted to the [illegible] River Basin and Lahontan Reservoir. This has [illegible] the hydrology of the river downstream to a highly variable regime of minimal low flows and periodic high flows when upstream [illegible] [illegible]. [illegible] the [illegible] [illegible], agricultural development, [illegible] [illegible] [illegible] with extensive stands of cottonwood and willow thickets. From Wadsworth to Marble Bluff Dam, and to Pyramid Lake, extensive [illegible] [illegible] was caused by a lowering of base levels at Pyramid Lake, as a result of the water diversions at Derby Dam. This channel [illegible] [illegible] irrigation diversions have dramatically changed the [illegible] [illegible] hydrologic regime of [illegible] riparian vegetation.

Floodplain and Channel Bank Mapping

Methodology. [illegible] (**Appendix A**), [illegible]

[illegible] (**Figure 1**). [illegible] (**Figure 1**). [illegible] (**Table II**). [illegible]

Table II. [illegible]

Site	[illegible] (Feet MSL)	USGS stream gage used to characterize hydrology
[illegible]	[illegible]	Truckee River at Tahoe City, CA
[illegible]	[illegible]	Truckee River at Tahoe City, CA
[illegible]	[illegible]	Truckee River at Tahoe City, CA
[illegible]	[illegible]	Truckee River at Truckee, CA
[illegible]	[illegible]	Truckee River at Truckee, CA
[illegible]	[illegible]	Truckee River at [illegible], CA
[illegible]	[illegible]	Truckee River at [illegible], CA
[illegible]	4,600	Truckee River at [illegible], NV
[illegible]	[illegible]	Truckee River at Sparks, NV
[illegible]	[illegible]	Truckee River [illegible], NV
[illegible]	[illegible]	Truckee River near [illegible], NV

Two to three (2 to 3) [illegible] cross-sections were surveyed in order to [illegible] levels. [illegible] cover data were simultaneously collected along the same cross-sections. Topographical datums were set at arbitrary elevation datums at each site. Cross section locations were marked on aerial photographs (scale 1 inch = [illegible]00 feet) and the hydraulic characteristics of the river [illegible] (e.g. water surface, channel roughness characteristics) [illegible] were calculated [illegible] were performed using the standard step backwater method in the U.S. Army Corps of Engineers HEC-2 computer simulation program. Cross section and hydraulic data were plotted [illegible] (see **Appendix B**). An analysis of aerial photographs was also conducted to characterize the degree of alteration to the river and its hydrology based upon a percentage of modification [illegible]. **Tables III and IV** show the channel bank and floodplain types. The results of the channel bank and floodplain type analyses are presented in pie and bar charts in the Discussion of **Project Reaches and Field Sites** [illegible].

Table III. Channel bank types identified on aerial photographs showing the degree of alteration of the [illegible] River.

TYPE	DEFINITION	
NATURAL	No significant local modification of the channel bank noted on the aerial photographs.	
DISTURBED	Channel bank impacted by grazing and/or cultivation [illegible] development.	
	Minor	Less than 25 percent of the channel bank shows detectable impacts.
	[illegible]	Greater than 25 percent of the channel bank shows impacts.
FILL/RIPRAP	Minor	Less than 25 percent of the channel bank has significant fill placement; typically associated with [illegible].
	Moderate	25 to 75 percent of the channel bank has fill placement and/or riprap. Generally in areas built [illegible] fill from [illegible] paralleling the stream channel.
	Extensive	75 to 100% of the channel bank is riprapped or channelized.

Table IV. [illegible] types and definitions used to [illegible] the degree of [illegible] of the [illegible] River.

TYPE	DEFINITION	
NATURAL	No significant modification of the floodplain [illegible] in the [illegible] period. May include infrequently used small [illegible] roads.	
DEVELOPED	Modification of the floodplain surface due to [illegible] grading and [illegible].	
	Minor	Less than 25 percent [illegible] typically minor grading and clearing, but may include [illegible] residences and structures.
	Moderate	Between 25 and 50 percent [illegible] density homes and commercial structures; [illegible] materials [illegible] present.
	Major	Greater than 50 percent [illegible] residential and commercial structures; extensive grading [illegible] fill.
AGRICULTURAL	Modification of the floodplain surface due to agricultural [illegible].	
	Low	Less than 50 percent of the [illegible].
	High	Greater than 50 percent of the floodplain [illegible] typically high intensity use.
FILL	Placement of artificial fill on the floodplain surface.	
	Low	Minor fill, [illegible] along road and/or railway alignments. Placement of fill does not significantly impede flow onto the floodplain.
	High	Thick fill [illegible] road and railway beds [illegible] alignments. Placement of fill will significantly impede [illegible] flow onto the floodplain.
[illegible]	[illegible] on the floodplain.	

Project Reaches and Field Sites. The Truckee River within the study area was divided into [illegible] reaches based upon [illegible] (**Table V**). [illegible] that influence the development of riparian vegetation include [illegible] the frequency of [illegible] flows, the degree of sediment mobility, [illegible] the frequency of [illegible] flows, [illegible] [illegible] (**Table II**).

Table V. [illegible]

Reach	River miles from Lake Tahoe	Elevation Change (feet above MSL)
Lake Tahoe to Boca Reservoir	0.0 - 23.25	6229 - [illegible]
Boca to State Line	[illegible]	[illegible]
State Line to Vista	[illegible]	[illegible]
Vista to Derby Dam	[illegible]	[illegible]
Derby Dam to Wadsworth	[illegible]	[illegible]
Wadsworth to Dead Ox Canyon	[illegible]	[illegible]
Dead Ox Canyon to Numana Dam	[illegible]	[illegible]
Numana Dam to Marble Bluff Dam	[illegible]	[illegible]

[illegible] gages [illegible] between [illegible] In general, **rain-flood** events, [illegible] generated by [illegible] flows [illegible] **snowmelt** [illegible]

[illegible] channel bank materials are fine grained and easily [illegible] [illegible] geomorphically significant flood events [illegible] channel [illegible] physical [illegible] riparian vegetation [illegible] is discussed in **Development of a Fluvial Hydrology-Vegetation Model** below. [illegible]

Lake Tahoe Dam to Boca Dam

The Truckee River between Lake Tahoe and the confluence of the Little Truckee River near Boca Dam flows through [illegible] channel [illegible] (**Figure 3**).

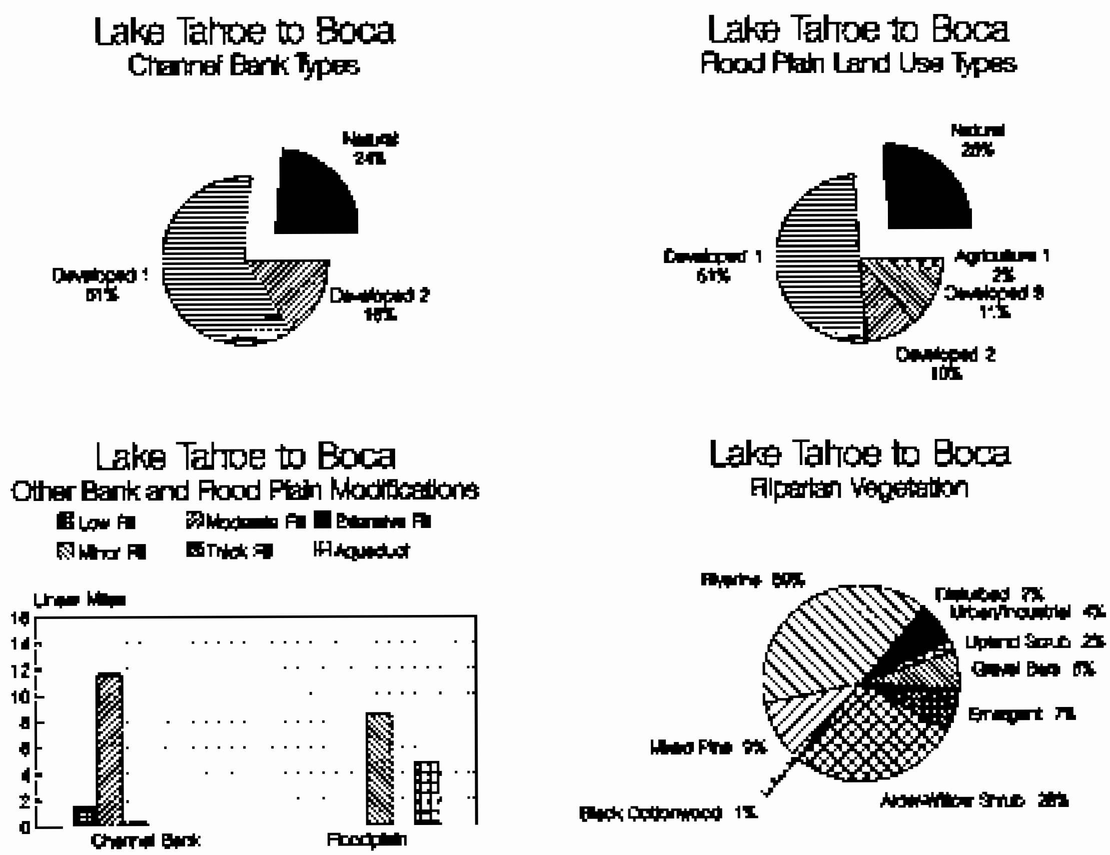

Figure 3. Channel bank types, flood plain land use types, other modifications, and riparian vegetation for the Lake Tahoe to Boca Reach.

[illegible] flows within a narrow canyon between [illegible] and the confluence with Squaw Valley Creek, [illegible] **American Gas** [illegible] **Walsh Bridge**[illegible]. Below Squaw Valley Creek, the canyon [illegible] valley [illegible]. The river gradually [illegible] whitewater is common. Most flows are well contained within the channel and offer little area for riparian vegetation. [illegible]

At [illegible] **Granite**[illegible], the channel gradient decreases [illegible] feet. The channel [illegible] every [illegible] years on average. The channel [illegible]

At [illegible] the river [illegible] Valley, where the river flows in a channel [illegible] valley [illegible]. The channel is steep and cobble-lined with [illegible] contained within the channel, although [illegible]. Between [illegible] and the sewage treatment [illegible] there is little riparian vegetation except [illegible] on the bank.

Between the sewage treatment plant [illegible] the **Martin Creek**[illegible] [illegible] floodplain [illegible] meadows, [illegible] and pine forest. The channel [illegible] riparian vegetation [illegible] every [illegible] years on average. [illegible] flows are generally well contained within the channel [illegible] vegetation. [illegible]

[illegible] water supply for riparian vegetation [illegible] flow in the river, [illegible] flow, and irrigation [illegible] at the sewage treatment plant. In the summer [illegible] Valley [illegible] support [illegible] riparian trees present ([illegible]).

Boca Reservoir to State Line

[illegible] **Farad.** [illegible] **Boca).** [illegible] **(Figure 3).** [illegible]

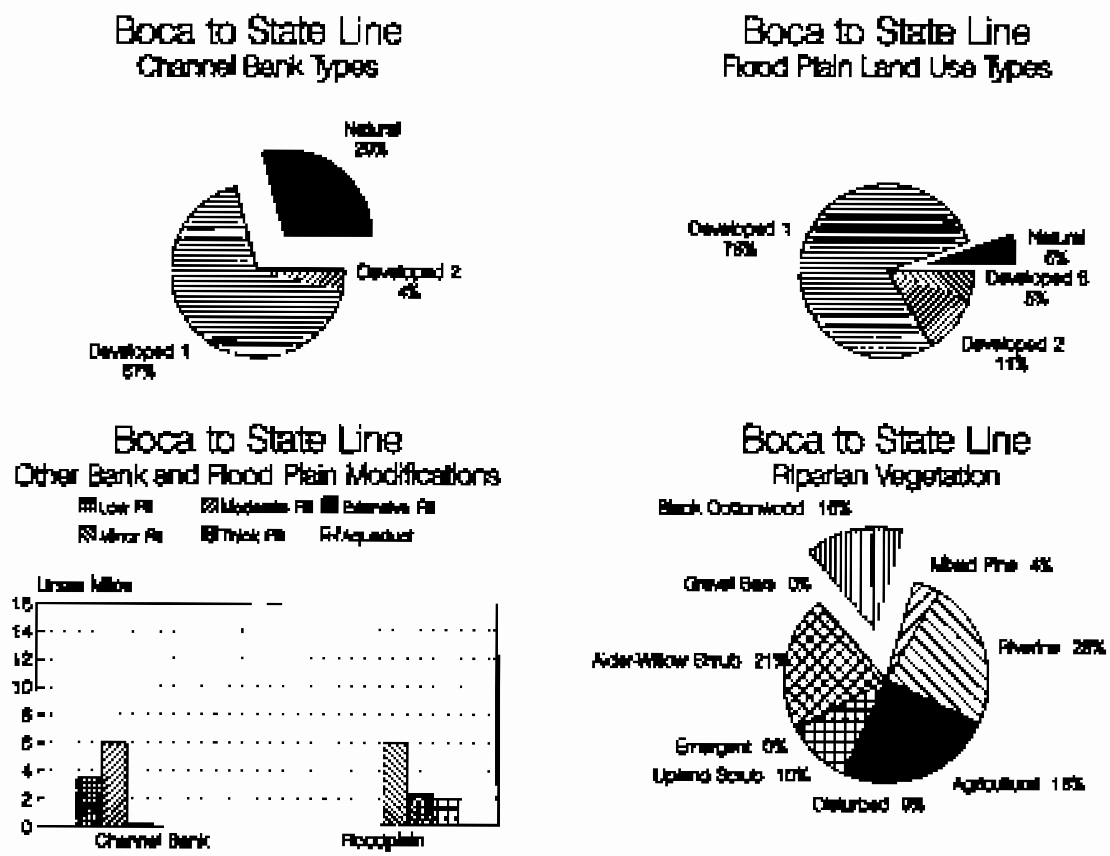

Figure 3. Channel bank types, flood plain land use types, other modifications, and riparian vegetation for the Boca to State Line Reach.

State Line to Vista

[illegible] (**Figure 4**).

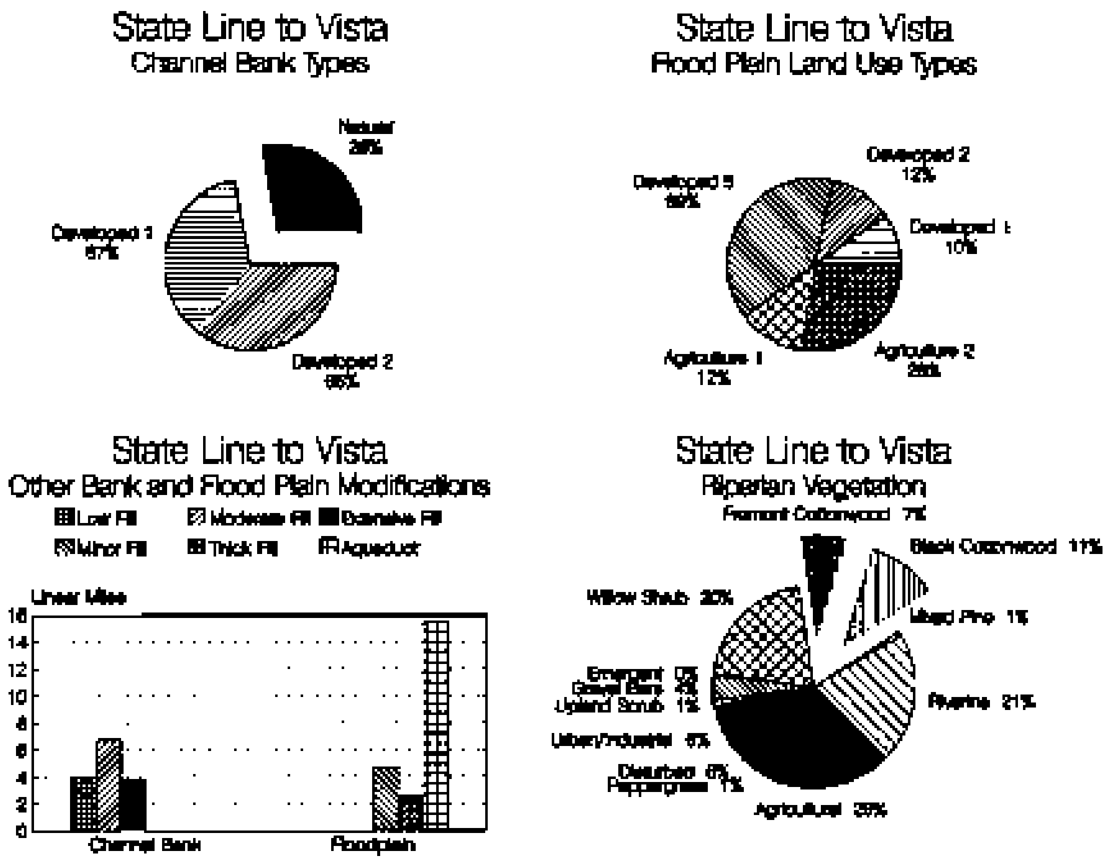

Figure 5. Channel bank types, flood plain land use types, other modifications, and riparian vegetation for the State Line to Vista Reach.

[illegible]

[illegible]

areas which support black cottonwood and [illegible] **Verdi** [illegible]

[illegible] **Oxbow**).

Below [illegible] within the town of Sparks, the river is channelized [illegible] of [illegible] **Spice Island**). The [illegible] public [illegible] There is limited [illegible]

Municipal water supply diversions occur between [illegible]

[illegible] at Verdi [illegible] February [illegible] flood, [illegible]

Vista to Derby Dam

The Truckee River between Vista and Derby Dam [illegible] (**Figure 5**). [illegible] **Clark Tracy** [illegible]

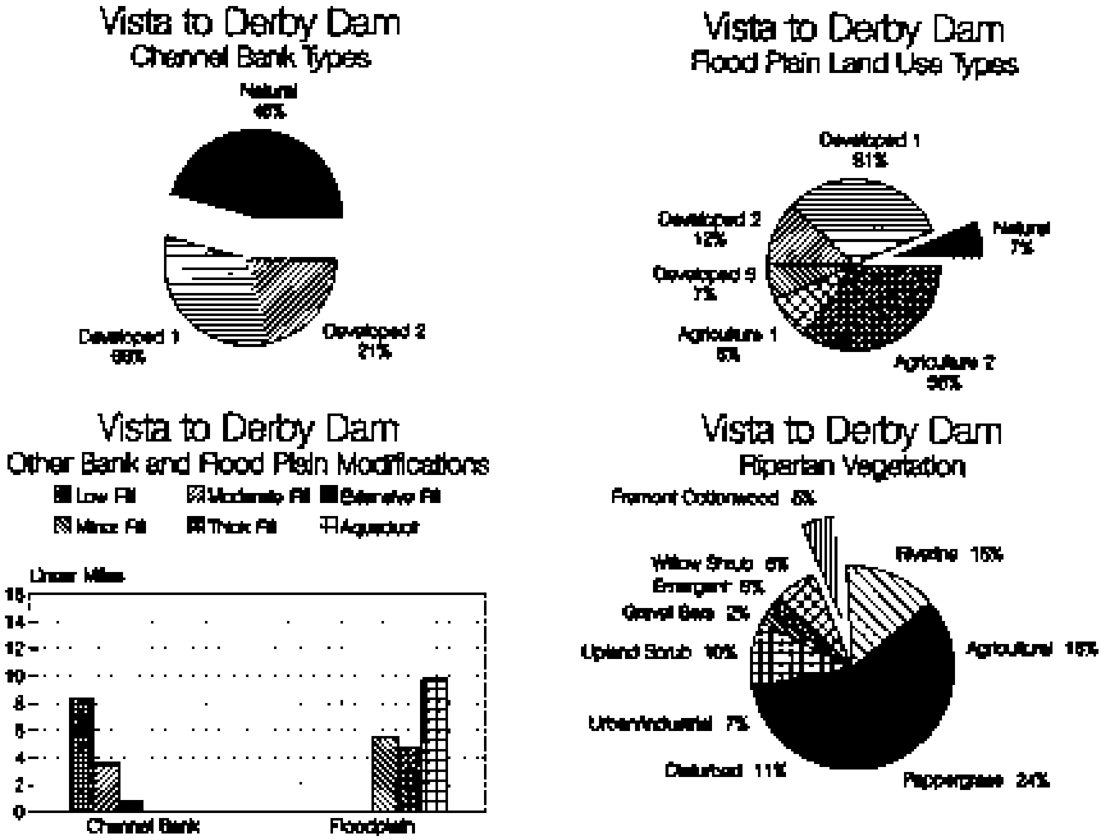

Figure 5. Channel bank types, flood plain land use types, other modifications, and riparian vegetation for the Vista to Derby Dam reach.

[illegible]

[illegible] **(Figure 6)**. [illegible]

[illegible]

[illegible]

[illegible] **(Figure 7).**

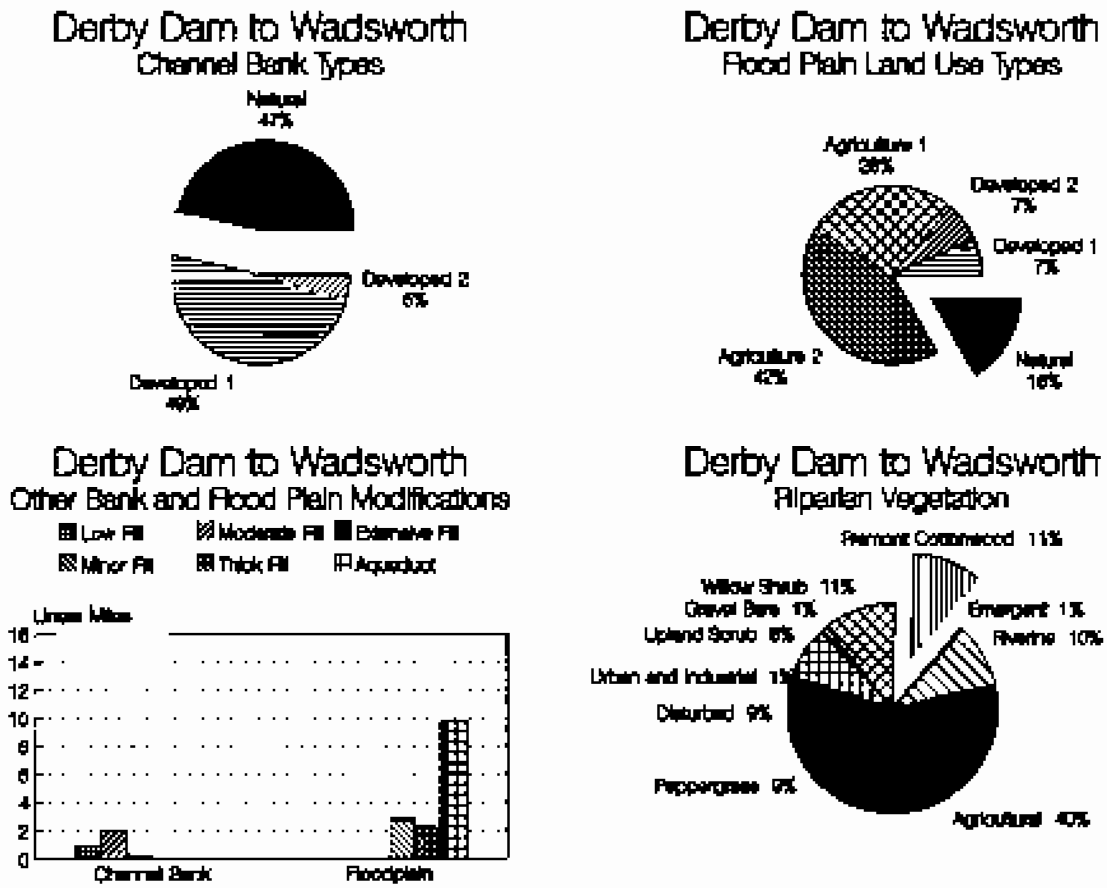

Figure 6 . Channel bank types, flood plain land use types, other modifications, and types of vegetation for the Derby Dam to Wadsworth Reach.

[illegible] **Powerline**. [illegible]

[illegible] eliminated [illegible] vegetation, particularly young plants [illegible] seedlings.

[illegible]

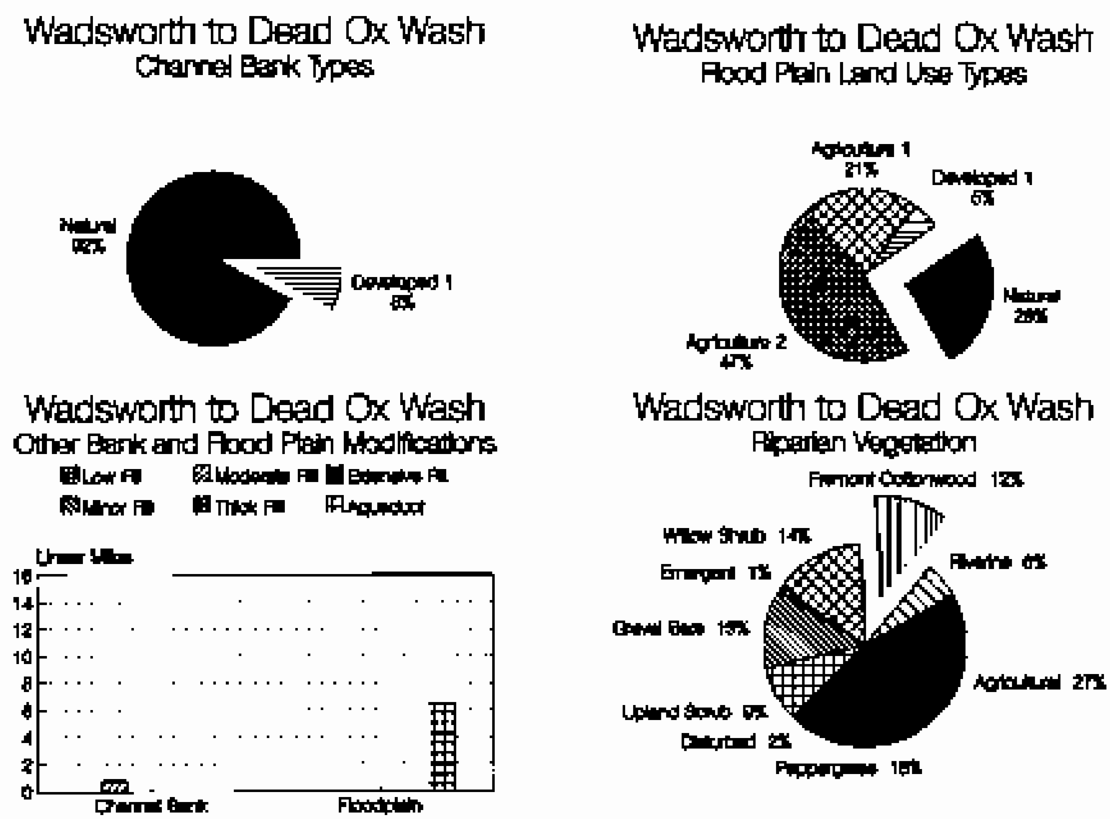

Figure 7. [illegible] Wadsworth [illegible]

[illegible]

[illegible]

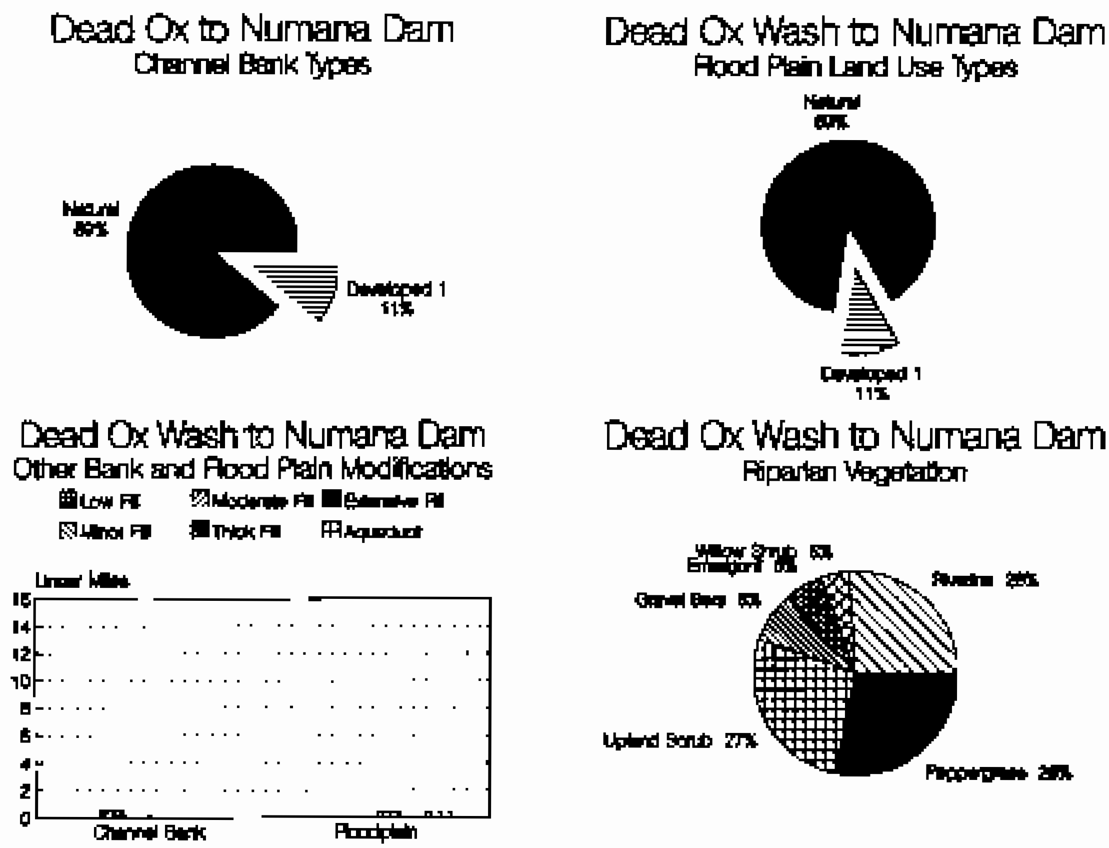
Dead Ox to Numana Dam
Channel Bank Types
Natural
Developed 1
11%
Dead Ox Wash to Numana Dam
Flood Plain Land Use Types
Natural
Developed 1
11%
Dead Ox Wash to Numana Dam
Other Bank and Flood Plain Modifications
Low Fill
Moderate Fill
Extensive Fill
Minor Fill
Thick Fill
Aqueduct
Linear Miles
15
14
12
10
8
6
4
2
0
Channel Bank
Floodplain
Dead Ox Wash to Numana Dam
Riparian Vegetation
Willow Shrub
Emergent
Gravel Bars
Upland Scrub 27%
Pepperqrass

Figure 8 [illegible]

[illegible]

[illegible]

[illegible] (**Figure 9**). [illegible]

[illegible] Dam [illegible] patches of willow [illegible] riparian vegetation [illegible] Marble Bluff Dam [illegible] wetland [illegible] and forbs [illegible].

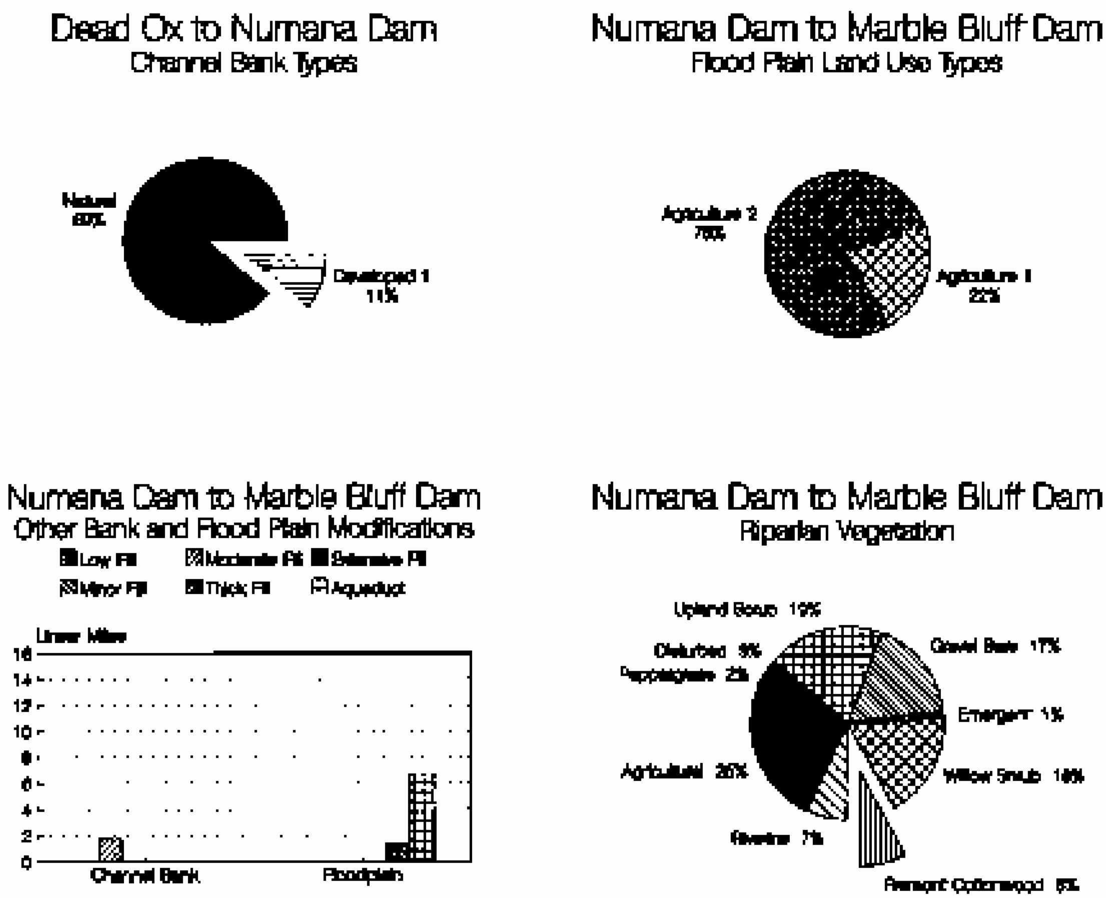

Figure 9. Channel bank types, flood plain land use types, other modifications, and riparian vegetation for the Numana Dam to Marble Bluff Dam reach.

GENERAL VEGETATION

Overview

Two approaches were used to assess the nature and condition of the [illegible] riparian vegetation. [illegible] was employed for a general assessment of the [illegible] extent of riparian vegetation along the entire [illegible] the primary use for this information [illegible] the [illegible] procedures [illegible] discussed later in this section. [illegible] data on the [illegible] vegetation and [illegible] were [illegible] sites (**Figure 1**) [illegible] riparian [illegible] of hydrology [illegible] The [illegible] of floodplain [illegible].

The vegetation of the study area [illegible] Lake [illegible] desert vegetation [illegible] Lake. The [illegible] community classification [illegible] the [illegible] Department of Fish and [illegible] useful framework for [illegible] these extremes (**Table VI**). [illegible] additional types [illegible] described in detail below.

[illegible] in **Table VI** [illegible] polygons [illegible] in the [illegible] the [illegible] photographs [illegible] the community types. [illegible] in **Tables VII** and **VIII** [illegible] **Figures 2 through 9** [illegible] Map [illegible] also given in **Table VI**.

[illegible] techniques were [illegible] important aspects of the [illegible] the proportion of [illegible] riparian [illegible] the total acreage of vegetation [illegible] disturbed, [illegible] agricultural types). [illegible] the greatest [illegible] a low proportion of [illegible] the existing riparian [illegible] floodplain [illegible].

Table VI. [illegible] **Appendix C.** [illegible] **Figures 2 through 9** [illegible]

Natural Community Classification	**Map Code Figures 2-9**	
[illegible]		
[illegible]	BC	**Black Cottonwood**
[illegible]	FC	**Fremont Cottonwood**
[illegible]	W	**Alder-Willow Shrub**
[illegible]	W	**Willow Shrub**
[illegible]		
[illegible]	E	**Emergent**
[illegible]	G	**Gravel Bars**
[illegible]		
[illegible]	PI	**Mixed Pine**
[illegible]	PT	**Mixed Pine**
[illegible]	PT	**Mixed Pine**
[illegible]		
[illegible]	S	**Upland Shrub**
[illegible]	S	**Upland Shrub**
[illegible]	S	**Upland Shrub**
[illegible]		
[illegible]	R	**Riverine**
[illegible]	P	--------
[illegible]	UI	**Urban and Industrial**
[illegible]	D	**Disturbed**
[illegible]	WT	**P e p p e r g r a s s**
[illegible]	A	**Agricultural**
[illegible]	IA	**Agricultural**
[illegible]	AF	**Agricultural**
[illegible]	AA	**Agricultural**

[illegible]

Riparian and Bottomland Forest and Scrub Habitats

[illegible]

[illegible]

canopy [illegible] (or nearly complete [illegible]) [illegible] of mature [illegible]. Dense patches of willows, commonly yellow willow [illegible] [illegible] willow [illegible] may be present [illegible] [illegible] [illegible] Kentucky bluegrass [illegible] [illegible] [illegible] [illegible]. A variety of herbaceous species may also be present.

Table VIII. [illegible] extent of cover types [illegible] [illegible] [illegible] [illegible] for each reach.

	Lake Tahoe to Boca	Boca to State Line	State Line to Vista	Vista to Derby Dam
Reach Length	23 mi (14.3 km)	13 mi (8.1 km)	23 mi (14.3 km)	17 mi (10.6 km)
COVER TYPE	ac (ha) %	ac (ha) %	ac (ha) %	ac (ha) %
OPEN WATER			0.00	
Riverine	39.95 (98.72) 39.4	29.15 (72.03) 23.4	0.00	49.07 (121.25) 14.9
Ponds	----- ----- ----	----- ----- ----	0.13 (0.32) <0.1	0.12 (0.30) <0.1
FOREST				
Mixed Pine	9.57 (23.65) 9.4	5.13 (12.68) 4.1	2.01 (4.97) 0.7	----- ----- ----
Black Cottonwood	1.43 (3.53) 1.4	19.66 (48.58) 15.8	29.71 (73.41) 11.1	----- ----- ----
Fremont Cottonwood	----- ----- ----	----- ----- ----	18.88 (46.65) 7.1	17.95 (44.35) 5.4
SCRUB-SHRUB				
Alder-Willow	28.15 (69.56) 27.7	26.38 (65.18) 21.1	----- ----- ----	----- ----- ----
Mixed Willow	----- ----- ----	----- ----- ----	54.59 (134.87) 20.4	21.14 (52.24) 6.4
EMERGENT	7.06 (17.44) 7.0	0.46 (1.14) 0.4	0.79 (1.95) 0.3	11.06 (27.38) 3.3
GRAVEL BARS	6.48 (16.01) 6.4	0.50 (1.23) 0.4	10.75 (26.56) 4.0	5.43 (13.42) 1.6
UPLAND SHRUB	1.93 (4.77) 1.9	12.36 (30.54) 9.9	2.27 (5.61) 0.8	34.00 (84.01) 10.2
OTHER				
Urban and Industrial	4.38 (10.82) 4.3		15.76 (38.94) 5.9	22.92 (56.63) 6.9
Disturbed	2.51 (6.20) 2.5	11.24 (27.77) 9.0	12.73 (31.46) 4.8	35.10 (86.73) 10.6
Peppergrass	----- ----- ----	----- ----- ----	2.22 (5.49) 0.8	80.32 (198.47) 24.2
Agricultural		19.85 (49.05) 15.9	61.17 (151.15) 22.9	54.55 (134.79) 16.4
Reach Totals	**101.46 (250.71)**	**124.73 (308.21)**	**266.97 (659.68)**	**331.68 (819.58)**
Acres/Mile	4.4	9.6	11.6	19.5

Table VIII. [illegible]

	Derby Dam to Wadsworth	Wadsworth to Dead Ox Wash	Dead Ox Wash to Numana Dam	Numana Dam to Marble Bluff Dam
Reach Length	11 mi (6.8 km)	10 mi (6.2 km)	4 mi (2.5 km)	7 mi (4.3 km)
COVER TYPE	ac (ha) %	ac (ha) %	ac (ha) %	ac (ha) %
OPEN WATER			0.00	
Riverine	23.58 (58.27) 9.65	17.92 (44.28) 5.6	0.00	15.83 (39.12) 6.5
Ponds	0.79 (1.96) 0.32	0.18 (0.44) <0.1	0.04 (0.10) <0.1	0.38 (0.94) 0.2
FOREST				
Mixed Pinn	----- ----- -----	----- ----- -----	-----	
Black Cottonwood	----- ----- -----	----- ----- -----		-
Fremont Cottonwood	26.17 (64.67) 10.71	37.90 (93.65) 11.8	----- ----- -----	19.70 (48.68) 8.2
SCRUB-SHRUB				
Alder Willow	----- ----- -----	----- ----- -----	----- -----	----- ----- -----
Mixed Willow	27.37 (67.63) 11.20	46.12 (113.67) 14.4	2.02 (4.99) 4.5	42.41 (104.79) 17.7
EMERGENT	1.45 (3.28) 0.59	3.42 (8.45) 1.1	2.82 (6.97) 6.3	3.40 (8.40) 1.4
GRAVEL BARS	2.56 (6.33) 1.05	40.09 (99.06) 12.5	3.49 (8.62) 7.8	41.30 (102.05) 17.3
UPLAND SHRUB	20.01 (49.44) 8.19	28.36 (70.08) 8.8	12.15 (30.02) 27.1	46.11 (113.94) 19.3
OTHER				
Urban and Industrial	2.45 (6.05) 1.00	----- ----- -----	----- ----- -----	----- ----- -----
Disturbed	22.26 (55.00) 9.10	6.97 (17.22) 2.2	----- ----- -----	6.90 (16.09) 2.8
Peppergrass	21.02 (51.94) 8.60	51.74 (127.85) 16.1	12.63 (31.21) 28.2	3.68 (9.09) 1.5
Agricultural	96.76 (239.14) 39.59	87.83 (217.03) 27.4		59.64 (147.37) 25.0
Reach Totals	**244.44 (604.01)**	**320.51 (791.73)**	**44.77 (110.63)**	**239.25 (591.19)**
Acres/Mile	22.2	32.0	11.2	34.2

[illegible]

[illegible]

presettlement conditions. Most other forests have little, if any, understory, although patches of broadleaved peppergrass [illegible] are [illegible] [illegible] present [illegible] except [illegible] [illegible] [illegible] may also reflect the effects of a lowered water table.

[illegible]

This community [illegible] occurs as a narrow [illegible] along the banks of the river [illegible] a few [illegible] upstream of Reno. [illegible] species occur, but the most common [illegible] [illegible] [illegible] willow [illegible] [illegible] [illegible] [illegible] A dense canopy [illegible] [illegible] development of a significant [illegible] layer. [illegible] [illegible] understory [illegible]

[illegible] Riparian [illegible]

This [illegible] community occurs as a [illegible] along the river banks [illegible] [illegible] downstream of Verdi. It also [illegible] gravel bars. Large willows are uncommon [illegible] [illegible] [illegible] [illegible] of the [illegible] Coyote willow is the most common species, although both yellow and [illegible] willows are also [illegible] [illegible] [illegible] The [illegible] by the [illegible] [illegible] [illegible] of this type. [illegible] along the river channel, [illegible] up to 6 feet in height [illegible] willows and [illegible] [illegible] [illegible] [illegible] [illegible] the [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] All but the [illegible] are native species.

Emergent Vegetation and Gravel Bars

[illegible] Freshwater Marsh

This community is uncommon and is generally restricted to a few islands between the towns of Truckee and [illegible] [illegible] [illegible] along the river banks. Common species include [illegible] [illegible] and [illegible] sedge (Carex [illegible]). Numerous other [illegible] species may be present.

[illegible]

[illegible]

[illegible]

[illegible]

Montane Coniferous Forests

[illegible]

[illegible]

Upland Scrub Habitats

[illegible]

[illegible]

[illegible] Rocky Mountain bee plant (Cleome [illegible]), [illegible] Russian thistle (Salsola kali).

Other

Urban and Industrial

Urban areas include [illegible] small towns and [illegible] residential areas along the [illegible] corridor. [illegible]

Disturbed

Areas mapped as disturbed included highways, roads and [illegible] of the [illegible]

Pepperweed

[illegible]

Agricultural

[illegible]

[illegible]

Vegetation Analysis

Methodology

Cover Type Mapping

Cover type maps were prepared for the riparian corridor of the Truckee River between Lake Tahoe and Marble Bluff Dam. Vegetation and land use types were mapped [illegible] overlay of [illegible] with aerial photography [illegible] 1 inch = [illegible] feet [illegible]. [illegible] for these enlargements were taken [illegible]. The scale of the original photos was [illegible]. Cover type polygons were manually delineated according to the classification shown in **Table VI.** Natural community classifications have been developed by the California Department of Fish and Game (Holland 1986). These [illegible] natural communities only [illegible] of the study area [illegible] by [illegible] disturbance, and must be used as a general guide to the existing vegetation. Additional cover types are cultural types resulting from human activities. Montane coniferous forests were mapped only as [illegible] forest because of the difficulty of identification of species from the aerial photography. Upland shrub types were lumped for the same reason.

The minimum mapping resolution for forested types was [illegible] [illegible] [illegible]. [illegible] was generally [illegible], [illegible] it was not possible to delineate [illegible] [illegible] canopy [illegible] [illegible] [illegible] aspect of [illegible]. An emergent stratum is present [illegible] [illegible] [illegible] [illegible] [illegible] at the [illegible]. [illegible] it was identifiable from the photography, it was mapped, but [illegible] [illegible] [illegible] [illegible] mixed. Because of the dynamic nature [illegible] [illegible] [illegible] Marble Bluff Dam, it was excluded from the [illegible] of the project and cover type mapping was not done in this [illegible]. [illegible] that area is densely vegetated by tamarisk [illegible]. Cover type mapping was restricted to the floodplain and [illegible] upland areas. The [illegible], distribution, and relative proportions of these cover types are [illegible] in the **Project Reaches and Field Sites** section above.

Data Collection

[illegible] the correlation between riparian vegetation with [illegible] [illegible], canopy structure data were collected along the [illegible] [illegible] [illegible] channel hydraulics. These data were collected by structural layer according to the [illegible] definitions and [illegible]:

Tree layer: [illegible] or **multiple** [illegible] woody plants [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] diameter breast height (dbh). [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] and [illegible] [illegible] of the [illegible]. Canopy [illegible] was [illegible] at [illegible] [illegible] along the [illegible] [illegible] [illegible] densiometer. Canopy height was [illegible] [illegible] [illegible].

Shrub layer(s): All woody plant species less than [illegible] ft in height. Canopy cover type was estimated [illegible] intersection along the line intercept transect (Mueller-Dombois and Ellenberg 1974). [illegible] detailed information on shrub structure, these data were [illegible] three height classes: [illegible] > [illegible] ft, [illegible] and ≤ [illegible], and shrubs ≤ 3 ft.

Herbaceous layer: All herbaceous species including herbs, grasses, and [illegible]. Canopy coverage visually estimated by species using the line intercept method.

Ground surface: Ground surface data [illegible] was tallied using the line intercept method. Data [illegible] bedrock, [illegible] clay, silt, sand, gravels, cobbles, and boulders.

Other information collected included site elevation, aspect, [illegible] slope, riparian [illegible] from aerial photos, current land use, and evidence of recent disturbance (e.g., grazing, beaver activity). A list of [illegible] plant species encountered along the transect is attached (**Appendix D**). [illegible] plant [illegible] of this report [illegible] Appendix D.

Data Analysis

Classification techniques. All vegetation samples were [illegible] Species Analysis (TWINSPAN), a hierarchical [illegible] (Hill 1979; Gauch and Whittaker 1981). The basic process of TWINSPAN is to divide the initial group of samples [illegible] into two groups, each of which is then subdivided into two [illegible] until a [illegible] is reached. [illegible] the data set, samples were stratified by [illegible] (forest, shrub, emergent) prior to analysis.

Ordination techniques. Ordination [illegible] statistical techniques [illegible] the basis of the abundance of the species. [illegible] summary of the community data (**Figure 10**). [illegible] species [illegible] environmental data [illegible] analysis [illegible] canonical [illegible] analysis [illegible] et al. [illegible].

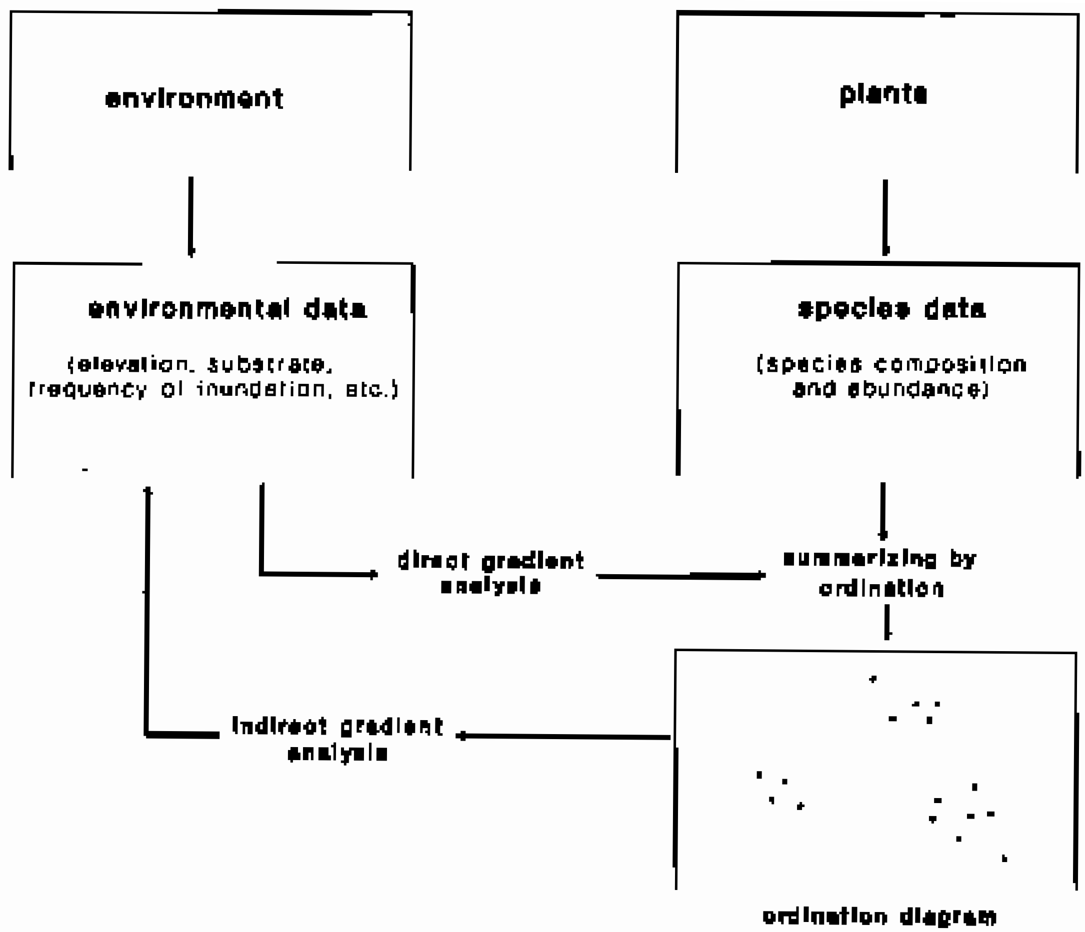
environment
plants
environmental data
(elevation, substrate, frequency of inundation, etc.)
species data
(species composition and abundance)
direct gradient analysis
summarizing by ordination
indirect gradient analysis
ordination diagram

Figure 10. [illegible]

[illegible]

RIPARIAN VEGETATION

Overview

Riparian vegetation occupies one of the most dynamic areas of the landscape, the zone of direct interaction between terrestrial and aquatic [illegible] with a rich [illegible] of fluvial landforms and the [illegible] that create them. Riparian zones extend outward to the limits of flooding and upward into the canopy of streamside vegetation. They can be viewed as [illegible] [illegible] terrestrial plant [illegible] aquatic ecosystems [illegible] vary in both space and time [illegible] et al. 1991).

Because most rivers span a broad ecological gradient [illegible] the same basin, riparian ecosystems can be viewed as [illegible] of [illegible] types, channel units, and channel [illegible] functional [illegible] between valley landforms and the processes that create them [illegible] et al. 1991). Segments of a drainage network are defined by [illegible] patterns and range in scale from [illegible] km to more than [illegible] km. [illegible] are often [illegible] by major topographic [illegible], such as [illegible] of lower-gradient rivers on valley floors [illegible] (Gregory et al. 1991).

[illegible] applies to the Truckee River [illegible] the [illegible] segment tend to be [illegible] by bedrock and have relatively straight, narrow channels. The stream channel [illegible] relatively fixed within narrow floodplains [illegible] and velocity, [illegible] rapidly with increasing discharge. In contrast, [illegible] reaches in the lower [illegible] segment tend to have [illegible] and may have complex channels with more extensive floodplains. At [illegible] flows, water may spread across the floodplain [illegible] energy of the current.

The [illegible] of the Truckee River [illegible] within the study [illegible] segment and a valley floor segment [illegible] by an [illegible] between [illegible] slope of the Sierra Nevada and the [illegible] climate of the Great Basin [illegible] a marked difference [illegible] between the two segments, perhaps because of the influence of [illegible], however, [illegible] extends downstream to the vicinity of Reno.

[illegible] factors [illegible] determine the direction and [illegible] of plant [illegible] within the study area. These include [illegible] as well as the [illegible] effects of human [illegible] and [illegible] of [illegible], [illegible] World War II [illegible] the [illegible] (Leopold [illegible] 1964) [illegible] channelization, and water management and diversion. While the emphasis of this report is on the latter three of these impacts, a plan for the management of the riparian resources of the Truckee River must be cognizant of [illegible] system [illegible].

The damming of rivers for hydropower production, flood control, or water supply has resulted in reductions in annual flow volumes, shifts in seasonal flow peaks from spring to summer, and greater fluctuations in annual flow volumes ([illegible] 1985). The consequent downstream effects on riparian vegetation range from extreme to subtle (Williams and Wolman 1984; Rood and [illegible] 1990). Extreme effects have included the widespread loss of low-elevation riparian ecosystems ([illegible] and [illegible] 1990). More subtle effects may include a reduction in the structural integrity of downstream riparian ecosystems through changes in total area, density, species composition, and species diversity ([illegible] et al. 198[illegible]).

Downstream effects of water management and diversion on the Truckee River have ranged from extreme to subtle. A good example of an extreme effect is the [illegible] of the [illegible] in the vicinity of [illegible] as a result of [illegible] due to the lowering of the level of Pyramid Lake after the construction of the [illegible] at Derby. More subtle changes [illegible] a reduction in total area and fragmentation of the riparian forest [illegible] changes in the stand structure of [illegible].

Other causes of [illegible] have resulted from the construction of [illegible] roads, highways, bridges, and channelization projects. The effects of such projects range from [illegible] impacts to significant change in channel morphology and the removal of riparian vegetation.

Three broad classes of riparian vegetation occur within the study area along the Truckee River: forests, shrublands, and meadows. The classification and ecological relationships of vegetation types within these three broad classes are discussed in the following sections. Because of its greater structural complexity and ecological importance, the riparian forests are considered in greater detail. Nevertheless, riparian forests, shrublands, and herbaceous vegetation comprise an integrated mosaic which provides ecosystem functions [illegible] provided by the individual vegetation types. Thus, [illegible] of the [illegible] individual structural types separately, the importance of landscape level factors such as patch size, shape, distribution, and [illegible] ecosystem [illegible].

Riparian Forests

Overview. Because of the ecological importance of riparian forests, a special effort was made to collect data on the species composition, structure, and ecological condition of these forests within the study area. Two species of cottonwood, Fremont's and black, are predominant in the riparian forests of the Truckee River. There is a somewhat distinct geographical separation between the species with Fremont's cottonwood being the [illegible] downstream of Reno and black cottonwood being the [illegible] upstream of Verdi. Between Reno and Verdi the two species may be found growing together. The geographical separation represents the ecological difference between the [illegible] of the dry [illegible] steppe-[illegible] desert shrub [illegible] adjacent to the river downstream of Reno and the [illegible] of the foothills and montane forests of the eastern slope of the Sierra Nevada. This ecological distinction is also expressed in a gradual increase in evergreen conifer trees in the riparian forests. The conifers, which include ponderosa and Jeffrey pine and, to a lesser extent, white fir (Abies concolor), comprise a significant percentage of the forest canopy only upstream of Truckee.

Cottonwood Community Classification. A total of [illegible] vegetation samples were taken within various stages and conditions of cottonwood dominated communities. These samples yielded a total of [illegible] vascular plant species. The results of the TWINSPAN analysis are shown schematically in **Figure 6**. As can be seen, the first division separates those samples in which black cottonwood is predominant from those in which Fremont's cottonwood predominates. As noted earlier, this is a geographical separation which expresses an ecological distinction between these two cottonwood species.

Further distinctions are made within the black cottonwood group on the basis of [illegible] and associated species composition. The first division of the black cottonwood [illegible] separates [illegible] from those which are located more approximate to the river. The first group comprises black cottonwood/[illegible] communities with [illegible]. [illegible] of Kentucky bluegrass or clover [illegible] in the understory. The [illegible] communities are [illegible] of the forests, and are commonly found where there has been recent beaver activity, [illegible] frequently inundated by flood waters. [illegible] hydrologic data [illegible] recurrence interval of about [illegible] years, [illegible] more frequently, as suggested by the more common occurrence of [illegible].

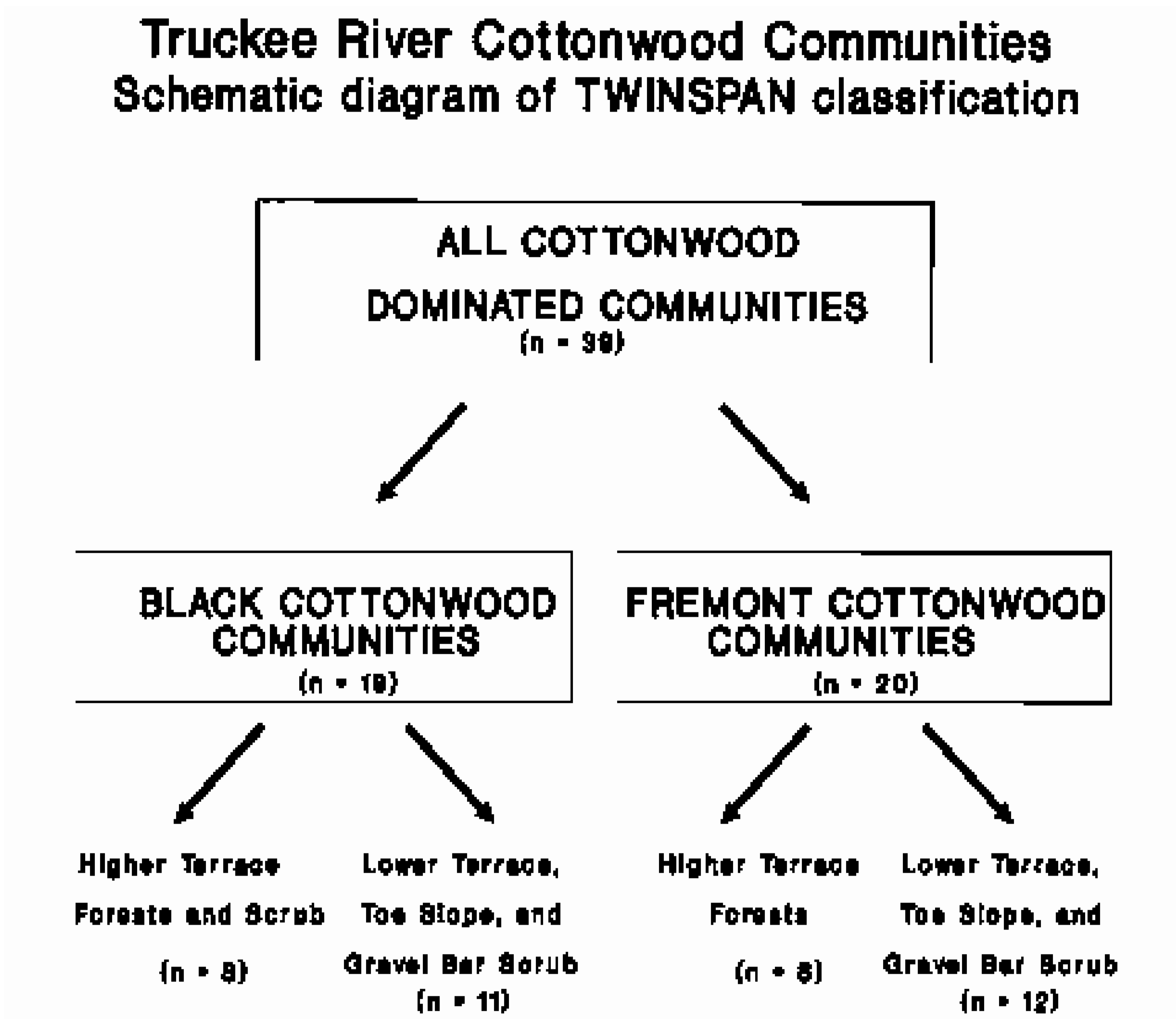

Figure 11. Schematic diagram of Two-Way Indicator Species Analysis (TWINSPAN) [illegible] dominated [illegible] Nevada.

The [illegible] group of Black Cottonwood communities [illegible] frequency of inundation (**Figure 11**). These are generally [illegible] terraces and toe slopes [illegible] channel [illegible] gravel bars within the [illegible] Stands of black cottonwood [illegible]

[illegible], and yellow or coyote willow predominate. These shrubs, as well as the associated species, are indicative of a more hydric environment. [illegible] periodically inundated by river water [illegible].

The [illegible] of the [illegible] cottonwood [illegible] separates those dominated by [illegible] (**Figure 6**). As [illegible], the [illegible] higher terraces subject to a lower frequency of inundation. [illegible] communities are generally depauperate, comprised of scattered [illegible] and patches of [illegible] peppergrass. The latter species probably [illegible] the land history of [illegible] on the lower levels, [illegible] presence of [illegible] is probably indicative of a general lowering of groundwater levels below the [illegible] due to water diversion.

Fremont's cottonwood dominated [illegible] that are located on lower terraces, the higher [illegible] to the river channel, and on gravel bars with the river channel. Other shrub species are uncommon in these stands, although several samples with yellow and coyote willow were [illegible] with the [illegible] samples on the basis of the willow species. Most [illegible] indicate a more hydric environment. Based on [illegible] and a review of aerial photographs, it appears that most of these [illegible] have become established since the major [illegible] of 19[illegible].

Cottonwood Community Samples and Species Ordinations. A [illegible] of the [illegible] samples [illegible] similar to the classification [illegible] by [illegible] (**Figure 7**). [illegible] Fremont's cottonwood and black cottonwood show [illegible] Axis 1 of the [illegible]. Fremont's cottonwood forests and shrub communities [illegible] along Axis [illegible], although [illegible] between forests and shrub communities dominated by [illegible]. [illegible], there is more difference between the Fremont's cottonwood forest and shrub samples than there is between the [illegible] cottonwood [illegible] samples with respect to [illegible] along Axis [illegible]. The environmental differences underlying this [illegible] separation will be addressed [illegible] this report.

The samples [illegible] in **Figure 7** [illegible] of the species in the 39 samples. A species ordination (**Figure 8**) shows the species which [illegible] the distribution of the samples in the ordination diagram. Note that "species" [illegible] with respect to the [illegible] and [illegible] of [illegible] as [illegible].

[illegible] (Figure 6) [illegible]

Forest stand structure. [illegible]

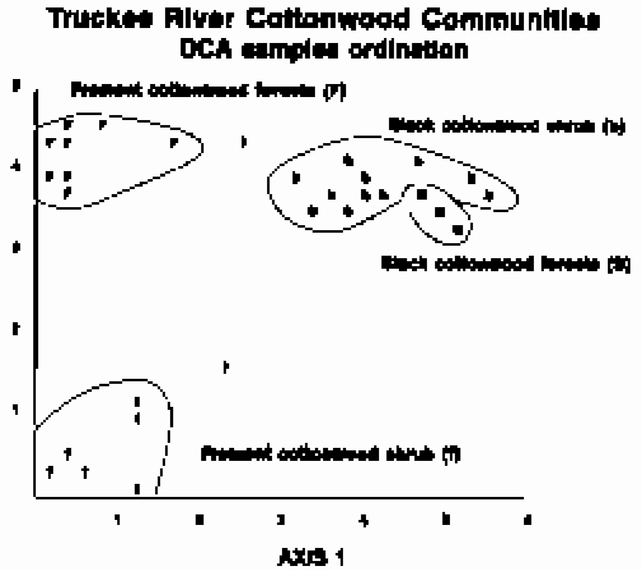

Figure 12. Detrended Correspondence Analysis (DCA) [illegible]

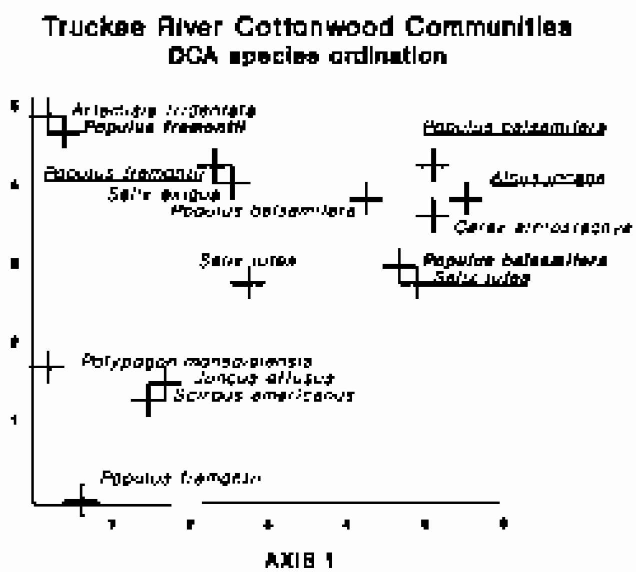

Figure 13. [illegible]

[illegible] Table X [illegible] (Figures 11, 12). Table X [illegible] Clark, [illegible] Verdi, [illegible] Granite, and [illegible] The [illegible] Fremont's cottonwood [illegible]

Table X. Tree densities, mean diameter-at-breast height (dbh), and basal area for forest samples along the Truckee River. The Powerline, Clark, and Oxbow samples are from Fremont's cottonwood forests. Black cottonwood (bc), Jeffrey pine (jp), and lodgepole pine (lp) are dominant at the other sites.

Forest Stand	Number of trees measured	Number of trees/ha	Mean dbh (cm)	Std. Dev.	Std. Error	Basal Area (m²/ha)
Powerline 1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Powerline 2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Powerline 3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Powerline 4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Powerline 5		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Powerline 6		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Clark 1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Clark 2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Clark 3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Clark 4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Oxbow 1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Verdi 1 (bc)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Verdi 2 (bc)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] (bc)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Granite 2 (jp)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Granite 3 (jp)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] 1 (lp)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] 2 (lp)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] Powerline and Clark samples (Table X). [illegible] ANOVA [illegible] differences [illegible] significantly different [illegible] Powerline [illegible] samples [illegible]. In contrast, the Clark samples [illegible] higher than those of the Powerline sites, and [illegible] more than 20 [illegible]. Basal areas of the Clark [illegible] range from [illegible] than [illegible] that of the Powerline samples. The [illegible] sample [illegible] similar to those of the Powerline [illegible], although [illegible] somewhat smaller.

There [illegible] differences among the [illegible] samples in canopy coverage (**Table XI**). Powerline samples [illegible] canopy [illegible] values ranging between [illegible], while those of the Clark sites range between [illegible]. There do not appear to be any differences [illegible] between [illegible] the two sites. The canopy coverage of the [illegible] is comparable to those of the Clark sites, [illegible] the canopy [illegible] represent [illegible].

The [illegible] are of interest [illegible] what they [illegible] the [illegible] situation of the riparian forests at the [illegible]. [illegible] histogram for the [illegible] site approximates the [illegible] of the [illegible] forest (**Figure 9**). [illegible] by chicken-wire. [illegible] more than [illegible] of the [illegible] in the smallest size class, [illegible] larger [illegible]. There is a general trend toward fewer individuals [illegible] successively larger size classes. An attempt was made [illegible] larger trees [illegible] by the Nevada Department [illegible] 40 years in age, [illegible] personal communication, [illegible]. Cottonwoods have relatively short life-spans, less than [illegible] years [illegible] 15 [illegible] greater [illegible] the population [illegible].

The [illegible] (**Figure 9**). [illegible] the largest percentage [illegible] smallest size class, and there is a decrease in the number of individuals in successive larger size classes. There are no trees [illegible] either site, however, [illegible]. These stands [illegible] younger forests. [illegible] may be adequate [illegible] at these sites.

Table XI. Mean canopy coverage and canopy height (single measurement) for forest samples along the Truckee River. The Powerline, Clark, and Oxbow samples are from Fremont's cottonwood forests. Black cottonwood (bc), Jeffrey pine (jp), and lodgepole pine (lp) are dominant at the other sites.

Stand	Number of Readings	Mean Canopy Coverage (%)	Std. Dev.	Std. Error	Canopy Height (m)
Powerline 1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Powerline 2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Powerline 3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Powerline 4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Powerline 5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Powerline 6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Clark 1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Clark 2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Clark 3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] (bc)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] (bc)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Granite 1 (jp)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Granite 2 (jp)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Granite 3 (jp)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] 1 (lp)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] 2 (lp)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] **Figure 9** [illegible]

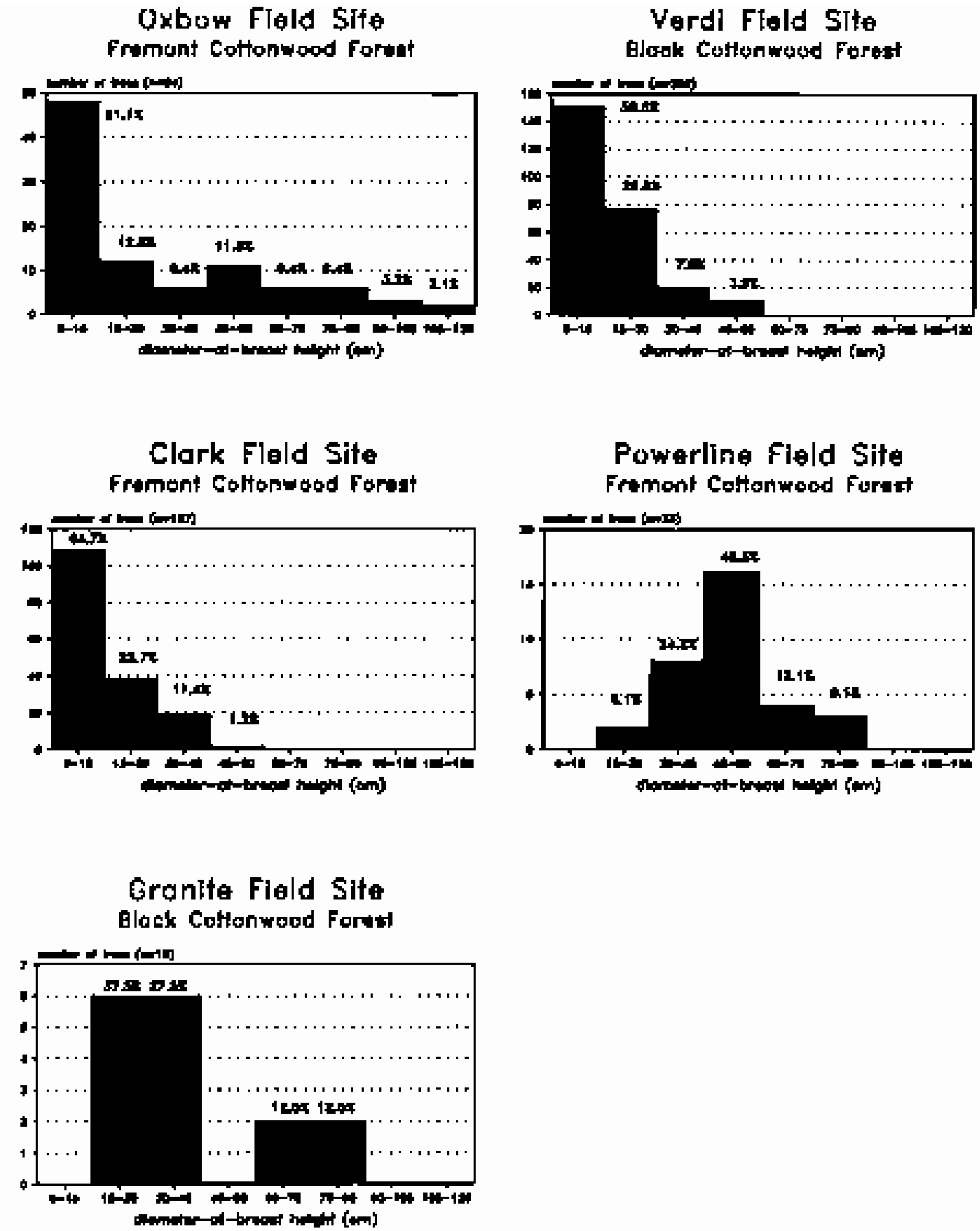

Figure 14. [illegible] Fremont cottonwood and black cottonwood forests [illegible] field site[illegible] along the [illegible] River. [illegible]

[illegible] histogram [illegible] from [illegible] (**Figure 9**). The population [illegible] distribution [illegible] the [illegible] between [illegible] and the [illegible] between [illegible] on [illegible] are [illegible] between [illegible] ecological survey [illegible] The results are skewed by the small sample size [illegible]

[illegible] the Granite [illegible] mixed populations [illegible] Jeffrey pine (**Figure 10**). [illegible] entirely of Jeffrey [illegible] while the smaller size classes include both lodgepole pine and [illegible] There are no trees present [illegible] leading to the present [illegible] are [illegible] histogram is presented to show [illegible] typical size class distribution [illegible] the upper [illegible] within the study area. The Bridge site (**Figure 10**) [illegible] of the individuals in the lowest size class with fewer individuals [illegible] larger size classes. In particular [illegible] of Jeffrey pine and white fir [illegible] the smallest size classes. [illegible] the effects of [illegible] the recent years of [illegible] the establishment [illegible]

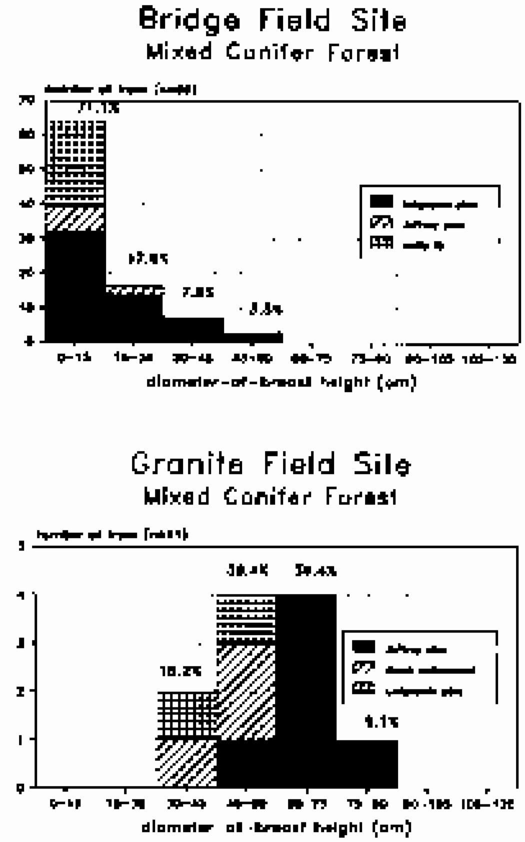

Figure 15. [illegible] histograms for mixed [illegible] at Bridge [illegible] text [illegible]

Riparian Scrub-shrub

Overview. [illegible] coyote willow, yellow willow, [illegible] dusky willow, and mountain alder. [illegible] black cottonwood. [illegible] montane riparian [illegible] Sierra Nevada [illegible] Fremont's cottonwood [illegible] coyote willow [illegible] black cottonwood, mountain alder, and dusky willow [illegible] montane riparian assemblage.

[illegible] more easily interpretable results.

Scrub-shrub Community Classification. [illegible] TWINSPAN hierarchical classification. [illegible] Fremont's cottonwood [illegible] (**Figure 16**).

[illegible] Fremont's cottonwood community [illegible]

[illegible] coyote and yellow willows [illegible] Fremont's cottonwood [illegible]

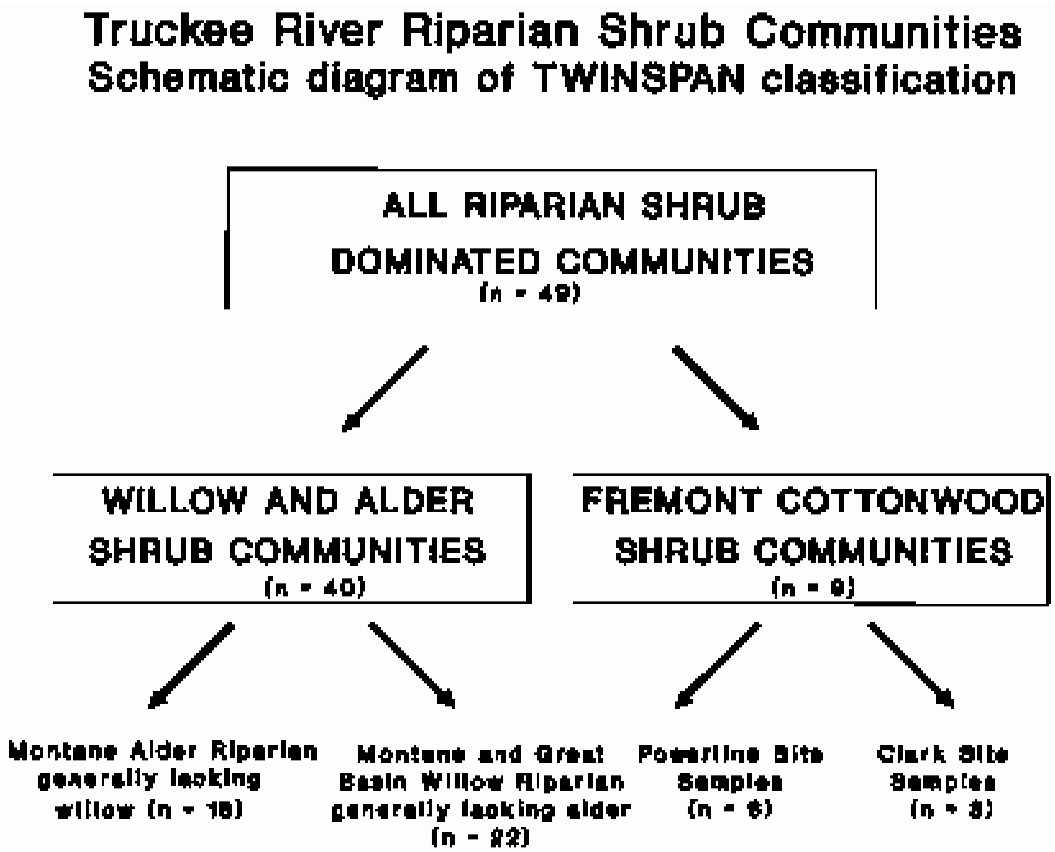

Figure 16. Schematic diagram of Two-way Indicator Species Analysis (TWINSPAN) of riparian shrub communities along the Truckee River in California and Nevada. See text for further details.

Scrub-shrub Samples and Species Ordinations [illegible] (**Figure 16**). [illegible] in the upper portion of the diagram.

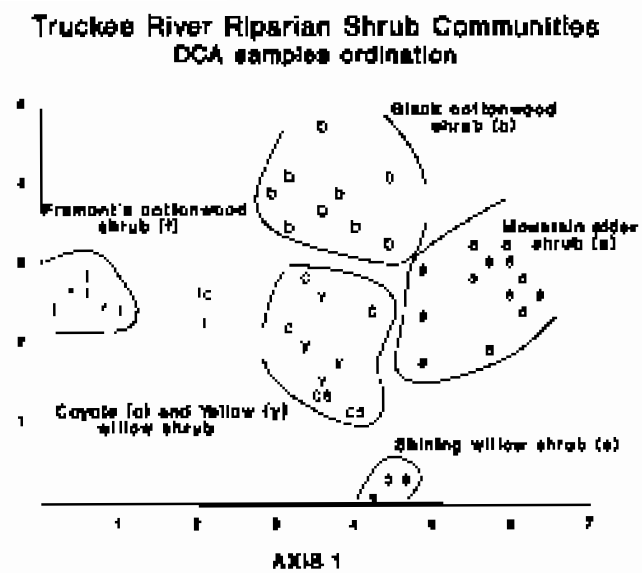

Figure 17. Detrended Correspondence Analysis (**DCA**) [illegible] diagram of [illegible] from Truckee River [illegible]. See text for [illegible].

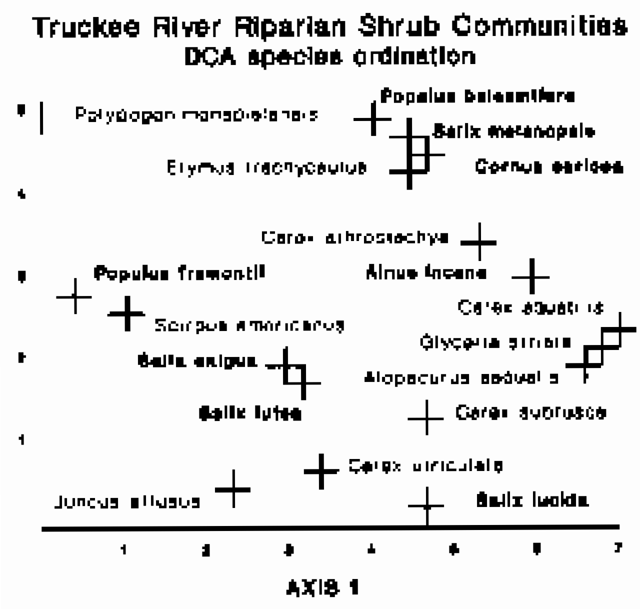

Figure 18. Species [illegible] diagram [illegible] the distribution of samples shown in [illegible].

[illegible] **Figure 17** [illegible] on the [illegible] [illegible] the [illegible]. A [illegible] **(Figure 18)** [illegible] the [illegible] of the samples [illegible] the [illegible] diagram. [illegible] the [illegible] it can be seen that Fremont's [illegible] is the only [illegible] for placement of the samples along the left margin of the diagram. Mountain alder plays a similar [illegible] along the right margin of the diagram. [illegible] in the Fremont's cottonwood shrub [illegible] include annual [illegible] grass, broadleaved [illegible], and [illegible]. [illegible]

Shrub [illegible] Axis 2 [illegible] yellow willow, [illegible] willow, and [illegible]. [illegible] water [illegible] and [illegible] Carex [illegible] common [illegible] sedge [illegible].

Emergent Vegetation and Gravel Bars

Overview. [illegible] patches of emergent herbaceous vegetation and [illegible] vegetated gravel bars [illegible] adjacent to and within the active river channel [illegible] backwater areas throughout the study area. [illegible] gravel bars, although they [illegible] have only sparse vegetation cover, [illegible] habitat for a diverse assemblage of herbaceous species. [illegible] study [illegible] period of drought, gravel bars [illegible] well established stands of vegetation.

Emergent Vegetation/Gravel Bar Classification. [illegible] emergent and gravel bar samples [illegible] by TWINSPAN [illegible] similar to that [illegible] for forest and shrub vegetation (**Figure 19**). [illegible] communities [illegible] and gravel bar [illegible] of the lower river [illegible]. The third level of the [illegible] between [illegible] densely vegetated [illegible] of montane [illegible] and [illegible] typical of [illegible] gravel [illegible] lower river samples [illegible] species. [illegible] the active stream channel. [illegible] were taken from [illegible].

Emergent Vegetation/Gravel Bar Sample and Species Ordinations. When the [illegible] samples of emergent herbaceous vegetation and gravel bar communities [illegible] subjected to DCA ordination, a similar pattern emerged (**Figure 20**). The primary axis [illegible] the environmental gradient between upper [illegible] montane [illegible] and gravel bars, and the [illegible] typical of the lower river.

The species ordination (**Figure 21**) shows the primary species [illegible] the ecological [illegible] displayed in the sample ordination. [illegible] communities [illegible] by either water depth, coarse [illegible] or silty [illegible]. The [illegible] gravel bars [illegible] the lower river. [illegible] along the lower river.

Truckee River Emergent/Gravel Bar Communities
Schematic diagram of TWINSPAN classification

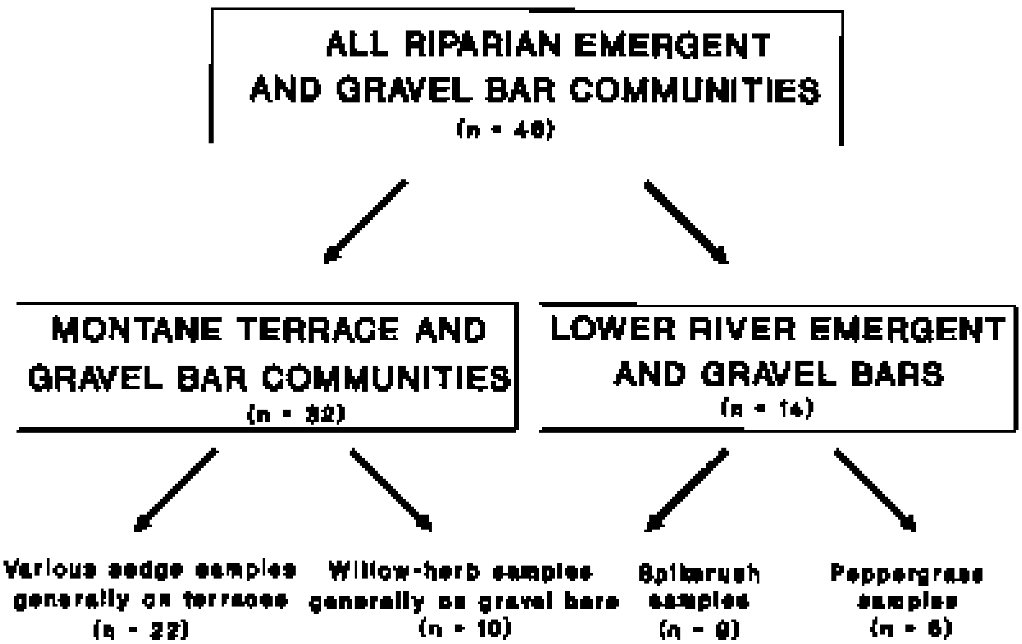

Figure 19. [illegible] Two-way Indicator Species Analysis (TWINSPAN) [illegible]

[illegible] may [illegible] with small amounts of [illegible] [illegible] many [illegible] peppergrass [illegible] community, peppergrass may be the [illegible] species, although [illegible] within the community.

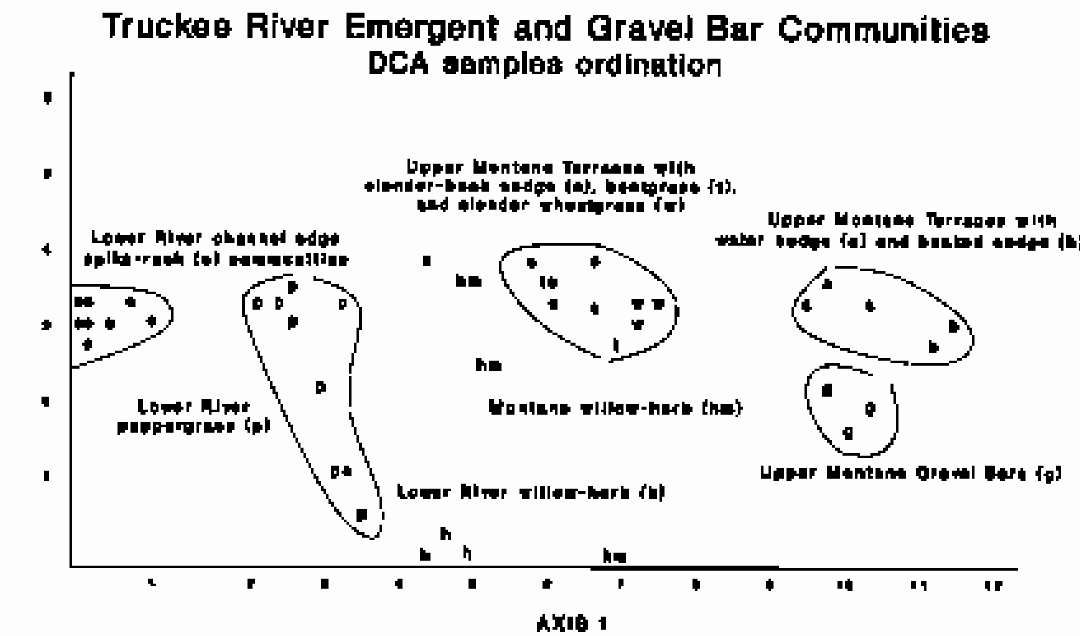

Figure 20. [illegible] (DECORANA) [illegible]

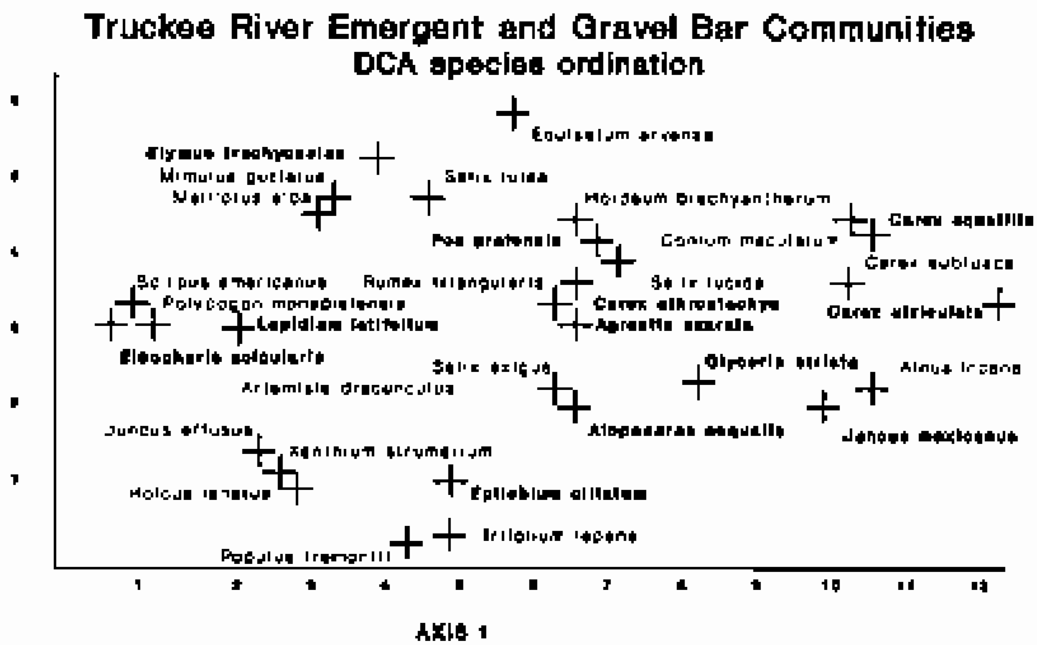

Figure 21. [illegible]

DEVELOPMENT OF FLUVIAL HYDROLOGY-VEGETATION MODELS

Introduction

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] **Impacts Analysis** [illegible] **Appendix E.** [illegible]

Overview of the General Models

The general models presented in **Appendix E** are preliminary Habitat Suitability Index [illegible] models. There are three models, one each for [illegible] riparian, [illegible] riparian, and forested riparian. [illegible]

[illegible]

[illegible]

[illegible]

Fremont's cottonwood is not a phreatophyte [illegible] suggest [illegible] groundwater (Fenner et al. 1985). [illegible] the [illegible] loss of moisture [illegible] If [illegible] will be rapid [illegible] the Central Valley of California, where the [illegible] Fremont's cottonwood may extend to depths of 15 feet [illegible] years (G. Greer [illegible]). Willows are [illegible] wetland [illegible] they appear to have a more shallow maximum rooting depth than cottonwood. [illegible] which [illegible] support [illegible] cottonwood along the lower [illegible] River probably [illegible] at elevations of [illegible] feet above the level of [illegible] and [illegible] willows. Willows appear to be restricted to areas within [illegible] feet of groundwater. Alder appears to be more restricted, [illegible] feet above groundwater.

Growth and [illegible] requirements of cottonwood [illegible] to quantify [illegible] Some [illegible] available for [illegible] Creek in Inyo County, and for [illegible] in the Mono Lake Basin (Stromberg and Patten 1990, 1991). Relationships were developed between seasonal flow volumes and [illegible] between [illegible] ring width and [illegible] and between ring width and [illegible] mortality. At Rush Creek, healthy cottonwoods were found to have annual ring widths between 3 [illegible] mm depending on elevation. In the Mono Lake Basin, annual growth [illegible] below 2 mm/year [illegible] correlated with [illegible] very low growth [illegible] than [illegible] years were [illegible] associated with tree mortality. Based on these [illegible] flow recommendations were [illegible] for three [illegible] of flows: 1) **subsistence flows** [illegible] with growth [illegible] mm/year [illegible] 2) **maintenance flows** [illegible] growth [illegible] mm/year and [illegible] 3) **attainment flows** [illegible] growth [illegible] mm/year and [illegible] allowing [illegible] not [illegible] for [illegible] within the study area.

Because the [illegible] flow [illegible] which [illegible] with [illegible] growth [illegible] the [illegible] the flow recommendations [illegible] not transferable to the [illegible] River. It is worthy [illegible] however, that [illegible] are necessary to maintain floodplain [illegible] required for [illegible] In addition, the data suggest that the flow [illegible] of floodplain trees [illegible] higher [illegible] than they [illegible] This may be because [illegible] available [illegible] trees from a [illegible]

[illegible] flow hydrologic [illegible] we [illegible] adequate [illegible] the frequency of [illegible] magnitude of flows [illegible] The [illegible] of timing of flows is also important, however, [illegible] weekly basis. The [illegible] of inundation [illegible] primarily [illegible] estimated [illegible] of the

[illegible]

[illegible] can be estimated [illegible] frequency [illegible] **Appendix A.** This value, expressed in years, [illegible] environmental variable [illegible] **detrended correspondence analysis** [illegible] described [illegible] the [illegible] discussion [illegible] environmental variables may be included as well. In addition to the frequency [illegible] direct **gradient analysis** [illegible] **detrended canonical correspondence analysis** (DCCA). [illegible]

Upper Truckee River

The results of the DCCA ordination for the Upper Truckee River [illegible] **Figure 22.** [illegible]

[illegible] frequency of inundation [illegible] **Figure 23.** [illegible] **(Tables XI** and **XII).** [illegible]

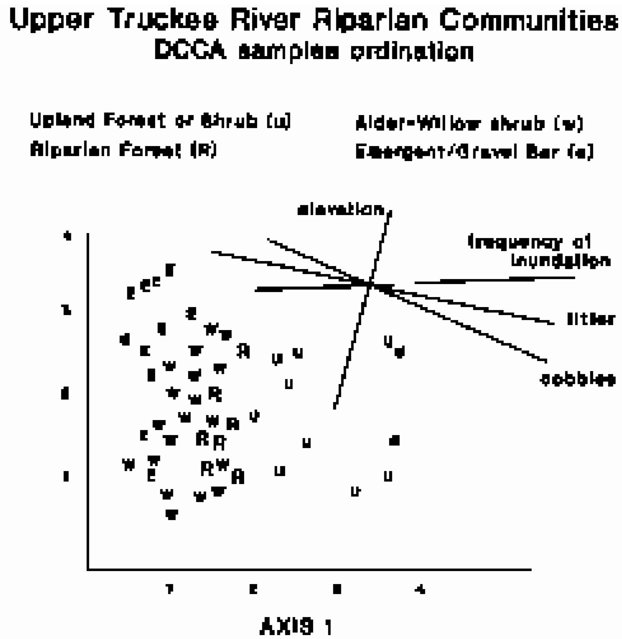

Figure 22. Detrended Canonical Correspondence Analysis [illegible] upper river [illegible] vegetation. [illegible]

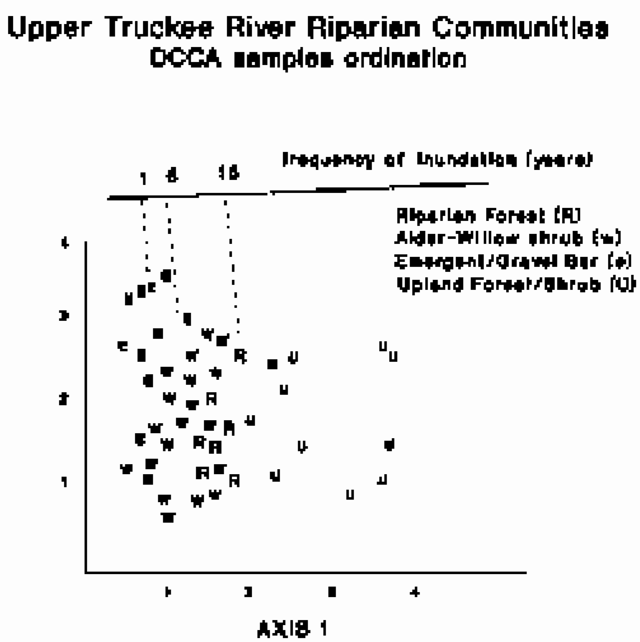

Figure 23. [illegible]

Emergent and Gravel Bar Communities

Emergent wetland and gravel bar communities [illegible] within the active river channel. [illegible] (Table XII). [illegible] typically of cobbles. [illegible] types and the prevalence [illegible] suggest that the [illegible] (Table XI).

Because of the generally steep [illegible] profile, [illegible] in response to flow [illegible] significantly [illegible] reduce the [illegible] along the channel [illegible] thereby [illegible] to colonize the exposed [illegible] emergent vegetation [illegible]

Table XI. [illegible] supporting various riparian plant communities along the [illegible] frequency of inundation [illegible] are given in parentheses. [illegible]

Gaging Station	Emergent/Gravel Bar (annual)	Alder-Willow Shrub (1-5 years)	Riparian Forest (5-15 years)	Upland Forest or Shrub (> 15 years)
@ Tahoe City	70-100 [99-20%]	100-1100	1100-1600	>1600
@ Farad	<100 [95%]	100-5500	5500-9300	>9300
@ Reno	400-600 (46-28%)	600-6000	6000-10200	>10200

Table XII [illegible] **percentage canopy coverage** [illegible] **constancy** [illegible] **Indicator Category** [illegible] **asterisk**. **Common Names** [illegible] **Appendix D**.

		Frequency of Inundation			
	Indicator	**1 year**	**1 to 5 yrs**	**5 to 15 yrs**	**>15 years**
Scientific Name/Substrate Type	Category	(n = 21)	(n = 38)	(n = 18)	(n = 14)
Trees					
[illegible]	[illegible]	---------	[illegible]	[illegible]	---------
[illegible]	[illegible]		[illegible]	---------	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	---------	-------		[illegible]
Tall Riparian Shrubs					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]		[illegible]
[illegible]	[illegible]	---------	[illegible]	[illegible]	
[illegible]	[illegible]	---------	---------	[illegible]	[illegible]
[illegible]	[illegible]	---------	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	----------
Medium Riparian Shrubs					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	----------
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	----------
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	---------	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]		[illegible]		
[illegible]	[illegible]		[illegible]	[illegible]	
Low Riparian Shrubs					
[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	---------	----------
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	-------	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	---------	[illegible]	[illegible]	
[illegible]	[illegible]	-----	[illegible]		[illegible]

			Frequency	of Inundation	
	Indicator	1 year	1 to 5 yrs	5 to 15 yrs	>15 years
Scientific Name/Substrate Type	Category	(n = 21)	(n = 39)	(n = 18)	(n = 14)
Upland Shrubs					
[illegible]	[illegible]	[illegible]	------	----	[illegible]
[illegible]	[illegible]	-------	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	---------	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	---------	[illegible]	[illegible]	--------
[illegible]	[illegible]	--------	[illegible]		[illegible]
[illegible]	[illegible]	---		[illegible]	[illegible]
[illegible]	[illegible]	-------	--------	-------	[illegible]
[illegible]	[illegible]	---------	-----	[illegible]	[illegible]
[illegible]	[illegible]	-----	---	-----	[illegible]
[illegible]	[illegible]	-------		----	[illegible]
Grasses and Graminoids					
[illegible]	[illegible]	[illegible]	[illegible]	---------	
[illegible]	[illegible]	[illegible]	[illegible]	---------	---------
[illegible]	[illegible]	[illegible]	[illegible]	---------	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	--	-----
[illegible]	[illegible]	[illegible]	[illegible]	-------	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		------
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	---------	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	---------	----
[illegible]	[illegible]	[illegible]		[illegible]	-----
[illegible]	[illegible]	[illegible]	[illegible]	--------	----
[illegible]	[illegible]	---------	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		----------
[illegible]	[illegible]		[illegible]	---------	[illegible]
[illegible]	[illegible]	---------	[illegible]	[illegible]	-------
[illegible]	[illegible]	---------	[illegible]		[illegible]

	Indicator		Frequency	of Inundation	
	Indicator	1 year	1 to 5 yrs	5 to 15 yrs	>15 years
Scientific Name/Substrate Type	Category	(n = 21)	(n = 39)	(n = 18)	(n = 14)
[illegible]	[illegible]	------	--------	[illegible]	-----
[illegible]	[illegible]	--	-----	------	[illegible]
[illegible]	[illegible]	--------	---------		[illegible]
[illegible]	[illegible]		------	----	[illegible]
[illegible]					
[illegible]	[illegible]	[illegible]	--------	--	-----
[illegible]	[illegible]	[illegible]	[illegible]	-------	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	---	[illegible]
[illegible]	[illegible]	[illegible]	---------	[illegible]	--
[illegible]	[illegible]	[illegible]	---------	--	-
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--
[illegible]	[illegible]	[illegible]	---	---------	-----
[illegible]	[illegible]	[illegible]	---------	--	--
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	--------	[illegible]	---
[illegible]	[illegible]	[illegible]		[illegible]	-------
[illegible]	[illegible]	[illegible]	--------	[illegible]	-----
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	-------
[illegible]	[illegible]	---------	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	----
[illegible]	[illegible]		[illegible]	[illegible]	
[illegible]	[illegible]	---------	[illegible]	---------	[illegible]
[illegible]	[illegible]	--------	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]		
[illegible]	[illegible]		[illegible]	---------	-----
[illegible]	[illegible]	---------	--------	[illegible]	----------
[illegible]	[illegible]	[illegible]		[illegible]	----------
[illegible]	[illegible]	---------	---------	[illegible]	--
[illegible]	[illegible]			[illegible]	----
[illegible]	[illegible]	---------	---------	[illegible]	[illegible]

			Frequency	of Inundation	
	Indicator	1 year	1 to 5 yrs	5 to 15 yrs	>15 years
Scientific Name/Substrate Type	Category	(n = 21)	(n = 35)	(n = 18)	(n = 14)
[illegible]	[illegible]	--------	-- --	----	[illegible]
[illegible]	[illegible]	--	----	---------	[illegible]
[illegible]	[illegible]			---------	[illegible]
[illegible]	[illegible]	--------	-------		[illegible]
[illegible]	[illegible]	-----	-----	---------	[illegible]
Substrate					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	----	[illegible]	[illegible]	--
[illegible]	[illegible]	[illegible]	[illegible]	----	[illegible]
[illegible]	[illegible]	---------	[illegible]	[illegible]	-------
gravel	[illegible]	[illegible]	---------	---	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible] (**Table XIII**). [illegible]

[illegible]

Riparian Forest Communities

These [illegible] wetlands are dominated by [illegible] in low abundance. The [illegible] willows and [illegible] shrubs [illegible] the tree [illegible] and the shrub layer [illegible] open forest with a variety of [illegible] and [illegible] growing on the [illegible] surface (**Table XII**). [illegible] is the most abundant and [illegible] of these, although the [illegible] species [illegible] as well. The [illegible] Most of the ground surface is covered with litter, [illegible] Many of these [illegible] from material [illegible] flows in previous years. The [illegible] for these terraces is between [illegible] and [illegible] years, with [illegible] flow rates between [illegible] and [illegible] cfs.

These [illegible] in general, [illegible] regeneration is [illegible] and there is little [illegible] Downstream of the [illegible] most of the terraces [illegible] have been converted to [illegible] residential [illegible] with [illegible] patches remaining. Between the [illegible] and [illegible] these forests are restricted to narrow bands between the [illegible] and [illegible] Upstream of [illegible] these [illegible] flow requirements [illegible] appears to be sufficient [illegible] although [illegible] development, and [illegible]

Upland Forest and Shrub Communities

Upland forest and shrub communities are never inundated by [illegible] water and are not likely to be affected by changes in flow regime. Our data suggest that [illegible] present [illegible] in this study [illegible] areas. However, whether [illegible] precipitation [illegible] could possibly lead to [illegible] Continued low flows [illegible] are likely to [illegible] the establishment of upland plant species [illegible] riparian areas. Over the long term, this would lead to a loss of riparian adapted species in favor of [illegible] taxa ([illegible] et al. [illegible]).

[illegible]

Most of the losses of riparian vegetation along the upper Truckee River is related to highway and railroad construction in the narrow Truckee canyon. In addition, some losses can be attributed to urban and agricultural development in the riparian corridor. Restoration work [illegible] was limited due to the nature of the impacts along the upper river. A limited survey of the [illegible] stands in the canyon in the vicinity of [illegible] showed that beaver [illegible] a significant threat to the long-term maintenance of existing riparian [illegible] in this area. Most of the trees in the riparian forest [illegible] already reduced to a narrow strip by the highway and/or the railroad [illegible] evidence of beaver predation. Numerous beaver cut trees were already [illegible]. As noted earlier, beaver are not thought to be native to the Truckee River. [illegible] may be desired, where [illegible] wetland [illegible] enhancement [illegible] of beaver populations [illegible] detriment [illegible] the ecosystem. Unless steps are taken to remove the beaver, or protect the remaining trees with chicken wire, the [illegible] of a riparian cottonwood forest along the upper Truckee River is doubtful.

The results of the DCCA ordination for the lower Truckee River samples are shown in **Figure 24**. The diagram shows that the upland scrub samples are at the far left of Axis 1 and spikerush communities at the far right. The other community types [illegible] between these extremes. The environmental axes [illegible] are shown in the upper right [illegible]. Note that the environmental axes associated with frequency of inundation are nearly parallel to Axis 1 of the ordination diagram, while the vertical axis [illegible] (Table [illegible]).

Because Axis 1 is most correlated with frequency of inundation [illegible], this environmental axis is more closely examined in **Figure 25**. Here the frequency of inundation axis is extended and labeled with values, which can be extrapolated to the various samples by the environmental [illegible] lines. The spikerush communities, at the far right, can be seen to be inundated annually, while the upland scrub [illegible] at the far left are inundated only by floods occurring every 15 or more years. [illegible] at [illegible] year intervals, and cottonwood [illegible] communities every **1** to [illegible] years (**Tables XIII, XIV**). The interpretation of [illegible] is [illegible] probably better.

Spikerush [illegible]

This emergent wetland type occurs as a band adjacent to the active river channel. The width of the band varies with local topography, but seldom exceeds [illegible] feet. Common spikerush is the most abundant and [illegible] species, but a variety of other grasses, [illegible] (**Table XIV**). [illegible] may be present but are always sparse. Introduced weeds are neither frequent nor abundant. The substrate is comprised of a mixture of clay and silt with [illegible]. This community is inundated [illegible]. The narrow distribution of this community and the prevalence of obligate wetland plant species indicate that it cannot tolerate extended periods of [illegible]. [illegible] flows in the range of several hundred cfs are [illegible] the topographic surfaces on which this community occurs (**Table XIII**). [illegible] most of the species in this community probably have the ability to migrate in response to [illegible] fluctuations. Flows significantly greater than [illegible] in the past several years would probably reduce the total area of this [illegible] by restricting it to a narrow band along the [illegible]. [illegible] do not appear to impact these communities.

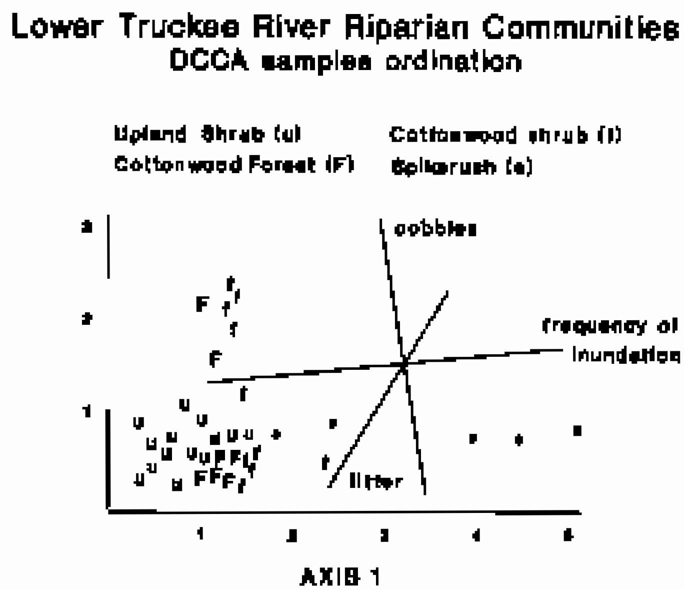

Figure 24. Detrended Canonical Correspondence Analysis ordination of lower river riparian vegetation. Major environmental vectors are also shown.

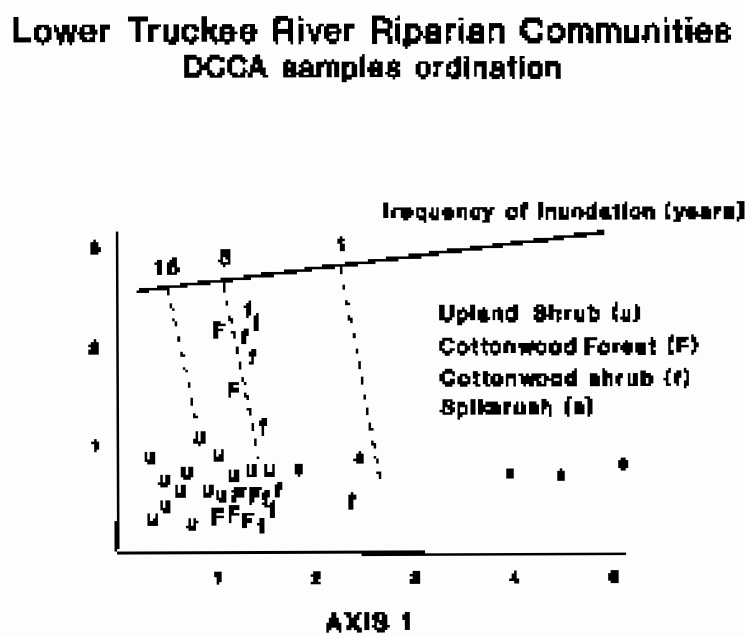

Figure 25. [illegible]

Table XIII. [illegible]

Gaging Station	Spikerush (annual)	Riparian Shrub (1-5 years)	Forest (5-15 years)	Upland Shrub (> 15 years)
@ Reno	400-600 [45-78%]	600-5000	6000-10200	>10200
@ Sparks	100-200 [[illegible]]	100-6500	6500-10500	>10500
Near Vista	<100 [91%]	100-5800	5800-10000	>10000
Below Tracy	400-600 [[illegible]-39%]	600-6000	6000-11200	>11200
Below Derby Dam	100-200 [37-[illegible]%]	200-5000	5000-9000	>9000
@ Wadsworth	<100 [63%]	100-6600	6600-12000	>12000
Near Nixon	80-125 [45-53%]	100-5500	5500-10000	>10000

[illegible]

[illegible]

Table XIV [illegible] **percentage canopy coverage** [illegible] **constancy** [illegible] **Indicator Category** [illegible] **asterisk.**

		Frequency	of Inundation		
	Indicator	1 year	1 to 5 yrs	5 to 15 yrs	>15 years
Scientific Name/Substrate Type	Category	(n = 12)	(n = 18)	(n = 26)	(n = 27)
Trees					
[illegible]	[illegible]	---------	---------	[illegible]	[illegible]
Tall Riparian Shrubs					
[illegible]	[illegible]	-		[illegible]	-----
Medium Riparian Shrubs					
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	--------	[illegible]	[illegible]	--
[illegible]	[illegible]	--------	[illegible]	[illegible]	-
[illegible]	[illegible]	[illegible]	[illegible]	----	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
Low Riparian Shrubs					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	---------	----	---------
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-
[illegible]	[illegible]	[illegible]		[illegible]	---------
[illegible]	[illegible]	---------	[illegible]	---------	
Upland Shrubs					
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	---------	---------	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	---------	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	--------	---------	[illegible]	[illegible]
[illegible]	[illegible]	---------	------	[illegible]	[illegible]

			Frequency	of Inundation	
	Indicator	1 year	1 to 5 yrs	5 to 15 yrs	>15 years
Scientific Name/Substrate Type	**Category**	(n = 12)	(n = 18)	(n = 25)	(n = 27)
Grasses and Graminoids					
[illegible]	[illegible]	[illegible]	[illegible]	-----	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	------
[illegible]	[illegible]	[illegible]	[illegible]	-------	--
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	------
[illegible]	[illegible]	[illegible]	[illegible]	-----	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	----	----
[illegible]	[illegible]	[illegible]	[illegible]	------	----
[illegible]	[illegible]	---	[illegible]	--	-----
[illegible]	[illegible]	-------	[illegible]	----	------
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	----	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	----	--------	[illegible]	[illegible]
[illegible]	[illegible]	------	---------	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	-----	[illegible]	[illegible]
Herbs					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	-----	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	---------
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	---------
[illegible]	[illegible]	---------	[illegible]	--------	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]		[illegible]	--------	--------
[illegible]	[illegible]	---------	[illegible]	--------	-----
[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]		[illegible]		-------

Scientific Name/Substrate Type	Indicator Category	1 year (n = 12)	Frequency 1 to 5 yrs (n − 16)	of Inundation 5 to 15 yrs (n = 26)	>15 years (n = 27)
Substrate					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] ... **and studded with fine large cotton-wood trees ... which were here and there grouped into delightful groves, sometimes unencumbered, but generally with a shrubby undergrowth, amongst which the "buffalo-berry" [illegible] was conspicuous."** [illegible] **except that the valley was considerably broader and the cotton-wood [illegible] groves proportionately more extensive."**

[illegible]

[illegible]