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Subbasin Management Plan for the

White Salmon River

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Appendix B

Appendix B. Common and Scientific Names Used in Big White Salmon Assessment

Common Name	Species Name
Amphibians	
bullfrog	*Rana catesbeiana*
Oregon spotted frog	*Rana pretiosa*
Birds	
acorn woodpecker	*Melanerpes formicivorus*
American robin	*Turdus migratorius*
ash-throated flycatcher	*Myiarchus cinerascens*
bald eagle	*Haliaeetus leucocephalus*
black-headed grosbeak	*Pheucticus melanocephalus*
black-throated gray warbler	*Dendroica nigrescens*
brown creepers	*Certia americana*
Cassin's finch	*Cardopacus cassinii*
chipping sparrow	*Spizella passerine*
Clark's nutcracker	*Nucifraga columbiana*
common merganser	*Mergus merganser*
dusky flycatchers	*Empidonax oberholseri*
European starlings	*Sturnus vulgaris*
evening grosbeak	*Coccothraustes vespertinus*
flammulated owl	*Otus flammeolus*
greater sandhill crane	*Grus canadensis tabida*
harlequin duck	*Histrionicus histrionicus*
hermit thrush	*Catherus guttatus*
lazuli bunting	*Passerina anoena*
Lewis' woodpecker	*Melanerpes lewis*
MacGillivray's warbler	*Oporornis tolmiei*
mountain chickadee	*Poecile gambeli*
Nashville warbler	*Vermivora ruficapilla*
osprey	*Pandion haliaetus*
pygmy nuthatch	*Sitta pygmaea*
red crossbill	*Loxia curvirostra*
red-breasted nuthatch	*Sitta Canadensis*
scrub jays	*Aphelocoma coerulescens*

spotted towhee	*Pipilo erythrophthalmus*
western tanager	*Piranga ludoviciana*
western wood-peewee	*Contopus sordidulus*
white-headed woodpecker	*Picoides albolarvatus*
Williamson’s sapsucker	*Sphyrapicus thyroideus*
Mammals	
American beaver	*Castor canadensis*
black bear	*Ursus americanus*
California ground squirrel	*Spermophilus beecheyi*
cougar	*Puma concolor*
eastern gray squirrels	*Sciurus carolinensis*
northern river otter	*Lontra candensis*
western gray squirrel	*Sciurus griseus*
Reptiles	
California mountain king snake	*Lampropeltis zonata*
sharptail snake	*Contia tenuis*
sliders	*Trachemys scripta*
snapping turtles	*Chelydra serpentina*
southern alligator lizard	*Elgaria multicarinata*
western pond turtle	*Clemmys marmorata*
western rattlesnake	*Crotalus viridis*
western skink	*Eumeces skiltonianus*
Fish	
coho salmon	*Oncorhynchus kisutch*
cutthroat trout	*Oncorhynchus clarki*
salmon or trout	*Oncorhynchus* spp.
Plants	
alder	*Alnus* spp.
arrow weed	*Sagittaria* spp.
arrowleaf groundsel	*Senecio triangularis*
ash	*Sorbus* spp.
big huckleberry	*Vaccinium membranaceum*
bitterbrush	*Purshia tridentata*
black cottonwood	*Populus balsamifera* ssp. *Trichocarpa*
blackberry	*Rubus discolor*
blue wildrye	species??
bluebunch wheatgrass	*Pseudoroegneria spicata*

bluejoint reedgrass	*Calamagrostis canadensis*
bulrush	*Scirpus* spp.
Canada bluegrass	*Poa compressa*
Cascade azalea	*Rhododendron albiflorum*
cheatgrass	*Bromus tectorum*
clasping-leaved twisted-stalk	*Streptopus amplexifolius*
common camas	*Camassia quamash*
common cattail	*Typha latifolia*
common hornwort	*Ceratophyllum demersum*
common snowberry	*Symphoricarpus albus*
common watercress	*Nasturtium officinale*
creeping buttercup	*Ranunculus repens*
currant	*Ribes* spp.
deerbrush	*Ceanothus integerrimus*
dogbane	*Apocynum* spp.
Douglas' spirea	*Spirea douglasii*
Douglas-fir	*Pseudotsuga menziesii*
dwarf shrub bog blueberry	*Vaccinium uliginosum*
elk sedge	*Corex geyeri*
Engelmann spruce	*Picea engelmannii*
false bugbane	*Trautvetteria carolinensis*
fewflower spikerush	*Eleocharis quinquiflora*
field horsetail	*Equisetum arvense*
five-leaved bramble	*Rubus pedatus*
fools huckleberry	*Menziesia ferruginea*
glandular Labrador-tea	*Ledum glandulosum*
greasewood	*Sarcobatus vermiculatus*
great basin wild rye	*Leymus cinereus*
greater bladderwort	*Utricularia vulgaris*
grouseberry	*Vaccinium scoparium*
hazel	*Corylus cornuta*
Holm's Rocky Mountain sedge	*Carex scopulorum*
Idaho fescue	*Festuca idahoensis*
Jeffrey pine	*Pinus jeffreyi*
Kentucky bluegrass	*Poa pratensis*
knapweed	*Centaurea* spp.
ladyfern	*Athyrium filix-femina*

lodgepole pine	*Pinus contorta latifolia*
lodgepole pine	*Pinus contorta*
mosses	*?*
mountain alder	*Alnus incana*
mountain hemlock	*Tsuga mertensiana*
narrow-leaved bur-reed	*Sparganium angustifolium*
needlegrass	*Stipa comata*
ninebark	*Physocarpus malvaceus*
oceanspray	*Holodiscus discolor*
Oregon grape	*Berberis nervosa*
oval-leaf huckleberry	*Vaccinium ovalifolium*
Pacific silver fir	*Abies amabilis*
paper birch	*Betula papyrifera*
peach-leaf willow	*Salix anygdaloides*
pine grass	species??
pond lilies	*Nuphar* spp.
purple loosestrife	*Lysimachia salicaria*
red-osier dogwood	*Cornus stolonifera*
redstem ceanothus	*Ceanothus sanguineus*
reed canarygrass	*Phalaris arundinacea*
rocky mountain juniper	*Juniperus scopulorum*
sago pondweed	*Potamogeton pectinatus*
salmonberry	*Rubus spectabilis*
sedges	*Carex* spp.
singleleaf foamflower	*Tiarella trifoliata var. unifoliata*
Sitka alder	*Alnus viridis ssp. sinuata*
skunk-cabbage	*Lysichiton americanus*
slough sedge	*Carex obnupta*
smartweeds	*Polygonum* spp.
snowberry	*Symphoricarpos* spp.
snowbrush	*Ceanothus velutinus*
soft rush	*Juncus effusus*
spike rushes	*Scirpus* spp.
squaw carpet	*Ceanothus prostrates*
subalpine fir	*Abies lasiocarpa*
swordfern	*Polystuchum munitum*
trembling aspen	*Populus tremuloides*

tule	*Scirpus* spp.
twinflower	*Linnaea borealis*
two-flowered marshmarigold	*Caltha leptosepala* ssp. *howellii*
wapato	*Sagittaria latifolia*
water birch	*Betula occidentalis*
water-plantain	*Alisma plantago-aquatica*
western bunchberry	*Cornus unalaschkensis*
western hemlock	*Tsuga heterophylla*
western juniper	*Juniperus occidentalis*
western larch	*Larix occidentalis*
western oakfern	*Gymnocarpium dryopteris*
Western redcedar	*Thuja plicata*
widefruit sedge	*Carex angustata*
wild onion	*Allium* spp.
willow	*salix* spp.
Wood's rose	*Rosa woodsii*
yellow waterlily	*Nuphar polysepalum*
yellow-cedar	*Chamaecyparis nootkatensis*
Other	
fungus sp.?	*Phytophthora ramorum*
shoestring root rot	*Amillaria mellea*
trunk rot	*Polyporus dryophilus*

Appendix C

Appendix C: Wildlife Species of the Big White Salmon Subbasin.
Table C.1. Wildlife Species Occuring in the Big White Salmon Subbasin (IBIS 2003).

Common Name	Scientific Name	Presence / Status
Amphibians		
Tiger Salamander	*Ambystoma tigrinum*	Breeds
Northwestern Salamander	*Ambystoma gracile*	Breeds
Long-toed Salamander	*Ambystoma macrodactylum*	Breeds
Cope's Giant Salamander	Dicamptodon copei	Breeds
Pacific Giant Salamander	*Dicamptodon tenebrosus*	Breeds
Cascade Torrent Salamander	*Rhyacotriton cascadae*	Breeds
Rough-skinned Newt	*Taricha granulosa*	Breeds
Larch Mountain Salamander	*Plethodon larselli*	Breeds
Van Dyke's Salamander	*Plethodon vandykei*	Breeds

Western Red-backed Salamander	*Plethodon vehiculum*	Breeds
Ensatina	*Ensatina eschscholtzii*	Breeds
Tailed Frog	*Ascaphus truei*	Breeds
Great Basin Spadefoot	*Scaphiopus intermontanus*	Breeds
Western Toad	*Bufo boreas*	Breeds
Woodhouse's Toad	*Bufo woodhousii*	Breeds
Pacific Chorus (Tree) Frog	*Pseudacris regilla*	Breeds
Red-legged Frog	*Rana aurora*	Breeds
Cascades Frog	*Rana cascadae*	Breeds
Oregon Spotted Frog	*Rana pretiosa*	Breeds
Columbia Spotted Frog	*Rana luteiventris*	Breeds
Bullfrog	*Rana catesbeiana*	Breeds
Birds		
Pied-billed Grebe	*Podilymbus podiceps*	Breeds
Western Grebe	*Aechmophorus occidentalis*	common during migration
American Bittern	*Botaurus lentiginosus*	usually seen
Great Blue Heron	*Ardea herodias*	Breeds
Black-crowned Night-heron	*Nycticorax nycticorax*	uncommon during migration
Turkey Vulture	*Cathartes aura*	Breeds
Canada Goose	*Branta canadensis*	Breeds
Tundra Swan	*Cygnus columbianus*	uncommon during migration
Wood Duck	*Aix sponsa*	Breeds
Gadwall	*Anas strepera*	Breeds
Mallard	*Anas platyrhynchos*	Breeds
Blue-winged Teal	*Anas discors*	uncommon during migration
Cinnamon Teal	*Anas cyanoptera*	Breeds
Northern Shoveler	*Anas clypeata*	common during migration
Northern Pintail	*Anas acuta*	common during migration
Green-winged Teal	*Anas crecca*	Breeds
Redhead	*Aythya americana*	uncommon during migration
Ring-necked Duck	*Aythya collaris*	Breeds
Greater Scaup	*Aythya marila*	common during migration
Harlequin Duck	*Histrionicus histrionicus*	Breeds
Barrow's Goldeneye	*Bucephala islandica*	Breeds
Hooded Merganser	*Lophodytes cucullatus*	Breeds
Common Merganser	*Mergus merganser*	Breeds
Ruddy Duck	*Oxyura jamaicensis*	usually seen during migration

Osprey	*Pandion haliaetus*	Breeds
Bald Eagle	*Haliaeetus leucocephalus*	Breeds
Northern Harrier	*Circus cyaneus*	Breeds
Sharp-shinned Hawk	*Accipiter striatus*	Breeds
Cooper's Hawk	*Accipiter cooperii*	Breeds
Northern Goshawk	*Accipiter gentilis*	Breeds
Swainson's Hawk	*Buteo swainsoni*	Breeds
Red-tailed Hawk	*Buteo jamaicensis*	Breeds
Ferruginous Hawk	*Buteo regalis*	Breeds
Rough-legged Hawk	*Buteo lagopus*	common during migration
Golden Eagle	*Aquila chrysaetos*	Breeds
American Kestrel	*Falco sparverius*	Breeds
Prairie Falcon	*Falco mexicanus*	Breeds
Chukar	*Alectoris chukar*	Breeds
Gray Partridge	*Perdix perdix*	Breeds
Ring-necked Pheasant	*Phasianus colchicus*	Breeds
Ruffed Grouse	*Bonasa umbellus*	Breeds
Blue Grouse	*Dendragapus obscurus*	Breeds
Wild Turkey	*Meleagris gallopavo*	Breeds
Mountain Quail*	*Oreortyx pictus*	*Extirpated
California Quail	*Callipepla californica*	Breeds
Virginia Rail	*Rallus limicola*	Breeds
Sora	*Porzana carolina*	Breeds
American Coot	*Fulica americana*	Breeds
Sandhill Crane	*Grus canadensis*	Breeds
Killdeer	*Charadrius vociferus*	Breeds
Black-necked Stilt	*Himantopus mexicanus*	Breeds
American Avocet	*Recurvirostra americana*	rare
Greater Yellowlegs	*Tringa melanoleuca*	uncommon during migration
Lesser Yellowlegs	*Tringa flavipes*	rare
Solitary Sandpiper	*Tringa solitaria*	rare
Spotted Sandpiper	*Actitis macularia*	Breeds
Long-billed Curlew	*Numenius americanus*	Breeds
Western Sandpiper	*Calidris mauri*	uncommon during migration
Least Sandpiper	*Calidris minutilla*	uncommon during migration
Baird's Sandpiper	*Calidris bairdii*	rare
Pectoral Sandpiper	*Calidris melanotos*	rare

Dunlin	*Calidris alpina*	usually seen during migration
Stilt Sandpiper	*Calidris himantopus*	Not on list
Long-billed Dowitcher	*Limnodromus scolopaceus*	rare
Wilson's Phalarope	*Phalaropus tricolor*	usually seen during migration
Red-necked Phalarope	*Phalaropus lobatus*	rare
Ring-billed Gull	*Larus delawarensis*	common during migration
California Gull	*Larus californicus*	Breeds
Herring Gull	*Larus argentatus*	uncommon during migration
Caspian Tern	*Sterna caspia*	common during migration
Forster's Tern	*Sterna forsteri*	Breeds
Black Tern	*Chlidonias niger*	Breeds
Rock Dove	*Columba livia*	Breeds
Band-tailed Pigeon	*Columba fasciata*	uncommon during migration
Mourning Dove	*Zenaida macroura*	Breeds
Barn Owl	*Tyto alba*	Breeds
Flammulated Owl	*Otus flammeolus*	Breeds
Western Screech-owl	*Otus kennicottii*	Breeds
Great Horned Owl	*Bubo virginianus*	Breeds
Northern Pygmy-owl	*Glaucidium gnoma*	Breeds
Burrowing Owl	*Athene cunicularia*	Breeds
Spotted Owl	*Strix occidentalis*	Breeds
Barred Owl	*Strix varia*	Breeds
Long-eared Owl	*Asio otus*	Breeds
Short-eared Owl	*Asio flammeus*	Breeds
Northern Saw-whet Owl	*Aegolius acadicus*	Breeds
Common Nighthawk	*Chordeiles minor*	Breeds
Common Poorwill	*Phalaenoptilus nuttallii*	Breeds
Black Swift	*Cypseloides niger*	rare
Vaux's Swift	*Chaetura vauxi*	Breeds
White-throated Swift	*Aeronautes saxatalis*	Breeds
Black-chinned Hummingbird	*Archilochus alexandri*	usually seen during migration
Calliope Hummingbird	*Stellula calliope*	Breeds
Rufous Hummingbird	*Selasphorus rufus*	Breeds
Belted Kingfisher	*Ceryle alcyon*	Breeds
Lewis's Woodpecker	*Melanerpes lewis*	Breeds
Williamson's Sapsucker	*Sphyrapicus thyroideus*	Breeds
Red-naped Sapsucker	*Sphyrapicus nuchalis*	Breeds

Red-breasted Sapsucker	*Sphyrapicus ruber*	Breeds
Downy Woodpecker	*Picoides pubescens*	Breeds
Hairy Woodpecker	*Picoides villosus*	Breeds
White-headed Woodpecker	*Picoides albolarvatus*	Breeds
Black-backed Woodpecker	*Picoides arcticus*	rare
Northern Flicker	*Colaptes auratus*	Breeds
Pileated Woodpecker	*Dryocopus pileatus*	Breeds
Olive-sided Flycatcher	*Contopus cooperi*	Breeds
Western Wood-pewee	*Contopus sordidulus*	Breeds
Willow Flycatcher	*Empidonax traillii*	Breeds
Hammond's Flycatcher	*Empidonax hammondii*	Breeds
Gray Flycatcher	*Empidonax wrightii*	Breeds
Dusky Flycatcher	*Empidonax oberholseri*	Breeds
Pacific-slope Flycatcher	*Empidonax difficilis*	Breeds
Say's Phoebe	*Sayornis saya*	Breeds
Ash-throated Flycatcher	*Myiarchus cinerascens*	Breeds
Western Kingbird	*Tyrannus verticalis*	Breeds
Eastern Kingbird	*Tyrannus tyrannus*	Breeds
Loggerhead Shrike	*Lanius ludovicianus*	usually seen during migration
Northern Shrike	*Lanius excubitor*	Breeds
Cassin's Vireo	*Vireo cassinii*	Breeds
Hutton's Vireo	*Vireo huttoni*	Breeds
Warbling Vireo	*Vireo gilvus*	Breeds
Red-eyed Vireo	*Vireo olivaceus*	Breeds
Gray Jay	*Perisoreus canadensis*	Breeds
Steller's Jay	*Cyanocitta stelleri*	Breeds
Western Scrub-Jay	*Aphelocoma californica*	Breeds
Clark's Nutcracker	*Nucifraga columbiana*	rare
Black-billed Magpie	*Pica pica*	Breeds
American Crow	*Corvus brachyrhynchos*	Breeds
Common Raven	*Corvus corax*	Breeds
Horned Lark	*Eremophila alpestris*	Breeds
Tree Swallow	*Tachycineta bicolor*	Breeds
Violet-green Swallow	*Tachycineta thalassina*	Breeds
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	Breeds
Bank Swallow	*Riparia riparia*	Breeds
Cliff Swallow	*Petrochelidon pyrrhonota*	Breeds

Barn Swallow	*Hirundo rustica*	Breeds
Black-capped Chickadee	*Poecile atricapillus*	Breeds
Mountain Chickadee	*Poecile gambeli*	Breeds
Chestnut-backed Chickadee	*Poecile rufescens*	Breeds
Bushtit	*Psaltriparus minimus*	Breeds
Red-breasted Nuthatch	*Sitta canadensis*	Breeds
White-breasted Nuthatch	*Sitta carolinensis*	Breeds
Pygmy Nuthatch	*Sitta pygmaea*	Breeds
Brown Creeper	*Certhia americana*	Breeds
Rock Wren	*Salpinctes obsoletus*	Breeds
Canyon Wren	*Catherpes mexicanus*	Breeds
Bewick's Wren	*Thryomanes bewickii*	Breeds
House Wren	*Troglodytes aedon*	Breeds
Winter Wren	*Troglodytes troglodytes*	Breeds
American Dipper	*Cinclus mexicanus*	Breeds
Golden-crowned Kinglet	*Regulus satrapa*	Breeds
Ruby-crowned Kinglet	*Regulus calendula*	common during migration
Western Bluebird	*Sialia mexicana*	Breeds
Mountain Bluebird	*Sialia currucoides*	Breeds
Townsend's Solitaire	*Myadestes townsendi*	Breeds
Swainson's Thrush	*Catharus ustulatus*	Breeds
Hermit Thrush	*Catharus guttatus*	Breeds
American Robin	*Turdus migratorius*	Breeds
Varied Thrush	*Ixoreus naevius*	common during migration
Gray Catbird	*Dumetella carolinensis*	Breeds
Northern Mockingbird	*Mimus polyglottos*	Breeds
European Starling	*Sturnus vulgaris*	Breeds
American Pipit	*Anthus rubescens*	uncommon during migration
Cedar Waxwing	*Bombycilla cedrorum*	Breeds
Orange-crowned Warbler	*Vermivora celata*	Breeds
Nashville Warbler	*Vermivora ruficapilla*	Breeds
Yellow Warbler	*Dendroica petechia*	Breeds
Yellow-rumped Warbler	*Dendroica coronata*	Breeds
Black-throated Gray Warbler	*Dendroica nigrescens*	Breeds
Townsend's Warbler	*Dendroica townsendi*	Breeds
Hermit Warbler	*Dendroica occidentalis*	Breeds
Macgillivray's Warbler	*Oporornis tolmiei*	Breeds

Common Yellowthroat	*Geothlypis trichas*	Breeds
Wilson's Warbler	*Wilsonia pusilla*	common during migration
Yellow-breasted Chat	*Icteria virens*	Breeds
Western Tanager	*Piranga ludoviciana*	Breeds
Spotted Towhee	*Pipilo maculatus*	Breeds
Chipping Sparrow	*Spizella passerina*	Breeds
Brewer's Sparrow	*Spizella breweri*	Breeds
Vesper Sparrow	*Pooecetes gramineus*	Breeds
Lark Sparrow	*Chondestes grammacus*	Breeds
Savannah Sparrow	*Passerculus sandwichensis*	Breeds
Grasshopper Sparrow	*Ammodramus savannarum*	Breeds
Fox Sparrow	*Passerella iliaca*	Breeds
Song Sparrow	*Melospiza melodia*	Breeds
Lincoln's Sparrow	*Melospiza lincolnii*	uncommon during migration
White-crowned Sparrow	*Zonotrichia leucophrys*	Breeds
Dark-eyed Junco	*Junco hyemalis*	Breeds
Black-headed Grosbeak	*Pheucticus melanocephalus*	Breeds
Lazuli Bunting	*Passerina amoena*	Breeds
Bobolink	*Dolichonyx oryzivorus*	Not on list
Red-winged Blackbird	*Agelaius phoeniceus*	Breeds
Western Meadowlark	*Sturnella neglecta*	Breeds
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	Breeds
Brewer's Blackbird	*Euphagus cyanocephalus*	Breeds
Brown-headed Cowbird	*Molothrus ater*	Breeds
Bullock's Oriole	*Icterus bullockii*	Breeds
Pine Grosbeak	*Pinicola enucleator*	rare
Purple Finch	*Carpodacus purpureus*	Breeds
Cassin's Finch	*Carpodacus cassinii*	Breeds
House Finch	*Carpodacus mexicanus*	Breeds
Red Crossbill	*Loxia curvirostra*	uncommon during migration
Pine Siskin	*Carduelis pinus*	Breeds
Lesser Goldfinch	*Carduelis psaltria*	Breeds
American Goldfinch	*Carduelis tristis*	Breeds
Evening Grosbeak	*Coccothraustes vespertinus*	Breeds
House Sparrow	*Passer domesticus*	Breeds
Mammals		
Virginia Opossum	*Didelphis virginiana*	Breeds
Masked Shrew	*Sorex cinereus*	Breeds

Vagrant Shrew	*Sorex vagrans*	Breeds
Montane Shrew	*Sorex monticolus*	Breeds
Water Shrew	*Sorex palustris*	Breeds
Pacific Water Shrew	*Sorex bendirii*	Breeds
Trowbridge's Shrew	*Sorex trowbridgii*	Breeds
Shrew-mole	*Neurotrichus gibbsii*	Breeds
Townsend's Mole	*Scapanus townsendii*	Breeds
Coast Mole	*Scapanus orarius*	Breeds
California Myotis	*Myotis californicus*	Breeds
Western Small-footed Myotis	*Myotis ciliolabrum*	Breeds
Yuma Myotis	*Myotis yumanensis*	Breeds
Little Brown Myotis	*Myotis lucifugus*	Breeds
Long-legged Myotis	*Myotis volans*	Breeds
Fringed Myotis	*Myotis thysanodes*	Breeds
Long-eared Myotis	*Myotis evotis*	Breeds
Silver-haired Bat	*Lasionycteris noctivagans*	Breeds
Western Pipistrelle	*Pipistrellus hesperus*	Breeds
Big Brown Bat	*Eptesicus fuscus*	Breeds
Hoary Bat	*Lasiurus cinereus*	Breeds
Spotted Bat	*Euderma maculatum*	Breeds
Townsend's Big-eared Bat	*Corynorhinus townsendii*	Breeds
Pallid Bat	*Antrozous pallidus*	Breeds
American Pika	*Ochotona princeps*	Breeds
Eastern Cottontail	*Sylvilagus floridanus*	Breeds
Nuttall's (Mountain) Cottontail	*Sylvilagus nuttallii*	Breeds
Snowshoe Hare	*Lepus americanus*	Breeds
White-tailed Jackrabbit	*Lepus townsendii*	Breeds
Black-tailed Jackrabbit	*Lepus californicus*	Breeds
Mountain Beaver	*Aplodontia rufa*	Breeds
Least Chipmunk	*Tamias minimus*	Breeds
Yellow-pine Chipmunk	*Tamias amoenus*	Breeds
Townsend's Chipmunk	*Tamias townsendii*	Breeds
Yellow-bellied Marmot	*Marmota flaviventris*	Breeds
Hoary Marmot	*Marmota caligata*	Breeds
Townsend's Ground Squirrel	*Spermophilus townsendii*	Breeds
California Ground Squirrel	*Spermophilus beecheyi*	Breeds
Cascade Golden-mantled Ground Squirrel	*Spermophilus saturatus*	Breeds

Eastern Gray Squirrel	*Sciurus carolinensis*	Breeds
Western Gray Squirrel	*Sciurus griseus*	Breeds
Douglas' Squirrel	*Tamiasciurus douglasii*	Breeds
Northern Flying Squirrel	*Glaucomys sabrinus*	Breeds
Northern Pocket Gopher	*Thomomys talpoides*	Breeds
Great Basin Pocket Mouse	*Perognathus parvus*	Breeds
American Beaver	*Castor canadensis*	Breeds
Western Harvest Mouse	*Reithrodontomys megalotis*	Breeds
Deer Mouse	*Peromyscus maniculatus*	Breeds
Columbian Mouse	*Peromyscus keeni*	Breeds
Northern Grasshopper Mouse	*Onychomys leucogaster*	Breeds
Bushy-tailed Woodrat	*Neotoma cinerea*	Breeds
Southern Red-backed Vole	*Clethrionomys gapperi*	Breeds
Heather Vole	*Phenacomys intermedius*	Breeds
Montane Vole	*Microtus montanus*	Breeds
Townsend's Vole	*Microtus townsendii*	Breeds
Long-tailed Vole	*Microtus longicaudus*	Breeds
Creeping Vole	*Microtus oregoni*	Breeds
Water Vole	*Microtus richardsoni*	Breeds
Muskrat	*Ondatra zibethicus*	Breeds
Norway Rat	*Rattus norvegicus*	Breeds
House Mouse	*Mus musculus*	Breeds
Pacific Jumping Mouse	*Zapus trinotatus*	Breeds
Common Porcupine	*Erethizon dorsatum*	Breeds
Nutria	*Myocastor coypus*	Breeds
Coyote	*Canis latrans*	Breeds
Red Fox	*Vulpes vulpes*	Breeds
Black Bear	*Ursus americanus*	Breeds
Raccoon	*Procyon lotor*	Breeds
American Marten	*Martes americana*	Breeds
Fisher	*Martes pennanti*	Breeds
Ermine	*Mustela erminea*	Breeds
Long-tailed Weasel	*Mustela frenata*	Breeds
Mink	*Mustela vison*	Breeds
Wolverine	*Gulo gulo*	Breeds
American Badger	*Taxidea taxus*	Breeds
Western Spotted Skunk	*Spilogale gracilis*	Breeds

Striped Skunk	*Mephitis mephitis*	Breeds
Northern River Otter	*Lutra canadensis*	Breeds
Mountain Lion	*Puma concolor*	Breeds
Bobcat	*Lynx rufus*	Breeds
Elk	*Cervus elaphus*	Breeds
Mule Deer	*Odocoileus hemionus*	Breeds
White-tailed Deer	*Odocoileus virginianus*	Breeds
Mountain Goat	*Oreamnos americanus*	Breeds
Bighorn Sheep	*Ovis canadensis*	Breeds
Reptiles		
Painted Turtle	*Chrysemys picta*	Breeds
Western Pond Turtle	*Clemmys marmorata*	Breeds
Red-eared Slider Turtle	*Trachemys scripta*	Breeds
Northern Alligator Lizard	*Elgaria coerulea*	Breeds
Southern Alligator Lizard	*Elgaria multicarinata*	Breeds
Short-horned Lizard	*Phrynosoma douglassii*	Breeds
Sagebrush Lizard	*Sceloporus graciosus*	Breeds
Western Fence Lizard	*Sceloporus occidentalis*	Breeds
Western Skink	*Eumeces skiltonianus*	Breeds
Rubber Boa	*Charina bottae*	Breeds
Racer	*Coluber constrictor*	Breeds
Sharptail Snake	*Contia tenuis*	Breeds
Ringneck Snake	*Diadophis punctatus*	Breeds
Night Snake	*Hypsiglena torquata*	Breeds
California Mountain Kingsnake	*Lampropeltis zonata*	Breeds
Striped Whipsnake	*Masticophis taeniatus*	Breeds
Gopher Snake	*Pituophis catenifer*	Breeds
Western Terrestrial Garter Snake	*Thamnophis elegans*	Breeds
Northwestern Garter Snake	*Thamnophis ordinoides*	Breeds
Common Garter Snake	*Thamnophis sirtalis*	Breeds
Western Rattlesnake	*Crotalus viridis*	Breeds

Table C.2.A. Federal and State listed species of the Big White Salmon subbasin (WDFW 2003a, USFWS 2004a).

Common Name	Scientific Name	Federal Status*	State Status**
Amphibians			
Cascade Torrent Salamander	*Rhyacotriton cascadae*	-	SC
Larch Mountain Salamander	*Plethodon larselli*	-	SS

Van Dyke's Salamander	*Plethodon vandykei*	-	SC
Western Toad	*Bufo boreas*	-	SC
Oregon Spotted Frog	*Rana pretiosa*	FC	SE
Columbia Spotted Frog	*Rana luteiventris*	-	SC
Birds			
Bald Eagle	*Haliaeetus leucocephalus*	FT	ST
Black-backed Woodpecker	*Picoides arcticus*	-	SC
Burrowing Owl	*Athene cunicularia*	-	SC
Ferruginous Hawk	*Buteo regalis*	-	ST
Flammulated Owl	*Otus flammeolus*	-	SC
Golden Eagle	*Aquila chrysaetos*	-	SC
Lewis's Woodpecker	*Melanerpes lewis*	-	SC
Loggerhead Shrike	*Lanius ludovicianus*	-	SC
Northern Goshawk	*Accipiter gentilis*	-	SC
Pileated Woodpecker	*Dryocopus pileatus*	-	SC
Purple Martin	*Progne subis*	-	SC
Sage Grouse	*Centrocercus urophasianus*	FC	ST
Sandhill Crane	*Grus canadensis*	-	SE
Spotted Owl	*Strix occidentalis*	FT	SE
Vaux's Swift	*Chaetura vauxi*	-	SC
Western Grebe	*Aechmophorus occidentalis*	-	SC
White-headed Woodpecker	*Picoides albolarvatus*	-	SC
Mammals			
Black-tailed Jackrabbit	*Lepus californicus*	-	SC
Fisher	*Martes pennanti*	-	SE
Townsend's Ground Squirrel	*Spermophilus townsendii*	-	SC
Townsend's Big-eared Bat	*Corynorhinus townsendii*	-	SC
Western Gray Squirrel	*Sciurus griseus*	-	ST
White-tailed Jackrabbit	*Lepus townsendii*	-	SC
Wolverine	*Gulo gulo*	-	SC
Reptiles			
Western Pond Turtle	*Clemmys marmorata*	-	SE
Sagebrush Lizard	*Sceloporus graciosus*	-	SC
Sharptail Snake	*Contia tenuis*	-	SC
California Mountain Kingsnake	*Lampropeltis zonata*	-	SC
Striped Whipsnake	*Masticophis taeniatus*	-	SC

C.2.B. Definitions for State and Federally Listed Species (WDFW 2003a and USFW 2004b).

*Federal	
FT (Federally Threatened)	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
FC (Federal Candidate)	A species for which the U.S. Fish and Wildlife Service has on file sufficient information to support a proposal to list the species as endangered or threatened, but for which proposed rules have not yet been issued.
****State**	
SE (State Endangered)	Any wildlife species native to the state of Washington that is seriously threatened with extinction throughout all or a significant portion of its range within the state.
ST (State Threatened)	Any wildlife species native to the state of Washington that is likely to become an endangered species within the foreseeable future throughout a significant portion of its range within the state without cooperative management or removal of threats.
SS (State Sensitive)	Any wildlife species native to the state of Washington that is vulnerable or declining and is likely to become endangered or threatened throughout a significant portion of its range within the state without cooperative management or removal of threats.

Table C.3. Wildlife game species of the Big White Salmon subbasin, Washington (IBIS 2003).

Common Name	Scientific Name
Amphibians	
Bullfrog	*Rana catesbeiana*
Birds	
Canada Goose	*Branta canadensis*
Wood Duck	*Aix sponsa*
Gadwall	*Anas strepera*
Mallard	*Anas platyrhynchos*
Blue-winged Teal	*Anas discors*
Cinnamon Teal	*Anas cyanoptera*
Northern Shoveler	*Anas clypeata*
Northern Pintail	*Anas acuta*
Green-winged Teal	*Anas crecca*
Redhead	*Aythya americana*
Ring-necked Duck	*Aythya collaris*
Greater Scaup	*Aythya marila*
Harlequin Duck	*Histrionicus histrionicus*
Barrow's Goldeneye	*Bucephala islandica*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Ruddy Duck	*Oxyura jamaicensis*

Chukar	*Alectoris chukar*
Gray Partridge	*Perdix perdix*
Ring-necked Pheasant	*Phasianus colchicus*
Ruffed Grouse	*Bonasa umbellus*
White-tailed Ptarmigan	*Lagopus leucurus*
Blue Grouse	*Dendragapus obscurus*
Wild Turkey	*Meleagris gallopavo*
Mountain Quail	*Oreortyx pictus*
California Quail	*Callipepla californica*
American Coot	*Fulica americana*
Common Snipe	*Gallinago gallinago*
Band-tailed Pigeon	*Columba fasciata*
Mourning Dove	*Zenaida macroura*
Mammals	
Eastern Cottontail	*Sylvilagus floridanus*
Nuttall's (Mountain) Cottontail	*Sylvilagus nuttallii*
Snowshoe Hare	*Lepus americanus*
White-tailed Jackrabbit	*Lepus townsendii*
Black-tailed Jackrabbit	*Lepus californicus*
American Beaver	*Castor canadensis*
Muskrat	*Ondatra zibethicus*
Red Fox	*Vulpes vulpes*
Black Bear	*Ursus americanus*
Raccoon	*Procyon lotor*
American Marten	*Martes americana*
Ermine	*Mustela erminea*
Long-tailed Weasel	*Mustela frenata*
Mink	*Mustela vison*
American Badger	*Taxidea taxus*
Northern River Otter	*Lutra canadensis*
Mountain Lion	*Puma concolor*
Bobcat	*Lynx rufus*
Rocky Mountain Elk	*Cervus elaphus nelsoni*
Mule Deer	*Odocoileus hemionus columbianus*
Mountain Goat	*Oreamnos americanus*
Bighorn Sheep	*Ovis canadensis*

Table C.4. Partners in Flight species of the Big White Salmon subbasin, Washington (IBIS 2003).

Common Name	Scientific Name	PIF 1998-1999 Continental	PIF Ranking by Super Region Draft 2002	WA PIF Priority & Focal Species
Northern Harrier	*Circus cyaneus*			Yes
Swainson's Hawk	*Buteo swainsoni*		MO (Intermountain West, Prairies)	Yes
Ferruginous Hawk	*Buteo regalis*			Yes
Rough-legged Hawk	*Buteo lagopus*		PR (Arctic)	
American Kestrel	*Falco sparverius*			Yes
Gyrfalcon	*Falco rusticolus*		PR (Arctic)	
Sage Grouse	*Centrocercus urophasianus*		MA (Intermountain West, Prairies)	
White-tailed Ptarmigan	*Lagopus leucurus*		MO (Arctic)	
Blue Grouse	*Dendragapus obscurus*		MA (Pacific, Intermountain West)	
Mountain Quail	*Oreortyx pictus*		MO (Pacific)	
Long-billed Curlew	*Numenius americanus*	Yes		
Stilt Sandpiper	*Calidris himantopus*	Yes		
Short-billed Dowitcher	*Limnodromus griseus*	Yes		
Band-tailed Pigeon	*Columba fasciata*	Yes	MA (Pacific)	Yes
Flammulated Owl	*Otus flammeolus*		MO (Pacific, Intermountain West, Southwest)	Yes
Northern Pygmy-owl	*Glaucidium gnoma*		PR (Pacific)	
Burrowing Owl	*Athene cunicularia*			Yes
Spotted Owl	*Strix occidentalis*		IM (Pacific, Intermountain West, Southwest)	
Short-eared Owl	*Asio flammeus*	Yes	MA (Arctic, Northern Forests, Intermountain West, Prairies)	Yes
Common Poorwill	*Phalaenoptilus nuttallii*			Yes
Black Swift	*Cypseloides niger*	Yes	IM (Pacific, Intermountain West)	Yes
Vaux's Swift	*Chaetura vauxi*			Yes
White-throated Swift	*Aeronautes saxatalis*		MA (Intermountain West, Southwest)	Yes
Calliope Hummingbird	*Stellula calliope*		MO (Intermountain West)	Yes
Rufous Hummingbird	*Selasphorus rufus*	Yes	MA (Pacific, Intermountain West)	Yes
Lewis's Woodpecker	*Melanerpes lewis*	Yes	MO (Intermountain West, Prairies)	Yes
Williamson's Sapsucker	*Sphyrapicus thyroideus*		MO (Intermountain West)	Yes
Red-naped Sapsucker	*Sphyrapicus nuchalis*		MO (Intermountain West)	Yes

Red-breasted Sapsucker	*Sphyrapicus ruber*		MO (Pacific)	Yes
Downy Woodpecker	*Picoides pubescens*			Yes
White-headed Woodpecker	*Picoides albolarvatus*	Yes	PR (Pacific, Intermountain West)	Yes
Three-toed Woodpecker	*Picoides tridactylus*		PR (Northern Forests)	
Black-backed Woodpecker	*Picoides arcticus*		PR (Northern Forests)	Yes
Northern Flicker	*Colaptes auratus*			
Pileated Woodpecker	*Dryocopus pileatus*			Yes
Olive-sided Flycatcher	*Contopus cooperi*		MA (Pacific, Northern Forests, Intermountain West)	Yes
Western Wood-pewee	*Contopus sordidulus*			Yes
Willow Flycatcher	*Empidonax traillii*		MA (Prairies, East)	Yes
Hammond's Flycatcher	*Empidonax hammondii*			Yes
Gray Flycatcher	*Empidonax wrightii*		PR (Intermountain West)	Yes
Dusky Flycatcher	*Empidonax oberholseri*		MA (Intermountain West)	Yes
Pacific-slope Flycatcher	*Empidonax difficilis*		PR (Pacific)	Yes
Ash-throated Flycatcher	*Myiarchus cinerascens*			Yes
Loggerhead Shrike	*Lanius ludovicianus*			Yes
Northern Shrike	*Lanius excubitor*		PR (Northern Forests)	
Hutton's Vireo	*Vireo huttoni*			Yes
Warbling Vireo	*Vireo gilvus*			Yes
Red-eyed Vireo	*Vireo olivaceus*			Yes
Gray Jay	*Perisoreus canadensis*		PR (Northern Forests)	
Clark's Nutcracker	*Nucifraga columbiana*		PR (Intermountain West)	Yes
Horned Lark	*Eremophila alpestris*			Yes
Purple Martin	*Progne subis*			Yes
Bank Swallow	*Riparia riparia*			Yes
Chestnut-backed Chickadee	*Poecile rufescens*		PR (Pacific)	
Bushtit	*Psaltriparus minimus*			Yes
White-breasted Nuthatch	*Sitta carolinensis*			Yes
Brown Creeper	*Certhia americana*			Yes
House Wren	*Troglodytes aedon*			Yes
Winter Wren	*Troglodytes troglodytes*			Yes
American Dipper	*Cinclus mexicanus*			Yes
Western Bluebird	*Sialia mexicana*			Yes
Mountain Bluebird	*Sialia currucoides*		PR (Intermountain West)	
Townsend's Solitaire	*Myadestes townsendi*			Yes
Swainson's Thrush	*Catharus ustulatus*			Yes

Hermit Thrush	*Catharus guttatus*			Yes
Varied Thrush	*Ixoreus naevius*			Yes
American Pipit	*Anthus rubescens*		PR (Arctic)	Yes
Bohemian Waxwing	*Bombycilla garrulus*		MA (Northern Forests)	
Orange-crowned Warbler	*Vermivora celata*			Yes
Nashville Warbler	*Vermivora ruficapilla*		PR (Northern Forests)	Yes
Yellow Warbler	*Dendroica petechia*			Yes
Yellow-rumped Warbler	*Dendroica coronata*			Yes
Black-throated Gray Warbler	*Dendroica nigrescens*		MO (Pacific)	Yes
Townsend's Warbler	*Dendroica townsendi*			Yes
Hermit Warbler	*Dendroica occidentalis*	Yes	MO (Pacific)	Yes
Macgillivray's Warbler	*Oporornis tolmiei*			Yes
Wilson's Warbler	*Wilsonia pusilla*			Yes
Yellow-breasted Chat	*Icteria virens*			Yes
Western Tanager	*Piranga ludoviciana*			Yes
Chipping Sparrow	*Spizella passerina*			Yes
Brewer's Sparrow	*Spizella breweri*	Yes	MA (Intermountain West)	Yes
Vesper Sparrow	*Pooecetes gramineus*			Yes
Lark Sparrow	*Chondestes grammacus*			Yes
Grasshopper Sparrow	*Ammodramus savannarum*		MA (Prairies)	Yes
Fox Sparrow	*Passerella iliaca*			Yes
Lincoln's Sparrow	*Melospiza lincolnii*		PR (Northern Forests)	Yes
Lapland Longspur	*Calcarius lapponicus*		PR (Arctic)	
Black-headed Grosbeak	*Pheucticus melanocephalus*			Yes
Bobolink	*Dolichonyx oryzivorus*	Yes		
Western Meadowlark	*Sturnella neglecta*			Yes
Bullock's Oriole	*Icterus bullockii*			Yes
Pine Grosbeak	*Pinicola enucleator*		MO (Northern Forests)	
Purple Finch	*Carpodacus purpureus*			Yes
Cassin's Finch	*Carpodacus cassinii*		MA (Intermountain West)	
Red Crossbill	*Loxia curvirostra*			Yes
Lesser Goldfinch	*Carduelis psaltria*			Yes

Table C.5. Wildlife species in the Big White Salmon subbasin used in the Habitat Evaluation Procedure (HEP) to assess habitat losses associated with federal hydroelectric facilities on the Lower Snake and Columbia Rivers (IBIS 2003).

Common Name	Scientific Name	Comments
Birds		
Bald eagle	*Haliaeetus leucocephalus*	Use at Grand Coulie/Chief Joe
Black-capped chickadee	*Parus atricopillus*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
Blue grouse	*Dendragapus obscurus*	Use by CTUIR for McNary/John Day and at other selected sites.
California quail	*Lophortyx californicus*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
Canada goose	*Branta Canadensis*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
Downy woodpecker	*Picoides puescens*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
Great blue heron	*Ardea herodias*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
Greater Sage Grouse	*Centrocercus urophasianus*	Use at Grand Coulie/Chief Joe
Lewis woodpecker	*Melanerpes lewis*	Use at Grand Coulie/Chief Joe
Long-eared owl	*Asio otus*	Use at Grand Coulie/Chief Joe
Mallard	*Anas platyrhynchos*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
Mourning Dove	*Zenaida macroura*	Use at Grand Coulie/Chief Joe
Northern Flicker	*Colaptes auratus*	Use at Grand Coulie/Chief Joe
Ring-necked pheasant	*Phasianus colchicus*	Use at Grand Coulie/Chief Joe
Ruffed grouse	*Bonasa umbellus*	Use at Grand Coulie/Chief Joe
Spotted sandpiper	*Actitis macularia*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
Western meadow lark	*Sturnella neglecta*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
Yellow warbler	*Dendroica petechia*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
Mammals		
American Beaver	*Castor canadensis*	Use at Grand Coulie/Chief Joe
Bobcat	*Lynx rufus*	Use at Grand Coulie/Chief Joe
Mink	*Mustella vison*	HEP Species used in the loss assessments for the lower four Columbia River Dam with existing models.
Mule deer	*Dendragapus obscurus*	Use by CTUIR for McNary/John Day and at other selected sites.
Northern River Otter	*Lutra Canadensis*	Use for Minidoka Dam
White-tailed deer	*Odocoileus virginianus*	Use at Grand Coulie/Chief Joe

* CTUIR - Confederated Tribes of the Umatilla Indian Reservation

Table C.6.A. Wildlife species in the Big White Salmon subbasin, Washington that eat salmonids (IBIS 2003). See table C.6.B for definitions of relationship types, and table C.6.C for definitions of salmonid stages.

Common Name	Scientific Name	Relationship Type	Salmonid Stage
Amphibians			
Cope's Giant Salamander	*Dicamptodon copei*	Recurrent	Freshwater rearing - fry, fingerling, and parr
			Incubation - eggs and alevin
Pacific Giant Salamander	*Dicamptodon tenebrosus*	Recurrent	Incubation - eggs and alevin
			Freshwater rearing - fry, fingerling, and parr
Birds			
Pied-billed Grebe	*Podilymbus podiceps*	Recurrent	Freshwater rearing - fry, fingerling, and parr
Western Grebe	*Aechmophorus occidentalis*	Recurrent	Freshwater rearing - fry, fingerling, and parr
			Saltwater - smolts, immature adults, and adults
		Rare	Carcasses
Great Blue Heron	*Ardea herodias*	Recurrent	Freshwater rearing - fry, fingerling, and parr
			Saltwater - smolts, immature adults, and adults
Black-crowned Night-heron	*Nycticorax nycticorax*	Recurrent	Saltwater - smolts, immature adults, and adults
			Freshwater rearing - fry, fingerling, and parr
Turkey Vulture	*Cathartes aura*	Recurrent	Carcasses
Mallard	*Anas platyrhynchos*	Rare	Incubation - eggs and alevin
			Carcasses
Greater Scaup	*Aythya marila*	Rare	Incubation - eggs and alevin
			Carcasses
Harlequin Duck	*Histrionicus histrionicus*	Strong, consistent	Saltwater - smolts, immature adults, and adults
			Incubation - eggs and alevin
		Indirect	Carcasses
Barrow's Goldeneye	*Bucephala islandica*	Recurrent	Incubation - eggs and alevin
			Freshwater rearing - fry, fingerling, and parr
			Carcasses
		Rare	Saltwater - smolts, immature adults, and adults
Hooded Merganser	*Lophodytes cucullatus*	Rare	Carcasses
			Freshwater rearing - fry, fingerling, and parr
			Incubation - eggs and alevin
Common Merganser	*Mergus merganser*	Strong, consistent	Freshwater rearing - fry, fingerling, and parr
			Saltwater - smolts, immature adults, and adults
			Incubation - eggs and alevin

		Recurrent	Carcasses
Osprey	*Pandion haliaetus*	Strong, consistent	Freshwater rearing - fry, fingerling, and parr
			Saltwater - smolts, immature adults, and adults
			Spawning - freshwater
Bald Eagle	*Haliaeetus leucocephalus*	Strong, consistent	Spawning - freshwater
			Saltwater - smolts, immature adults, and adults
			Carcasses
		Indirect	Incubation - eggs and alevin
			Saltwater - smolts, immature adults, and adults
			Freshwater rearing - fry, fingerling, and parr
			Carcasses
Red-tailed Hawk	*Buteo jamaicensis*	Rare	Carcasses
Golden Eagle	*Aquila chrysaetos*	Recurrent	Spawning - freshwater
			Carcasses
Gyrfalcon	*Falco rusticolus*	Indirect	Freshwater rearing - fry, fingerling, and parr
			Carcasses
			Saltwater - smolts, immature adults, and adults
Killdeer	*Charadrius vociferus*	Indirect	Carcasses
Greater Yellowlegs	*Tringa melanoleuca*	Rare	Incubation - eggs and alevin
Spotted Sandpiper	*Actitis macularia*	Indirect	Carcasses
Ring-billed Gull	*Larus delawarensis*	Recurrent	Carcasses
			Freshwater rearing - fry, fingerling, and parr
			Saltwater - smolts, immature adults, and adults
California Gull	*Larus californicus*	Recurrent	Saltwater - smolts, immature adults, and adults
			Carcasses
Herring Gull	*Larus argentatus*	Recurrent	Saltwater - smolts, immature adults, and adults
			Carcasses
			Freshwater rearing - fry, fingerling, and parr
Thayer's Gull	*Larus thayeri*	Recurrent	Saltwater - smolts, immature adults, and adults

Glaucous Gull	*Larus hyperboreus*	Recurrent	Carcasses
			Saltwater - smolts, immature adults, and adults
Caspian Tern	*Sterna caspia*	Strong, consistent	Freshwater rearing - fry, fingerling, and parr
			Saltwater - smolts, immature adults, and adults
Forster's Tern	*Sterna forsteri*	Recurrent	Freshwater rearing - fry, fingerling, and parr
			Saltwater - smolts, immature adults, and adults
Belted Kingfisher	*Ceryle alcyon*	Recurrent	Spawning - freshwater
			Saltwater - smolts, immature adults, and adults
			Freshwater rearing - fry, fingerling, and parr
Willow Flycatcher	*Empidonax traillii*	Indirect	Carcasses
Gray Jay	*Perisoreus canadensis*	Rare	Carcasses
Steller's Jay	*Cyanocitta stelleri*	Recurrent	Carcasses
Black-billed Magpie	*Pica pica*	Recurrent	Freshwater rearing - fry, fingerling, and parr
			Carcasses
American Crow	*Corvus brachyrhynchos*	Recurrent	Freshwater rearing - fry, fingerling, and parr
			Carcasses
Northwestern Crow	*Corvus caurinus*	Recurrent	Freshwater rearing - fry, fingerling, and parr
			Saltwater - smolts, immature adults, and adults
			Carcasses
Common Raven	*Corvus corax*	Recurrent	Freshwater rearing - fry, fingerling, and parr
			Carcasses
			Spawning - freshwater
Tree Swallow	*Tachycineta bicolor*	Indirect	Carcasses
Violet-green Swallow	*Tachycineta thalassina*	Indirect	Carcasses
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	Indirect	Carcasses
Bank Swallow	*Riparia riparia*	Indirect	Carcasses
Cliff Swallow	*Petrochelidon pyrrhonota*	Indirect	Carcasses
Barn Swallow	*Hirundo rustica*	Indirect	Carcasses
Winter Wren	*Troglodytes troglodytes*	Rare	Carcasses

American Dipper	*Cinclus mexicanus*	Recurrent	Freshwater rearing - fry, fingerling, and parr
			Incubation - eggs and alevin
			Carcasses
		Indirect	Carcasses
American Robin	*Turdus migratorius*	Rare	Incubation - eggs and alevin
Varied Thrush	*Ixoreus naevius*	Rare	Carcasses
			Incubation - eggs and alevin
Spotted Towhee	*Pipilo maculatus*	Rare	Carcasses
Song Sparrow	*Melospiza melodia*	Rare	Carcasses
Mammals			
Virginia Opossum	*Didelphis virginiana*	Recurrent	Carcasses
Masked Shrew	*Sorex cinereus*	Indirect	Carcasses
		Rare	Carcasses
Vagrant Shrew	*Sorex vagrans*	Rare	Carcasses
		Indirect	Carcasses
Montane Shrew	*Sorex monticolus*	Indirect	Carcasses
		Rare	Carcasses
Water Shrew	*Sorex palustris*	Recurrent	Carcasses
			Freshwater rearing - fry, fingerling, and parr
			Incubation - eggs and alevin
		Indirect	Carcasses
Pacific Water Shrew	*Sorex bendirii*	Rare	Carcasses
		Indirect	Carcasses
Trowbridge's Shrew	*Sorex trowbridgii*	Rare	Carcasses
		Indirect	Carcasses
Douglas' Squirrel	*Tamiasciurus douglasii*	Rare	Carcasses
Northern Flying Squirrel	*Glaucomys sabrinus*	Rare	Carcasses
Deer Mouse	*Peromyscus maniculatus*	Rare	Carcasses
Coyote	*Canis latrans*	Recurrent	Carcasses
Red Fox	*Vulpes vulpes*	Rare	Carcasses
Black Bear	*Ursus americanus*	Strong, consistent	Carcasses
			Spawning - freshwater
Raccoon	*Procyon lotor*	Recurrent	Freshwater rearing - fry, fingerling, and parr
			Carcasses

American Marten	*Martes americana*	Rare	Carcasses
Fisher	*Martes pennanti*	Rare	Carcasses
Long-tailed Weasel	*Mustela frenata*	Rare	Carcasses
Mink	*Mustela vison*	Recurrent	Spawning - freshwater
			Carcasses
			Freshwater rearing - fry, fingerling, and parr
Wolverine	*Gulo gulo*	Rare	Carcasses
Striped Skunk	*Mephitis mephitis*	Rare	Carcasses
Northern River Otter	*Lutra canadensis*	Strong, consistent	Freshwater rearing - fry, fingerling, and parr
			Spawning - freshwater
			Carcasses
Mountain Lion	*Puma concolor*	Rare	Spawning - freshwater
Bobcat	*Lynx rufus*	Recurrent	Spawning - freshwater
			Carcasses
Reptiles			
Western Pond Turtle	*Clemmys marmorata*	Rare	Carcasses
			Freshwater rearing - fry, fingerling, and parr
Western Terrestrial Garter Snake	*Thamnophis elegans*	Rare	Freshwater rearing - fry, fingerling, and parr
Common Garter Snake	*Thamnophis sirtalis*	Rare	Freshwater rearing - fry, fingerling, and parr

Table C.6.B. Definitions of Salmon-Wildlife Relationships (Johnson and O'Neil 2001).

Strong, Consistent Relationship
Salmon play (or historically played) an important role in this species distribution, viability, abundance, and/or population status. The ecology of this wildlife species is supported by salmon, especially at particular life stages or during specific seasons. Timing of reproductive activities, and daily or seasonal movements often reflect salmon life stages. Relationship with salmon is direct (e.g., feeds on salmon, or salmon eggs) and routine. The relationship may be regional or localized to one or more watersheds. Examples: A significant portion of the diet of killer whales is adult salmon (*Saltwater* stage); common mergansers may congregate to feed on salmon fry (*Freshwater Rearing* stage) when they are available.
Recurrent Relationship
The relationship between salmon and this species is characterized as routine, albeit occasional, and often tends to be in localized areas (thus affecting only a small portion of this species population). While the species may benefit from this relationship, it is generally not considered to affect the distribution, abundance, viability, or population status of this species. The percent of salmon in the diet of these wildlife species may vary from 5% to over 50%, depending on the location and time of year. Example: turkey vultures routinely feed on salmon carcasses, but feed on many other items as well.
Indirect Relationship
Salmon play an important routine, but *indirect* link to this species. The relationship could be viewed as one of a secondary consumer of salmon; for example, salmon support other wildlife that are prey of this species. This includes aspects such as salmon carcasses that support insect populations that are a food item for this species. Example: American dippers feed on aquatic insects that are affected by salmon-derived nutrients. The hypothesis of an *indirect* relationship between an aerial insectivore and salmon was supported by the presence of two or more of the following characteristics of the insectivore: (1) riparian obligate or associate, (2) feeds below or near the canopy layer of riparian trees, (3) known or perceived to feed on midges, blackflies, caddisflies, stoneflies, or other aquatic insects that benefit from salmon-derived nutrients, and/or (4) feeds

near the water surface. While this category includes general aspects of salmon nutrient cycling in stream/river systems, we are not including or examining the role of carcass-derived nutrient cycling on lentic system riparian and wetlands vegetation, and subsequent links to wildlife.
Rare Relationship
Salmon play a very minor role in the diet of these species, often amounting to less than 1 percent of the diet. Typically, salmon are consumed only on rare occasions, during a shortage of the usual food and may be especially evident during El Niño events. As salmon are often present in large quantities, they may be consumed on rare occasions by species that normally do not consume them. Examples: red-tailed hawks are known to consume salmon carcasses in times of distress; trumpeter swans are primarily vegetarians, but on rare occasions will consume eggs, parr, as well as salmon carcass tissue.

Table C.6.C. Salmon Life Stages and Definitions (Johnson and O'Neil 2001).

Alevin	Larval salmonid that has hatched but has not yet emerged from the spawning gravel.
Parr	Young salmonid in the stage between alevin and smolt that has developed distinctive dark "parr marks" on its sides and is actively feeding in fresh water.
Fingerling	Young fish, usually in its first or second year and generally between 2 and 25 cm long.
Fry	Life stage of trout or salmon between full absorption of the yolk sac and fingerling or parr stage, which generally is reached by the end of the first summer.
Smolt	Juvenile salmonid one or more years old that has undergone physiological changes to cope with a marine environment; the seaward migrant stage of an anadromous salmonid.
Spawner	Sexually mature salmonid migrating to or at its natal spawning grounds.
Carcass	The dead bodies of the salmonid.
Egg	One of the female reproductive cells consisting of an embryo surrounded by nutrient material and protective covering.

Table C.7. Priority Habitat Species (PHS) known to occur in Big White Salmon Subbasin, based on IBIS data (WDFW 2003b).

Common Name	**Scientific Name**
Amphibians	
Columbia spotted frog	*Rana pretiosa*
Oregon spotted frog	*Rana pretiosa*
Western toad	*Bufo boreas*
Cascades torrent salamander	*Rhyacotriton cascadae*
Larch Mountain salamander	*Plethodon larselli*
Van Dyke's salamander	*Plethodon vandykei*
Birds	
Western Grebe	*Aechmophorus occidentalis*
Black-crowned night heron	*Nycticorax nycticorax*
Great blue heron	*Ardea herodias*
Aleutian Canada goose	*Branta canadensis leucopareia*

Wood duck	*Aix sponsa*
Barrow's goldeneye	*Bucephala islandica*
Hooded merganser	*Lophodytes cucullatus*
Bald eagle	*Haliaeetus leucocephalus*
Ferruginous hawk	*Buteo regalis*
Golden eagle	*Aquila chrysaetos*
Northern goshawk	*Accipiter gentilis*
Prairie falcon	*Falco mexicanus*
Chukar	*Alectoris chukar*
Mountain quail	*Oreortyx pictus*
Ring-necked pheasant	*Phasianus colchicus*
Sage grouse	*Centrocercus urophasianus*
Wild turkey	*Meleagris gallopavo*
Sandhill crane	*Grus canadensis*
Band-tailed pigeon	*Columba fasciata*
Burrowing owl	*Athene cunicularia*
Flammulated owl	*Otus flammeolus*
Spotted owl	*Strix occidentalis*
Vaux's swift	*Chaetura vauxi*
Black-backed woodpecker	*Picoides arcticus*
Lewis' woodpecker	*Melanerpes lewis*
Pileated woodpecker	*Dryocopus pileatus*
White-headed woodpecker	*Picoides albolarvatus*
Loggerhead shrike	*Lanius ludovicianus*
Oregon vesper sparrow (?)	*Pooecetes gramineus affinis*
Purple martin	*Progne subis*
Sage sparrow	*Amphispiza belli*
Sage thrasher	*Oreoscoptes montanus*
Slender-billed, white-breasted nuthatch (?)	*Sitta carolinensis aculeata*
Streaked, horned lark (?)	*Eremophila alpestris strigata*
Birds (Other)	
Eastern Washington breeding concentrations of:	
Grebes (Podicipedidae)	
Cormorants (Phalacrocoracidae)	
Eastern Washington breeding:	
Terns (Laridae)	
Waterfowl concentrations:	

(Anatidae excluding Canada geese in urban areas)	
Eastern Washington breeding occurrences of:	
Phalaropes (Phalaropodidae)	
Stilts and avocets (Recurvirostridae)	
Mammals	
Big brown bat	*Eptesicus fuscus*
Myotis bats	*Myotis* spp., all
Pallid bat	*Antrozous pallidus*
Townsend's big-eared bat	*Corynorhinus townsendii*
Black-tailed jackrabbit	*Lepus californicus*
White-tailed jack rabbit	*Lepus townsendii*
Townsend’s ground squirrel	*Spermophilus townsendii townsendii*
Western gray squirrel	*Sciurus griseus*
Fisher	*Martes pennanti*
American Marten	*Martes americana*
Mink	*Mustela vison*
Wolverine	*Gulo gulo*
Bighorn sheep	*Ovis canadensis*
Columbian black-tailed deer	*Odocoileus hemionus columbianus*
Columbian white-tailed deer	*Odocoileus virginianus leucurus*
Mountain goat	*Oreamnos americanus*
Rocky Mountain elk	*Cervus elaphus nelsoni*
Rocky Mountain mule deer	*Odocoileus hemionus hemionus*
Reptiles	
Sagebrush lizard	*Sceloporus graciousus*
California mountain kingsnake	*Lampropeltis zonata*
Sharptail snake	*Contia tenuis*
Striped whipsnake	*Masticophis taeniatus*
Western pond turtle	*Clemmys marmorata*

Appendix D

Appendix D: Rare Plants and Plant Communities of the White Salmon watershed area.

Table D.1.A. The 51 rare plants identified in Klickitat County (Washington Natural Heritage Program 2003). Definitions of status are in table D.2.B.

COMMON NAME	SCIENTIFIC NAME	State Status	Federal Status
Tall agoseris	*Agoseris elata*	S	

Grand redstem	*Ammannia robusta*	T	
Northern wormwood	*Artemisia campestris ssp borealis var wormskioldii*	E	C
Palouse milk-vetch	*Astragalus arrectus*	S	
Pauper milk-vetch	*Astragalus misellus var pauper*	S	
Ames' milk-vetch	*Astragalus pulsiferae var suksdorfii*	E	
Bolandra	*Bolandra oregana*	S	
Long-bearded sego lily	*Calochortus longebarbatus var longebarbatus*	S	
Few-flowered collinsia	*Collinsia sparsiflora var bruceae*	S	
Beaked cryptantha	*Cryptantha rostellata*	T	
Snake river cryptantha	*Cryptantha spiculifera*	S	
Douglas' draba	*Cusickiella douglasii*	T	
Shining flatsedge	*Cyperus bipartitus*	S	
Clustered lady's-slipper	*Cypripedium fasciculatum*	S	
Fringed waterplantain	*Damasonium californicum*	T	
Piper's daisy	*Erigeron piperianus*	S	
Oregon coyote-thistle	*Eryngium petiolatum*	T	
Common blue-cup	*Githopsis specularioides*	S	
Diffuse stickseed	*Hackelia diffusa var diffusa*	T	
Gooseberry-leaved alumroot	*Heuchera grossulariifolia var tenuifolia*	S	
Nuttall's quillwort	*Isoetes nuttallii*	S	
Dwarf rush	*Juncus hemiendytus var hemiendytus*	T	
Kellogg's rush	*Juncus kelloggii*	E	
Baker's linanthus	*Linanthus bolanderi*	S	
Twayblade	*Liparis loeselii*	E	
Awned halfchaff sedge	*Lipocarpha aristulata*	T	
Smooth desert-parsley	*Lomatium laevigatum*	T	
Suksdorf's desert-parsley	*Lomatium suksdorfii*	S	
White meconella	*Meconella oregana*	T	
Liverwort monkey-flower	*Mimulus jungermannioides*	Pos Extirpated	
Pulsifer's monkey-flower	*Mimulus pulsiferae*	S	
Suksdorf's monkey-flower	*Mimulus suksdorfii*	S	
Washington monkey-flower	*Mimulus washingtonensis*	Pos Extirpated	
Branching montia	*Montia diffusa*	S	
Marigold navarretia	*Navarretia tagetina*	T	
Coyote tobacco	*Nicotiana attenuata*	S	
Tufted evening-primrose	*Oenothera caespitosa ssp marginata*	S	

Adder's-tongue	*Ophioglossum pusillum*	T	
Rosy owl-clover	*Orthocarpus bracteosus*	E	
Western yellow oxalis	*Oxalis suksdorfii*	T	
Barrett's beardtongue	*Penstemon barrettiae*	T	
Hot-rock penstemon	*Penstemon deustus var variabilis*	T	
Fuzzytongue penstemon	*Penstemon eriantherus var whitedii*	S	
Obscure buttercup	*Ranunculus reconditus*	E	
Persistentsepal yellowcress	*Rorippa columbiae*	E	
Lowland toothcup	*Rotala ramosior*	T	
Soft-leaved willow	*Salix sessilifolia*	S	
Pale blue-eyed grass	*Sisyrinchium sarmentosum*	T	
Western ladies-tresses	*Spiranthes porrifolia*	S	
Flat-leaved bladderwort	*Utricularia intermedia*	S	
Siskiyou false-hellebore	*Veratrum insolitum*	T	

Table D.1.B. Definitions for state and federal plant listings (Washington Natural Heritage Program 2003).

State Status	
E (Endangered)	In danger of becoming extinct or extirpated from Washington.
T (Threatened)	Likely to become Endangered in Washington.
S (Sensitive)	Vulnerable or declining and could become Endangered or Threatened in the state.
Federal Status	
C (Candidate)	Sufficient information exists to support listing as Endangered or Threatened.

Table D.2. The 23 rare plant communities in Klickitat County (Washington Natural Heritage Program 2003).

Scientific Name	**Common Name**
Abies grandis / achlys triphylla forest	Grand fir / vanillaleaf
Abies grandis / calamagrostis rubescens woodland	Grand fir / pinegrass
Abies grandis / clintonia uniflora forest	Grand fir / queen's cup
Abies grandis / holodiscus discolor forest	Grand fir / oceanspray
Abies grandis / mahonia nervosa var. Nervosa forest	Grand fir / dwarf oregongrape
Abies grandis / vaccinium membranaceum forest	Grand fir / big huckleberry
Alnus rhombifolia forest (provisional)	White alder
Artemisia rigida / poa secunda dwarf-shrub herbaceous vegetation	Stiff sagebrush / Sandberg's bluegrass

Artemisia tridentata / festuca idahoensis shrub herbaceous vegetation	Big sagebrush / Idaho fescue
Eriogonum compositum / poa secunda dwarf-shrub herbaceous vegetation	Arrow-leaf buckwheat / sandberg's bluegrass
Eriogonum douglasii / poa secunda dwarf-shrub herbaceous vegetation	Douglas' buckwheat / Sandberg's bluegrass
Eriogonum sphaerocephalum / poa secunda dwarf-shrub herbaceous vegetation	Rock buckwheat / Sandberg's bluegrass
Festuca idahoensis - hieracium cynoglossoides herbaceous vegetation	Idaho fescue - houndstounge hawkweed
Pinus ponderosa - pseudotsuga menziesii cover type	Ponderosa pine - douglas-fir forest
Populus tremuloides cover type	Quaking aspen forest
Pseudoroegneria spicata - poa secunda lithosolic herbaceous vegetation	Bluebunch wheatgrass - Sandberg's bluegrass lithosol
Pseudotsuga menziesii / holodiscus discolor forest	Douglas-fir / oceanspray
Purshia tridentata / festuca idahoensis shrub herbaceous vegetation	Bitterbrush / Idaho fescue
Quercus garryana - pinus ponderosa cover type	Oregon white oak - ponderosa pine forest
Quercus garryana / elymus glaucus woodland	Oregon white oak / blue wildrye
Quercus garryana / festuca idahoensis woodland	Oregon white oak / idaho fescue
Quercus garryana / pseudoroegneria spicata woodland	Oregon white oak / bluebunch wheatgrass
Quercus garryana forest (provisional)	Oregon white oak

Table D.3. Priority Habitats of Southwest Washington (Region 5), (WDFW, PHS list, 2004).

Habitat Type or Element	Priority Area
Aspen Stands	Pure or mixed stands of aspen greater than 0.8 ha (2 acres). **Criteria:** High fish and wildlife species diversity, limited availability, high vulnerability to habitat alteration.
Caves	A naturally occurring cavity, recess, void, or system of interconnected passages (including associated dendritic tubes, cracks, and fissures) which occurs under the earth in soils, rock, ice, or other geological formations, and is large enough to contain a human. Mine shafts may mimic caves, and those abandoned mine shafts with actual or suspected occurrences of priority species should be treated in a manner similar to caves. A mine is a man-made excavation in the earth usually used to extract minerals.
	Criteria: Comparatively high wildlife density, important wildlife breeding habitat and seasonal ranges, limited availability, vulnerable to human disturbance, dependent species.
Cliffs	Greater than 7.6 m (25 ft) high and occurring below 1524 m (5000 ft).
	Criteria: Significant wildlife breeding habitat, limited availability, dependent species.
Estuary, Estuary-like	Deepwater tidal habitats and adjacent tidal wetlands, usually semi-enclosed by land but with open, partly obstructed or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land. The salinity may be periodically increased above that of the open ocean by evaporation. Along some low-energy coastlines there is appreciable dilution of sea water. Estuarine habitat extends upstream and landward to where ocean-derived salts measure less than 0.5% during the period of average annual low flow. Includes both estuaries and lagoons.
	Criteria: High fish and wildlife density and species diversity, important breeding habitat, important fish and wildlife seasonal ranges and movement corridors, limited availability, high vulnerability to habitat alteration.
Freshwater Wetlands and Fresh Deepwater	**Wetlands:** Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have one or more of the following attributes: the land supports, at least periodically, predominantly hydrophytic plants; substrate is predominantly undrained hydric soils; and/or the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.
	Deepwater habitats are permanently flooded lands lying below the deepwater boundary of wetlands. Deepwater habitats include environments where surface water is permanent and often deep, so that water, rather than air, is the principal medium within which the dominant organisms live. The dominant plants are hydrophytes; however, the substrates are considered nonsoil because the water is too deep to support emergent vegetation. These habitats include all underwater structures and features (e.g., woody debris, rock piles, caverns).
	Criteria: Comparatively high fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife seasonal ranges, limited availability, high vulnerability to habitat alteration.
Instream	The combination of physical, biological, and chemical processes and conditions that interact to provide functional life history requirements for instream fish and invertebrate resources.
	Criteria: Comparatively high fish and wildlife density and species diversity, important fish and wildlife seasonal ranges, limited availability, high vulnerability to habitat alteration, dependent species.
Juniper Savannah	All juniper woodlands.

	Criteria: High fish and wildlife species diversity, important fish and wildlife breeding habitat and seasonal ranges, limited availability.
Marine / Estuarine Shorelines	Shorelines include the intertidal and subtidal zones of beaches, and may also include the backshore and adjacent components of the terrestrial landscape (e.g., cliffs, snags, mature trees, dunes, meadows) that are important to shoreline associated fish and wildlife and that contribute to shoreline function (e.g., sand/rock/log recruitment, nutrient contribution, erosion control).
	Consolidated Substrate: Rocky outcroppings in the intertidal and subtidal marine/estuarine environment consisting of rocks greater that 25 cm (10 in) diameter, hardpan, and/or bedrock.
	Unconsolidated Substrate: Substrata in the intertidal and subtidal marine environment consisting of rocks less than 25 cm (10 in) diameter, gravel, shell, sand, and/or mud.
	Criteria: Comparatively high fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife seasonal ranges, limited availability, high vulnerability to habitat alteration, dependent species.
Old-growth / Mature Forests	<u>Old-growth east of Cascade crest:</u> Stands are highly variable in tree species composition and structural characteristics due to the influence of fire, climate, and soils. In general, stands will be >150 years of age, with 25 trees/ha (10 trees/acre)> 53 cm (21 in) dbh, and 2.5-7.5 snags/ha (1 - 3 snags/acre) > 30-35 cm (12-14 in) diameter. Downed logs may vary from abundant to absent. Canopies may be single or multi-layered. Evidence of human-caused alterations to the stand will be absent or so slight as to not affect the ecosystem's essential structures and functions.
	<u>Mature forests:</u> Stands with average diameters exceeding 53 cm (21 in) dbh; crown cover may be less that 100%; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; 80 - 200 years old west and 80 - 160 years old east of the Cascade crest.
	Criteria: High fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife seasonal ranges, limited and declining availability, high vulnerability to habitat alteration.
Oregon White Oak Woodlands	Stands of pure oak or oak/conifer associations where canopy coverage of the oak component of the stand is 25%; or where total canopy coverage of the stand is <25%, but oak accounts for at least 50% of the canopy coverage present. The latter is often referred to as oak savanna. In non-urbanized areas west of the Cascades, priority oak habitat consists of stands 0.4 ha (1.0 ac) in size. East of the Cascades, priority oak habitat consists of stands 2 ha (5 ac) in size. In urban or urbanizing areas, single oaks or stands < 0.4 ha (1 ac) may also be considered a priority when found to be particularly valuable to fish and wildlife.
	Criteria: Comparatively high fish and wildlife density, high fish and wildlife species diversity, limited and declining availability, high vulnerability to habitat alteration, dependent species.
Prairies and Steppe	Relatively undisturbed areas (as indicated by dominance of native plants) where grasses and/or forbs form the natural climax plant community.
	Criteria: Comparatively high fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife seasonal ranges, limited and declining availability, high vulnerability to habitat alteration, unique and dependent species.

Riparian	The area adjacent to aquatic systems with flowing water that contains elements of both aquatic and terrestrial ecosystems which mutually influence each other. In riparian systems, the vegetation, water tables, soils, microclimate, and wildlife inhabitants of terrestrial ecosystems are influenced by perennial or intermittent water. Simultaneously, the biological and physical properties of the aquatic ecosystems are influenced by adjacent vegetation, nutrient and sediment loading, terrestrial wildlife, as well as organic and inorganic debris. Riparian habitat encompasses the area beginning at the ordinary high water mark and extends to that portion of the terrestrial landscape that is influenced by, or that directly influences, the aquatic ecosystem. Riparian habitat includes the entire extent of the floodplain and riparian areas of wetlands that are directly connected to stream courses.
	Criteria: High fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife breeding habitat, important wildlife seasonal ranges, important fish and wildlife movement corridors, high vulnerability to habitat alteration, unique or dependent species.
Rural Natural Open Space	A priority species resides within or is adjacent to the open space and uses it for breeding or regular feeding; and/or the open space functions as a corridor connecting other *priority habitats*, especially areas that would otherwise be isolated; and/or the open space is an isolated remnant of natural habitat larger than 4 ha (10 acres) and surrounded by agricultural developments. Local consideration may be given to open space areas smaller than 4 ha (10 acres).
	Criteria: Comparatively high fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife seasonal ranges, important fish and wildlife movement corridors, high vulnerability to habitat alteration, unique species assemblages in agricultural areas.
Shrub Steppe	Large Tracts: Tracts of land >259 ha (640 ac) consisting of plant communities with one or more layers of perennial grasses and a conspicuous but discontinuous layer of shrubs. Large tracts of shrub-steppe contribute to the overall continuity of the habitat type throughout the region because they are relatively unfragmented, contain a substantial amount of interior habitat, and are in close proximity to other tracts of shrub-steppe. These tracts should contain a variety of habitat features (e.g., variety of topography, riparian areas, canyons, habitat edges, plant communities). Another important component is habitat quality based on the degree with which a tract resembles a site potential natural community, which may include factors such as soil condition and degree of erosion; and distribution, coverage, and vigor of native shrubs, forbs, grasses, and cryptogams.
	Small Tracts: Tracts of land <259 ha (640 ac) with a habitat type consisting of plant communities with one or more layers of perennial grasses and a conspicuous but discontinuous layer of shrubs. Although smaller in size and possibly more isolated from other tracts of shrub-steppe these areas are still important to shrub-steppe obligate and other state-listed wildlife species. Also, important are the variety of habitat features and habitat quality aspects as listed above.
	Criteria: Comparatively high fish and wildlife density and species diversity; important fish and wildlife breeding habitat and seasonal ranges, limited availability, high vulnerability to habitat alteration, unique and dependent species.

Snags and Logs	Snags and logs occur within a variety of habitat types that support trees. Trees are considered snags if they are dead or dying and exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a diameter at breast height of ≥ 51 cm (20 in) in western Washington and ≥ 30 cm (12 in) in eastern Washington, and are ≥ 2 m (6.5 ft) in height. Priority logs are ≥ 30 cm (12 in) in diameter at the largest end, and ≥ 6 m (20 ft) long. Abundant snags and logs can be found in old-growth and mature forests or unmanaged forests of any age, in damaged, burned, or diseased forests, and in riparian areas. Priority snag and log habitat includes individual snags and/or logs, or groups of snags and/or logs of exceptional value to wildlife due to their scarcity or location in a particular landscape. Areas with abundant, well distributed snags and logs are also considered priority snag and log habitat. Examples include large, sturdy snags adjacent to open water, remnant snags in developed or urbanized settings, and areas with a relatively high density of snags.
	Criteria: Comparatively high fish and wildlife density and species diversity, important fish and wildlife breeding habitat and seasonal ranges, limited availability, high vulnerability to habitat alteration, large number of cavity-dependent species.
Talus	Homogenous areas of rock rubble ranging in average size 0.15 - 2.0 m (0.5 - 6.5 ft), composed of basalt, andesite, and/or sedimentary rock, including riprap slides and mine tailings. May be associated with cliffs.
	Criteria: Limited availability, unique and dependent species, high vulnerability to habitat alteration.
Urban Natural Open Space	A priority species resides within or is adjacent to the open space and uses it for breeding and/or regular feeding; and/or the open space functions as a corridor connecting other *priority habitats*, especially those that would otherwise be isolated; and/or the open space is an isolated remnant of natural habitat larger than 4 ha (10 acres) and is surrounded by urban development. Local considerations may be given to open space areas smaller than 4 ha (10 acres).
	Criteria: Comparatively high fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife movement corridors, limited availability, high vulnerability to habitat alteration.

Table D.4.A. Noxious weeds found in the White Salmon watershed, (M. Hudson, Klickitat County NWB, pers. comm.).

Common Name	Scientific Name
Class A	
buffalobur	*Solanum rostratum*
Class B	
broom, Scotch*	*Cytisus scoparius*
catsear, common	*Hypochaeris radicata*
cinquefoil, sulfur	*Potentilla recta*
daisy, oxeye*	*Leucanthemum vulgare*
parsley, hedge*	*Torilis arvensis*
houndstongue*	*Cynoglossum officinale*

indigobush	*Amorpha fruticosa*
knapweed, diffuse	*Centaurea diffusa*
knapweed, spotted*	*Centaurea biebersteinii*
pepperweed, perennial	*Lepidium latifolium*
starthistle, yellow	*Centaurea solstitialis*
toadflax, Dalmatian*	*Linaria dalmatica ssp. dalmatica*
watermilfoil, Eurasian	*Myriophyllum spicatum*
sandbur, longspine	*Cenchrus longispinus*
kochia	*Kochia scoparia*
puncturevine	*Tribulus terrestris*
skeletonweed, rush	*Chondrilla juncea*
knapweed, Russian	*Acropilon repens*
thistle, Scotch	*Onopordum acanthium*
Class C	
thistle, Canada	*Cirsium arvense*
cocklebur, spiny	*Xanthium spinosum*
Other	
whitetop, hairy	Cardaria pubescens

* species found less here than in Big White Salmon and Klickitat watersheds.

Table D.4.B. The three classes of weed categories and their definitions (WS NWCB 2004).

Class A	The State of Washington through RCW 17.10 has listed Class A weeds for eradication statewide. Class A consists of those noxious weeds not native to state that are of limited distribution or are unrecorded in the state andthat pose a serious threat to the state.
Class B	The State of Washington through RCW 17.10 has listed Class B weeds as designated for control in Klickitat County. Class B-designate consists of those noxious weeds not native to the state and that are of limited distribution or are unrecorded in a region of the state and whose populations in a region or area are such that all seed production can be prevented within a calendar year.
Class C	Each species is already widely established in Washington or is of special interest to the state's agricultural industry. Placement on the state noxious weed list allows counties to enforce control if locally desired. Other counties may choose simply to provide education or technical consultation to county residents.

Table D.5. A few of the plant species culturally important to the Yakama Nation (not all found in the White Salmon watershed) (Hunn 1990, Lyons 1995, Taylor, 1992, Uebelacker 1985).

Species Name	Common Name	Habitat / Areas Found	Traditional and Current Uses
Celeries			
Lomatium grayi	Gray's desert parsley	Shrub Steppe	First food, mid-feb., honored at first food feast along with suckers
Lomatium nudicaule	Bare-stem desert parsley	Shrub Steppe	Honored at second feast in mid-April (with Salmon and bitterroot), marks beginning of

			root season
Lomatium dissectum	Fern-leaf desert parsley	Shrub Steppe, talus slopes	Traditional food, medicinal
Balsamorhiza sagittata	Arrow-leaf balsamroot	Shrub Steppe	Traditional food
Balsamorhiza careyana	Carey's balsamroot	Shrub Steppe	Traditional food
Wyethia amplexicaulis	Mule's ear	Moist areas	Traditional food
Heracleum lanatum	Cow's parsnip	Higher elevation, wet	Traditional food
Plant Foods That Are Dug			
Camassia quamash	Camas	Wet Meadow	Traditional food
Lomatium cous	Cous or Biscuitroot	Shrub Steppe, dry open slopes	Traditional food
Lomatium canbyi	Canby Lomatium	Priest Rapids	Traditional food
Lomatium piperi	Not found	Not found	Traditional food
Lomatium grayi	Gray's desert parsley	Shrub Steppe	First food, mid-feb., honored at first food feast along with suckers
Lomatium macrocarpum	Large-fruited biscuitroot	Shrub Steppe	Traditional food
Lomatium hambleniae	Not found	Not found	Traditional food
Lomatium minus	Not found	Not found	Traditional food
Lomatium gormanii	Salt and Pepper	Shrub Steppe	Traditional food
Lewisia rediviva	Bitterroot	Shrub Steppe	Traditional food, honored at second feast in mid-April
Perideridia gairdneri	Yampah, Indian carrot	High elevation Shrub Steppe, conifer, aspen, subalpine meadows	Traditional food
Claytonia lanceolata	Spring beauty or Indian potato	High elevation meadows, alpine slopes, Shrub Steppe plains	Traditional food
Brodiaea hyacinthina	Hyacinth brodiaea, Fool's Onion	Moist areas	Traditional food
Brodiaea howellii	Brodiaea, Wild hyacinth	Shrub Steppe, Ponderosa pine	Traditional food
Brodiaea douglasii	Brodiaea, Wild hyacinth	Shrub Steppe, Ponderosa pine	Traditional food
Fritillaria pudica	Yellow bell	Shrub Steppe	Traditional food
Tauschia hooveri	Not found	Not found	Traditional food
Calochortus macrocarpus	Mariposa lily	River drainages, dry, sandy soils	Traditional food
Microseris troximoides	Microseris, "false dandelion"	Shrub Steppe	Traditional food
Erythronium grandiflorum	Yellow avalanche lily,	Low-mid elevation	Traditional food

	glacier lily	meadows	
Osmorhiza occidentalis	Not found	Not found	Traditional food
Lillium columbianum	Tiger lily	Damp soil, up to 4000'	Traditional food
Valeriana edulis	Not found	Not found	Traditional food
Balsamorhiza hookeri	Hooker's balsamroot	Shrub Steppe	Traditional food
Allium acuminatum	Wild onion	Shrub Steppe	Traditional food
Allium douglasii	Wild onion	Shrub Steppe	Traditional food
Allium robinsonii	Wild onion	Shrub Steppe	Traditional food
Plants Picked For Food			
Vaccinium membranaceum	Black huckleberry	Riparian/Forest	Traditional food, most important fruit
Vaccinium alaskaense	Alaskan huckleberry / blueberry	Forest	Traditional food
Vaccinium scoparium	Grouseberry / huckleberry	Forest	Traditional food
Vaccinium ovalifolium	Oval-leaved blueberry/blue	Riparian/Forest	Traditional food
Vaccinium parvifolium	Red huckleberry	West of cascades	Traditional food
Vaccinium deliciosum	Blue-leaved huckleberry	Riparian/Forest	Traditional food
Bryoria fremontii	Black tree lichen	Low elevation forests	Traditional food
Prunus virginia ssp. demissa	Chokecherry	Shrub Steppe, bunchgrass and ponderosa pine	Traditional food
Amelanchier alnifolia	Serviceberry	Riparian	Traditional food
Sambucus cerulea	Blue elderberry	Riparian	Traditional food
Sambucus racemosa var. melanocarpa	Black elderberry	Riparian	Traditional food
Ribes aureum	Golden currant	Forest	Traditional food
Rubus leucodermis	Black rasberry	Riparian	Traditional food
Rubus idaeus	Red rasberry	Riparian	Traditional food
Rubus parviflorus	Thimbleberry	Riparian	Traditional food
Trees			
Pinus ponderosa	Ponderosa pine	Forest	Edible inner bark and sugar, medicinal
Salix spp.	Willow	Riparian	Non-food, building material
Salix amygdaloides	Peachleaf willow	Riparian	Used to construct longhouse frames
Quercus garryana	Oregon white or Gary oak	Low elevation forest	Acorns (food), dip net material, trading

Acer circinatum	Vine maple	Along creeks or meadows	Dip net hoops
Acer glabrum	Douglas maple	Mid-elevation forests	Dip net hoops
Holodiscus discolor	Oceanspray	Low-elevation mountain and ponderosa pine	Crosspiece giving strength to dip net hoop
Populus spp.	Cottonwood, Aspen	Riparian	Non-food, building material
Thuja plicata	Western red cedar	Wet forests	Crafts, basketry
Larix occidentalis	Western Larch	Forest	Medicinal
Picea engelmannii	Engelmann Spruce	East-side forests	Medicinal drink
Fibers			
Apocynum cannabinum	Indian hemp or Common dogbane	Shrub Steppe, grass and p. pine community	Dip nets, root collecting bags, hats, tule mats
Scirpus acutus	Bulrush or Tule	Low elevation riparian	Mats for winter longhouses, summer homes
Scirpus validus	Bulrush or Tule	Low elevation riparian	Mats for winter longhouses, summer homes
Xerophyllum tenax	Bear-grass	Riparian/Forest	Roots boiled to make soap, basketry, trade item
Prunus emarginata	Bitter cherry	Shrub Steppe, bunchgrass and ponderosa pine	Traditional food, medicinal
Sacrobates. vermiculatus	Greasewood	Shrub Steppe, alkaline flats and playas	Tule mats
Phragmites communis	Common reed	Not found	Work mat
Typha latifolia	Common cattail	Riparian	Bags for storing salmon meal
Elymus cinereus	Giant wild rye	Not found	Drying salmon, baking mat, disposable floor mats
Arctostaphylos uva-ursi	Kinnikinnick	Alpine meadow	Traditional food and material
Medicines			
Lomatium dissectum	Fern-leaf desert parsley	Shrub Steppe, talus slopes	Traditional food, medicinal
Ligustichum canbyi	Lovage (?)	Not found	Medicinal
Helianthus cusickii	Cusick's (Wild) sunflower	Dry, open plains and foothills	Medicinal
Prunus emarginata	Bitter cherry	Shrub Steppe, bunchgrass and ponderosa pine	Traditional food, medicinal
Agastache occidentalis	Western giant-hyssop, Horsemint	Foothills and eastern slope of cascades	Medicinal
Picea engelmannii	Engelmann Spruce	East-side forests	Medicinal drink

Nicotiana attenuata	Wild tabacco	Not found	Medicinal drink

Appendix E. Washington State Department of Fish and Wildlife Fisheries Monitoring and Evaluation Plan for Steelhead and Salmon Fisheries in the Middle Columbia River ESU.

Appendix F

Documentation used in the Ecosystem Diagnosis and Treatment Model (EDT) for the White Salmon Watershed.

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May 10, 2004

Summary

This report summarizes the Ecosystem Diagnosis and Treatment Model (EDT) dataset for the White Salmon River. In this project we rated over 43 reaches with 45 environmental attributes per reach for current conditions and historical conditions. Over 4,000 ratings were assigned and empirical observations within the reach are not available for all of these ratings. To develop the remaining data we used expansion of empirical observations, derived information, expert opinion, and hypothetical. For example, if a stream width measurement existed for a reach and the reach upstream and downstream had similar characteristics then we used the expansion of empirical information from the middle reach to estimate widths in the downstream and upstream reaches. For the fine sediment attribute we could find no data within these watersheds, except that collected by Greg Morris (YN) in Rattlesnake and Indian creeks. However, Rawding (unpublished 2003) established a relationship between road density and fine sediment in the Wind River watershed. We applied this relationship to White Salmon reaches, this is an example of derived information. In some cases such as bed scour we had no data for these basins. However, data is available from the Gobar Creek in the Kalama River and observations have been made in the Wind River. We noted that bed scour is related to gradient, stream width, and confinement. Based on these observations expert opinion was used to generate a bed scour look up table to be consistent across reaches and watersheds. For rationale behind the ratings see the text below. For specific reach scale information please see the EDT database for the watershed of interest.

Current EDT estimates can be assessed when long-term estimates of wild spawners, hatchery spawners, reproductive success of hatchery spawners, and smolts are available. The information in the White Salmon River was insufficient for this type of analysis. However, in other basins within the Lower Columbia and the Gorge Provinces, the EST predicted estimates of smolt and/or adults performance are reasonably close to empirical estimates from WDFW population estimates. Since a similar approach was used in the White Salmon River, we believe the predicted performance of salmon and steelhead in the basin is reasonable. The environmental attributes with the most significant impact on salmon performance include: maximum water temperature, riparian condition, sediment, bed scour, peak flows, confinement, wood, and stream habitat type.

Orientation

The White Salmon River Subbasin was divided into 43 reaches. Table 1 lists the reach abbreviation, description, length, and geographic area. Figure 1 is the location of these reaches.

Table 1. White Salmon River reach description

Reach Name	Description	River Miles	Length (Mi)		Geographic Area	River Miles	Length (Mi)
B1	Buck Ck. mouth to diversion intake	(0 - 2)	2.0		Buck Creek	(0 - 3.2)	3.2
B2	Diversion intake to BFalls1	(2 - 3.2)	1.2		Buck Creek	(0 - 3.2)	3.2
B3	BFalls1 to BFalls2	(3.2 - 4)	0.9				
B4	BFalls2 to end of anadromous distrib.	(4 - 4.2)	0.2				
I1	Indian Ck mouth to Indian Ck. Culvert1	(0 - 0.1)	0.1		Indian Creek	(0 - 1.9)	1.9
I2	Indian Ck. culvert1 to Indian Ck. culvert2	(0.1 - 0.8)	0.8		Indian Creek	(0 - 1.9)	1.9
I3	Indian Ck. culvert2 to Indian Ck. culvert3	(0.8 - 1.1)	0.3		Indian Creek	(0 - 1.9)	1.9
I4	Indian Ck. culvert3 to Indian Ck. culvert4	(1.1 - 1.2)	0.1		Indian Creek	(0 - 1.9)	1.9
I5	Indian Ck. culvert4 to end of anadromous	(1.2 - 1.9)	0.8		Indian Creek	(0 - 1.9)	1.9
LB1	Historic LBuck Ck. mouth to top of reservoir	(0 - 0.1)	0.1				
LB2	Top of reservoir to reach break	(0.1 - 1)	0.8				
LB3	Reach break to end of anadromous	(1 - 2.2)	1.2				
M1	Historic Mill Ck. mouth to top of reservoir	(0 - 0.2)	0.2				
M2	Top of reservoir to Mill Ck. Culvert1	(0.2 - 0.4)	0.2				
M3	Mill Ck. culvert1to Mill Ck. culvert2	(0.4 - 1.1)	0.7				
M4	Mill Ck. culvert 2 to end of anadromous distrib	(1.1 - 1.9)	0.9				
R1	Rattlesnake Ck. mouth to Indian Ck.	(0 - 0.5)	0.5		Rattlesnake Creek	(0-10.2)	10.2
R2	Indian Ck. to RFalls1	(0.5 - 1.6)	1.2		Rattlesnake Creek	(0-10.2)	10.2
R3	RFalls1 to end of confinement	(1.6 - 3.3)	1.6		Rattlesnake Creek	(0-10.2)	10.2
R4	End of confinement to upper confinement	(3.3 - 6.6)	3.3		Rattlesnake Creek	(0-10.2)	10.2
R5	Upper confinement to RFalls2	(6.6 - 10.2)	3.6		Rattlesnake Creek	(0-10.2)	10.2
R6	RFalls2 to end of anadromous	(10.2 - 10.5)	0.4				
S1	Spring Ck. mouth to dam	(0 - 0.7)	0.7		Spring Creek	(0-1.1)	1.1
S2	Pond behind Spring Ck. dam	(0.7 - 0.8)	0.1		Spring Creek	(0-1.1)	1.1
S3	Top of Spring Ck. Pond to forks	(0.8 - 1.1)	0.3		Spring Creek	(0-1.1)	1.1
WS1	Mouth to first riffle_end of BON pool influence	(0 - 1.2)	1.2		WS Below Condit	(0 - 3.4)	3.4
WS2	End of BON pool influence to Powerhouse	(1.2 - 2.1)	0.9		WS Below Condit	(0 - 3.4)	3.4
WS3	Powerhouse to Steelhead Falls	(2.1 - 2.7)	0.6		WS Below Condit	(0 - 3.4)	3.4
WS4	Steelhead Falls to Condit Dam	(2.7 - 3.4)	0.7		WS Below Condit	(0 - 3.4)	3.4
WS5	Condit Dam to Little Buck Ck.	(3.4 - 3.6)	0.2		WS Inundated	(3.4 - 4.9)	1.5
WS6	Little Buck Creek to Mill Creek	(3.6 - 4.1)	0.5		WS Inundated	(3.4 - 4.9)	1.5
WS7	Mill Ck. to end of deep reservoir	(4.1 - 4.9)	0.8		WS Inundated	(3.4 - 4.9)	1.5
WS8	End of deep reservoir to Buck Ck.	(4.9 - 5.1)	0.2		WS Top of Res to Husum Falls	(4.9 - 7.9)	3.0
WS9	Buck Ck. to Sandy Beach (first riffle)	(5.1 - 5.6)	0.5		WS Top of Res to Husum Falls	(4.9 - 7.9)	3.0
WS10	Sandy Beach (first riffle) to Spring Creek	(5.6 - 6.8)	1.2		WS Top of Res to Husum Falls	(4.9 - 7.9)	3.0
WS11	Spring Ck. to Deadman's Corner	(6.8 - 7.5)	0.7		WS Top of Res to Husum Falls	(4.9 - 7.9)	3.0
WS12	Deadman's Corner to Rattlesnake Ck.	(7.5 - 7.8)	0.3		WS Top of Res to Husum Falls	(4.9 - 7.9)	3.0
WS13	Rattlesnake Ck. to Husum Falls	(7.8 - 7.9)	0.2		WS Top of Res to Husum Falls	(4.9 - 7.9)	3.0
WS14	Husum Falls to Sunshine Eddy	(7.9 - 9.9)	2.0		WS Husum to BZ	(7.9 - 13.2)	5.3
WS15	Sunshine Eddy to Diversion Hole	(9.9 - 10.3)	0.4		WS Husum to BZ	(7.9 - 13.2)	5.3
WS16	Diversion Hole to BZ Falls	(10.3 - 13.2)	2.9		WS Husum to BZ	(7.9 - 13.2)	5.3
WS17	BZ Falls to Double Drop Falls	(13.2 - 14.4)	1.2		WS BZ to Big Brother	(13.2 - 16.5)	3.3
WS18	Double Drop Falls to Big Brother Falls	(14.4 - 16.5)	2.1		WS BZ to Big Brother	(13.2 - 16.5)	3.3

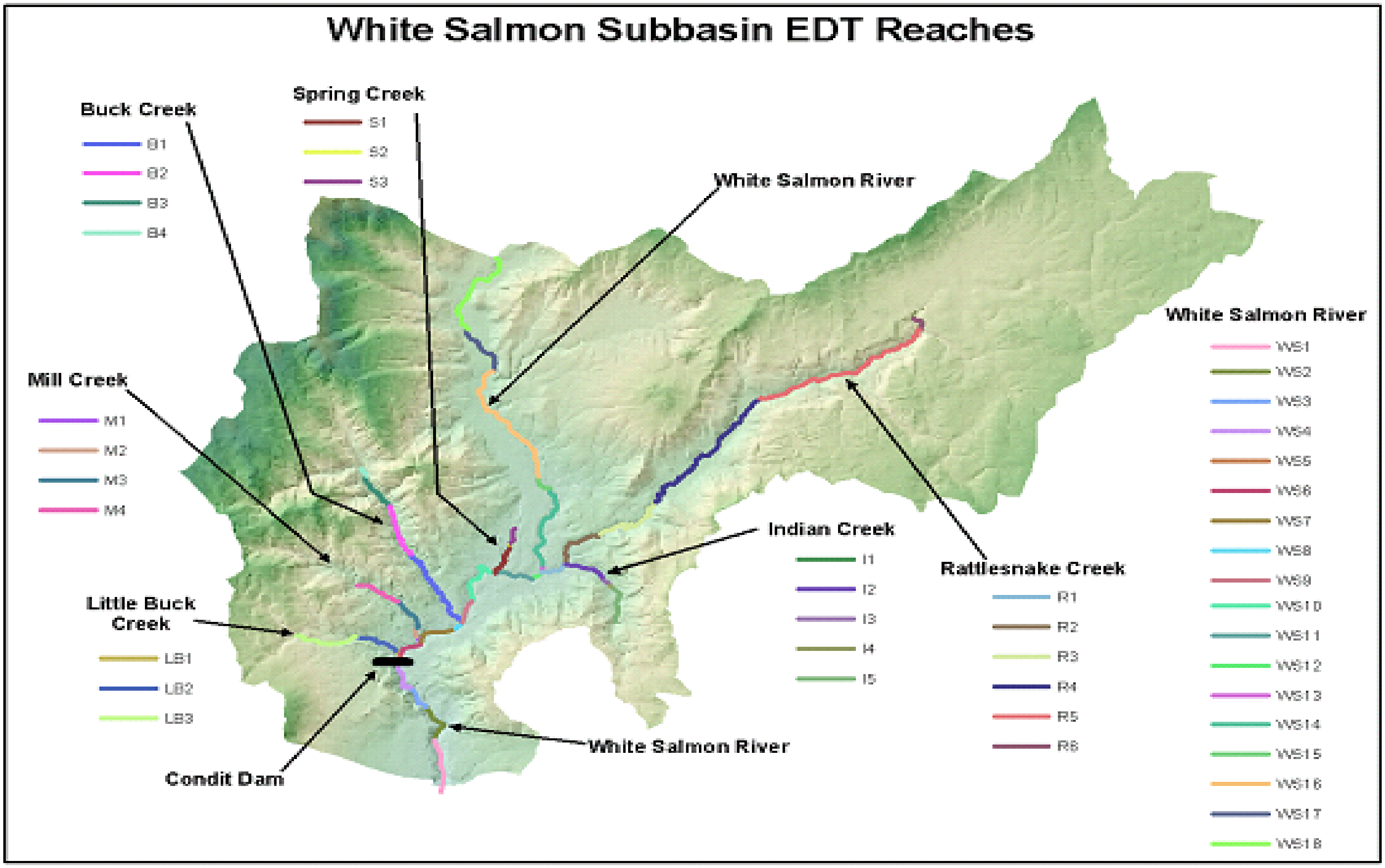

Figure 1. Location of reaches used in the White Salmon Subbasin EDT assessment.

HYDROLOGIC CHARACTERISTICS

Hydrologic Regime

Hydrologic regime – natural

Definition: The natural flow regime within the reach of interest. Flow regime typically refers to the seasonal pattern of flow over a year; here it is inferred by identification of flow sources. This applies to an unregulated river or to the pre-regulation state of a regulated river.

Rationale: These watersheds originate on the southern slope of Mt. Adams. The maximum elevation is approximately 12,307 ft, which is above the elevation of substantial snow accumulation. The higher elevations in the White Salmon exhibit a snow-melt pattern (USGS Gauge at Trout Lake). However, we rated the White Salmon from BZ Corner downstream. These elevations are consistent with rain-on-snow transitional patterns based on the USGS Underwood Gauge and are classified as such. These watersheds were given an EDT rating of 2 for the historic and current conditions. The exception to this is Spring Cr (S1 – S3), which is groundwater-source-dominated, and was given an EDT rating of 0 for the historic and current conditions.

Level of Proof: Expansion of empirical observations and derived information were used to estimate the current and historical conditions and the level of proof is thoroughly established (USGS Gauge data) or has a strong weight of evidence in support but not fully conclusive (expanded USGS data).

Hydrologic regime – regulated

Definition: The change in the natural hydrograph caused by the operation of flow regulation facilities (e.g., hydroelectric, flood storage, domestic water supply, recreation, or irrigation supply) in a watershed. Definition does not take into account daily flow fluctuations (See Flow-Intra-daily variation attribute).

Rationale: This attribute is not rated in the template condition, since there was no hydro-electric development. There is no evidence in the change of the natural hydrograph above Northwestern Reservoir. Water retention time in Northwestern Reservoir was not available. However, based on acre-feet of storage and inflow, the estimated water retention was less than 1 day. This converted to an EDT rating of 1. This rating for all reaches from the powerhouse to the mouth includes reach 1, which is also influenced by Bonneville. This rating does not apply to the bypass reach (WS3&4).

Level of Proof: Empirical observations were used to estimate the ratings for this attribute and the level of proof is thoroughly established.

Flow Variation

Flow - change in interannual variability in high flows

Definition: The extent of relative change in average peak annual discharge compared to an undisturbed watershed of comparable size, geology, orientation, topography, and geography (or as would have existed in the pristine state). Evidence of change in peak flow can be empirical where sufficiently long data series exists, can be based on indicator metrics (such as TQmean, see Konrad [2000]), or inferred from patterns corresponding to watershed development. Relative change in peak annual discharge here is based on changes in the peak annual flow expected on average once every two years (Q2yr).

Rationale: By definition the template conditions for this attribute are rated as a value of two because this describes this attribute rating for watersheds in pristine conditions. Direct measures of inter annual high flow variation are not available for most basins. USFS has conducted watershed analysis in the White Salmon (USFS 1997). Peak flow analysis was conducted using the State of Washington "Standard methodology for conducting watershed analysis". The primary data used for the peak flow analysis is vegetation condition, elevation, road network, and aspect. USFS found that peak flows had increased up to 12% in the Upper White Salmon River, Trout Lake Creek, and Cave and Bear Creeks (USFS 1997a, USFS 1997b, and USFS 1997c).

Peak flow in the White Salmon River as measured at the Underwood Gauge has increased (Figure 1). For the White Salmon a change in Q2yr was estimated according to the methods in the EDT manual. A 10% increase in peak flow was estimated for the White Salmon above the Underwood Gauge (USGS), which corresponds to an EDT rating of 2.3. Below RM 16 basin size is 675 sq miles with 195 miles of roads. This yields a road density of 3.5 mi/mi^2. USFS Watershed Analysis of similar road density suggested increase in peak flow of ~ 10%. This rating was applied to the remainder of the basin but if additional information for tributaries is available it should be used.

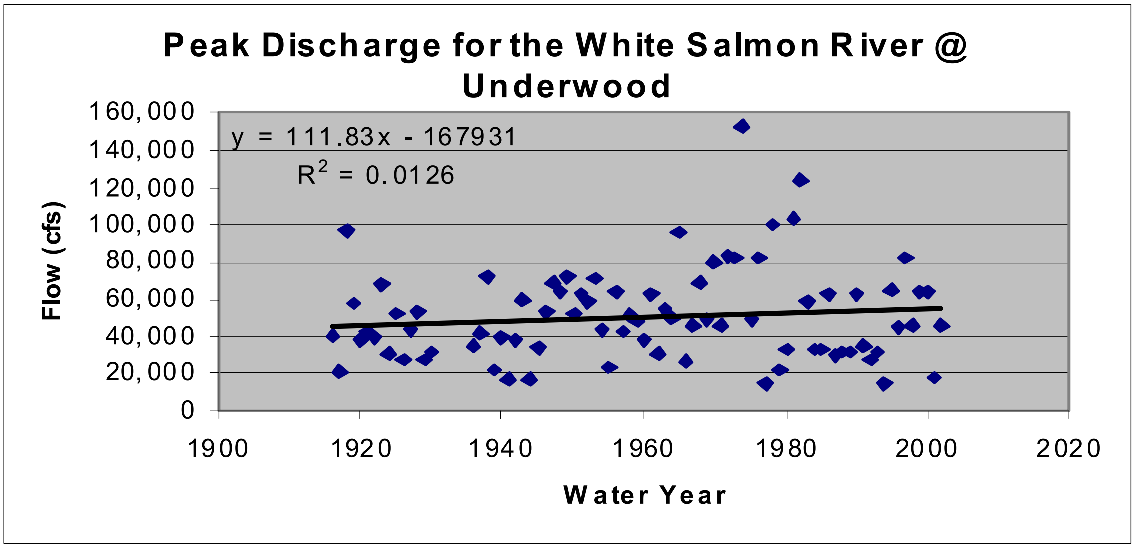

Figure 1. Peak discharge by water year in the White Salmon River measured at the Underwood Gauge by USGS.

Level of Proof: Empirical observations were used to estimate the historical ratings for this attribute and the level of proof is thoroughly established. Empirical information was used to estimate the current ratings for this attribute for the mainstem and derived information was used for the tributaries. The current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive.

Flow - changes in interannual variability in low flows

Definition: The extent of relative change in average daily flow during the normal low flow period compared to an undisturbed watershed of comparable size, geology, and flow regime (or as would have existed in the pristine state). Evidence of change in low flow can be empirically-based where sufficiently long data series exists, or known through flow regulation practices, or inferred from patterns corresponding to watershed development. Note: low flows are not systematically reduced in relation to watershed development, even in urban streams (Konrad 2000). Factors affecting low flow are often not obvious in many watersheds, except in clear cases of flow diversion and regulation.

Rationale: By definition the template conditions for this attribute are rated as a value of two because this describes this attribute rating for watersheds in pristine conditions. Research on the effects of land use practices on summer low flow is inconclusive (Spence et al. 1996). Therefore, we rated the template and current conditions the same (EDT rating of 2).

The bypass reach (WS3, WS4) has a minimum flow requirement of 15 cfs (Haring 2003 Limiting Factors Analysis). Low flow in the bypass reach is drastically reduced from the template condition. It received an EDT rating of 4.

Irrigation from the White Salmon River occurs in Trout Lake and Mt Adams Orchard withdraws water at Gilmer, Glacier, and Condit. However, the water withdrawals relative to the inflow are believed to be small. Therefore, low flow was assumed to be the same as the template condition in the mainstem White Salmon. At the top of Buck Cr (B1), an irrigation diversion diverts up to 70% of flow, which yielded an EDT rating of 4. Further upstream the water was diverted for the city of White Salmon. Young and Rybak (1987) reported that the lower water diversion removed 70% of water from Buck Creek.

A water right on Rattlesnake Cr can divert a substantial amount of flow and water may be used by landowners on Indian Creek. Based on this information we assumed slight reduction in low flow for both creeks, which is an EDT rating of 3. This analysis would benefit from obtaining the allocated and actual water withdrawals and field estimates of summer low flow to complete the low flow calculation.

Level of Proof: Empirical observations were used to estimate the historical ratings for this attribute and the level of proof is thoroughly established. Derived information was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive.

Flow – intra daily (diel) variation

Definition: Average diel variation in flow level during a season or month. This attribute is informative for rivers with hydroelectric projects or in heavily urbanized drainages where storm runoff causes rapid changes in flow.

Rationale: By definition the template conditions for this attribute are rated as a value of 0 because this describes this attribute rating for watersheds in pristine conditions. For the majority of the watershed, impervious surfaces are low, and we assumed no change in this attribute.

Below Condit, data from USGS gauge from 2-15-04 to 3-17-04 shows max hourly change of 4.3"/hr resulting in a EDT rating of 2.1. Typical Condit load factoring operations involve ramping from about 1400 cfs to approximately 800 cfs. This range of flow reduction would precipitate a concomitant stage change of 0.8 feet in Segment 2 (PacifiCorp 1994). Entrix's (1991) ramping rate evaluation page 143 suggested the change in gauge height would occur over a 1-2 hour period. This would equate to 4.8 to 9.6 inches/hour. These correspond to EDT ratings of 2.3 to 3.1. We suggest an individual monthly pattern be developed for diel variation. For this analysis, we used an EDT rating of 2.6 for reach WS2.

For WS1, Bonneville operations can cause stage fluctuations up to 4.5 feet per day, but averaging 2-3 ft/day" (PacifiCorp 1994). A 2 foot daily fluctuation if conducted in an even manner would equate to 1 inch/hour. This equates to en EDT rating of 1. We could find no information on diel variation in the bypass reach (WS3&4). We assumed diel variation was minimal in the reach and it received an EDT rating of 0.

Level of Proof: Empirical observations were used to estimate the historical ratings for this attribute and the level of proof is thoroughly established. Empirical observations were used to estimate WS1 and WS2. Derived information was used to estimate the current ratings for this attribute in the remaining reaches and the level of proof has a strong weight of evidence in support but not fully conclusive.

Flow –Intra annual flow pattern

Definition: The average extent of intra-annual flow variation during the wet season -- a measure of a stream's "flashiness" during storm runoff. Flashiness is correlated with % total impervious area and road density, but is attenuated as drainage area increases. Evidence for change can be empirically derived using flow data (e.g., using the metric TQmean, see Konrad [2000]), or inferred from patterns corresponding to watershed development.

Rationale: By definition the template conditions for this attribute are rated as a value of 2 because this describes this attribute rating for watersheds in pristine conditions. Similar to high flows, monthly and seasonal flow patterns have been affected by land use practices in this watershed. Since there was no data for this attribute, it was suggested that its rating should be similar to that for changes in inter-annual variability in high flows. (pers. com. Larry Lestelle, Mobrand, Inc).

Level of Proof: Empirical observations were used to estimate the historical ratings for this attribute and the level of proof is thoroughly established. Derived information was used to estimate the current ratings for this attribute and the level of proof has theoretical support with some evidence from experiments or observations.

STREAM CORRIDOR STRUCTURE

Stream Morphology

Channel length

Definition: Length of the primary channel contained within the stream reach -- Note: this attribute will not be given by a category but rather will be a point estimate. Length of channel is given for the main channel only--multiple channels do not add length.

Rationale: The length of each reach was provided by SSHIAP GIS layers with the exception of R6, which was applied a field length. We assumed the stream length was the same in both the historical and current conditions.

Level of Proof: Derived information (GIS) was used to estimate the current ratings for this attribute for all reaches but R6, and the level of proof has a strong weight of evidence in support but not fully conclusive especially for historical length. Empirical observations were used to estimate the current ratings for this attribute for the reach R6, and the level of proof is thoroughly established.

Channel width – month minimum width

Definition: Average width of the wetted channel. If the stream is braided or contains multiple channels, then the width would represent the sum of the wetted widths along a transect that extends across all channels. Note: Categories are not to be used for calculation of wetted surface area; categories here are used to designate relative stream size.

Rationale: We assigned the same value for both the current and historical conditions, unless a major hydromodification within the reach affects stream width. Representative reaches in the White Salmon watershed were surveyed WDFW and USGS in 2003 (WDFW unpublished). Surveys were completed during a low-flow period in December and wetted widths corresponded to average summer low flows (August) in the mainstem White Salmon, based on the USGS Underwood gauge data. Rattlesnake and Indian Creeks were surveyed intensively in 2003 during the summer months to measure average summer low flows (USGS, unpublished). Ratings for non-surveyed reaches were inferred by applying data from representative reach surveys with similar habitat, gradient and confinement, by measuring GIS aerial photos, or cited from PacifiCorp's FERC re-licensing document.

Level of Proof: A combination of empirical observations, expansion of empirical observations, and derived information was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive. For historical information we expanded empirical observations and used expert opinion and the level of proof has theoretical support with some evidence from experiments or observations.

Channel width – month maximum width

Definition: Average width of the wetted channel during peak flow month (average monthly conditions). If the stream is braided or contains multiple channels, then the width would represent the sum of the wetted widths along a transect that extends across all channels. Note: Categories are not to be used for calculation of wetted surface area; categories here are used to designate relative stream size.

Rationale: Wetted width corresponding to average high flows were not measured as part of the habitat surveys conducted. Historical reaches were assigned the same value as the current condition for all reaches, unless a major hydromodification within the reach currently affects stream width.

VanderPloeg (2003) surveyed several tributaries of the Lower Columbia and measured wetted widths during average low flows and average high flows. We compared the percent increase between low and high flow widths to the EDT (SSHIAP) confinement rating for each reach. Regression analysis demonstrated little correlation between confinement rating and percent increase in stream width. Mean increase in stream width was 60% after removing outliers for subterranean flow in the summer and Kalama questionable data. A possible explanation for this relationship is that all unconfined reaches in the dataset are downcut due to lack of large woody debris and hydroconfinement. If maximum wetted width exceeded bankfull width using the multiplier it was capped at bankfull. For streams that have very low summer flows due to natural or manmade dewater, a 1.6 multiplier may under estimate stream widths. In confined reaches, a 1.2 multiplier was used based on review of some confined reaches in the dataset.

Level of Proof: A combination of empirical observations, expansion of empirical observations, derived information, and expert opinion was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but is not fully conclusive. For historical information, we expanded current empirical observations and the level of proof has theoretical support with some evidence from experiments or observations.

Gradient

Definition: Average gradient of the main channel of the reach over its entire length. Note: Categorical levels are shown here but values are required to be input as point estimates for each reach.

Rationale: The average gradient for each stream reach (expressed as % gradient) was calculated by dividing the change in reach elevation by the reach length and multiplying by 100. SSHIAP GIS segments layer (WDFW 2003) was used to provide the beginning elevation, ending elevation, and length for each EDT reach.

Average reach gradient was generated from SSHIAP GIS segments layer (WDFW 2003), by dividing the change in reach elevation by reach length. Reaches within Northwestern Lake (LB1, M1, and WS5-7) given 0.1% gradient for current conditions. M2 was visually estimated to be 3% in the field, which is considerably less than SSHIAP segments layer estimate. USGS surveyed Rattlesnake 1-6 and Indian 2 and 5, and the field-measured gradients were applied (USGS unpublished).

Historic gradient for the lake was generated by using GIS provided elevations below Condit Dam and at the top of the lake. The difference in elevation was then divided by the total length from below Condit to top of the lake. Elevations for historical mouths of Mill and Little Buck creeks were obtained by multiplying the calculated historical gradient by the length of each reach. Historical gradients for these two reaches were then calculated using GIS provided reach lengths and derived historical elevations. For the remaining reaches, historical gradient was assumed to be the same as current.

Level of Proof: Empirical information was used for the field measured reaches (R1-R6, I2, I5) and derived information (GIS) was used to estimate the current and historical ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive especially for historical length. Professional opinion was used for the current rating for M2 and the level of proof has a strong weight of evidence in support but not fully conclusive.

Confinement

Confinement – natural

Definition: The extent that the valley floodplain of the reach is confined by natural features. It is determined as the ratio between the width of the valley floodplain and the bankfull channel width. Note: this attribute addresses the natural (pristine) state of valley confinement only.

Rationale: Representative reaches in the White Salmon watershed were surveyed by WDFW/USGS in 2003. Confinement ratings were estimated during these surveys (WDFW unpublished). In addition, SSHIAP confinement ratings for the watersheds were consulted. Field surveys noted discrepancies between GIS and field ratings. DNR DEMs (WDFW 2003) were consulted when SSHIAP ratings fell between the 0.5 increments to determine which rating should be applied. In turn, EDT confinement ratings were developed by converting SSHIAP ratings of 1-3 to EDT ratings of 0-4:

SSHIAP	1	1.5	2	2.5	3
EDT	0	1	2	3	4

There is likely to be multiple SSHIAP segments per EDT segment, where the average SSHIAP confinement rating is calculated, then converted into EDT ratings.

Level of Proof: Derived information (GIS) was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive.

Confinement – hydromodifications

Definition: The extent that man-made structures within or adjacent to the stream channel constrict flow (as at bridges) or restrict flow access to the stream's floodplain (due to streamside roads, revetments, diking or levees) or the extent that the channel has been ditched or channelized, or has undergone significant streambed degradation due to channel incision/entrenchment (associated with the process called "headcutting"). Flow access to the floodplain can be partially or wholly cutoff due to channel incision. Note: Setback levees are to be treated differently than narrow-channel or riverfront levees--consider the extent of the setback and its effect on flow and bed dynamics and micro-habitat features along the stream margin in reach to arrive at rating conclusion. Reference condition for this attribute is the natural, undeveloped state.

Rationale: In the historic condition (prior to manmade structures) reaches were fully connected to the floodplain. By definition the template conditions for this attribute are rated as a value of 0 because this describes this attribute rating for watersheds in pristine conditions. Most hydro-modification consists of roads in the floodplain and diking. We consulted the SSHIAP GIS roads layer (WDFW 2003), DNR digital ortho-photos (WDFW 2003), USGS maps, and WRIA 29 LFA (Haring 2003) and used professional judgment to assign EDT ratings.

Hydroconfinement occurs at the SR-14 bridge (WS1), the fish-rearing raceways (WS2), houses on the mainstem above Buck Creek (WS9), road and houses below the confluence with Rattlesnake Creek (WS12), & a house and an old diversion near the Bend Hole (WS14). These reaches all received EDT ratings of 1. Hydroconfinement occurs on R1 due to road encroachment and downcutting. This reach received an EDT rating of 3. Hydroconfinement occurs at: B1 due to road and diking, B2 due to spotty road rip rap and I2-5, R4, and S1 due to downcutting. These reaches all receive EDT ratings of 1.

Level of Proof: A combination of empirical observations, expansion of empirical observations, and expert opinion was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive.

Habitat Type

Habitat Types

Definition:

Backwater pools is the percentage of the wetted channel surface area comprising backwater pools.

Beaver ponds is the percentage of the wetted channel surface area comprising beaver ponds. Note: these are pools located in the main or side channels, not part of off-channel habitat.

Primary pools is the percentage of the wetted channel surface area comprising pools, excluding beaver ponds.

Pool tailouts are the percentage of the wetted channel surface area comprising pool tailouts.

Large cobble/boulder riffles is the percentage of the wetted channel surface area comprising large cobble/boulder riffles.

Small cobble/gravel riffles is the percentage of the wetted channel surface area comprising small cobble/gravel riffles. Particle sizes of substrate modified from Platts et al. (1983) based on information in Gordon et al. (1992): gravel (0.2 to 2.9 inch diameter), small cobble (2.9 to 5 inch diameter), large cobble (5 to 11.9 inch diameter), boulder (>11.9 inch diameter).

Glides is the percentage of the wetted channel surface area comprising glides. Note: There is a general lack of consensus regarding the definition of glides (Hawkins et al. 1993), despite a commonly held view that it remains important to recognize a habitat type that is intermediate between pool and riffle. The definition applied here is from the ODFW habitat survey manual

(Moore et al. 1997): an area with generally uniform depth and flow with no surface turbulence, generally in reaches of <1% gradient. Glides may have some small scour areas but are distinguished from pools by their overall homogeneity and lack of structure. They are generally deeper than riffles with few major flow obstructions and low habitat complexity.

Rationale: B1, B2, M2, S1, WS8-16 were surveyed by WDFW/USGS in 2003 (WDFW unpublished). R1-6, I2 and I5 have been extensively surveyed by USGS (unpublished). Habitat type composition was measured or estimated during these surveys. Ratings for non-surveyed reaches were inferred by applying data from representative reach surveys or averages of representative reach surveys with similar habitat, gradient and confinement. Comments are provided in the stream reach editor.

In WS1-4, in 1991, ENTRIX performed a Physical Ramping Study and provided maps of their results. Habitat types were measured in WS2-4 and the percentages were provided in the report. The construction of Bonneville Dam inundated portions of the lower White Salmon River corresponding to EDT reach WS1. Based on field observation the estimated habitat in this reach is 78% pool, 20% glide and 2% small gravel riffle.

S2, WS5-7, M1 and LB1 are reservoirs. These reach is rated at 50% primary pool and 50% dammed pool for the current condition. Table 2 illustrates ratings inferred from surveyed reaches.

Unsurveyed Reach(es)	**Inferred reach data**
WS17 & 18	WS16
S3	S1
B3	B1
B4	B2
M3 & 4	Average of M2, B1, B2 and S1
I1, 3 & 4	Average of I2 and I5
LB2 & 3	Average of B1 and B2

Table 2. Habitat type inferences for the White Salmon Subbasin EDT model.

Habitat simplification has resulted from timber harvest activities. These activities have decreased the number and quality of pools. Reduction in wood and hydromodifications are believed to be the primary causes for reduction in primary pools. Historic habitat type composition was estimated by examining percent change in large pool frequency data (Sedell and Everest 1991 - Forest Ecosystem Management July 1992, page V-23), and applying this to current habitat type composition estimates. On Germany Creek, the Elochoman River and the Grays River the frequency of large pools between 1935 and 1992 has decreased by 44%, 84%, and 69%, respectively. However, the frequency of large pools increased on the Wind River, but this is likely due to different survey times. The original surveys were conducted in November and the 1992 surveys were conducted during the summer, when flows are lower and pools more abundant.

In general, we assumed for historical conditions that the percentage of pools was slightly higher than the current percentage in the mainstem and significantly higher in the tributaries. This assumption was based on observations that geology (bedrock canyon) in the mainstem is the dominant characteristic in the forming and maintenance of pools in the mainstem. Therefore in the mainstem primary pools and gravel riffles increased due to increase wood.

In the tributaries wood played a larger role in pool forming process. In the tributaries for gradients less than 2%, historical pool habitat was estimated to be 50%, which is similar to pool frequency for good habitat (Petersen et al. 1992). For habitats with gradients 2-5% and greater than 5%, we estimated pool habitat to be 40% and 30%, respectively (DNR 1994). We assumed that tailouts represent 15-20% of pool habitat, which is the current range from WDFW surveys. Glide habitat decreased as gradient increased (Mobrand 2002). Habitat surveys on the Washougal River demonstrated a strong relationship between gradient and glides and this regression was used to estimate glide habitat, which ranged from 25% at gradients less than 0.5% to 6% for gradients greater then 3%. Riffle habitat was estimated by subtracting the percentage of pool, tailout, and glide habitat from 100%. This yielded a relationship where the percentage of riffle habitat increased with gradient. WDFW field data indicated the percentage of gravel riffle habitat decreased with stream gradient, and cobble/boulder riffle habitat increased with stream gradient; the percentage of gravel riffles compared to the total riffle habitat ranged from over 60% at gradients of less than 1% to 15% at gradients greater than 6%. WDFW surveys indicated backwater and dammed habitat increased as gradient decreased. For historical ratings, unconfined low gradient reaches were assumed to have some of these habitat types, and expert opinion was used to assign ratings.

Level of Proof: A combination of empirical observations, expansion of empirical observations, and expert opinion was used to estimate the current ratings for this attribute. Stream surveys allowed accurate classification of fast water (riffles) and slow water (pools and glides) habitat. However, there was likely inconsistency in distinguishing pools from glides and this is likely to affect coho production due to this species' extended freshwater rearing and preference for pools. The level of proof for current ratings has a strong weight of evidence in support but not fully conclusive. For historical information we assumed pool habitats were in the "good" range and the level of proof has theoretical support with some evidence from experiments or observations.

Habitat types – off-channel habitat factor

Definition: A multiplier used to estimate the amount of off-channel habitat based on the wetted surface area of the all combined in-channel habitat.

Rationale: When rivers are unconfined they tend to meander across their floodplains forming wetlands, marshes, and ponds. These are considered off-channel habitat. Confined and moderately confined reaches (Rosgen Aa+, A , B and F channels) typically have little or no off-channel habitat. Off-channel habitat increases in unconfined reaches (Rosgen C and E channels). Norman et al. (1998) indicated the potential for abundant off-channel habitat in the lower East Fork Lewis. An EDT rating of 0 was assigned to Aa+ and A channels, a rating of 0 to 1 for B channels, while low gradient C channels were assigned EDT ratings of 1 to 2 for the current rating and 2 to 3 for the historical rating. Off-channel habitat is not significant in the White

Salmon River, with the exception of the inundated reach. Old photographs suggested that limited off-channel habitat was historically present.

Level of Proof: A combination of empirical observations, expansion of empirical observations, and expert opinion was used to estimate the current ratings for this attribute. Stream surveys allowed accurate classification of fast water (riffles) and slow water (pools and glides) habitat. However, there was likely inconsistency in distinguishing pools from glides and this is likely to affect coho production due to this species' extended freshwater rearing and preference for pools. The level of proof for current ratings has a strong weight of evidence in support but not fully conclusive. For historical information we expanded empirical observations and used expert opinion and the level of proof has theoretical support with some evidence from experiments or observations.

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Level of Proof: A combination of empirical observations, expansion of empirical observations, and expert opinion was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive. For historical information we expanded empirical observations and used expert opinion and the level of proof has theoretical support with some evidence from experiments or observations.

Obstructions

Obstructions to fish migration

Definition: Obstructions to fish passage by physical barriers (not dewatered channels or hindrances to migration caused by pollutants or lack of oxygen).

Rationale: Falls and culverts were identified based on local knowledge and SHHIAP data. Due to time constraints, all falls and culverts were assumed to have 100% passage. Exceptions to this are Sdam and Condit_Dam, which were rated as 0% passage. Finalizing passage ratings would allow culvert analysis.

Level of Proof: A combination of empirical observations, and expansion of empirical observations, and expert opinion was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive.

Water withdrawals

Definition: The number and relative size of water withdrawals in the stream reach.

Rationale: No water withdrawals occurred in the pristine condition.

There is only one large withdrawal on the mainstem White Salmon, and that is Condit Dam (above WS4). A large proportion of the total flow is sent through an unscreened diversion into turbines. WS4 received an EDT rating of 3.

Several small irrigation pumps in WS 14, 15 and 16, appear screened; entrainment probability considered low and these reaches received EDT ratings of 1. There is an unscreened irrigation withdrawal at the top of B1, where up to 70% of flow is claimed. Young and Rybak reported that the lower water diversion removed 70% of water from Buck Creek (1987), which is one of the largest anadromous tributaries in the basin. B1 received an EDT rating of 3.

An unscreened withdrawal in Spring Creek at the top of S1, which appears to empty into a plunge pool directly below the dam, diverts all flow. S1 received an EDT rating of 1. There are only three recorded water rights for the Rattlesnake Creek area. Two of which are groundwater and one is a surface water right for 166 acre/feet/yr in EDT segment R5 of Rattlesnake creek (WPN 2003). It is an unscreened irrigation withdrawal and the water right exceeds low summer flow. R5 received an EDT rating of 2. All other reaches were rated at 0

Level of Proof: A combination of empirical observations, expansion of empirical observations, and expert opinion was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive. For historical information, empirical observations were used to estimate the ratings for this attribute and the level of proof is thoroughly established.

Riparian and channel integrity

Bed Scour

Definition: Average depth of bed scour in salmonid spawning areas (i.e., in pool-tailouts and small cobble-gravel riffles) during the annual peak flow event over approximately a 10-year period. The range of annual scour depth over the period could vary substantially. Particle sizes of substrate modified from Platts et al. (1983) based on information in Gordon et al. (1992): gravel

(0.2 to 2.9 inch diameter), small cobble (2.9 to 5 inch diameter), large cobble (5 to 11.9 inch diameter), boulder (>11.9 inch diameter).

Rationale: No bed scour data was available for this subbasin. Historic bed scour ratings were determined by applying gradient, confinement, and wetted width-high ratings to a bed scour look up table developed by Dan Rawding (WDFW unpublished). Current bed scour ratings were increased by 5% for every 0.1 increase in EDT peak flow rating and 5% for each 1.0 increase in EDT hydroconfinement rating.

The exception to this is the ground water reaches of Spring Creek, which receive a rating of 1. In reaches inundated by Northwestern Lake, scour was rated as 0. In WS1, where scour was likely decreased due to inundation from Bonneville pool, ratings were reduced to 50% of current. WS3 & 4 are in the by-pass reach and bed scour was reduced by 50% from historic due to decreased flows. There was some contention about bed scour in the reach above the deep reservoir of Northwestern Lake (WS8). For this reach, bed scour was not increased for peak flow, and confinement ratings were reduced for use with the look-up table and the bed-scour rating remained the same at an EDT value of 2.0.

Level of Proof: Expert opinion was used to estimate the current and historical ratings for this attribute and the level of proof has theoretical support with some evidence from experiments or observations.

Icing

Definition: Average extent (magnitude and frequency) of icing events over a 10-year period. Icing events can have severe effects on the biota and the physical structure of the stream in the short-term. It is recognized that icing events can under some conditions have long-term beneficial effects to habitat structure.

Rationale: These watersheds are rain-on-snow dominated. Anchor ice and icing events are likely to be rare based on elevations. EDT ratings of 0 were assigned to all reaches in the historical and current condition.

Level of Proof: Derived information was used to estimate the ratings for this attribute and the level of proof is theoretical with some evidence of support. The most uncertainty for this attribute is the upper elevations of tributaries.

Riparian

Definition: A measure of riparian function that has been altered within the reach.

Rationale: By definition the template conditions for this attribute are rated as a value of zero because this describes this attribute rating for watersheds in pristine conditions. The following rules were developed for use with EDT analysis in the Lower Columbia. These rules were used as guidelines in rating the White Salmon subbasin for riparian function in EDT.

Riparian zones with mature conifers are rated at 0.0 - 1.0 depending on floodplain connectivity. Riparian zones with saplings and deciduous trees are rated at 1.5 due to loss of shade and bank stability. Riparian zones with brush and few trees would be rated as 2.0. For an EDT rating to exceed 2.0, residential developments or roads need to be in the riparian zone. Therefore, for current conditions, as long as the riparian area has trees, it should have a score of 2.0 or better.

Most vegetated riparian zones with no hydro-confinement should be rated as a 1.0 - 1.5. When hydro-confinement exists start rating from rules on % hydro-confinement and increase rating based on lack of vegetation. Key reaches were established for current riparian function through out the watershed. Other reaches were referenced to these key reaches to develop a final EDT rating. Reservoir riparian habitat has very much changed from the historical condition but still very functional.

Level of Proof: There is no statistical formula used to estimate riparian function. Therefore, expert opinion was used to estimate the current and historical ratings for this attribute and the level of proof has theoretical support with some evidence from experiments or observations.

Wood

Definition: The amount of wood (large woody debris or LWD) within the reach. Dimensions of what constitutes LWD are defined here as pieces >0.1 m diameter and >2 m in length. Numbers and volumes of LWD corresponding to index levels are based on Peterson et al. (1992), May et al. (1997), Hyatt and Naiman (2001), and Collins et al. (2002). Note: channel widths here refer to average wetted width during the high flow month (< bank full), consistent with the metric used to define high flow channel width. Ranges for index values are based on LWD pieces/CW and presence of jams (on larger channels). Reference to "large" pieces in index values uses the standard TFW definition as those > 50 cm diameter at midpoint.

Rationale: Density of LWD equals pieces/length * width. Template condition for wood is assumed to be 0 for all reaches except the large canyon sections on the White Salmon, which are assumed to be 2 because these confined reaches would have difficulty accumulating large amounts of wood. Template conditions for Rattlesnake and Indian Creeks were assumed to be 2 due to eastside climate and vegetation. To determine current EDT ratings we used survey data listed below. USGS surveyed all wood pieces measured to be >10 cm diameter and 2 m length counted within bankfull width in 20 meter increments for all of Indian Creek's I2 and I5 and Rattlesnake Creek's R1-R6. USGS and WDFW (unpublished) counted wood pieces visually estimated to be >10 cm diameter and 2 m length within the wetted width (12-18-03) in reaches WS16-8. USGS and WDFW (unpublished) counted wood pieces visually estimated to be >10 cm diameter and 2 m length within the wetted width (12-23-03) while surveying representative length of reaches B1, B2, M1, M2, S1, and S2.

For 'west-side' tributary reaches lacking data (B3&4, M3&4, and LB1-3), we used the average rating from Spring, Buck, and Mill Creeks which was 2.8. For 'east-side' tributary reaches lacking data (I1,3 & 4), we used the average rating from Rattlesnake and Indian Creeks which was 3.1. For mainstem reaches lacking data, we used average rating for mainstem reaches surveyed (3.8). Since there are no reservoir rules, Northwestern Lake was rated at 2 due to aquatic vegetation and submerged wood, and S2 was rated at 3 for aquatic vegetation.

Level of Proof: A combination of empirical observations, expansion of empirical observations, and expert opinion was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive. For historical information, derived information was used to estimate the ratings for this attribute and the level of proof is thoroughly established.

Sediment Type

Fine Sediment (intragravel)

Definition: Percentage of fine sediment within salmonid spawning substrates, located in pool-tailouts, glides, and small cobble-gravel riffles. Definition of "fine sediment" here depends on the particle size of primary concern in the watershed of interest. In areas where sand size particles are not of major interest, as they are in the Idaho Batholith, the effect of fine sediment on egg to fry survival is primarily associated with particles <1mm (e.g., as measured by particles <0.85 mm). Sand size particles (e.g., <6 mm) can be the principal concern when excessive accumulations occur in the upper stratum of the stream bed (Kondolf 2000). See guidelines on possible benefits accrued due to gravel cleaning by spawning salmonids.

Rationale: In the template (pristine) condition, SW Washington watersheds were assumed to have been 6%-11% fines (Peterson et. al. 1992) which corresponds to an EDT rating of 1. Rawding (WDFW unpublished) found as road densities increased by 1 mile per square mile, the % fine sediment in spawning gravels increased by 1.3% in the Wind River. To rate % fines in the current condition, a scale was developed relating road density to % fines. Individual sub-watershed polygons were created to obtain the following sub-watershed road densities and EDT Ratings:

Sub-Watershed	**Road Density mi/mi^2**	**EDT Rating**
Indian	3.27	1.8
Little Buck	4.60	2
Mill	4.31	2
Buck	5.05	2
Spring	3.28	1.8
Rattlesnake	3.54	1.8
White Salmon above Condit	3.25	1.8

Table 3. Estimates of percentage of fines in the White Salmon River from the road density model.

Exceptions to this rule were: fines were increased in S1 due to visual survey from 1.8 to 2, fines below Condit Dam (WS2, 3, & 4) remained at the template condition based on sampling below the Merwin project that indicated fines dropped out in the reservoir.   Reservoir and inundated tributaries had rating of 4.

Level of Proof: Expert opinion was used to estimate the historical ratings for this attribute and the level of proof has theoretical support with some evidence from experiments or observations. Derived information was used to estimate the current ratings for this attribute and the level of proof has theoretical support with some evidence from experiments or observations

Embeddedness

Definition: The extent that larger cobbles or gravel are surrounded by or covered by fine sediment, such as sands, silts, and clays. Embeddedness is determined by examining the extent (as an average %) that cobble and gravel particles on the substrate surface are buried by fine sediments. This attribute only applies to riffle and tailout habitat units and only where cobble or gravel substrates occur.

Rationale: Peterson et al. (1992) estimated fines to be 6% to 11% in the template (pristine) condition, which is an EDT rating of 1. Under these same conditions we assumed embeddedness was less than 10%, which corresponds to an EDT rating of 0.5.
Rawding (WDFW unpublished) found as road densities increased by 1 mile per square mile, the % fine sediment in spawning gravels increased by 1.3% in the Wind River. To rate % fines in the current condition, a scale was developed relating road density to % fines. Using fines as a surrogate for embeddedness, EDT ratings were developed. Individual sub-watershed polygons were created to obtain the following sub-watershed road densities and EDT Ratings:

Sub-Watershed	**Road Density mi/mi^2**	**EDT Rating**
Indian	3.27	0.7
Little Buck	4.60	0.8
Mill	4.31	0.8
Buck	5.05	0.8
Spring	3.28	0.7
Rattlesnake	3.54	0.7
WS above Condit	3.25	0.7

Table 4. Estimates of percentage of fines in the White Salmon River from the road density model.

Exceptions to this rule were: fines were increased in S1 due to visual survey from 0.7 to 0.9, fines below Condit Dam (WS-2, 3, &4) remained at the template condition based on sampling below Merwin project that indicated fines dropped out in the reservoir, and reservoir and inundates tribs had ratings of 0.

Level of Proof: A combination of derived information and expert opinion was used to estimate the current and historical ratings for this attribute and the level of proof has theoretical support with some evidence from experiments or observations.

Turbidity (suspended sediment)

Definition: The severity of suspended sediment (SS) episodes within the stream reach. (Note: this attribute, which was originally called turbidity and still retains that name for continuity, is more correctly thought of as SS, which affects turbidity.) SS is sometimes characterized using turbidity but is more accurately described through suspended solids; hence the latter is to be used in rating this attribute. Turbidity is an optical property of water where suspended, including very fine particles such as clays and colloids, and some dissolved materials cause light to be scattered; it is expressed typically in nephelometric turbidity units (NTU). Suspended solids represents the actual measure of mineral and organic particles transported in the water column, either expressed as total suspended solids (TSS) or suspended sediment concentration (SSC)—both as mg/l. Technically, turbidity is not SS but the two are usually well correlated. If only NTUs are available, an approximation of SS can be obtained through relationships that correlate the two. The metric applied here is the Scale of Severity (SEV) Index taken from Newcombe and Jensen (1996), derived from: $SEV = a + b(\ln X) + c(\ln Y)$, where, X = duration in hours, Y = mg/l, $a = 1.0642$, $b = 0.6068$, and $c = 0.7384$. Duration is the number of hours out of month (with highest SS typically) when that concentration or higher normally occurs. Concentration would be represented by grab samples reported by USGS. See rating guidelines.

Rationale: Suspended sediment levels in the template (pristine) condition were assumed to be at low levels, even during high flow events. An EDT rating of 0, 0.3, and 0.5 were assigned to all small tributaries, medium tributaries, and mainstem reaches.

Turbidity (mg/L) from water quality monitoring was 35, 25, and 90 mg/L for White Salmon, Gilmer, and Rattlesnake. Since these were grab samples, the duration of values is unknown. Using SEV index assuming short duration (1-24 hours), these values yield EDT ratings of 0.4-0.9, 0.3-0.8, and 0.7-1.1, respectively. For current conditions mainstem reaches were rated as 0.7 and smaller tributaries 0.3. However, these should be re-visited in light of unknown duration.

Level of Proof: A combination of derived information and expert opinion was used to estimate the current and historical ratings for this attribute and the level of proof has theoretical support with some evidence from experiments or observations

WATER QUALITY

Temperature variation

Temperature – daily maximum (by month)

Definition: Maximum water temperatures within the stream reach during a month.

Rationale: The Underwood Conservation District, U. S. Geological Survey and Yakama Nation placed temperature loggers in various locations within the White Salmon River watershed during the summers of 1995-1999 and continuously all year in 2000-2003 (UCD, USGS, YN, unpublished data). Mainstem reaches with thermographs are: WS1, WS2, WS11, and above WS18. Tributary reaches with thermographs are: R1, R2, R3, R4, R5, I2, B1, and B2. This data was entered into the EDT temperature calculator provided by Mobrand, Inc. to produce EDT ratings for July and August. To develop maximum temperature ratings for the remaining months, we used the template monthly pattern “Temperature maximum pattern in Rain-on-Snow transitional stream” for Little Buck, Mill, Buck, Rattlesnake, and Indian creeks. The template monthly pattern of “Temperature maximum pattern in groundwater dominated stream” was used for Spring Creek, and “Temperature maximum pattern in glacial melt dominated system” was used for the mainstem White Salmon River.

The EDT ratings generated by the temperature calculator were used for reaches with a temperature logger present, and ratings for other reaches were inferred/extrapolated from these based on proximity and similar gradient, habitat, and confinement. If temperature loggers were mid-reach we used the reading for the entire reach. If temperature loggers were at the end of the reach and evidence from other temperature loggers above indicated there was cooling within the reach (as you move upstream), professional judgment was used to develop an average for the reach. The same logic was applied to reaches without temperature loggers located between reaches with temperature loggers – ratings from reaches with temperature loggers were “feathered” for reaches in between. Readings from loggers at the end of a reach were used to estimate the rating for the reaches downstream.

Specifically we used the following expansions. Reaches B3&4, LB2, and M2-3 were assumed equal to B2. LB3, and M4 were decreased 0.1 based on increased elevation and distance upstream. Reaches LB1, M1, WS3-8 were assumed equal to WS2. Reaches S1-3, WS9-18 were assumed equal to WS11. Reaches I2-4 were assumed to be equal to I1 and I-5 was rated 0.1 lower due to increased elevation and distance upstream from thermograph.

The Regional Ecosystem Assessment Project estimated the range of historical maximum daily stream temperatures for the Lewis at 15-19 C, the Hood/Wind at 7-20 C (USFS 1993). However, this broad range was not very informative for historical individual reach scale temperatures.

Historical temperatures are unknown the in the Wind River subbasin. The Regional Ecosystem Assessment Project estimated the range of historical maximum daily stream temperatures for the Hood/Wind at 7-20 degrees C (USFS 1993). However, this broad range was not very informative for historical individual reach scale temperatures. The only historical temperature data that we located were temperatures recorded in the 1930’s and 40’s while biologists inventoried salmon abundance and distribution (WDF 1951). Since this data consisted of spot measurements and many basins had been altered by human activity, it was not useful in estimating maximum water temperatures. Stream temperature generally tends to increase in the downstream direction from headwaters to the lowlands because air temperature tends to increase with decreasing elevation, groundwater flow compared to river volume decreases with elevation, and the stream channel widens decreasing the effect of riparian shade as elevation decreases (Sullivan et al. 1990).

To estimate historical maximum temperature, human activities that effect thermal energy transfer to the stream were examined. Six primary process transfer energy to streams and rivers: 1) solar radiation, 2) radiation exchange with the vegetation, 3) convection with the air, 4) evaporation, 5) conduction to the soil, and 6) advection from incoming sources (Sullivan et al. 1990). The four primary environmental variables that regulate heat input and output are: riparian canopy, stream depth, local air temperature, and ground water inflow. Historical riparian conditions along most stream environments in the Lower Columbia River domain consisted of old growth forests. Currently most riparian areas are dominated by immature forest in the lower portions of many rivers. Trees in the riparian zone have been removed for agriculture, and residential or industrial development (Wade 2002). Therefore, on average historical maximum temperatures should be lower than current temperatures.

A temperature model developed by Sullivan et al (1990) assumed there is a relationship between elevation, percentage of shade and the maximum daily stream temperature. This model was further described in the water quality appendix of the current Washington State watershed analysis manual (WFPB 1997). Elevation of stream reaches is estimated from USGS maps. The sky view percentage is the fraction of the total hemispherical view from the center of the stream channel. To estimate the sky view we used the estimated maximum width and assumed that trees in the riparian zone were present an average of 5 meters back from the maximum wetted width. Next we assumed that the riparian zone would consist of old growth cedar, hemlock, Douglas Fir, and Sitka spruce. Mature heights of these trees are estimated to be between 40 – 50 meters for cedar and 60 - 80 meters for Douglas fir (Pojar and MacKinnon 1994). For modeling, we used 49 meters as the average riparian tree height within the western hemlock zone and a canopy density of 85% was assumed (Pelletier 2002). The combination of the height of the bank and average effective tree height was approximately 40 meters for old growth reaches. A relationship was developed between forest shade angle and bankfull width. To estimate the percentage of shade, we used the relationship between forest angle and percentage of shade (WFPB 1997 Appendix G-33.). Finally we used the relationship between elevation, percentage of shade and the maximum daily stream temperature to estimate the maximum temperature (Sullivan et al. 1990, page 204 Figure 7.9). This information was used to establish the base for maximum historical water temperature. These were converted to EDT ratings based on a regression of EDT ratings to maximum temperatures. The model assumed western Washington canopy densities, which could be adjusted for Eastern Washington vegetation (Rattlesnake and Indian Creek).

The percentage shade from old growth forests in Oregon was estimated to be 84% (Summers 1983) and 80% to 90% in western Washington (Brazier and Brown 1973). For small streams our estimates of stream shade were similar. In comparison to Pelletier (2002), our historical temperatures were slightly lower in small tributaries and slightly higher in the lower mainstem reaches. We developed a correction factor for small tributaries, which consisted of adding 0.3 to the estimated historical EDT rating. These differences are not unexpected, since our simplistic temperature model used only elevation/air temperature and shade, while Pelletier (2002) used QUAL2K which includes other parameters. We recommend more sophisticated temperature models be used in future analysis because they more accurately estimate temperatures. However, due to limited resources available for this study, the shade/elevation model was used for consistency throughout the Lower Columbia River. Historical maximum stream temperature data was limited in the White Salmon River. Stream temperature generally tends to increase in the downstream direction from headwaters to the lowlands because air temperature tends to increase with decreasing elevation, groundwater flow compared to river volume decreases with elevation, and the stream channel widens decreasing the effect of riparian shade as elevation decreases (Sullivan et al. 1990).

To estimate maximum temperature we had to look at the effect of human activities that effect thermal energy transfer to the stream. Six primary process transfer energy to streams and rivers: 1) solar radiation, 2) radiation exchange with the vegetation, 3) convection with the air, 4) evaporation, 5) conduction to the soil, and 6) advection from incoming sources (Sullivan et al. 1990). The four primary environmental variables that regulate heat input and output are: riparian canopy, stream depth, local air temperature, and ground water inflow. Historical riparian conditions along most stream environments in the White Salmon River consisted of old growth forests. Currently most riparian areas are dominated by immature forest in the lower portions of many rivers. Trees in the riparian zone have been removed for agriculture, and residential or industrial development (Herring 2003). Therefore, on average historical maximum temperatures should be lower than current temperatures.

Level of Proof: A combination of derived information and expert opinion was used to estimate the historical ratings for this attribute and the level of proof has theoretical support with some evidence from experiments or observations. A combination of empirical observations, expansion of empirical observations, and expert opinion was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive.

Temperature – daily minimum (by month)

Definition: Minimum water temperatures within the stream reach during a month.

Rationale: The Underwood Conservation District, U. S. Geological Survey and Yakama Nation placed temperature loggers in various locations within the White Salmon River watershed during the summers of 1995-1999 and year round in 2000-2003 (UCD, USGS, YN, unpublished data). Mainstem reaches with thermographs are: WS1, WS2, WS11, and above WS18. Tributary reaches with thermographs are: R1, R2, R3, R4, R5, I2, B1, and B2. Thermograph data was consolidated to number of days below 4 C and 1 C by month. It was then entered into an Excel spreadsheet provided by Chris Fredrickson of the Yakama Nation (Chris Fredrickson unpublished), which generates EDT ratings and monthly patterns.

As with daily maximum temperatures, ratings were expanded into adjacent and similar reaches. Spring Creek has no thermograph data and significant groundwater input. Therefore temperatures were assumed not to exceed EDT standards. WS2 rating was expanded to WS 3, and WS4. WS11 ratings expanded from WS 5 to WS18. B1 and B2 (1.6) expanded to the remaining Buck Creek reaches, as well as Mill, and Little Buck Creeks. R5 expanded to R6. I2 was expanded to remaining Indian Creek reaches. Historic ratings were assumed to be the same as current ratings.

Level of Proof: A combination of empirical observations, expansion of empirical observations, and expert opinion was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive. Expert opinion was used to estimate historic ratings.

Temperature – spatial variation

Definition: The extent of water temperature variation within the reach as influenced by inputs of groundwater.

Rationale: Historically there was likely significant groundwater input in low gradient, unconfined to moderately confined reaches of the White Salmon tributary watersheds. Higher gradient reaches of the tributaries higher in the watershed likely had less groundwater input. We found limited data on the current or historical conditions for ground water input. In the current condition, groundwater input in low gradient, unconfined to moderately confined reaches low in the watershed has likely been reduced by current land use practices. The removal of wood from the mainstem and tributaries has reduced pool depths that may have provided coldwater refugia.

Specific reach rational for ratings is presented below. Instream flow analysis show no flow accretion below Condit Dam (PacifiCorp 1994). Diversion of the majority of flow in the bypass reach and lack of gravel recruitment has left several deep pools with the opportunity to stratify. Therefore the bypass reach was rated at 2 and the reach below the powerhouse at 4. Historically, these areas would have fast turbulent water due to higher flows (Entrix 1991) and were rated as 4. Currently, WS1 has stratification due to pooling effects of Bonneville Dam and was rated at 3.

There are abundant springs entering the reaches WS18, and WS17. This also occurs to a lesser extent in reaches WS16 and WS 15. These spring sources have probably not changed much from historic. EDT ratings were 0 for WS17 and WS18, 1 for WS16, and 2 for WS15. Northwestern Lake is deep enough to stratify and provide coldwater refugia, particularly in its downstream reaches and was rated at 0.Groundwater inputs are present in upper Buck Creek and this reach was rated at 2 (Greg Morris-YN). EDT ratings were reduced lower Buck Creek reaches.

Indian and Rattlesnake Creeks have lost their historic deeper pools due to the removal of pool forming structures (WWA 1997). These factors have reduced the thermal refugia that historically occurred. The upper Panakanic Plateau of Rattlesnake Creek historically had large wetlands, beaver ponds, and a higher water table which slowed and retained flow longer into the summer. This would have allowed for more groundwater infiltration, providing more spring influence in the lower reaches of Rattlesnake Creek particularly during low flow periods. Currently The Plateau has been ditched, wetlands have been drained, cattle have compacted the land surface, streams have down cut, thereby lowering the water table and reducing the opportunity for recharge of subsurface flows. Additionally Indian and Rattlesnake Creeks have lost their historic deeper pools due to the removal of pool forming structures (WWA 1997). These factors have reduced the thermal refugia that historically occurred.

Level of Proof: Expert opinion was used to estimate the current and historical ratings for this attribute and the level of proof has theoretical support with some evidence from experiments or observations.

Chemistry

Alkalinity

Definition: Alkalinity, or acid neutralizing capacity (ANC), measured as milliequivalents per liter or mg/l of either HCO_3or $CaCO_3$.

Rationale: Alkalinity (Hardness, HCO_3) in the historic condition was given the same value as the current condition. Current alkalinity levels were measured by UCD at Buck and Rattlesnake creeks, below Trout Lake Valley, at BZ, and below the WS bypass reach. Alkalinity was also measured by USGS, WDOE, and USBOR. These measurements were used to rate these reaches. Where alkalinity (mg/l) was not measured but conductivity (µs/cm) was, the following conversion was used: ALK = 0.421* CON - 2.31 developed by Ptolemy (1993). Reaches without data were rated based on similar or adjacent reaches with measurements. Empirical estimates were available for B1, R1, WS2, WS14, WS5, above WS18, and R4. These estimates were expanded to adjacent reaches.

Level of Proof: A combination of empirical information, expansion of empirical information and derived information was used to estimate the current and historical ratings for this attribute and the level of proof has theoretical support with some evidence from experiments or observations.

Dissolved oxygen

Definition: Average dissolved oxygen (DO) within the water column for the specified time interval.

Rationale: Dissolved oxygen in the template (historic) condition was assumed to be unimpaired with an EDT rating of 0. Current USGS/UCD water quality data have no DO measurements less than 8 mg/l in the mainstem White Salmon River, or the tributaries Buck, Rattlesnake, and

Indian creeks. No records were found for Little Buck, Mill, and Spring creeks. All reaches assumed to have EDT rating of zero.

Level of Proof: A combination of empirical observations, expansion of empirical observations, and expert opinion was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive. For historical information, empirical observations were used to estimate the ratings for this attribute and the level of proof is thoroughly established.

Metals – in water column

Definition: The extent of dissolved heavy metals within the water column.

Rationale: Historically (template condition), toxic chemicals and metals in the water column and/or sediment were assumed to be non-existent or at background levels. Currently no toxicity is expected due to dissolved heavy metals to salmonids under prolonged exposure. Arsenic, copper, lead, and zinc were routinely sampled at the mouths of WS River, Buck, and Rattlesnake creeks as well as at BZ and WS below TLV. Of these, total levels were below analytical detection limits for all except arsenic, which was well below EPA drinking water standards and DOE aquatic life criteria. Key references are Stampfli (1994) and PacifiCorp (1996).

Level of Proof: A combination of empirical observations, expansion of empirical observations, and expert opinion was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive. For historical information, derived information and expert opinion were used to estimate the ratings for this attribute and the level of proof is thoroughly established.

Metals/Pollutants – in sediments/soils

Definition: The extent of heavy metals and miscellaneous toxic pollutants within the stream sediments and/or soils adjacent to the stream channel.

Rationale: Historically (template condition), toxic chemicals and metals in the water column and/or sediment were assumed to be non-existent or at background levels. All reaches assumed to be at natural (background) levels except WS5 and WS8 had low levels of metals and pollutants and were rated at 1.

The only data available for this analysis were lake sediments. Stratified random boring of lake sediments measured metal concentrations, as well as pesticides and herbicides. Metals tested: Antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, silver, thallium, zinc. Uppermost sediment samples were below both Provincial Sediment Quality Guidelines (PSQG, no effect - severe effect), and EPA ranges for non-polluted sediments, except mercury in the 7.4-foot sample (0.52 ppm exceeded the no effect - severe effect guideline of 0.2-2 in the region near the dam). "A comparison of the detected concentrations indicates that, in

general, the metal concentrations in the reservoir sediments are below levels of concern. The exception is the elevated concentrations detected in the 10-ft zone of Area 4 (upper reservoir near boat launch). According to the PSQG, the sediment collected from this zone barely exceeded the "No Effect" limit for cadmium, chromium and mercury. Copper, nickel, and zinc all fall into the "Moderately Polluted" category. According to these guidelines, the lead contamination indicates "Heavy Pollution" also considered "Heavy Pollution" by the EPA Region V guidelines. Mercury concentration generally exceeded guideline values, but were considered background concentrations, also true for nickel and copper."
Dioxin, pentachlorophenol, gasoline, diesel, PCB, PAH, Volatile Organic Compounds, PP metals were not found. Chlorinated pesticides were detected in mid-level sediments (area 1, 2, 3 (mid-way between Buck and Mill creeks), but not in shallow or deep sediments (basically deposited during the period of use (banned 20 yrs ago)) (PacifiCorp 1994).

Level of Proof: A combination of empirical observations, expansion of empirical observations and expert opinion was used to estimate the current and historical ratings for this attribute and the level of proof is speculative with little empirical support because of the lack of data except in the reservoir reaches.

Miscellaneous toxic pollutants – water column

Definition: The extent of miscellaneous toxic pollutants (other than heavy metals) within the water column.

Rationale: Historically (template condition), toxic chemicals and metals in the water column and/or sediment were assumed to be non-existent or at background levels. The current conditions were assumed to be the same as the template condition. Current levels are unknown and except in the reservoir, B1, R1, WS2, WS16, and WS18. Dioxin, pentachlorophenol, gasoline, diesel, PCB, PAH, Volatile Organic Compounds, PP metals were sampled for and not found. Chlorinated pesticides were detected in mid-level sediments (area 1, 2, 3 (mid-way between Buck and Mill creeks), but not in shallow or deep sediments (basically deposited during the period of use (banned 20 yrs ago)) (PacifiCorp 1994).

This document lists the acres of each land use type within each basin and types and quantities of chemicals used by each land use type. Relative water quality concern is listed for each chemical used. There are several chemicals applied to forestland and orchards that were of high concern for water quality (Stampfli 1994).

Level of Proof: In the reaches with measurements empirical observations were used to estimate the ratings. In the reaches with no measurements, expert opinion was used to estimate the current and historical ratings for this attribute and the level of proof is speculative with little empirical support because of the lack of data.

Nutrient Enrichment

Definition: The extent of nutrient enrichment (most often by either nitrogen or phosphorous or both) from anthropogenic activities. Nitrogen and phosphorous are the primary macronutrients that enrich streams and cause build ups of algae. These conditions, in addition to leading to other adverse conditions, such as low DO can be indicative of conditions that are unhealthy for salmonids. Note: care needs to be applied when considering periphyton composition since relatively large mats of green filamentous algae can occur in Pacific Northwest streams with no nutrient enrichment when exposed to sunlight.

Rationale: Actual data (collected as chlorophyll a concentrations) for this attribute was unavilable. Historically nutrient enrichment did not occur because watersheds were in the "pristine" state. To determine the amount of nutrient enrichment in various reaches the following factors were examined: fish rearing ponds, visual surveys for presence of filamentous algae in shaded areas and fecal coliform levels associated with agriculture, and septic tanks.

There is a USFWS fish-rearing pond present in the WS2 reach, which gives an EDT rating of 1. There is significant cattle presence in the Panakanic plateau of Rattlesnake Creek. Upper Rattlesnake Creek has exceeded fecal coliform standards regularly; however large mats of filamentous green algae typically are not seen. The entire creek was given an EDT rating of 0.5 to indicate that nutrient enrichment is higher than historic levels, yet not high enough to give a rating of 1.

In lower Buck Creek, several surveyors reported the smell of sewage, likely small nutrient enrichment from houses adjacent to the creek. This reach has exceeded fecal coliform standards regularly; therefore the B1 reach was given an EDT rating of 0.5. The reaches adjacent to Northwestern Lake were increased slightly to a rating of 0.3 to indicate the increased nutrient input from the houses adjacent to the reservoir.

The White Salmon River below Trout Lake Valley has exceeded fecal coliform standards regularly (RM18.2 = exceeded 53% of the time). However, dilution by springs reduces nutrient enrichment levels from WS17 down. Therefore the entire length of the White Salmon River was given an EDT rating of 0.2 as a placeholder to indicate that nutrient enrichment is higher than historic but not enough to give an EDT rating of 1. Key references for this attribute are Hennelly et al. 1994, USFS 1995, and USFS 1996 and UCD unpublished data.

BIOLOGICAL COMMUNITY

Community effects

Fish community richness

Definition: Measure of the richness of the fish community (no. of fish taxa, i.e., species).

Rationale: Historic fish community richness was estimated from the current distribution of native fish in these watersheds; personal communications with professional fish biologist and other personnel familiar with fish behavior and habitat preferences; and historical accounts as referenced in the Panakanic Watershed Analysis report. Current fish community richness was estimated from direct observation (stream surveys and electro-shocking), referenced reports, personal communications with professional fish biologists and other personnel familiar with these areas, and local knowledge. The referenced reports are: (Connolly 2002, Connolly et al. 2001, Connolly 2002, Connolly et al. 2001, Hardisty et al. 1971, Moyle 2002, PacifiCorp 1996, WWA 1997, Wydoski et al. 1979). A spreadsheet summarizing the list of species obtained from the listed data sources was developed (Allen unpublished).

Using the sources mentioned above we think 36 species are found in the Bonneville inundated section (WS1). Most of these fish likely drop out in WS2 reach as gradient increases and water temperatures are reduced. The list includes fish such as mirror carp, and goldfish. We do not think that these fish inhabit the mouth of the White Salmon River in meaningful numbers, however they may be present in small numbers. Because we used integer EDT rankings the exact number of species present is less critical, so therefore these species remained on the list. In the majority of rankings the presence or absence of a few fish species in either the historic or current scenarios does not change the ranking. However in a few instances the ranking could change. For example, the presence of longnose dace is presumed in the mainstem White Salmon River above Husum Falls. If this species is not present, the current ranking would change from a 1 to a 0. Additional information is needed to be certain of some species distributions.

Page 3-16 of the FERC FEIS document (PacifiCorp 1996) has a table listing anadromous and resident fish species in the White Salmon from the mouth to Condit dam. Page E-3-4, Tables E-4, E-5, list of salmonids and non-salmonids and their lifestage use of the Whites Salmon River below Condit Dam split in to segments 1(bridge to first riffle), 2(first riffle to powerhouse), and 3 (powerhouse to Condit dam).

Page 235 and subsequent maps of the Panakanic Watershed Analysis contain information on current and historic salmonid distribution obtained from historic accounts (WWA 1997).

Level of Proof: A combination of empirical observations, expansion of empirical observations, and expert opinion was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive. For historical information a combination of empirical observations, historical accounts, and professional opinion was used to estimate ratings and the level of proof has a strong weight of evidence in support but is not fully conclusive.

Fish pathogens

Definition: The presence of pathogenic organisms (relative abundance and species present) having potential for affecting survival of stream fishes.

Rationale: For this attribute the release of hatchery salmonids is a surrogate for pathogens. In the historic condition there were no hatcheries or hatchery outplants and we assumed an EDT rating of zero.

Due to the large number of 'dip ins' in the Bonneville Pool inundated area and the rearing pond operations within the last decade in WS2, reaches WS1 and WS2 received an EDT rating of 3. Due to the lesser number of strays and rearing pond effects reaches WS3 and 4 received ratings of 2. Northwestern Lake is regularly stocked with rainbow trout therefore by definition received a rating of 2. The adjacent tributary reaches and mainstem reaches also received a rating of 2.

Level of Proof: A combination of empirical observations, expansion of empirical observations, and expert opinion was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive. For historical information, expansion of empirical observations, and expert opinion were used to estimate the ratings for this attribute and the level of proof has theoretical support with some evidence from experiments or observations thoroughly established.

Fish species introductions

Definition: Measure of the richness of the fish community (no. of fish taxa). Taxa here refers to species.

Rationale: By definition the template conditions for this attribute are rated as a value of 0 because this describes this attribute rating for watersheds in pristine conditions. Introduced species were derived from current fish species richness data (see Fish Community Richness above). Because we have more certainty about the number of introduced fish in each reach, the data precision of this attribute was rated non-categorically. Additional sources are detailed below:

Bair et al. (2002) stated that brook trout are a non-indigenous species to the White Salmon River and although hatchery outplants have been discontinued, brook trout have established naturally reproducing populations above Condit Dam. In Connolly (2002) on Page A-45, Table 8 documented the presence of brook trout (n=1) in the R2 section of Rattlesnake Creek. Data also includes all fish species found in the Rattlesnake Creek Basin during two years of intensive electrofishing.

Page 3-16 of the FERC FEIS document (PacifiCorp 1996) has a table (table 3-5) listing anadromous and resident fish species in the White Salmon from the mouth to Condit dam. Page E-3-4, Tables E-4, E-5, list of salmonids and non-salmonids and their lifestage use of the Whites Salmon River below Condit Dam split in to segments 1(bridge to first riffle), 2(first riffle to powerhouse), and 3 (powerhouse to Condit dam).

Of the six species of anadromous species that are believed to inhabit the lower White Salmon River below Condit Dam (Table 3-5 cited above), one species, the american shad, is non-native to the lower White Salmon River. One of the three resident salmonids, the brook trout, is non-native, and 13 of 24 resident non-salmonids are non-native. Of the non-native species cited above, only the lepomis spp. (n=2) are documented (table e-5 cited document above) above the first riffle section (WS2 and WS3). This account is questionable due to the cold turbulent water that would need to be passed to get to those reaches and was not included until the accuracy of the information in the table can be verified.

To the best of our knowledge brook trout are the only non-indigenous fish species present above Condit dam. Although their precise distribution and population within the watershed is largely unknown at this time, we believe that they inhabit all mainstem reaches and all tributary streams below residential fish barriers.

Level of Proof: A combination of empirical observations, expansion of empirical observations, and expert opinion was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive. For historical information, this attribute is rated 0 by definition and the level of proof is thoroughly established.

Harassment

Definition: The relative extent of poaching and/or harassment of fish within the stream reach.

Rationale: In the historic condition (prior to 1850 and European settlement), harassment levels were assumed to be low. By definition the template conditions for this attribute are rated as a value of 0 because this describes this attribute rating for watersheds in pristine conditions. The exception to this is where there were known Native American fishing locations or longhouses. These include reaches I1, R1, R2, R4, WS1, and WS14 and were rated at 4.

Harassment is high in all White Salmon reaches from the mouth to BZ due to fishing below Condit, recreation use in the lake, and whitewater use from BZ to Northwestern Lake and given an EDT rating of 4. Reaches above BZ have limited access but also see limited Kayak use (EDT=1). A road runs along Buck and Rattlesnake Creeks (EDT=2). Other tributaries considered low (EDT =1). Inundated reaches in Little Buck and Mill Creeks considered high due to reservoir activity. Bypass reach has less harassment (EDT=3).

Level of Proof: There is no statistical formula used to estimate harassment. Therefore, expert opinion was used to estimate the current ratings for this attribute and the level of proof has theoretical support with some evidence from experiments or observations. For historical information, empirical observations were used to estimate the ratings for this attribute and the level of proof is thoroughly established.

Hatchery fish outplants

Definition: The magnitude of hatchery fish outplants made into the drainage over the past 10 years. Note: Enter specific hatchery release numbers if the data input tool allows. "Drainage" here is defined loosely as being approximately the size that encompasses the spawning distribution of recognized populations in the watershed.

Rationale: By definition the template conditions for this attribute are rated as a value of 0 because this describes this attribute rating for watersheds in pristine conditions. In the historic condition (prior to 1850 and European settlement), there were no hatcheries or hatchery outplants.

WDFW releases trout into Northwestern Lake annually, which are caught up to Sandy beach. WDFW/USFWS releases anadromous fishes below lake. WS1-9 were given an EDT rating of 4.

Level of Proof: For current and historical information, empirical observations were used to estimate the ratings for this attribute and the level of proof is thoroughly established.

Predation risk

Definition: **Level of predation risk on fish species due to presence of top level carnivores or unusual concentrations of other fish eating species. This is a classification of per-capita predation risk, in terms of the likelihood, magnitude and frequency of exposure to potential predators (assuming other habitat factors are constant). NOTE: This attribute is being updated to distinguish risk posed to small-bodied fish (<10 in) from that to large bodied fish (>10 in).**

Rationale: **By definition the template conditions for this attribute are rated as a value of 2 because this describes this attribute rating for watersheds in pristine conditions. The magnitude and timing of yearling hatchery smolt and trout releases, and increases in exotic/native piscivorous fishes were considered when developing this rating. In general, reaches from Condit to the Sandy Beach were rated 3 due to the potential of increased predation from hatchery and native rainbow trout. In WS1, introduced fishes and northern pike minnow increased predation relative to historical and was rated at and EDT=4. In WS2, effects from introduced fishes and northern pike minnow are reduced, and the reach was given an EDT rating of 2.5.**

Level of Proof: There is no statistical formula used to estimate predation risk. A combination of empirical observations, expansion of empirical observations, and expert opinion was used to estimate the current ratings for this attribute and the level of proof has a strong weight of evidence in support but not fully conclusive. For historical information, expansion of empirical observations and expert opinion were used to estimate the ratings for this attribute and the level of proof has theoretical support with some evidence from experiments or observations thoroughly established.

Salmon Carcasses

Definition: Relative abundance of anadromous salmonid carcasses within watershed that can serve as nutrient sources for juvenile salmonid production and other organisms. Relative abundance is expressed here as the density of salmon carcasses within subdrainages (or areas) of the watershed, such as the lower mainstem vs. the upper mainstem, or in mainstem areas vs. major tributary drainages.

Rationale: Historic carcass abundance was estimated based on the distribution of anadromous fish in the watershed. Reaches with historic chum presence (spawning) were given a rating of 0. Mainstem reaches with chinook and coho, but no chum were given a rating of 2. Reaches with only coho were given a rating of 3. Reaches with only cutthroat or steelhead were given a rating of 4, since these fish are iteroparus. Tidal reaches below areas of chum spawning were given a 1 (it was assumed carcasses from spawning reaches above are washed into these reaches).

For the current condition, the twelve-year average (Harlan 2003) for fall chinook escapement was 1729 from the powerhouse down. This is an average of 809 carcasses per mile in reaches WS1 and 2 which corresponds to an EDT rating of 0. Carcasses not counted in WS3 and 4 but assumed to be in the range of 25 to 200, giving an EDT rating of 3.

Level of Proof: A combination of empirical observations, expansion of empirical observations, and expert opinion was used to estimate the current ratings for this

Macroinvertebrates

Benthos diversity and production

Definition: Measure of the diversity and production of the benthic macroinvertebrate community. Three types of measures are given (choose one): a simple EPT count, Benthic Index of Biological Integrity (B-IBI)—a multimetric approach (Karr and Chu 1999), or a multivariate approach using the BORIS (Benthic evaluation of ORegon RIverS) model (Canale 1999). B-IBI rating definitions from Morley (2000) as modified from Karr et al. (1986). BORIS score definitions based on ODEQ protocols, after Barbour et al. (1994).

Rationale: No direct measures of benthos diversity were available for these watersheds. We assigned an EDT rating of "0" and assumed that in the historic condition macroinvertebrate populations were healthy, diverse, and productive and in the natural/pristine state.

Disturbed and undisturbed B channel reaches on the Wind had B-IBI scores of 44 (EDT=0.6). We assumed the same on the White Salmon and its tributaries. Degraded C channels in the Wind River had EDT B-IBI scores of 1.5. This rating was applied to Indian, Rattlesnake, and Spring Creeks since they may have lower B-IBI scores due to reduced summer flows, increased temperature, and sediment.

B-IBI score in Northwestern, and Spring Creek pond are unknown. Assumed very degraded for stoneflies. Used EDT rating of 2.6 that were derived from B-IBI scores on Cedar Creek (tributary of North Fork Lewis River).

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USGS. United States Geological Survey. Daily Streamflow for Washington. USGS 14123500 WHITE SALMON RIVER NEAR UNDERWOOD, WA http://waterdata.usgs.gov/wa/nwis/uv/?site_no=14123500&PARAmeter_cd=00060,00065

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Appendix G

Comparison of Spawner-Recruit Data with Estimates of Ecosystem Diagnosis and Treatment (EDT) Spawner-Recruit Performance

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Introduction

In the Lower Columbia River tributaries, the Ecosystem Diagnosis and Treatment (EDT) model was used to develop salmon and steelhead population performance goals for the Washington Department of Fish and Wildlife (WDFW), develop the habitat strategy for the Lower Columbia River Fish Recovery Board (LCFRB), and to identify specific habitat restoration projects. The EDT model is habitat based and estimates the expected salmon and steelhead performance in the environment used by these anadromous fish (Lestelle et al. 1996). WDFW rated habitat for the EDT model in Grays River, Skamokawa Creek, Elochoman River, Mill Creek, Abernathy Creek, Germany Creek, Cowlitz River below the Barrier Dam, Toutle River, Coweeman River, Kalama River, North Fork Lewis River below Merwin Dam, East Fork Lewis River, Salmon Creek, Washougal River, Duncan Creek, Hamilton Creek, Hardy Creek, Wind River, and the White Salmon River. This includes thousands of miles of habitat and stream reaches.

Empirical information was not available for all 45 EDT environmental attributes for any reach. For most reaches there was no empirical information available. To estimate the values when no empirical information was available, derived information or expanded information from adjacent or similar reaches was used. Only a limited amount of expert opinion was used for rating current environmental habitats and this occurred for attributes, where there were no quantitative rules (i.e. riparian function and harassment) or for historical information. For a more detailed description of the rationale behind the expansion of empirical information, and the use of derived information and professional judgment see the documentation reports (i.e. Rawding, Glaser, VanderPloeg, and Pittman 2004) or the EDT Stream Reach Editor (SRE) where reach specific data quality and source information is kept. To be consistent between subbasins, the use of expanded and derived information and professional judgment was standardized and comparisons between reaches or subbasins can be made because the data is standardized. This is the underlying assumption behind the development and use of the LCRFB habitat strategy.

In addition to the habitat data, salmon and steelhead life history information is required for the EDT model. For most individual fall chinook populations, there was information available on adult age structure, sex ratio, and fecundity. However for steelhead data was limited to the Wind, Kalama, and Toutle Rivers. For steelhead, the Kalama River dataset was used as a default when no other information was available because it is the most comprehensive. For chum salmon, less data was available and a common set was combined from many sources. Juvenile life history patterns and ocean survival were standardized from all races and the Columbia River capacity and survival estimates were derived from the Framework Process (Marcot et al. 2002).

The EDT model is a statistical model that explains the performance of salmon and steelhead based on the mechanisms of how salmon move through their environment (MBI 2002). To do this, EDT constructs a working hypothesis for a population within a subbasin based on the model and datasets used to populate the model. Mobrand Biometrics Inc (MBI) suggests three criteria for judging the usefulness of these type of models: 1) its predictions are consistent with observations, 2) it provides a clear and reasonable explanation for the observations, and 3) it provides useful guidance for management and enhancement.

Many models rely on data other than empirical data (ie Bayesian Belief Network). However, the use of non-empirical data has been a specific concern regarding the use of the EDT model in the context of salmon and steelhead recovery. WDFW welcomes the use of empirical information in the EDT model but this data was not always available when constructing the current database. Rather than waiting for more information WDFW has advocated using the "best available science" to move forward toward recovering salmon and steelhead populations that are listed under the Endangered Species Act (ESA). WDFW recommends funding surveys to collect key parameters that drive the model including habitat types, wood, percentage of fines in spawning gravel, bed scour, peak flow, low flow, maximum width, and minimum width.

Methods

The relationship between stock size and recruitment is a keystone in fishery science, because this function translates into the development of reference points used to set sustainable fisheries, and perform population viability analysis (Hilborn and Walters 1992, Chilcote 2000). However, these data sets are problematic due to environmental variation and observational errors (Hilborn and Walters 1992).

In basins with significant proportions of hatchery spawners, the estimates of spawners and recruits can be very uncertain. For fall chinook salmon only a small percentage of all the hatchery fish are marked for identification with coded-wire-tags (CWT). To estimate the number of hatchery fall chinook salmon present in a population, the adults recovered with CWT are expanded by the juvenile or adult tag rate. This expansion often indicates there were more hatchery fish present than total fish present. In addition, hatchery fish may have a different reproductive success in the stream and unless this is known and accounted for the estimate of recruits will be biased. Therefore, streams with significant hatchery populations were excluded from the analysis except for steelhead populations were the reproductive success was estimated (Chiclote at al 1986, Leider et al. 1990, and Hulett et al.1993). These criteria substantially reduced the number of streams to be considered for comparison with EDT.

Observational uncertainty includes measurement and sampling error when estimating the number of spawners and recruits (Francis and Shotton 1997). Spawning escapement estimation methods can be generally categorized as count, mark-recapture, redd counts, and peak count expansion. Counts are direct counts of fish trapped and passed over a weir or barrier. These counting facilities are rare and only a few populations are monitored with direct counts. Counts are assumed to have no sampling or measurement error, and represent the most accurate measure of escapement.

Mark-Recapture (M-R) is used by WDFW at partial barriers to estimate adult summer steelhead abundance using the pooled or stratified Petersen method (Seber 1982 and Arnason et al 1997). Adults are floy tagged and recaptured at upstream traps or "captured" through snorkeling, which is often called mark-resight (Rawding and Cochran 2001a). Juvenile estimates are made using the trap efficiency method (Rawding and Cochran 2001b). For M-R to be accurate the assumptions of the method must be met and WDFW conducts experiments to ensure these assumptions are not being substantially violated. The precision of the estimate is a function of the number of marks and recaptures. In general, WDFW's goal for precision, is that the 95% confidence interval (CI) to be less than 25% but in many cases they are less than 10%. When the assumptions and precision goals are met, these estimates rank just below direct counts for use in spawner-recruit analysis.

Redd surveys are used for winter steelhead since other methods are not available (Freymond and Foley 1986). Redd counts are a combination of a cumulative count of redds in some tributary reaches, an expansion of supplemental redd surveys, an expansion of average redd density to unsurveyed tributaries, and an Area-Under-the-Curve (AUC) estimate for the mainstem. Only redd survey data from the SF Toutle River is used in this analysis because the valley is open to get accurate AUC counts from a helicopter and tributaries are surveyed frequently enough that population estimates are expanded for only a few reaches.

Peak Count Expansion (PCE) is used for fall chinook salmon estimates. In these basins, a population estimate was made by tagging chinook carcasses using the Jolly-Seber (JS) model (Seber 1982). As with the Petersen method, the JS estimate is only valid if the assumptions are met and care is taken to ensure the assumptions were not violated. The PCE factor is developed by comparing the peak count of lives and deads to the total population estimate from carcass tagging. This one time PSE is used to expand previous and future peak counts into a population estimate.

Chum salmon abundance is often estimated using AUC (Ames 1984). Surveyors count the number of live chum salmon spawning and are asked to estimate their "observer efficiency" or the percent of the population they see based on water conditions. The periodic counts are plotted over the course of the season and the number of fish days is estimated by the AUC. The AUC is divided by the average residence time to develop the estimate. Redd counts, PCE, and AUC methodologies are potentially the least precise of the estimates because annual variance estimates are unknown, observation efficiency is varies between surveyors, true observer efficiency estimate is unknown, annual residence time is variable, and the standard residence time from other studies may be slightly different than the actual residence time.

The original EDT model and subsequent datasets focused on ESA listed species, which included chum salmon, chinook salmon, and steelhead. Coho salmon modeling was not fully funded in the subbasin planning effort due to lack of resources. To fully cover coho salmon, additional reaches need to be added since this species has a preference for small creeks not used by other species. Coho salmon were only fully included in the Elochoman River, and Skamokawa, Mill, Abernathy, Germany, and Salmon Creeks.

For Columbia River tributaries spawner-smolt data is a measure of tributary production and the smolt estimate is the number of smolts leaving the tributary. Recent studies have indicated ten fold changes in ocean variability as measured by smolt to adult survival (NRC 1996 , Rawding 2001, and ODFW unpublished). Spawner-smolt data are less variable than spawner-adult data because spawner-adult data also include assumptions from the Framework about survival conditions in the mainstem and estuary from limited studies (Marcot et al. 2002). For chinook salmon assumptions about ocean harvest rates are also included. Since there are less assumptions spawner-smolt data is a better measure for ensuring consistency with EDT than spawner-adult data.

One output of the EDT model is a Beverton-Holt (BH) spawner-recruit curve for adults or smolts (Beverton and Holt 1957, Mousalli and Hilborn 1987, and Lestelle et al 1996). To determine if EDT outputs are consistent with observations, EDT spawner-recruit curves will be compared to actual spawner-recruit data. In Table 1 and 2 are the populations with spawner-recruit data used for comparison with the EDT model. These datasets represent the most accurate information available for comparison with EDT model.

Table 1. Populations used in comparing the predicted EDT Beverton-Holt Curve with actual spawner and smolt data.

Stock	Escapement	Recruits	Age	Comments
Trout Cr	Weir Count	M-R at trap	scales	Some years adjustment when trap not operational and hatchery fish present
Wind R.	M-R at trap	M-R at trap	scales	One year juvenile scale data missing and adjustment for hatchery reproductive success to smolt stage
Cedar	M-R at trap	M-R at trap	All age 2	adjustment for hatchery reproductive success to smolt stage

Table 2. Populations used in comparing the predicted EDT Beverton-Holt Curve with actual spawner and adult recruit data.

Stock	Escapement	Recruits	Age	Comments
Washougal Summer steelhead	Mark-Resight snorkel survey	Same as escapement plus CRC & C&R estimate.	Use Kalama Scales	Used current estimates of snorkel efficiency from M-R estimates to adjust historical counts
Kalama Steelhead – summer & winter populations combined	Mark-Resight snorkel survey for summers and weir count for winters	Same as escapement plus CRC & C&R estimate.	Scales	Used estimates of successful jumpers and snorkel efficiency from M-R estimates to adjust historical counts
Wind River Summer Steelhead	Mark-Resight snorkel survey	Same as escapement plus CRC & C&R estimate.	Scales used avg for some years	Used current estimates of snorkel efficiency from M-R estimates to adjust historical counts
SF Toutle Winter Steelhead	Redd survey	Same as escapement plus CRC & C&R estimate.	Use Kalama Scales	
NF Toutle Winter Steelhead	Weir Count	Same as escapement but no fishery	Scales	
Coweeman Fall Chinook	Carcass Tagging Expansion	Same as escapement but Cowlitz CWT used to estimate fishery	Scales	
EF Lewis Fall Chinook	Carcass Tagging Expansion	Same as escapement but Cowlitz CWT used to estimate fishery	Scales	
NF Lewis Fall Chinook	Carcass Tagging Expansion	Same as escapement but Lewis wild CWT used to estimate fishery	Scales	
Grays River	Carcass Tagging	Assume no	Scales	

Chum Salmon	Expansion and AUC	fishery		

The EDT datasets were populated by WDFW and run on the MBI website (http://www.mobrand.com/edt). Results from the website were provided in "Report 1" , which provided an estimate of productivity and capacity for the BH spawner curves for adults and juveniles. The EDT model is deterministic and provides no estimates of uncertainty. The observed spawner-recruit data was fit to the same BH model used by EDT using maximum likelihood estimation (MLE) and assuming lognormal error Hilborn and Waters 1992).

$$R = (\alpha S / (1+ \alpha S/\beta)) * e^{\varepsilon_t} \qquad (1)$$

Where:

R = the number of recruits measured as adults or smolts
S = the number of spawners
α = the intrinsic productivity of the stock, and
β = the freshwater carrying capacity of the stock
ε_t = a normal distributed random variable ($N(0,\sigma)$)

A non-linear search over α, β, and σ was used to minimize the negative log-likelihood and estimate the parameters. A two-dimensional confidence interval on α and β was estimated using a likelihood profile by search over all values that provided a likelihood within a specified range of the negative log-likelihood (Hudson 1971, Hilborn and Mangel 1997). To estimate a 95% confidence region, a chi-squared distribution with two degrees of freedom was used to contour all negative likelihood values three greater than minimum value. The 95% confidence contour created an ellipse with a negative correlation between α and β. If the EDT point estimate of α, β was within the 95% confidence region from the spawner-recruit data, there was no significant difference between the two model estimates.

Results and Discussion

A comparison of EDT generated spawner-recruit curves with the spawner-recruit curves generated from the data was considered. To estimate a spawner recruit relationship from the data Hilborn and Walters (1992) recommend that: 1) data used in spawner-recruit analysis have low measurement error due to the destructive relationship of measurement error on these curves (Ludwig and Walters 1981), 2) the relation be examined for time series bias especially due to auto-correlated environmental events (Hilborn and Starr 1984), 3) the data be non-stationarity due to variablity in ocean regimes (Hare and Francis 1994) with productive periods (pre-1977 and post 1999) and an unproductive period in between, and 4) the data have sufficient contrast to determine the relationship. If data meet the recommendations and a spawner-recruit curve was generated than a comparison could be developed comparing the fit the EDT and data derived curves. Most of the data sets are too sparse or provide insufficient contrast for direct comparisons. Therefore, the EDT model was said to have a good fit if the predicted BH curve ran through the observed data and if the point estimates (α, β) from the EDT model fell within the 95% confidence region from MLE of these same parameters from the observed data.

EDT model was designed to predict average performance, as measured by smolt and adult productivity, capacity, and abundance, of the modeled population over specified environmental conditions. Spawner-smolt estimates are more likely to reflect average environmental conditions due to less environmental variation in freshwater (Cramer 2000). A comparison of EDT spawner-smolt curves to the three steelhead spawner-smolt datasets is found in Figures 1 & 2. The EDT curves passes through the individual data points reasonably well for all data sets. The point estimate (α, β), depicted by a white sun in the graphs, from the EDT analysis is within the 95% contour from the spawner-recruit data. Based on population monitoring protocols, these datasets are the best datasets to compare to the EDT model.

The adult steelhead comparisons are found in Figures 2, 3, and 4. While the Wind River smolt dataset compared favorably with the EDT output the adult dataset does not (Figure 2). This is due to the relatively recent adult dataset, that was collected primarily during an unproductive ocean regime during the late 1980's and 1990's. Recent returns, which are not included in the dataset because the full brood year has not returned, indicate the new spawner recruit data will fall at or above the EDT line.

Figure 3 contains the winter steelhead populations within the Toutle subbasin. The EDT performance estimate for the North Fork Toutle River above the Sediment Retention Structure (SRS) is outside the 95% confidence interval. The EDT analysis indicated that all steelhead production occurs in the tributaries and production from the mainstem Toutle River above the SRS is not possible due to sediment still working its way downstream after the eruption of Mt. St. Helens. The EDT model indicates that steelhead are very sensitive to sediment concentrations near the levels modeled in the Toutle subbasin. A slight change in the mainstem rating would increase steelhead capacity and the mainstem and the EDT point estimate would fall within the 95% contour.

The SF Toutle River had less sediment and recovered more rapidly after the eruption of Mt. St. Helens than the NF Toutle River. This dataset begins in the mid-1980's and has continued to the present. It exhibits a high level of variation due to favorable ocean conditions in the mid-1980s and unfavorable conditions through the rest of the period. The EDT estimate falls within the center of the 95% confidence region.

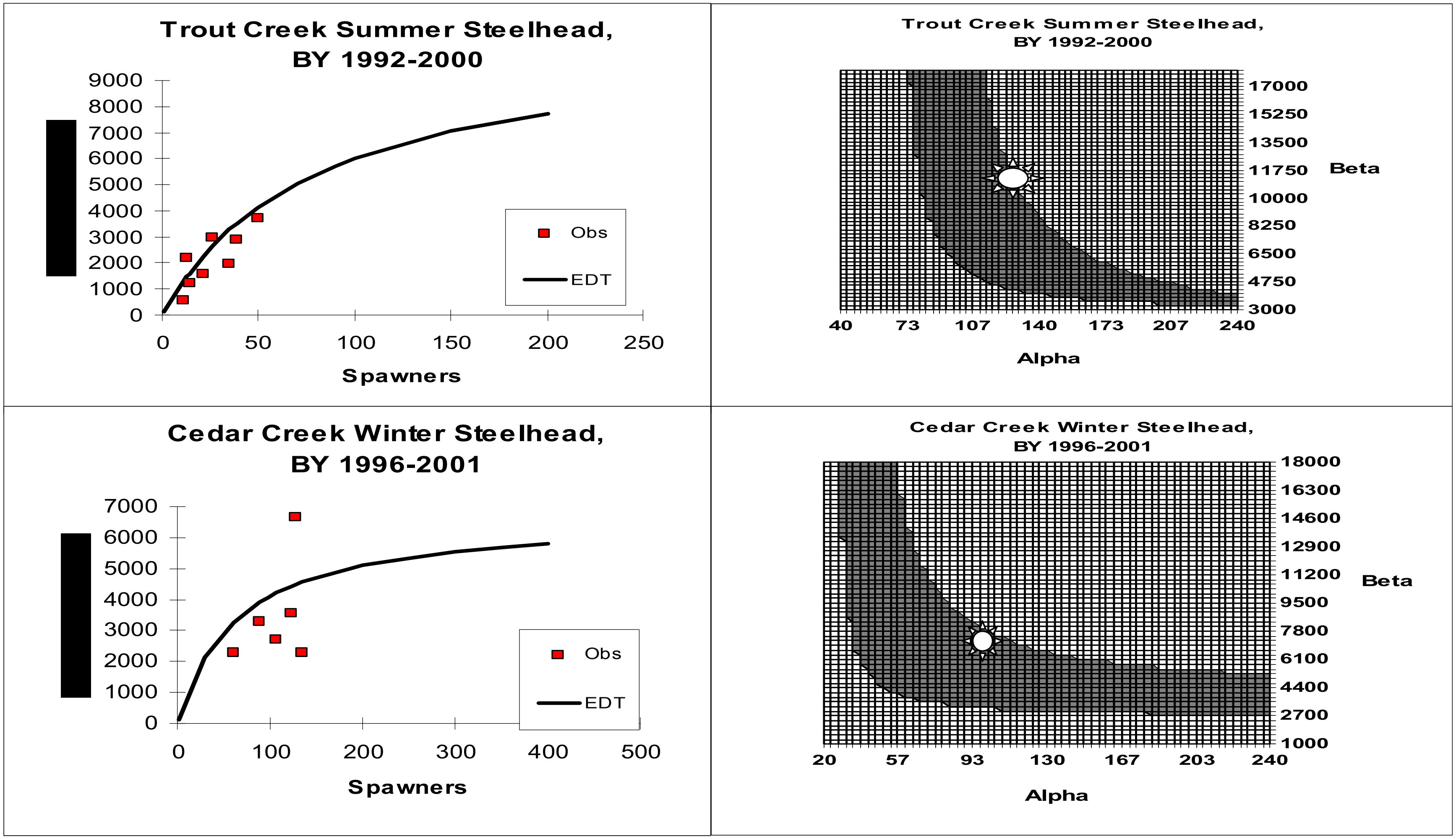

Figure 1. Comparison of EDT estimates of the Beverton-Holt spawner curve (solid line) with observed data (red squares) and the 95% confidence region determined by maximum likelihood analysis (dark grey pattern) compared to the EDT (α, β) point estimate (white sun).

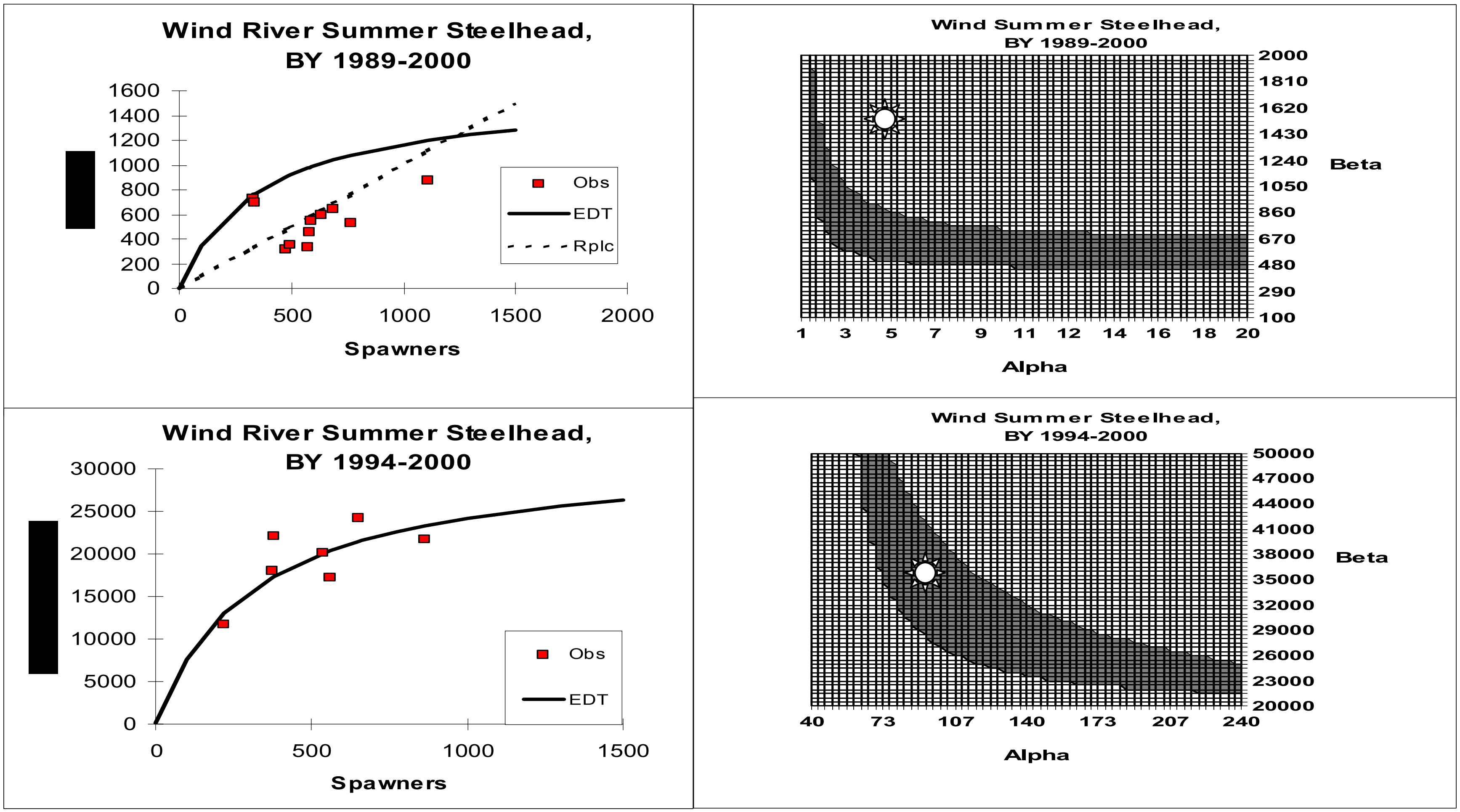

Figure 2. Comparison of EDT estimates of the Beverton-Holt spawner curve (solid line) with observed data (red squares) and the 95% confidence region determined by maximum likelihood analysis (dark grey pattern) compared to the EDT (α, β) point estimate (white sun).

Figure 4 contains the two longest steelhead datasets from the Washougal and Kalama Rivers. Both summer and winter steelhead are passed above Kalama Falls Hatchery (KFH). Since the exact spawning and rearing distribution of both races is unknown, a generic EDT steelhead population was modeled. Both wild and hatchery steelhead have been passed above KFH. The relative fitness of hatchery steelhead in the Kalama River is less than wild steelhead (Leider et al. 1990 and Hulett et al. 1996). Specific brood year data was used to reduce the effectiveness of hatchery spawners when available, otherwise the average reproductive success was used. The eruption of Mt. St. Helens, resulted in high stray rates into the Kalama River; therefore the returns influenced by this event were not used in this analysis (Leider 1989). Due to the hatchery program, escapements of hatchery and wild steelhead approached equilibrium levels and the spawner-recruit data are not very informative about the productivity of the stock. The EDT estimate of performance is slightly outside this 95% confidence region. In reviewing the EDT outputs, the survival of juvenile steelhead overwintering in the mainstem was reduced due to estimates of bed scour in these canyon reaches. This pattern was observed in other basins with larger canyons and a monitoring program for bed scour using TFW protocols should be established to address this uncertainty (WFPB 1997).

The Washougal River summer steelhead population has been monitored by snorkeling from the 1950's to the early 1970's and monitoring was re-initiated in 1985. Recently, these snorkel counts were standardized and population estimates were made using PCE from snorkeling. During the course of the data collection, the ocean regime has cycled through productive and unproductive periods (Hare and Francis 1994) and the data is highly variable. The EDT point estimate falls within the 95% contour.

Most fall chinook populations are associated with a hatchery program. Due to the potential uncertainties and lack of specific data, only three fall chinook populations were identified for comparison with the EDT model. Tule populations on the Coweeman and EF Lewis are shown in Figure 5. As mentioned above these populations are monitored using a PCE of live and dead counts and index reaches are expanded to estimate the entire population. To estimate ocean harvest, these stocks were assumed to have interception and maturity rates similar to the Cowlitz Hatchery CWT groups. Given these assumptions, there is an unknown amount of measurement error in the spawner-recruit data. When the EDT fit is plotted against both populations the fit is reasonable. The point estimate for the Coweeman population is within the 95% confidence region, while the EF Lewis estimate is not. The MLE of capacity in the EF Lewis River was over 100,000 adults which not feasible for this small basin.

Lewis River fall chinook are classified as a bright population. This population has a different life history pattern than the typical tule population. The Lewis River bright stock was modeled with extended freshwater rearing and higher smolt to adult survival due to their larger outmigration size. As with other populations, the spawner-recruit data is highly variable and the BH model had a poor fit to the data. The EDT fit to the data was through the middle of the scatter plot and point estimate is within the 95% confidence region (Figure 6).

The Grays River chum salmon dataset was the only one available for this species for a comparison with the EDT model because other datasets are too recent or other counts represent an unknown and potentially varying portion of the escapement. Similar to the tule spawner-recruit dataset, this dataset has an unknown amount of measurement error. There were no stock specific estimates of harvest and the recruits in this dataset are post harvest recruits. The original MLE were unrealistic and two data points with the lowest escapement were eliminated from the dataset to obtain a realistic convergence. The BH curve from EDT provides a reasonable estimate of chum performance and the point estimate falls within the 95% confidence region (Figure 6).

Summary

Overall EDT model passed the criteria that salmon performance is consistent with observed data. Estimates of spawner-recruit performance as measured by the BH model were similar between the MLE fit to observed data and the EDT estimate based on the quantity and quality of available habitat when recruits were measured as smolts. All three point estimates from the EDT model were within the 95% confidence region from the observed data. When recruits were measured as adults the MLE of the BH parameters were some times realistic and sometimes unrealistic due to high variability in datasets and the lack of data at low spawning densities. For the remaining nine adult datasets, five EDT point estimates were within the 95% confidence region, two under estimated performance, one over estimated performance, and the EF Lewis was off due to lack of a realistic MLE of the BH parameters from the observed data. Population monitoring should be expanded to add additional stocks to assess risk and check the reasonableness of the EDT model. Some current spawning ground survey programs should be improved to increase the accuracy and precision of the population estimates.

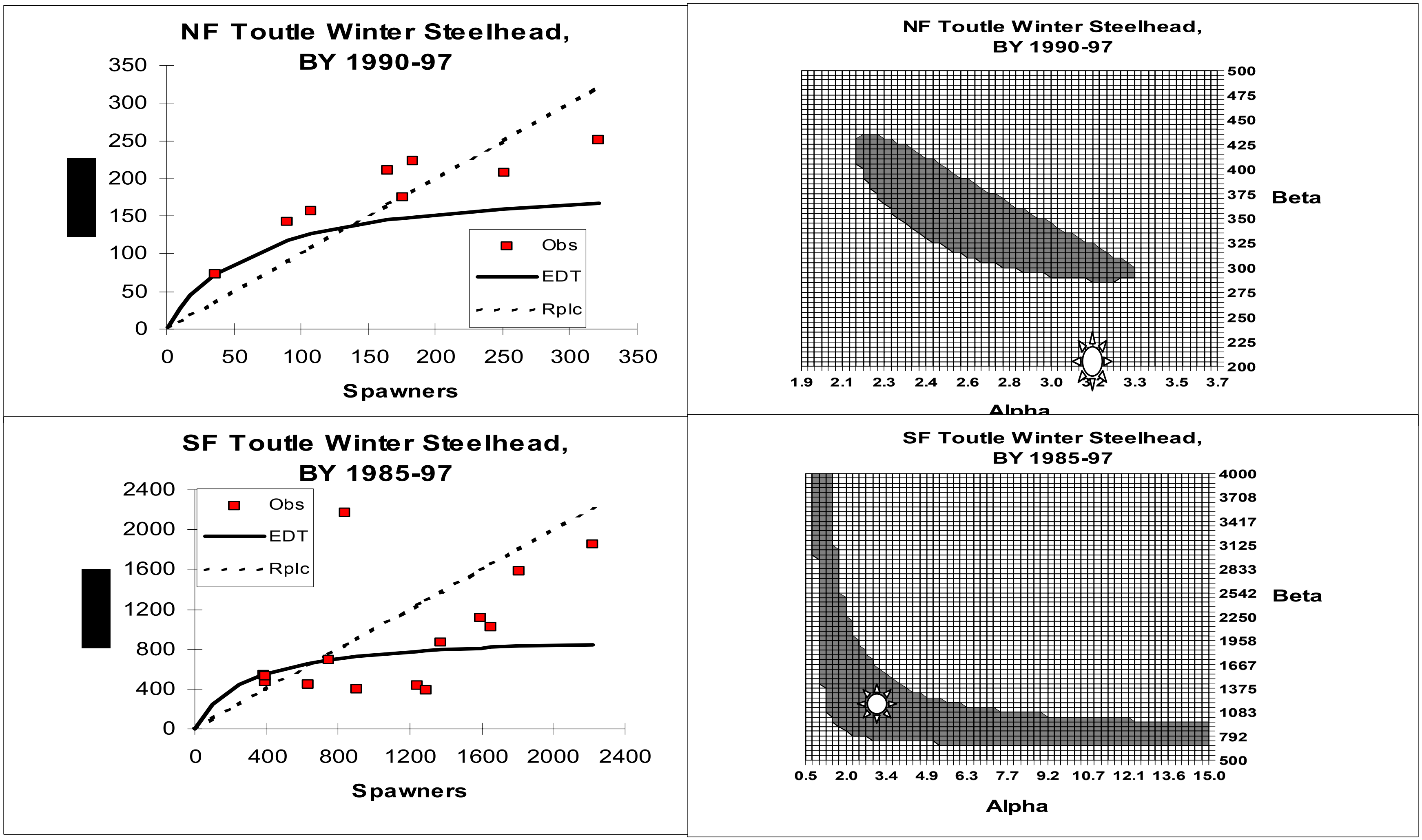

Figure 3. Comparison of EDT estimates of the Beverton-Holt spawner curve (solid line) with observed data (red squares) and the 95% confidence region determined by maximum likelihood analysis (dark grey pattern) compared to the EDT (α, β) point estimate (white sun).

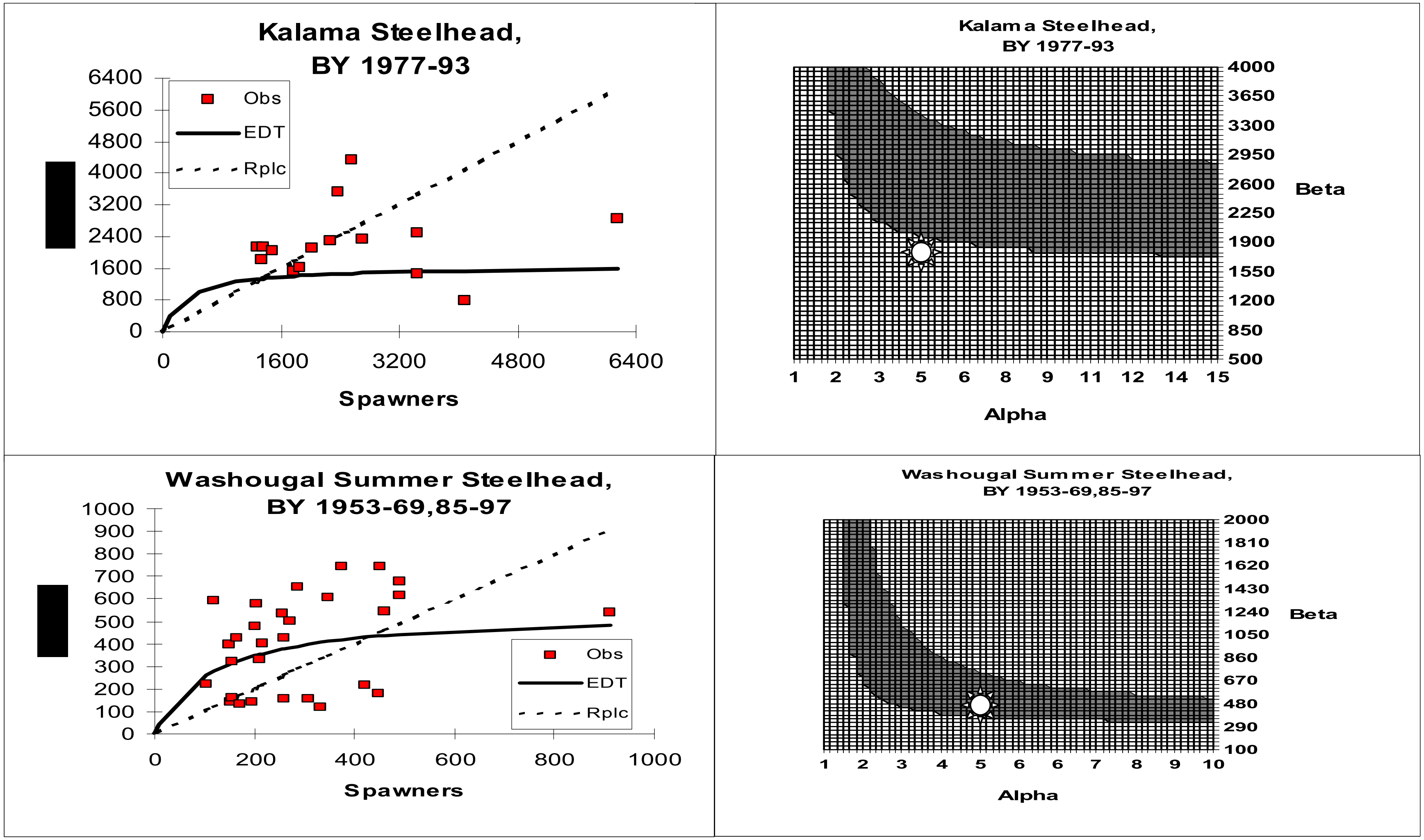

Figure 4. Comparison of EDT estimates of the Beverton-Holt spawner curve (solid line) with observed data (red squares) and the 95% confidence region determined by maximum likelihood analysis (dark grey pattern) compared to the EDT (α, β) point estimate (white sun).

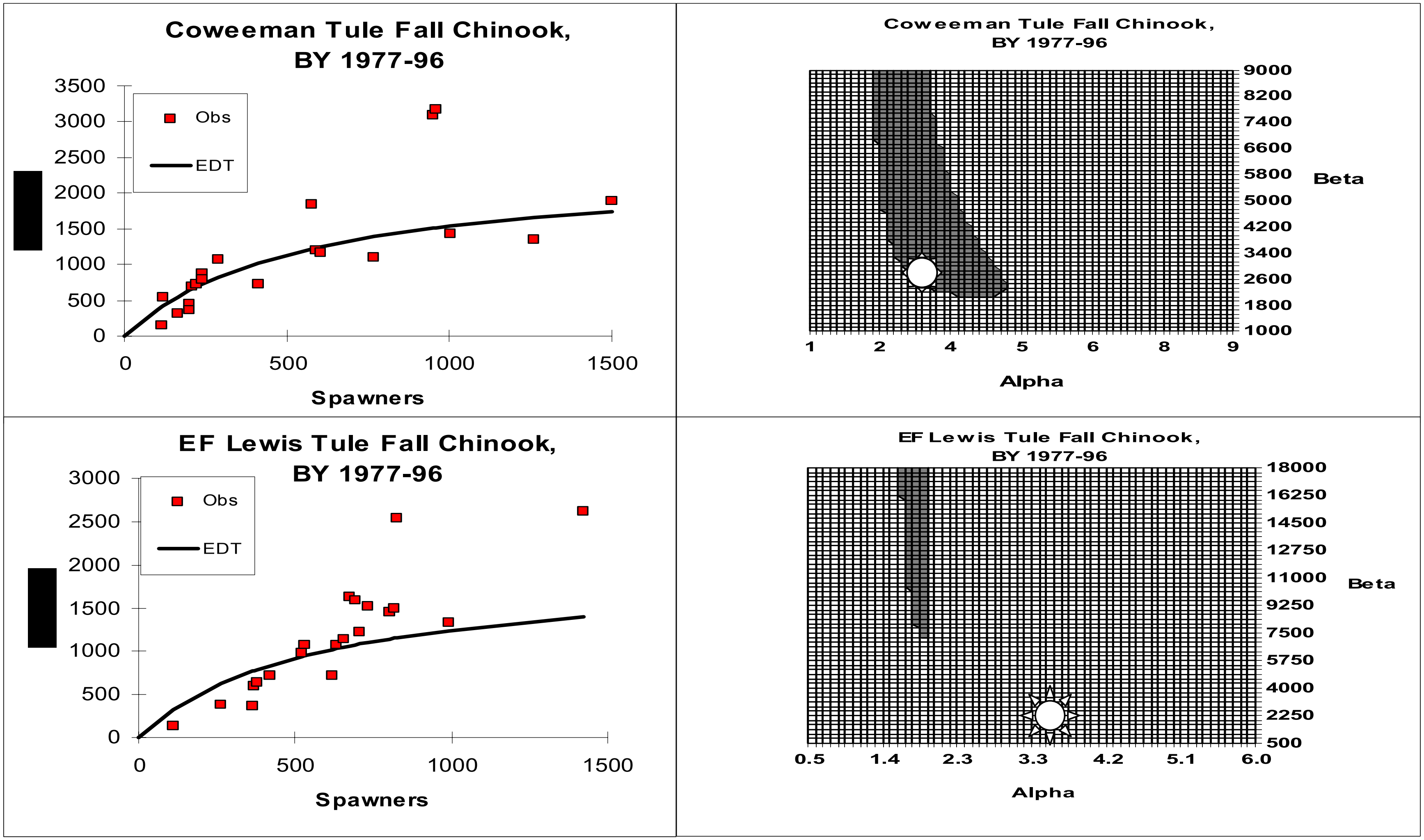

Figure 5. Comparison of EDT estimates of the Beverton-Holt spawner curve (solid line) with observed data (red squares) and the 95% confidence region determined by maximum likelihood analysis (dark grey pattern) compared to the EDT (α, β) point estimate (white sun).

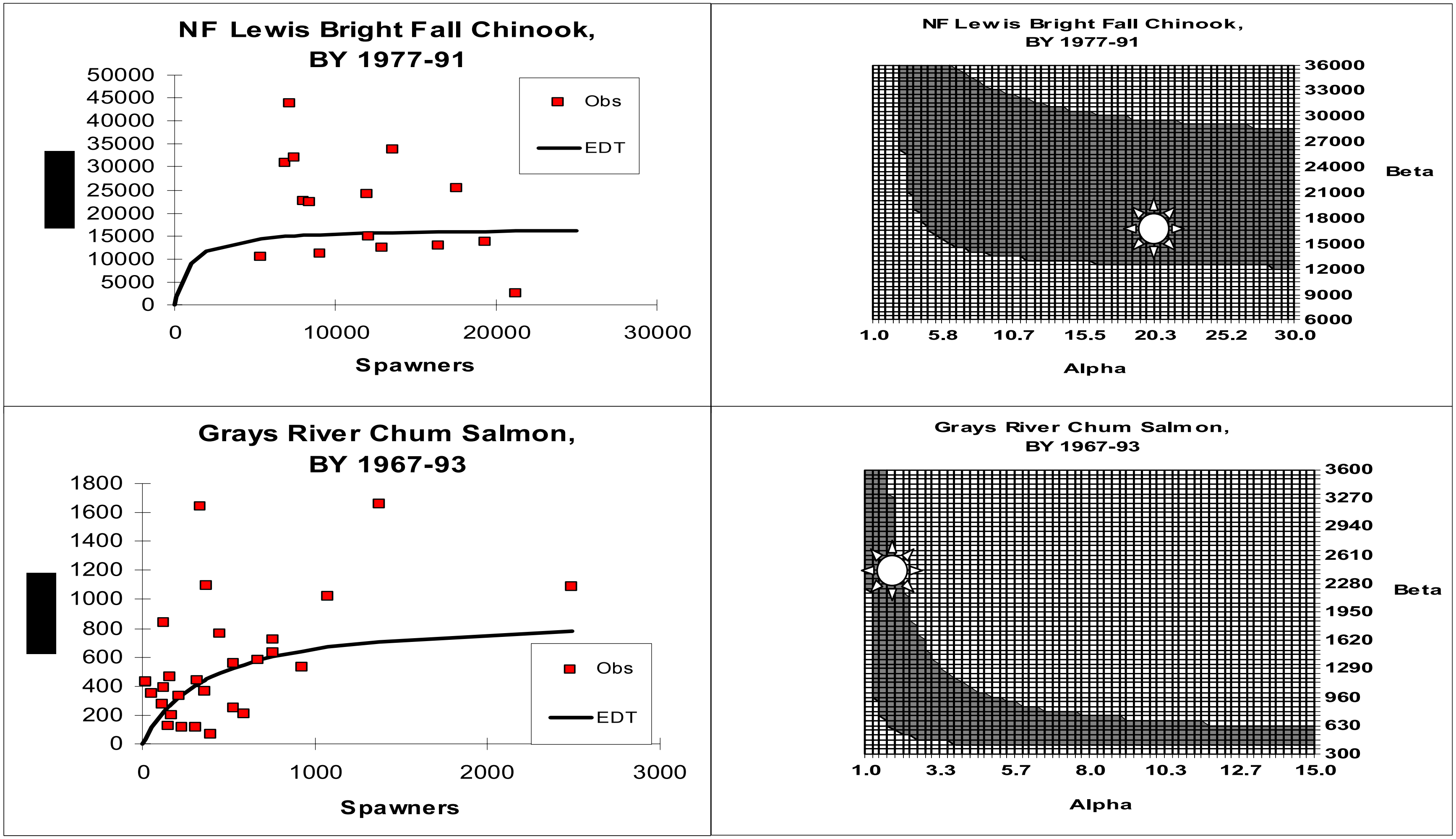

Figure 6. Comparison of EDT estimates of the Beverton-Holt spawner curve (solid line) with observed data (red squares) and the 95% confidence region determined by maximum likelihood analysis (dark grey pattern) compared to the EDT (α, β) point estimate (white sun).

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