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Appendix A: Mining in the Secret Ravine Watershed

History

Placer County is located along the old "Mother Lode Belt" in one of the state's most historically active regions for mining. Gold was discovered at Sutter's Mill in Coloma, California in 1848 in adjacent El Dorado County, and was the predominant commodity mined in Placer County, from its peak in the 1850s through its eventual decline in the 1960s (Haley 1923). The geology of this region dictated not only the types of commodities mined, but the types of mining methods employed. The alluvial deposits of the western Sierra Nevada, which contributed more than 40% of California's total gold output, are divisible into the Tertiary (older, 65-million-years) deposits, which consist predominantly of quartzitic gravels, and Quaternary deposits, which are in and adjacent to the present stream channels. The Tertiary channel deposits - which correspond to the higher gradient drainages upstream of Secret Ravine - including the Bear and Yuba Rivers - were exploited primarily by hydraulic and drift mining, while the greatest yields from Quaternary deposits - the type found directly along the low-gradient Secret Ravine basin - purportedly yielded the most efficient output through dredge mining.

Hydraulic mining came to prominence because of an abundance of cheap water and sufficient grade for the disposal of tailings (Haley 1923). Indeed, the Yuba contained "undoubtedly the largest single body of commercial hydraulic gravel in the State of California" by 1921 (Haley 1923). It was eventually recognized, however, by the early 1870s, that hydraulic mining was disruptive to other land interests. "Where irrigation canals are fed from rivers below the dumping ground of the mine, it is quite possible that these canals may be silted by mining operations; which would naturally result in trouble for all concerned" (Haley 1923). At the same time land primarily used by miners as dumping grounds, started increasing in value and agricultural interests overtook mining interests in the form of the 1893 Caminetti Act. (California State Mining Bureau 1916). The Act outlawed the practice of hydraulic mining, but made exceptions with the allowance of debris-restraining dams if they were shown to mitigate the sedimentation of streams by hydraulic mining, thus it continued through the 1920s. All-told, hydraulic mining was estimated to have been responsible for 1.295 billion cubic yards of gravel washed into tributaries of the Sacramento River during this time period (Haley 1923).

The shifts in geography and commodity, not to mention economy, corresponded to the concurrent chronological and physical shifts from panning of surface placer golds to hydraulic mining of gold from quartz veins to drift and dredge mining of the river gravels (i.e. methods increasingly more adverse to stream morphology) through the early part of the 20th century. Indeed, these changes are reflected in microcosm on the Secret Ravine watershed.

All-told, hydraulic mining was estimated to have been responsible for 1.295 billion cubic yards of gravel washed into tributaries of the Sacramento River during this time period. (Haley 1923). The shifts in geography and commodity, not to mention economy, corresponded to the concurrent chronological and physical shifts from panning of surface placer golds to hydraulic mining of gold from quartz veins to drift and dredge mining of the river gravels through the early part of the 20th century. Indeed, these changes are reflected in microcosm on the Secret Ravine watershed.

Risk Characterization for Source

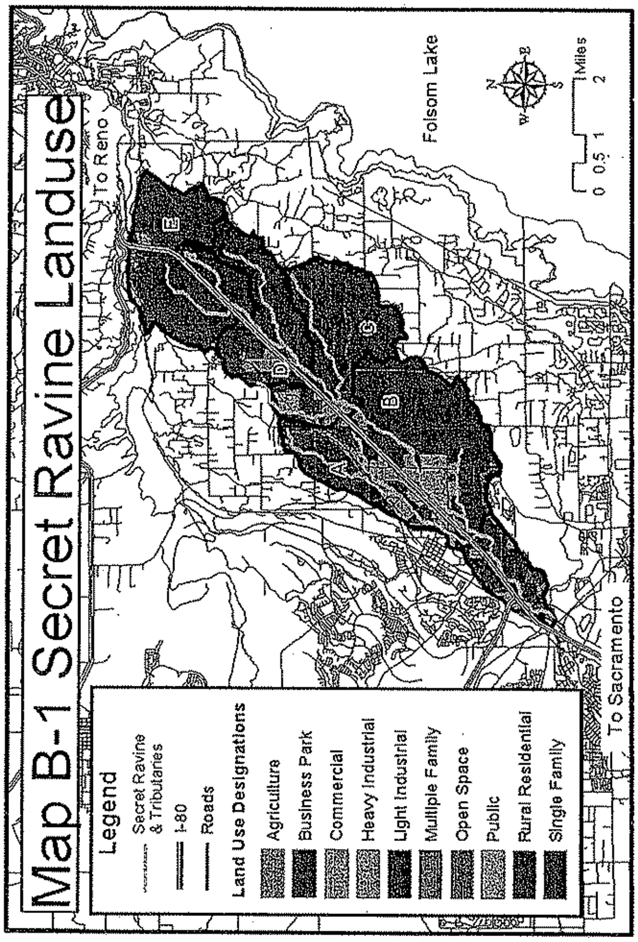
Risk characterization for mining was loosely based on a calculus of commodity mined (in terms of persistence chemical impacts), intensity of mining activity (or mining type) and mining duration. The refining chemicals chiefly associated with placer mining were zinc and cyanide (Haley 1923), and the tailings were primarily in the form of mercury.

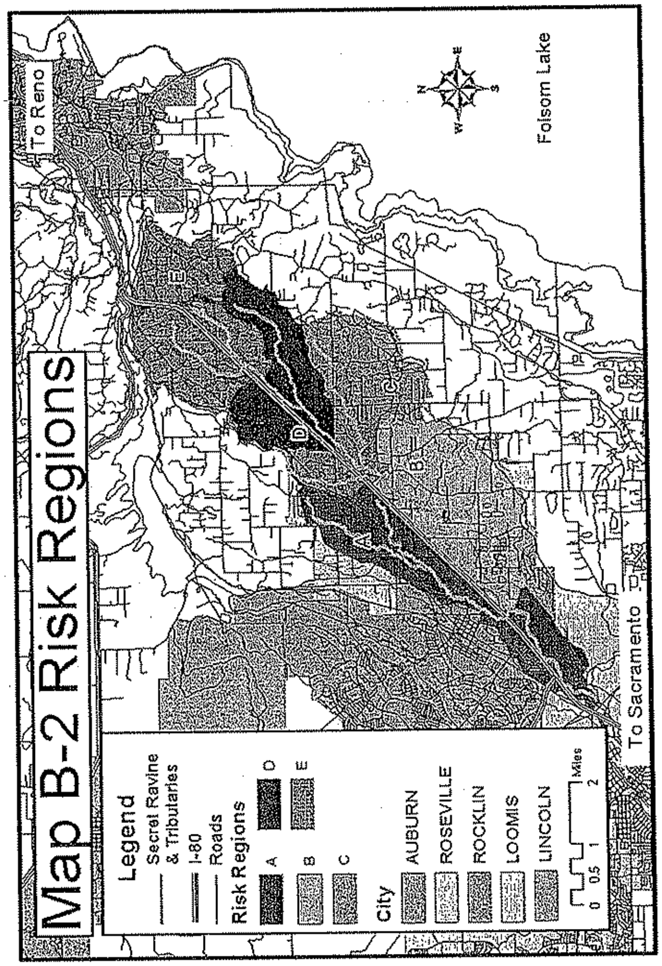
The entire watershed was most likely exposed to the hydraulic runoff from the lower Yuba and Bear Rivers via the canal system (the Boardman Canal, in particular), constructed during the turn of the century to transport foothill Sierra water to the agricultural lands surrounding Secret Ravine. (Meadow Vista Vegetation Management Project 2001). This produced a period of channel aggradation, which disrupted the stream morphology of the system so severely, that the stream is still not considered recovered (Swanson 2001). For this, a baseline of 2 is warranted across all risk regions. Secondly, Rocklin district (an area encompassing present day Risk Regions B and C) was the epicenter of granite quarry mining in Placer County in the early 20th century (for mining of quartz and feldspar, and for direct use in the construction of buildings, curbstone, paving bricks and riprap) (California State Mining Bureau 1916). The Lee Drift Mine (one of the principle placer gold mines), was also located squarely where Sierra College is presently located, and was dredge-mined through the late 1950s. Perhaps most famous of all were the Alabama and Mary Len mines (located on the border of Risk Regions D and E). Alabama reaped $1 million in profits from the sale of gold, silver, granite and quartz, Mary Len, $500,000 (California State Mining Bureau 1916). Risk Region E also had several limestone quarries. Thus, the upper four risk regions, based not only on pervasive hydraulic runoff from upper drainages, but on their documented accounts of major - although short-term mining operations and commodities and persistent refining chemicals, received 4s in relation to Risk Region A, where, according to the records consulted, there were no major mining operations. These chemicals may have had, and may still have, chronic toxicity implications for the fish, and they include zinc, copper and chrome.

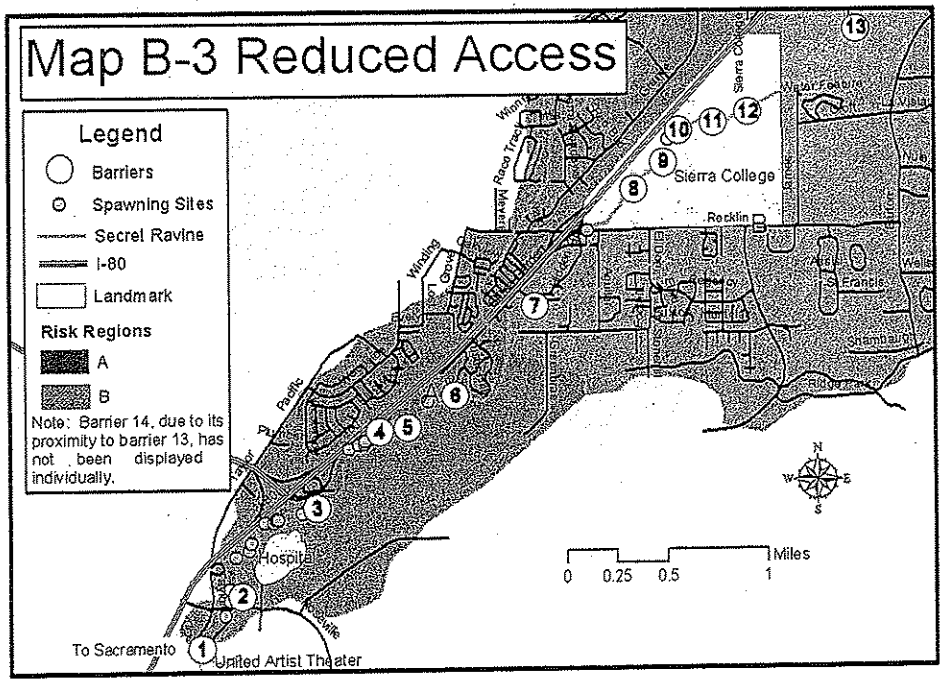
Dredging operations in the area were curtailed during World War II due to increasing costs, depletion of dredging grounds and changing land values. The last dredging operation shut down in Folsom in 1962. There are currently no known mining activities within or remotely near the Secret Ravine watershed, although there is high aggregate demand throughout southwestern Placer County (particularly in alluvial sand, gravel and crushed granite), and there are still active gold mines in eastern Placer County (The Mineral Industry Handbook 1999).

Appendix B: GIS Maps

The following pages contain GIS Maps B-1 through B-4.

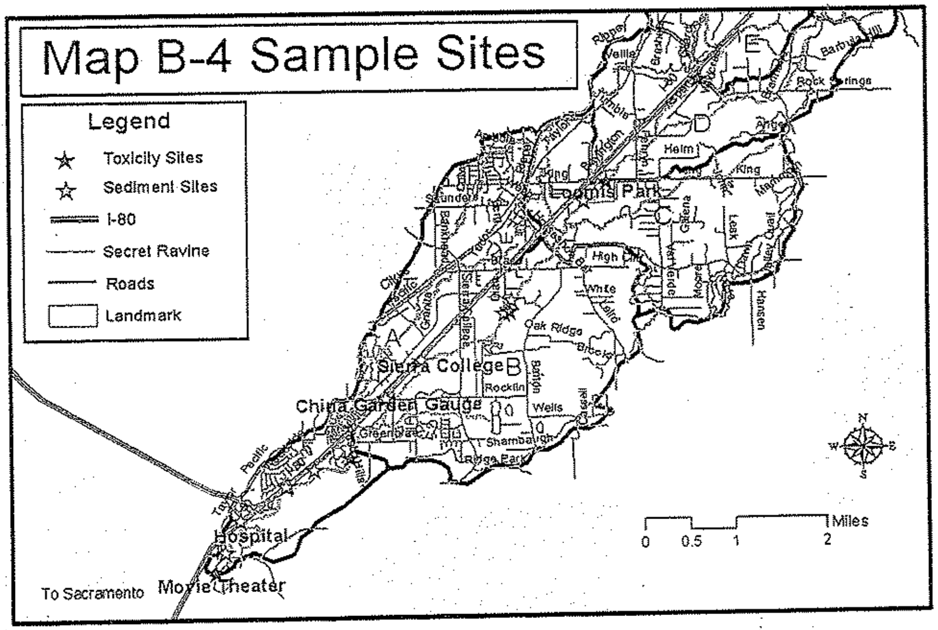

Map B-1 Secret Ravine Landuse
Legend
Secret Ravine & Tributaries
I-80
Roads
Land Use Designations
Agriculture
Business Park
Commercial
Heavy Industrial
Light Industrial
Multiple Family
Open Space
Public
Rural Residential
Single Family
To Reno
To Sacramento
Folsom Lake
A
B
C
D
E
N
E
S
W
0 0.5 1 2 Miles


Map B-2 Risk Regions
Legend
Secret Ravine & Tributaries
I-80
Roads
Risk Regions
A
B
C
D
E
City
AUBURN
ROSEVILLE
ROCKLIN
LOOMIS
LINCOLN
0
0.5
1
2
Miles
To Reno
To Sacramento
Folsom Lake
N
E
S
W
A
B
C
D
E



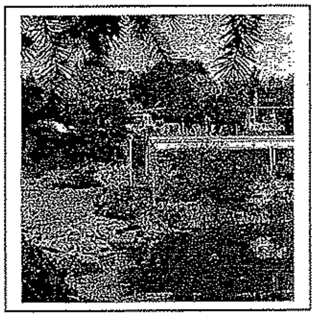
Map B-3 Reduced Access

Note: Barrier 14, due to its proximity to barrier 13, has not been displayed individually.

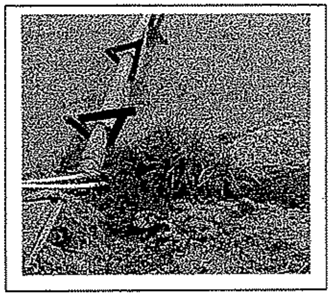


Map B-4 Sample Sites

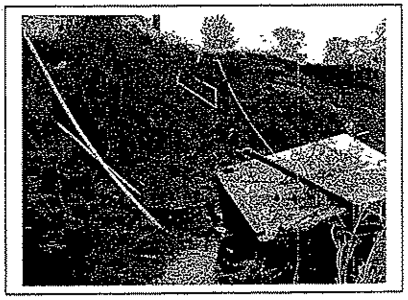
Appendix C: Images of Secret Ravine Today



TRAILER PARK PONDS IN CASTLE CITY TRAILER PARK

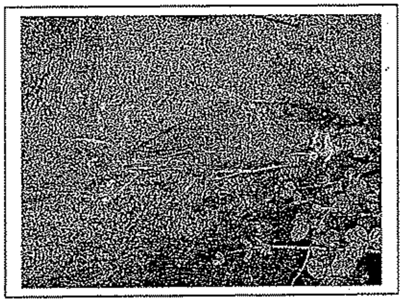


EUTROPHICATION AT NEWCASTLE



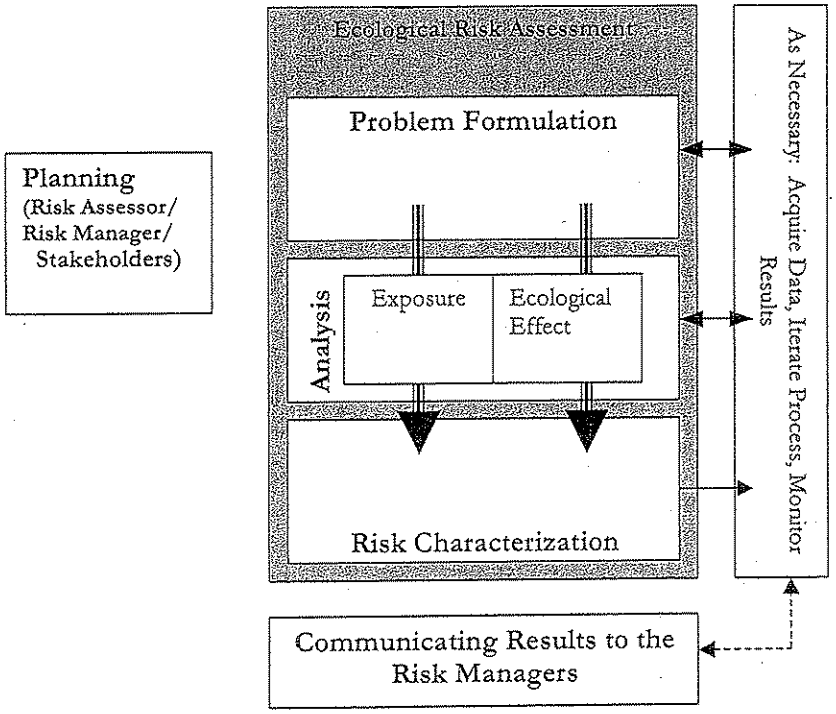
PUMPS, PIPES AND GARBAGE NEAR PENRYN ROAD (PHOTO COURTESY B. WASHBURN)

TREE FROG



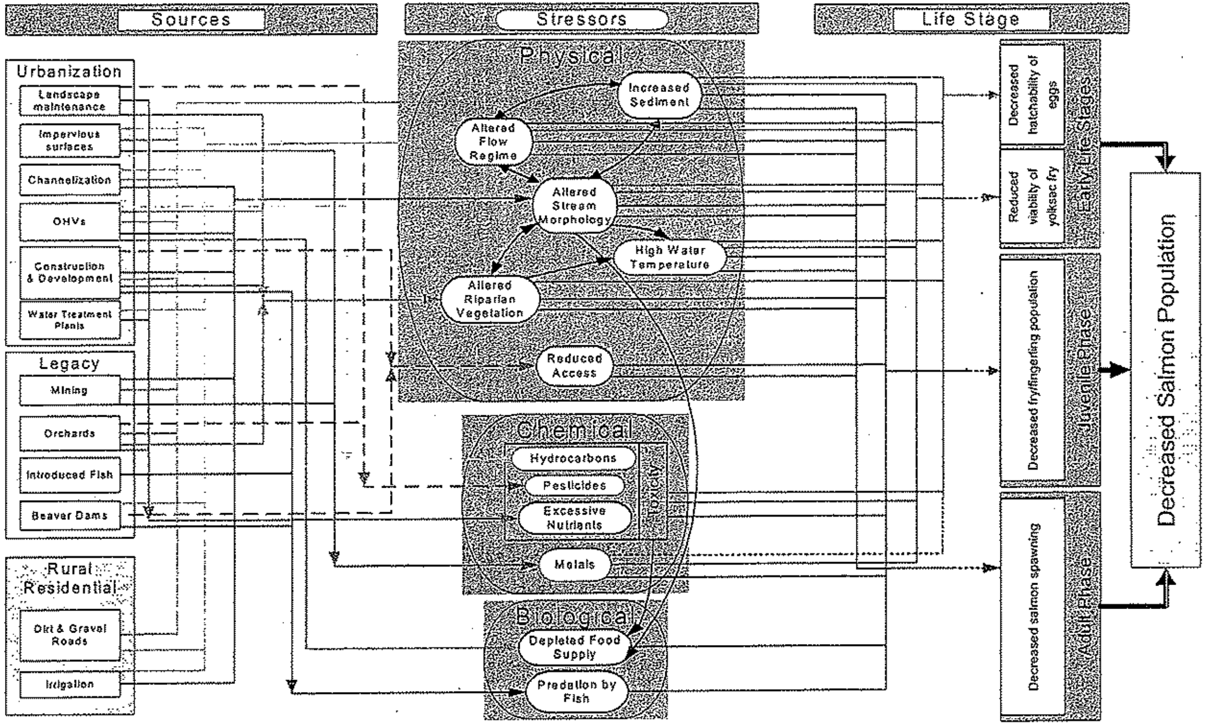
ADULT FALL-RUN CHINOOK IN SECRET RAVINE (PHOTO COURTESY M. POSEHN)

Appendix D: The Framework for Ecological Risk Assessment



Appendix E: The Conceptual Model

Conceptual Model - Stressors on Chinook Salmon - Secret Ravine



Appendix F: Sources and Stressors

Sources

LM	Landscape Maintenance
IS	Impervious Surface
CH	Channelization
OHV	Off Highway Vehicles
CD	Construction & Development
WTP	Water Treatment Plants
MI	Mining
OR	Orchards
IF	Introduced Fishes
BD	Beaver Dams
DG	Dirt & Gravel Roads
IR	Irrigation

Stressors

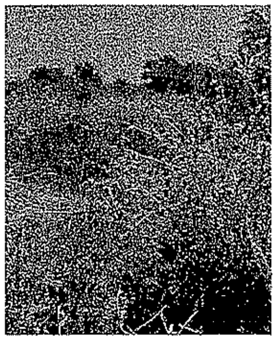
S	Sediment
F	Flow
M	Morphology
Te	Temperature
V	Altered Riparian Vegatation
RA	Reduced Access
To	Toxicity
Me	Metals
FS	Food Supply
P	Predation by Fish

	Stressors	Direct Sources	Indirect Sources	# of Sources
PHYSICAL	Sediment	IS, OHV, CD, DG, CH	IR, WTP, BD, LM, MI, OR	11
	Flow	IS, CH, CD, WTP, DG, IR, BD	OHV, MI, OR, LM	11
	Morphology	CH, OHV, CD, IR	WTP, IS, OR, DG, BD, LM, MI	11
	Temperature		LM, IS, CH, OHV, CD, WTP, MI, OR, BD, DG, IR	11
	Altered Riparian Vegetation	OHV, CD, LM	IS, CH, WTP, MI, IR, DG, BD, OR	11
	Reduced Access	CD, BD		2
CHEMICAL	Toxicity	IS, OHV, LM, OR, WTP		5
	Metals	IS, MI		2
BIOLOGICAL	Food Supply	OHV, WTP, IS, LM	CH, CD, MI, IR, OR, DG, BD	11
	Predation by Fish	IF, BD		2

Appendix G: Invasive Plants and Blackberry (*Rubus discolor*)

Invasive plant species can be divided into two categories, those plant species that alter ecosystem processes and replace native species or those plants that just displace native species. According to Randall and Hoshovsky 'the invasive species that cause the greatest damage are those that alter ecosystem processes such as nutrient cycling, intensity and frequency of fire, hydrological cycles, sediment disposition, and erosion (Randall 2000). None of the plants observed in the Secret Ravine stream system exhibit this type of biology.

The second category of invasive plant displaces native vegetation. Within Secret Ravine (as with other areas of California) this displacement has four effects: invasive plants "outcompete native species, suppress native recruitment, alter community structure, degrade or eliminate habitat for native animals, and provide food and cover for undesirable non-native animals"(Randall 2000). In Secret Ravine, examples of how these effects currently influence the stream can be observed in the biology of the six listed invasive species (CalEPPC 1999): medusa grass (*Taeniatherum caput-medusae*), star thistle (*Centurea solstitialis*), Himalayan blackberry (*Rubus discolor*), edible fig (*Ficus carica*), tree-of-heaven (*Ailanthus altissima*), and fennel (*Foeniculum vulgare*) (Holland 2000, per comm. S. Egan). The Medusa head and yellow star thistle are currently replacing the non-native annual grasses, that a century ago replaced the native perennial bunch grasses. Recruitment of native plant species has all but been eliminated in the grassland environment of the California Central Valley and has experienced complete shifts in community structure (Holland 2000, Randall 2000).



STAR THISTLE ON SECRET RAVINE

Another example, the edible fig, tree-of heaven and fennel, have in some locations of the Sierra Nevada dominated the canopy in the riparian zone changing community structure and degrading or eliminating habitat for native animals (Randall 2000). Currently, the invasion of edible fig, tree-of heaven and fennel have not progressed to this extent in Secret Ravine, but the management of these invasions should be a top management priority. Additionally, Himalayan blackberry, a shrub seen throughout Secret Ravine can provide nesting habitat to black rat (*Ratus ratus*), an exotic animal species and disease vector (City of San Francisco 2000, Hickman 1996, Dutson 1974).

	Today's Vegetation	**Mining Era**	**Pre-Columbian**
Dominant Grasses & Forbs	Naturalized annual grasses and invasive forbs have replaced nearly all native grasses in California: Soft chess (*Bromus hordaceus*), Ripgut brome (*Bromus diandrus*), Medusa grass ^{A1} (*Taeniatherum caput-medusae*), Filaree (*Erodium botrys*) Wild lettuce (*Lactuca serriola*) & Yellow star thistle^{A1} (*Centurea solstitialis*)	Mining activity in the riparian zone removed most pre-Columbian vegetation and provided ample opportunity for invasive plant introductions.	Native bunch grasses predominately Creeping wild rye (*Leymus triticoides*)
Dominant Scrub	Early seral community and invasive species indicative of disturbance including: Himalayan blackberry ^{A1} (*Rubus discolor*), Button willow (*Cephalanthus occidentalis*), Nettles (*Urtica dioica holosericea*)	Mining activity in the riparian zone removed most pre-Columbian vegetation and provided ample opportunity for invasive plant introductions.	Shade tolerant shrubs include: Ashes (*Fraxinus latifolia*), Box elder (*Acer negundo var. californicum*), Walnut (*Juglans hindsii*), & Wild grape (*Vitis california*)
Dominant Overstory	Valley oak (*Quercus lobata*) Fremont cottonwoods (*Populus fremontii*) White alder (*Alnus rhombifolia*) Species of Concern: Edible fig ^{A2} (*Ficus carica*) Tree-of-heaven ^{A2} (Ailanthus altissima) Fennel ^{A1} (*Foeniculum vulgare*)	Few Valley oaks (*Quercus lobata*)	Nearly closed canopy dominated by Valley Oak (*Quercus lobata*)

A1 - Medusa grass (*Taeniatherum caput-medusae*), Himalayan blackberry (*Rubus discolor*) star thistle (*Centurea solstitialis*) & fennel (Foeniculum vulgare) have a class A1 exotic pest plant designation, meaning they are invasive in three Jepson Regions or the more than half of California.

A2 – Edible Fig (*Ficus carica*) & Tree-of-heaven (*Ailanthus altissima*) have a class A2 exotic pest plant designation, meaning they are invasive in three Jepson Regions or the more than half of California.

A Jepson Region describes the floristic provinces within California as described by *The Jepson Manual: Higher Plants of California* (Hickman, J., Ed., 1993). The Jepson Manual is a taxonomic key providing a comprehensive treatment of the flora of California.

* - A forb is a low growing herb and the combination of forbs and grasses typically compose the ground cover in many ecosystems.

CHANGES IN DOMINANT VEGETATION IN RIPARIAN CORRIDOR OF SECRET RAVINE

We focused our analysis on Himalayan blackberry because these woody plants dominant the banks of Secret Ravine, creating most of the near shore fish cover for chinook salmon (Bishop 1997, Holland 2000, as per comm. S. Egan, Ecorp). However, the effects of blackberry were mixed between the habitat value it provides Secret Ravine salmon and the possible erosion caused by the replacement of native flora with blackberry. Therefore the decision was made not to include it in the overall risk calculation.

Himalayan blackberry (*Rubus discolor*)

The cultivation of Himalayan blackberry in California began in 1885 (Bailey 1945). Originally from Western Europe (Munz and Keck 1973), *Rubus discolor* had naturalized on the west coast of the North America by 1945 (Bailey 1945). Today, on the west coast of North America, *Rubus* discolor is considered an invasive weed and has been classified by CalEPPC as an A1 invasive weed (CalEPPC 1999). *Rubus discolor* is a woody shrub with prickly canes or brambles which produce black, berry-like fruit (Hickman 1996). The Himalayan blackberry reproduces via vegetative reproductions and sexual reproduction. Vegetative reproduction occurs when the canes root at the apices[11] of the cane stem and produce new stems (Amor 1974a). Typically this is how established brambles of *Rubus discolor* reproduced, however some sexual reproduction does occur. *Rubus discolor* produces berries that ripen in the summer and fall; sexual reproduction occurs via these berries. However seedlings require a sunny wet location to germinate which often does not include the area directly adjacent to the mature blackberry bramble. Experimentally it was determined that seedlings receiving less than 44 percent full sun died (Amor 1974a). This indicates that most reproduction by *Rubus discolor* maybe through vegetative regeneration and that sexual reproduction may occur primarily during pioneering of new sites.

Himalayan blackberries supplies a food source for foraging birds and mammals, including people, as well as providing nesting habitat for birds and small mammals (Hoshovsky 2001, Hickman 1996). Among the small mammals that utilize *Rubus discolor* for food and shelter includes the roof rat (*Ratus ratus*). This introduced mammal favors blackberry brambles and can transmit disease (City of San Francisco 2000, Hickman 1996, Dutson 1974).

In Secret Ravine, invasive plants crowd out native flora that would, to a greater degree prevent erosion and stabilize banks. However the greater stabilization afforded by native flora compared to the current plant assemblages found in Secret Ravine is unknown.

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[11] An apices is a growing tip of a shoot. This includes the ends of canes and stems in the case of Rubus discolor.

But given this caveat, the blackberry brambles do prevent and decrease some soil erosion (Bishop 1997). "Vegetation can prevent soil erosion by 1) interception of raindrops 2) restraint of the soil particles by root systems 3) providing physical roughness slows water down 4) enhanced infiltration and 5) uptake (of water)" (Hickin 1984). Blackberry to some extent prevents erosion through all five of these processes. Also blackberry provides habitat value to other animal species such as birds and mammals in the riparian zone. In addition to the habitat value to terrestrial animals, chinook salmon directly utilize the overhanging branches of the blackberry as fish cover and habitat complexity. Secret Ravine has essentially no large woody debris (Li 1999). Therefore these overhangs are a main component of fish habitat complexity within the creek. The question as to why Secret Ravine does not have a lot of woody debris is complex: related to the species composition of the riparian area and the amount of small sediment in the creek system. In any case, many streams with heavy infestation of blackberry have higher rates of woody debris. In consequence, the habitat complexity of blackberry provides a benefit to chinook salmon using Secret Ravine.

Given both the benefits and the costs of allowing *Rubus discolor* to dominant the ecosystem has been weighted by more comprehensive studies of the vegetation on Secret Ravine. Both Holland and Bishop suggest that Secret Ravine may benefit through the removal of blackberry (Holland 2000, Bishop 1997). This may well be the case, however, it should be stressed that before any management initiatives attempt to remove blackberry the question of what will replace the species as the dominant shrub in the ecosystem should be investigated and how the removal will be performed should be detailed. Other A1 weeds in Sierra Nevada foothills cause detrimental effects that do change basic ecosystem function such examples as tall white top (*Lepidium latifolium*), arundo (*Arundo donax),* tamarisks *(Tamarix chinensis, T. ramosissima, T. pentandra, T. parviflora)* can reduce actual water available to fish or can choke a stream with plants so fish cannot pass (Randall 2000). If a management approach replaced the blackberry infestation with an even more detrimental invasive species then perhaps this would not be the correct strategy. Also the process by which the plants are removed can cause more harm than good. The removal recommended must be done carefully; removal of vegetation from stream banks can destabilize banks and cause significant sediment input if not protected during the rainy season (Holland 2000, Bishop 1997). A well thought out program may gain much for the Secret Ravine ecosystem, but a second best management effort may be to prevent new invasions by exotic weeds, than to fight invasive weeds fully entrenched in the Secret Ravine ecosystem (Randall 2000).

Appendix H: Introduced Fish Species List

Common Name	Family	Feeding Strategy	Preferred Habitat	Effect on salmon	Status/Year of Introduction to California
Golden shiner, *Notemigonus crysoleucas* (Mitchill)	Minnow family (Cyprinidae)	Surface and midwater feeders, feed on zooplanton and zooplanters	Warm shallow ponds, lakes, and sloughs often associated with aquatic plants	Little effect due to poor adaptation to Secret Ravine	IIE, 1891(?)
Common carp, *Cyprinus carpio* (Linnaeus)	Minnow family (Cyprinidae)	Omnivorous bottom feeders, feed predominately on algae and aquatic insect larvae however fish larvae and eggs also eaten when available	Warm turbid water at low elevations but can survive in trout streams	Predation of fish eggs	IIE, 1872
Fathead minnow, *Pimephales promelas* (Rafinesque)	Minnow family (Cyprinidae)	Omnivorous bottom feeders, feed predominately on filamentous algae, diatoms, small invertebrates including chironomid larvea, and organic matter	Pools in small, muddy, streams and ponds	Competition with juveniles	IIE, 1953(?)
Black bullhead, *Ameiurus melas* (Rafinesque)	Catfish family (Ictaluridae)	Omnivorous bottom feeders, feed predominately on fish, amphipods, isopods, snails, and other invertebrates including chironomid larvae	Ponds, small lakes, river backwaters, and sloughs and pools of low gradient streams with muddy bottoms, warm turbid water	Competition with juveniles	IID, 1930s
Brown bullhead, *Ameiurus natalis* (Lesueur)	Catfish family (Ictaluridae)	Omnivorous bottom feeders, feed predominantly on amphipods, isopods, crayfish, and chironomid larvea	Highly adapted to cold and warm water including trout streams, also found in lakes, sloughs and river pools, with sluggish, low-gradient reaches and high turbidity, beds of aquatic plants and soft substrate	Competition with juveniles	IID, 1874
White catfish, *Ameiurus natalis* (Linnaeus)	Catfish family (Ictaluridae)	Carnivorous bottom feeders, feed predominately on invertebrates and fishes	Slow-current river habitat with water depths of 3-10 m	Little effect due to poor adaptation to Secret Ravine	IID, 1874
White crappie, *Pomoxis annularis* (Rafinesque)	Sunfish family (Centrarchidae)	Opportunistic predator, feed predominately on planktonic crustaceans and small fish	Warm turbid lakes, reservoirs, and river backwater	Little effect due to poor adaptation to Secret Ravine	IID, 1891 or 1908
Green sunfish, *Lepomis cyanellus* (Rafinesque)	Sunfish family (Centrarchidae)	Opportunistic predator, predominately on small fish and invertebrates including chironomids	Small, warm streams, ponds, and lake edges	Predation on juveniles and competition with juveniles	IIE/IID, 1891 or 1908

Common Name	Family	Feeding Strategy	Preferred Habitat	Effect on salmon	Status/Year of Introduction to California
Warmouth, *Lepomis gulosus (Cuvier)*	Sunfish family (Centrarchidae)	Opportunistic predators, feed predominately on opossum shrimp, amphipods, and aquatic insects but larger fish eat crayfish and fish	Abundant cover in warm, turbid, muddy-bottomed sloughs and backwater of the Sacramento and Colorado River	Little effect due to poor adaptation to Secret Ravine	IIC, 1891(?)
Redear sunfish, *Lepomis microlophus* (Gunther)	Sunfish family (Centrarchidae)	Omnivorous bottom feeders predominately on hard shelled invertebrates and aquatic plants	Deeper waters of warm, quiet ponds, lakes, and river backwater and sloughs with substantial beds of aquatic vegetation	Little effect due to poor adaptation to Secret Ravine	IID, 1950 & 1954
Bluegill, Lepomis macrochirus (Rafinesque)	Sunfish family (Centrarchidae)	Opportunistic predators, aquatic insect larvae, planktonic crustaceans, flying insects, snails, small fish and fish eggs.	Warm, shallow lakes, reservoirs, ponds, streams, and sloughs at low elevation	Predation on eggs and competition w/ juveniles	IID, 1908
Largemouth bass, *Micropterus salmoides* (Lacepede)	Sunfish family (Centrarchidae)	Opportunistic predators, feed largely on threadfin shad, golden shiners, and bluegill though in Bay Delta predate on juvenile salmon and native minnows	Warm shallow waters <6 M in depth can include farm ponds, lakes, reservoirs, sloughs, and river backwaters	Predation on juvenile salmon though Secret Ravine not ideal habitat	IID, 1891 or 1895
Smallmouth bass, *Micropterus dolomieu* (Lacepede)	Sunfish family (Centrarchidae)	Opportunistic predators, feed largely on crayfish also an introduced species	Clear lakes, clear streams with abundant cover and cool summer temperature (elevation between 100 and 1000M)	Good habitat for these fish, however prefer crayfish	IID, 1874
Spotted bass, *Micropterus punctulatus* (Rafinesque)	Sunfish family (Centrarchidae)	Opportunistic predators of larger invertebrates and fish; they feed largely on aquatic invertebrates, fish, crayfish, and terrestrial insects	Moderately sized, clear, low-gradient sections of rivers and reservoirs, like faster water than large mouth bass and more turbid water than small mouth bass	Most abundant fish seen in Secret Ravine, predation on juvenile fish	IIE, 1936
Western Mosquitofish, *Gambusia affinis* (Baird and Girard)	Livebearer family (Poeciliidae)	Opportunistic omnivore, predominately feed on what organisms are most abundant including aquatic invertebrate insects such as mosquito larvae and pupae, algae, zooplankton, and terrestrial insects	Wide range of conditions including warm ponds, lakes, and streams	Little effect due to preference for mosquitoes	IIE, 1922

Assessment of Stressors on Fall-Run Chinook Salmon in Secret Ravine (Placer County, CA)

Common Name	Family	Feeding Strategy	Preferred Habitat	Effect on salmon	Status/Year of Introduction to California

Status: Describes abundance trends and management needs. This is the status found in Moyle's Inland Fishes of California, 2002.

I. Alien Species

C. Localized likely to become more widespread or already widespread but not abundant in most areas. Alternately, it may be fairly common but is declining. The species is usually a recent introduction and is just starting to expand its range, or it is a long-established species that is only regionally abundant.

D. Widespread and stable. The species is widely distributed but seems to have reached the limits of its range. Presumably such species are integrated into local ecosystems.

E. Widespread and expanding. These fish are aggressive invaders that are still expanding their range to all suitable habitats in the state.

Appendix I: Source Analysis and Characterization

Category	Source	Analysis	Characterization				
			Risk Region				
			A	B	C	D	E
Urbanization	Landscape Maintenance	Ranks for both landscape maintenance and impervious surfaces were developed using land-use maps from the Sacramento Area Council of Governments (SACOG). Standard percent impervious surface values were applied based on literature reviews (percent landscape maintenance values were estimated based on BPJ). Audra Heinzel, Cal-EPA intern, then spot-checked these values specifically in the Secret Ravine watershed. Adjustments were made accordingly and areas were calculated for each land use category.	2	2	6	2	4
	Impervious Surfaces		4	2	6	2	4
	Channelization	Habitat data from ECORP indicated areas where rip-rap was present (channelized) in the stream and associated lengths for those sections. These stream lengths were summed for the risk region. A buffer of 100 feet was then applied to I-80 (from the PLTIGERV map). Stream lengths within that buffer were also considered channelized. Such sections only existed in risk regions A and B, but channelization most likely exists in other risk regions.	6	4	0	0	0

Urbanization	Construction & Development	Construction and development sites were digitized from a 2002 aerial photo Only one large construction site existed in Risk Region A.	4	0	0	0	0
	Water Treatment Plants	The Newcastle and Castle City sewage plants were digitized from a 2002 aerial. Both of these treatment plants in Risk Region E.	0	0	0	0	6
	OHVs	The extent of OHV trails was digitized from a 2002 aerial photo. From stakeholder information and direct observation it was determined that substantial OHV use occurs only in one large area within sections of risk regions A and B.	6	2	0	0	0

<table>
<tr>
<td>Legacy</td>
<td>Mining</td>
<td>The number of data points for current and historic quarries, shaft mines, dredge and hydraulic operations was determined using historic source data and previously mapped mining sites. Mining as a source was evaluated in terms of the physical: intensity and/or duration of the activity (which also embodies mining method), and in terms of chemical impacts: whether or not the metal was persistent or non-persistent. Following are the criteria we used in determining the ranks for this point source:
<table>
<tr><th>Criteria for Ranking</th><th>Rank</th></tr>
<tr><td>No historic record of mining</td><td>0</td></tr>
<tr><td>Low duration activity and/or non-persistent metal</td><td>2</td></tr>
<tr><td>Low duration activity and persistent metal</td><td>4</td></tr>
<tr><td>High duration or current activity and/or persistent metal</td><td>6</td></tr>
</table>
Although the upper four risk regions experienced some of the most intensive mining in Placer County, indirect exposure filters were applied to all stressors with the exception of metals, because they caused legacy effects are not currently manifested in the watershed (Section 4.1.5). See Appendix A: Mining in the Secret Ravine Watershed for a more complete description of some of the major recorded mining activity in the area and how the ranks were assigned.</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</table>

	Orchards	The extent of orchards came from estimates bases on a USGS topographic map from 1981. Approximate areas were estimated according to the icons associated with orchard use. No digital data existed for this source.	0	0	2	2	6
	Introduced Fish	Fish introduction has been defined to include the riparian buffer zone surrounding Secret Ravine	6	2	2	4	0
	Beaver Dams	Beaver dams were surveyed and mapped by ECORP for the first four miles from the Confluence. Additional beaver dams noted anecdotally were digitized in ArcMap as point sources. Because dams potentially block habitat (Stoecker et al. 2002) and restrict it in the form of energy costs - "source" was calculated by measuring the percent area of the watershed upstream of a particular beaver dam. **Appendix J-6: Reduced Access** contains the data used to estimate source.	6	4	0	0	0
Rural Residential	Dirt & Gravel Roads	2002 aerial photographs were used to determine locations of dirt and gravel roads within the floodplain (excluding those within the OHV region mentioned above).	0	6	2	2	6
	Irrigation/Canals	CAD files from PCWA depicting the canal system was analyzed for the number of spillways in each Risk Region.	2	2	2	4	4

Appendix J: Stressor Risk Analysis and Characterization (MRRM)

Appendix J-1: Sediment

Risk Characterization for Sediment (MRRM)

Sediment Rankings (Benthos)

Risk region C had an average of 0% survival, so a risk ranking of six was given. Risk region B received a ranking of four since it had a 29% average survival and Risk region A was assigned 2 since it had a 35% survival. Risk Regions D and E were both given fours based on observations (B. Washburn and G. Webber, pers. comm. 2003). A conservative ranking of four was chosen since fine sediments are abundant, but actual spawning potential in these upper risk regions is most likely decreased due to higher slopes (Swanson, 2000).

Risk Region	Rank (benthos)
A	2
B	4
C	6
D	4
E	4

FINAL RANKS FOR SEDIMENT IN THE BENTHOS

Raw Data and Mathematical Models for Characterizing Sediment in the Benthos

Secret Ravine Grain Size Distribution and Mortality Analysis (early life stages in benthos)

Ayres, E., J. Love and K. Vodopals 2002 (unpublished)

Site Name	% fines < 0.85 mm	% fines < 6.5 mm	% fines < 9.5mm	Estimated Percent Survival [Tappel and Bjornn (1983)]	Negative percent survivals were assumed to be 0% survivals	Percent mortality = 1 - Percent Survival	Risk Region
IC01	18.16	54	66.78	-43.71	0.00	100.00	B
IC02	16.96	47	48.77	17.59	17.59	82.41	B
LM01A	19.31	55	59.00	-26.68	0.00	100.00	C
RO02	11.66	51	54.83	29.21	29.21	70.79	B
SC01	10.15	33	35.95	70.27	70.27	29.73	B
SP04	9.49	30	34.87	73.55	73.55	26.45	A
SP08	13.63	38	41.65	49.06	49.06	50.94	A
SP18	16.95	45	49.01	16.94	16.94	83.06	A
SP18_DS	9.19	32	36.41	71.75	71.75	28.25	A
SP20	45.43	93	75.13	-314.37	0.00	100.00	A
					Average mortality:	67.16	

GRAIN SIZE DISTRIBUTIONS AND ASSOCIATED MORTALITIES

Sediment Rankings (Water Column - Turbidity)

Risk Region	Rank (water column)
A	2
B	6
C	2
D	2
E	2

FINAL RANKS FOR SEDIMENT IN THE WATER COLUMN

All risk regions scored SEV values of either six or seven except for Risk Region B. This resulted in a risk ranking of two for all risk regions besides Risk Region B. These SEV values indicate that no (or very low) levels are occurring but that moderate physiological stress and impaired homing may be affecting salmon migration and development. Risk Region B contained turbidity levels that had the potential to result in approximately 30% mortality to juvenile salmon. Thus, a risk rank of six was assigned to Risk Region B.

Risk Regions D and E did not have turbidity data and were thus assigned a rank of 2 based on the fact that the average SEV value for the other three risk regions was less than nine (average SEV equals eight).

Raw Data and Mathematical Models for Analyzing Sediment in the Water Column (Turbidity)

Assumptions:

1 NTU = 1 mg/L, Maximum duration of exposure = 2688 hours

Dates of residence:

Adults	Juveniles	Eggs
September to December	February to May	November to February

RISK REGION	Site ID	Sample Location	Start Date	TURB (NTU)
C	DC6	Secret Ravine @ Loomis Park	12/12/00	3.5
C	DC6	Secret Ravine @ Loomis Park	12/12/00	1.4
C	DC6	Secret Ravine @ Loomis Park	1/17/01	4.3
C	DC6	Secret Ravine @ Loomis Park	2/13/01	12.7
C	DC6	Secret Ravine @ Loomis Park	3/8/01	4.5
C	DC6	Secret Ravine @ Loomis Park	4/10/01	4.5
C	DC6	Secret Ravine @ Loomis Park	6/1/01	2.6
C	DC6	Secret Ravine @ Loomis Park	6/26/01	3.6
C	DC6	Secret Ravine @ Loomis Park	7/11/01	1.9
C	DC6	Secret Ravine @ Loomis Park	8/23/01	2.9
C	DC6	Secret Ravine @ Loomis Park	9/28/01	2.2
C	DC6	Secret Ravine @ Loomis Park	10/17/01	2.7
C	DC6	Secret Ravine @ Loomis Park	11/26/01	2.4
B	Sierra College	First Flush	11/13/01	13.9
B	SR at Miners Ravine	First Flush	11/13/01	16.1
B	5	Secret Ravine above Rocklin Road	3/9/02	8.0
B	A	Near Greenbrae Rd - Barrington Hills Drain	3/23/02	5010.0
B	A	Near Greenbrae Rd - Barrington Hills Drain	3/23/02	4970.0
B	5	Secret Ravine above Rocklin Road	5/19/02	14.5
B	5	Secret Ravine above Rocklin Road	5/21/02	28.2
B	A	Near Greenbrae Rd - Barrington Hills Drain	5/21/02	2020.0
B	5	Secret Ravine above Rocklin Road	6/15/02	2.3
B	5	Secret Ravine above Rocklin Road	6/15/02	3.2
B	5	Secret Ravine above Rocklin Road	6/18/02	2.2
B	5	Secret Ravine above Rocklin Road	10/15/02	1.1
B	5	Secret Ravine above Rocklin Road	10/15/02	1.0
A	6	Secret Ravine at Miner's Ravine	3/9/02	10.8
A	6	Secret Ravine at Miner's Ravine	3/9/02	10.8
A	6	Secret Ravine at Miner's Ravine	5/19/02	9.2
A	6	Secret Ravine at Miner's Ravine	6/15/02	1.9

A	6	Secret Ravine at Miner's Ravine	6/15/02	2.0
A	AA	Secret Ravine below Sewer Crossing	6/18/02	1010.0
A	6	Secret Ravine at Miner's Ravine	10/5/02	2.2
A	6	Secret Ravine at Miner's Ravine	11/8/02	51.7

RISK REGION	Site ID	Sample Location	Start Date	TURB (NTU)
A	SR at Miner's Ravine	First Flush	11/8/02	51.7
A	Miner's Ravine at SR	First Flush	11/8/02	29.5
unknown		Secret Ravine above Smaller Side Stream	12/11/01	2.6
unknown		Smaller Stream above Lower Pipe X-ing	12/11/01	81.3
unknown		Secret Ravine above Larger Side Stream	12/19/01	3.4
unknown		Secret Ravine 20' below Side Stream	12/19/01	27.6
unknown		Larger Side Stream below Lower Pipe X-ing	12/19/01	191.0
unknown		Secret Ravine above Smaller Side Stream	12/19/01	2.8
unknown		Secret Ravine below Lower Side Stream	12/19/01	10.6
unknown		Smaller Stream above Lower Pipe X-ing	12/19/01	178.0
unknown	B	Secret Ravine ~ 50M Below Ditch Outfall	3/23/02	45.0
unknown	B	Secret Ravine ~ 50M Below Ditch Outfall	3/23/02	46.0
unknown	C	Secret Ravine Beyond Sediment Trail	3/23/02	24.0
unknown	D	Secret Ravine ~ 5Mm Below Ditch Outfall	3/23/02	160.0
unknown	D	Secret Ravine ~ 5Mm Below Ditch Outfall	3/23/02	156.0
unknown	E	Secret Ravine ~ 1M Below Ditch Outfall	3/23/02	1925.0
unknown	E	Secret Ravine ~ 1M Below Ditch Outfall	3/23/02	1910.0
unknown	A	Near Greenbrae Rd - Barrington Hills Drain	5/19/02	3710.0
unknown	E	Secret Ravine ~ 1M Below Ditch Outfall	5/19/02	3010.0
unknown	B	Secret Ravine ~ 50M Below Ditch Outfall	5/21/02	32.2
unknown	E	Secret Ravine ~ 1M Below Ditch Outfall	5/21/02	182.0

SEDIMENT IN THE WATER COLUMN (TURBIDITY) DATA

SEV (severity of ill effects) = $a + b^{*}(\log_e x) + c^{*}(\log_e y)$

The a, b and c values are constants specific to the life stage; x is duration of exposure (in hours) and y is concentration of suspended sediment (in mg/L).

Constants	**Adult**	**Juvenile**	**Eggs**
a	1.68	0.73	3.75
b	0.48	0.70	1.09
c	0.76	0.71	0.31
SEV values			
Risk Region	**Adult**	**Juvenile**	**Eggs**
A	8	7	8
B	7	11	7
C	6	7	6
D	No data	No data	No data
E	No data	No data	No data

SEV VALUES FOR TURBIDITY

Appendix J-2: Flow

Risk Characterization for Flow (MRRM)

Flow Rankings (Benthos and Water Column)

All risk regions had critical depths below 24 cm (ranging from 4.95 cm in risk region C to 22.25 cm in risk region B) and thus were assigned a rank of six for the water column.

Risk Regions D and E had calculated critical depths of 15.82 cm. They were both assigned a rank of four in the benthos based on the optimal spawning depths (Allen et al. 1998). Risk Region C received a rank of six for the benthos since the estimated critical depth (4.95 cm) was well below 10 cm. Risk Regions A and B both had relatively high critical depths (20.27 cm and 22.25 cm respectively) and were thus assigned risk ranks of two.

Risk Region	Rank (water column)	Rank (benthos)
A	6	4
B	6	4
C	6	6
D	6	2
E	6	2

FINAL RANKS FOR FLOW

Appendix J-3: Morphology

Risk Characterization for Morphology (MRRM)

Morphology Rankings (Benthos and Water Column)

Risk Regions A and B both had percent pools by length (PBL) between 20% and 30%. A risk rank of 6 was therefore assigned to both the water column and benthos for these risk regions. Ranks for Risk Regions C, D and E were extrapolated from the percent pools reported for Risk Regions A and B. The average percent pools by length was estimated to be very low (16%). This resulted in a risk rank of 6 for all three of the upper risk regions.

Risk Region	Rank
A	6
B	6
C	6
D	6
E	6

FINAL RANKS FOR MORPHOLOGY FOR THE BENTHOS AND WATER COLUMN

Appendix J-4: Temperature

Risk Characterization for Temperature (MRRM)

Temperature Rankings (Benthos and Water Column)

The available data for Risk Region B reveals that water temperatures have not risen to temperatures high enough to threaten egg development and survivability for chinook salmon. Risk Region B indicates that the temperature range for November through February ranges from 6.1 – 11.2 °C. This indicates that Secret Ravine temperatures are well under the 14.5 °C threshold, and thus receive a rank of zero for the egg/yolk-sac fry life stage. The final rank for the benthos habitat of this life stage is zero, or no risk. The available data for Risk Region B reveals that water temperatures have not risen to temperatures high enough to threaten juvenile development and survivability for chinook salmon for the months of February, March, and April. All of these months show temperatures below the maximum weekly temperature of 15.6 °C. In May, however, the mean temperature of Risk Regions A and E is 17.4 °C. This value indicates risk to the juvenile life stage in Secret Ravine. Also the available data for Risk Region B reveals that water temperatures have risen to temperatures high enough to threaten adult migration and survivability for chinook salmon. Risk Region B indicates that the temperature range for September through November is 11.2 – 19.0 °C, while October has a temperature of 17.9 °C and thus receives a rank of 2. September has a temperature of 19.0 °C and thus receives a rank of 4. To generate the rank for the water column habitat, the most conservative monthly rank for the adult and juvenile life phase was assigned. The final rank for the water column habitat is 4.

Life Stage	Final Rank
Egg/Fry	0
Juvenile	4
Adult	4

SUMMARY TABLE OF FINAL RANKS FOR TEMPERATURE

Site	Sub-watershed	E	J	A
Confluence	A	0	4	4
Secret Court	B	0	4	4
Dias Lane	C	0	4	4
King Road	D	0	4	4
Rock Springs Rd.	E	0	4	4

SUMMARY TABLE OF FINAL RANKS ACROSS THE RISK REGIONS

Appendix J-5: Altered Riparian Vegetation

Risk Characterization for Altered Riparian Vegetation (MRRM)

Altered Riparian Vegetation Rankings (Benthos and Water Column)

In the context of the temporal condition of Secret Ravine, the vegetation composition has changed considerably over the last century and the quality of the habitat has been degraded in comparison to pre-Columbian California. Overall, the condition of Secret Ravine in the broader context of foothill streams maybe evaluated as fair. The creek has a fair degree of riparian cover, a fair degree of riparian zone extent, and only a few areas where the riparian zone narrows to less than a 100-foot buffer. Within the watershed itself, however, gradations in riparian zone extent, areas with a riparian zone less than the ascribed riparian buffer of 100-ft, may indicate gradations in vegetation quality between risk regions. Assigning of ranks used these gradation in riparian buffer to evaluate whether the risk region had a 2 or 4 rank.

Risk Region	Incidences of <100 ft	Length of Incidence (feet)	Ranks
A	3	3935	4
B	1	323	2
C	1	281	2
D	3	855	2
E	1	201	2
		5595	

SUMMARY OF INCIDENCES OF OVERLY SMALL RIPARIAN ZONE EXTENT

Appendix J-6: Reduced Access

Risk Characterization for Reduced Access (MRRM)

Reduced Access Rankings (Water Column)

Risk Region B received a six because it contains several beaver dams that are difficult to pass for most fish in both high and low flow conditions, in addition to what is considered a very prohibitive barrier in terms of reduced access for adult fish. This barrier consists of "cattle wire fencing strung across [the Sierra College Boulevard underpass] in triplicate in most places" with 4x4-inch holes not lined up with each other, making it impossible for a fish with the ability to weigh up to sixty kilograms, to navigate through (B. Washburn pers. comm. 2003). Surveyors confirm that they have seen salmon aggregating downstream of this obstruction behind Sierra College, north of Rocklin Road (G. Bates and B. Washburn, pers. comm. 2002). Indeed, the count records for the past six years seem to reflect this trend, as given below. Complete count data is located in **Appendix M-1: Reduced Access.**

Risk Region A contains a higher density of closely spaced beaver dams, but only two that pose problems under low flow conditions. However, Risk Region A contains several barriers, including an old concrete apron, responsible for creating one of "the more noteworthy deep [1st class] pools throughout the reach" (Vanicek 1993). This risk region also contains the highest concentration of known spawning sites.

We assigned Risk Regions C, D and E '0s' based on lack of available data, although there are anecdotal accounts that beaver dams were seen up in the lower extremes of Risk Region E in the fall season (Lieberman, S. pers. account, Rock Springs Road toxicity sampling site, 2002). Big boulders and large woody debris also characterize the upper risk regions, factors that would normally yield excellent flow conditions, if it were not for meager suitable substrate. Below are the tables that we used to determine passage via the '150%' rule.

Risk Region	Rank
A	4
B	6
C	0
D	0
E	0

FINAL RANKS FOR REDUCED ACCESS

Raw Data and Mathematical Models for Analyzing Sediment in the Benthos

Dam site	Risk region	Type of barrier	Photo(s)	Coordinates	Stream types (downstream)	Downstream pool depth (average)	Date data taken	Height of dam
1	A	concrete dam (G. Marsh)	PS03	2212380, 398824	pool	2	2001	3
2	A	not a dam, but an underpass; danger in very low flows	SR27, 26, PS09	221332, 400152	n/a	0.4	7/25/2002	n/a
3	A	fallen log (12" above water)	SR91-88	221529, 402384	run, riffle, run	1	8/13/2002	n/a
4	A	beaver dam	SR143-139	221704, 404344	pool, run, riffle	2.1	8/17/2002	2
5	A	beaver dam (submerged)	SR157-156	221769, 404447	pool, riffle, pool	3.8	8/17/2002	3
6	A	beaver dam (instream)	SR176-175	2218846, 405295	riffle, run, pool	1.2	8/17/2002	3
7	B	concrete dam (C.D. Vanicek)	none	2221064, 407554	pool	2	1993	3
8	B	beaver dam	SR296-294	2223690, 410663	run, riffle	0.9	10/26/2002	4
9	B	beaver dam	SR304-302	2224470, 411349	riffle, run, riffle	0.6	10/26/2002	1
10	B	beaver dam	SR319-320	2225170, 412169	riffle, pool	1.3	10/26/2002	3
11	B	beaver dam (G. Bates)	SR320	2225513, 412382	run, riffle, pool	2.2	10/26/2002	2
12	B	Sierra College Blvd. fence (B. Washburn, Bren students)	PS18	2226622, 412799	n/a	n/a	2002	
13	B	beaver dam	none	2235416, 423111	pool	1	12/6/2002	2.75
14	B	beaver dam	none	2239758, 424016	pool	0.87	12/6/2002	1.58

CRITERIA FOR ASSESSING REDUCED ACCESS

Low flow scenario/(early fall)	High flow scenario/ (late fall)	Area downstream from barrier (square feet)	Total area downstream from barrier (square feet)	Percent area upstream (square feet)	Source rank (2,4 or 6)	Habitat rank (constant)	Exp2	Effects rank (0,4, or 6)	Exposure rank (0 or 1)	Final Risk Score
1.50	0.86	0	0	1.00	6	4	1	4	1	96
n/a	n/a	3647623	3647623	0.99	6	4	1	0	1	0
n/a	n/a	10995125	14642748	0.98	6	4	1	0	1	0
0.95	0.54	13158434	27801182	0.96	6	4	1	0	1	0
0.79	0.45	1093549	28894731	0.95	6	4	1	0	1	0
2.50	1.43	5232983	34127714	0.95	6	4	1	4	1	96
1.50	0.86	36124588	70252302	0.89	6	6	1	4	1	144
4.44	**2.54**	47668088	117920390	0.81	4	6	1	6	1	144
1.67	0.95	8772245	126692635	0.80	4	6	1	4	1	96
2.31	1.32	14212081	140904716	0.78	4	6	1	4	1	96
0.91	0.52	3172838	144077554	0.77	4	6	1	0	1	0
		3685449	147763003	0.77	4	6	1	6	1	144
2.75	**1.57**	36484346	184247349	0.71	2	6	1	6	1	72
1.82	1.04	2914536	187161885	0.70	2	6	1	4	1	48

629310892	total s.r. area
1.75	stream depth at China Gd Road 12/6/02
1	average depth for ECORP stream-type values downstream of barriers
1.75	correction factor using only pool depth associated with barriers

CRITERIA FOR ASSESSING REDUCED ACCESS

The first column of data refers to the barrier site, ranging from 1-14. Barrier "1" is the most downstream barrier, "14," the most upstream barrier. The barriers are also referred to using these numbers on the GIS map in **Appendix B: GIS Maps.** The Risk Region refers to the risk region in which the barrier is located. The photos column indicates barriers for which photographs were taken and analyzed. The photographs in bold are located the photographs section below. Coordinates refer to UTM coordinates in GIS.

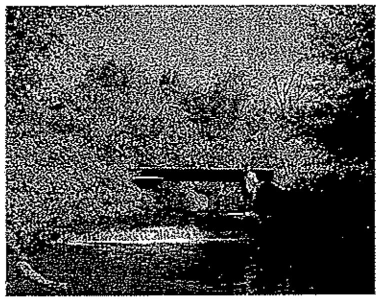
The ratio of downstream average pool depth to height of barrier immediately upstream of that pool (or other stream type) was used to assess whether or not the fish could be expected to pass (by the 150% rule, the height of the downstream pool needed to be at least 150% of the barrier immediately upstream of it). Low flow scenarios reflect fairly low flow averages as the depths associated with the pools (or other stream types) at the time ECORP conducted the survey were taken during the late summer/early fall. High flow depths used the depth estimated from the flow data taken by group members in December 2002 at the China Garden Road Gauge, following the second major storm event of the year.

Area upstream of a particular barrier was measured for the source analysis for the MRRM. We drew polygons in ArcMap in order to estimate the square-foot area upstream of each barrier and divided this by the total area of the watershed. Hence, the further downstream a particular barrier, the greater potential for an adult migrating upstream to encounter potential passage problems.

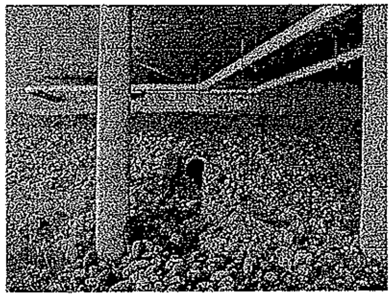
Source ranks, habitat ranks, exposure filter ranks and final ranks for reduced access are included in this spreadsheet in order to be able to determine how different factors affected the final outcome for risk scores per risk region.

Appendix J-6: Reduced Access

Photographs for Reduced Access



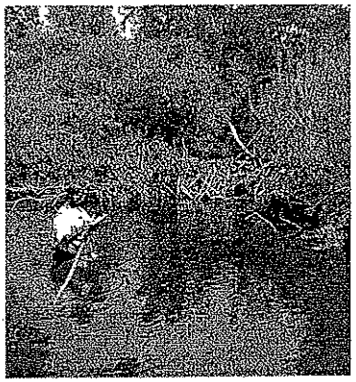
Concrete Dam at Confluence (Barrier #1 on GIS Map



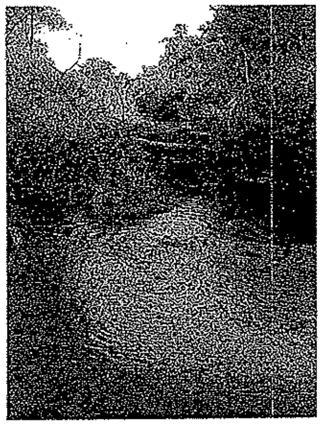
Interstate I-80 Underpass (Barrier #2 on GIS Map)

Cattle Fence on Secret Ravine

Fence Underneath Sierra College Boulevard (Barrier #12 on GIS Map)



Pool Below Beaver Dam Looking Upstream (Barrier #5 in GIS Map)



Run and Beaver Dam Looking Upstream (Barrier #8 in GIS Map)

Appendix J-7: Toxicity

Risk Characterization for Toxicity (MRRM)

Toxicity Rankings (Benthos and Water Column)

Risk Region	Rank (water column)	Rank (benthos)
A	0	2
B	0	6
C	0	4
D	0	2
E	0	6

SUMMARY TABLE OF FINAL RANKS FOR TOXICITY

Raw Data for Characterizing Toxicity in the Benthos

Summary of 10-day *Hyalella* sediment toxicity test conducted on Dry Creek samples collected 5 December 2002.[1]

Treatment	Growth[2] (mg/surv indiv)		Mortality[2] (%)	
	x	se	x	se
Laboratory Control	0.121[P]	0.012	6.3[P]	4.0
Confluence Eureka & Sunrise Road	0.213	0.016	22.5	17.0
Secret Court	0.173	0.025	41.4	21.0
Dias Street	0.192	0.021	60.0	25.0
King Road	0.188	0.020	21.4	18.0
Rock Springs Road	0.179	0.047	52.5	17.0

Quality Assurance Sample

Treatment	Growth[2] (mg/indiv)		Mortality[2] (%)	
	x	se	x	se
Control Duplicate: DIEPAMHR	0.119	0.022	7.1	4.0

1. Test initiated on 24 December 2002.
2. Highlighted areas indicate a significant increase in mortality or decrease in growth when compared to the laboratory control. The growth and mortality endpoints were analyzed with Dunnett's Test ($p<0.05$).

P. The laboratory control met the criteria for test acceptability.

SUMMARY TABLE FOR TOXICITY TESTING

Appendix J-8: Metals

Risk Characterization for Metals (MRRM)

Metals Rankings (Benthos)

Lead

Since all the risk regions exhibit Pb values well over the National Recommended Water Quality Criteria for freshwater (2.5 µg/L), all of the risk regions pose a chronic threat to chinook salmon. All risk regions therefore receive a rank of 6.

Risk Region	Pb (ug/L)	EPA Rec. CCC (ug/L)	Rank
A	36	2.5	6
B	270	2.5	6
C	83	2.5	6
D	56	2.5	6
E	420	2.5	6

FINAL RANKS FOR LEAD

Copper

Since all the risk regions exhibit Cu values well over the EPA's National Recommended Water Quality Criteria for chronic exposure to copper (9.0 µg/L), all of the risk regions pose a chronic threat to chinook salmon. All risk regions therefore receive a rank of 6.

Risk Region	Amount Cu (ug/L)	EPA Rec. CCC (ug/L)	Rank
A	83	9.0	6
B	520	9.0	6
C	230	9.0	6
D	140	9.0	6
E	760	9.0	6

FINAL RANKS FOR COPPER

Zinc

Since all the risk regions exhibit Zn values well over the EPA's National Recommended Water Quality Criteria for chronic exposure to copper (120 µg/L), all of the risk regions pose a chronic threat to chinook salmon. All risk regions therefore receive a rank of 6.

Risk Region	Zn (ug/L)	EPA Rec. CCC (ug/L	Rank
A	280	120	6
B	2300	120	6
C	430	120	6
D	210	120	6
E	1000	120	6

FINAL RANKS FOR ZINC

Appendix J-9: Food Supply

Risk Characterization for Food Supply (MRRM)

Food Supply Rankings (Water Column)

The amount of riffle habitat available to invertebrates is also important. Riffles are the most important habitat for benthic invertebrates because they are produced there and live there (DCC 2001). In Secret Ravine riffles have been characterized as low in abundance and in quality across the entire creek (Li and Fields, Jr. 1999). Consequently, risk to salmon is increased if suitable invert habitat is not available. Due to the similarities across the creek, the same rank should be assigned across all risk regions.

In light of the above analysis, food supply was ranked as 2 for all risk regions. The percentage analysis and feeding habits of juveniles indicated that food supply should be ranked as zero because there is minimal risk associated. But the quality and abundance of riffles in Secret Ravine increases the risk of a depleted food supply. Subsequently, all risk regions were given a rank of 2 for food supply.

From the sampled invertebrate assemblages, the percentage of edible invertebrates was calculated (**Table** 2). In Risk Region A 62% of the invertebrates were edible, in Risk Region B 65%, and in Risk Region C 63%. No data was collected in the upper two risk regions, therefore the average percent of edible invertebrates (63%) was used.

	Risk Region A			Risk Region B			Risk Region C			R.R. D	R.R. E
	2001	2000	1999	2001	2000	1999	2001	2000	1999		
# of invertebrates found	945	317	1158	891	no data collected	1169	no data collected	no data collected	1216	no data collected	no data collected
# of edible invertebrates	485	214	672	590		747			761		
% edible invertebrates	62%			65%			63%			63%	63%
subsequent rank	2			2			2			2	2

PERCENTAGE OF EDIBLE INVERTEBRATES ACCORDING TO RISK REGION

Raw Data and Mathematical Models for Characterizing Food Supply in the Water Column

To characterize the food supply in Secret Ravine, an understanding of recent benthic macroinvertebrate populations was needed. Two studies that spanned from 1999-2001 were utilized: The benthic macroinvertebrate fauna of Secret Ravine Creek, Placer County, California (Fields, Jr. 1999) and the Benthic Macroinvertebrate Counts performed by the Dry Creek Conservancy (unpub. DCC 2001). W.C. Fields, Jr. performed his study on September 3, 1999, where he analyzed six sites throughout Secret Ravine. The Dry Creek Conservancy performed their studies in 2000 and 2001, where four sites in total were analyzed. Both counts were conducted using California Stream Bioassessment Protocol, therefore all samples were taken within the riffles of Secret Ravine. Consequently, data from both studies were combined for this analysis.

Sampled sites were separated into groups according to their appropriate subsection of the creek (**Table 1**). Risk Region A had 5 sample sites, Risk Region B had 3 sample sites, Risk Region C had 2 sample sites, and Risk Region D and E had no sample sites.

	Dry Creek Conservancy		**Fields, Jr.**
	2001	2000	1999
Risk Region	**Sampled Sites**	**Sampled Sites**	**Sampled Sites**
A	Secret Ravine at Miners Ravine	Secret Ravine at Miners Ravine Gravel site at hospital	Upstream of Miners Ravine Meadow near end of China Garden Rd
B	Sierra College		Downstream of Dominguez Rd Behind Sierra College
C			Horseshoe Bar Rd Loomis Basin Park
D			
E			

LOCATION OF SITES SAMPLED FOR BOTH STUDIES

For each risk region of the creek, invertebrate counts from all representative sites were combined.

It was determined which of the sampled invertebrates were a food source for juvenile chinook. Of the aforementioned food sources, all were found except copepods and water fleas.

From the sampled invertebrate assemblages, the percentage of edible invertebrates was calculated. In Risk Region A 62% of the invertebrates were edible, in Risk Region B 65%, and in Risk Region C 63%. No data was collected in the upper two risk regions, therefore the average percent of edible invertebrates (63%) was used.

In order to characterize each risk region further, it was proposed to normalize each edible invertebrate percentage by the percentage of riffle found in that risk region. This idea proved to be ineffectual because percent riffle could only be calculated for Risk Region A and Risk Region B. An average percent riffle would have to be used for the upper three regions.

Essentially every region would be multiplied by the same factor, not helping in the characterization process.

Appendix J-10: Predation

Risk Characterization for Predation (MRRM)

Predation Rankings (Water Column)

Spotted bass have been found throughout the Secret Ravine watershed meaning that no risk region will be assigned a value of 0 for fish predation. The upper sections of Secret Ravine (Risk Region C, Risk Region D, and Risk Region E) tended to have local abundances of bass and sunfish, however the habitat quality for spotted bass decreases as the stream decreases in size and increases in slope (Swanson 2000, Titus 2003 unpublished). For this reason and the direct observation of this change in fish community by Rob Titus, the rank for fish predation was given a 2 for Risk Region C, Risk Region D, and Risk Region E.

Having established that the creek located closest to the confluence tends to contain more abundant spotted bass, these risk regions may be the location where the majority of predation by fish occurs. Therefore, Risk Region A and Risk Region B were evaluated using a "snap shot in time" of the predation of spotted bass on juvenile chinook (See Appendix P). The predation model predicted a 7% to 14% percent reduction in salmon biomass given two separate population scenarios based on fish count numbers from 1999 and 2002. Though rough estimates, these numbers indicate that for those areas of Secret Ravine where spotted bass are abundant a ranking of 4 should be assigned.

Risk Regions	Rank Assigned for Water Column Habitat
A	4
B	4
C	2
D	2
E	2

FINAL RANKS FOR PREDATION

Raw Data and Mathematical Models for Characterizing Predation in the Water Column

Possible Predation of Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) by Spotted Bass (*Micropterus punctulatus*)

The data provided by Dr. Rob Titus of the California Fish and Game contained a biomass estimation of spotted bass and a population study of out-migrating chinook salmon. The results of his study of Secret Ravine are summarized in Table 1 and Table 2.

"Biomass of Sacramento pikeminnow and black bass – primarily spotted bass – was estimated in a 30 m (177 m^2) section of Secret Ravine upstream from the East Roseville Parkway crossing on 28th October 2002. This work was done as a field exercise with the California State University, Sacramento fishery biology class. Abundance of these species was estimated with the two-pass removal method with use of electrofishing. Abundance estimates were then multiplied by the observed mean weight of each species to estimate biomass" (Attributed to Titus 2003).

Biomass of Spotted Bass Oct. 2002 *(Micropterus punctulatus)*	
The section of Secret Ravine studied	30 m (177 m^2)
Number of spotted bass	96
Average mass of bass observed	26 g
Total biomass of the stream section	2506 g
Biomass density of spotted bass	14.2 g/ m^2

BIOMASS OF SACRAMENTO PIKEMINNOW AND BLACK BASS

"The gear to catch juvenile salmon was a 5-foot diameter rotary screw trap, located at the confluence of Secret Ravine and Miners Ravine and fished from November 6, 1998 through June 2, 1999, and from January 9, 2000 through June 8, 2000" (Attributed to Titus 2003).

Juvenile Salmon Caught		
	1999	2000
January	0	5
February	658	103
March	1038	52
April	1375	57
May	1513	184
June	4	0

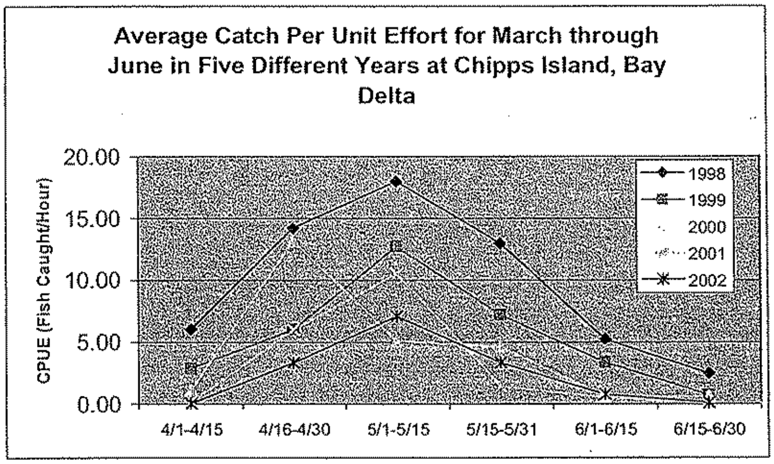
SCREW TRAP CATCH OF JUVENILE SALMON

These data sets provided the basis of the analysis of predation on salmon by non-native fish. The analysis concentrated on non-native fish for two reasons: spotted bass dominate the lower region of the watershed where the majority of the spawning habitat exists and salmon coevolved with the native fish in this environment and presumably have effective behaviors to minimize the consequences of this predation. The data sets, on the juvenile salmon and spotted bass population in Secret Ravine, are incomplete therefore projections filled some data gaps for the sake of this snap shot in time analysis. The analysis calculates three projected values the amount of chinook salmon hatched in Secret Ravine, the amount of biomass these salmon would grow in Secret Ravine, and the amount of biomass the number of spotted bass observed in the creek would be expected to consume.

Projecting Juvenile Salmon Biomass for 2002:

The screw trap study on Secret Ravine contained two years of data on the creek. One of these years 2000 was further investigated to see whether the crash in the Secret Ravine population was consistent with trends in the larger system. The Chipps Island data sampled the population of fish that the Secret Ravine salmon joined in the Bay Delta estuary and this data represents the most complete information readily available on the estuary. The salmon population in 1999 in the Bay Delta system appeared to reflect trends emergent in four out of the last five years (Figure 1), while the 2000 data seems to be indicative of a population crash in the salmon stocks. Therefore, the 2000 population were excluded from the analysis. This created a problem. With only one year of data and no way to quantify the population of salmon in Secret Ravine in 2002, the analysis could only investigate one year of data 1999 and the bass population was unknown. To overcome this problem a projection of juvenile chinook for 2002 was generated.

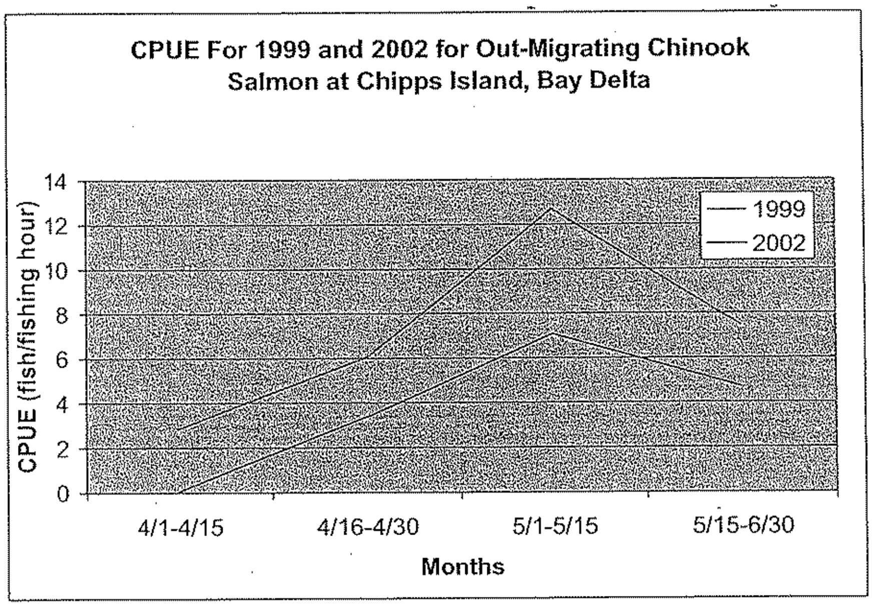
Two populations of animals in the same ecosystem may not always exhibit the same trends in abundance from year to year. However resident populations tend to remain more stable in comparison to migrating populations. For this reason the population estimate of spotted bass in 2002 was projected back to 1999, but direct use of the salmon population of 1999 for 2002 did not seem wise. So in consequence, it was decided to try and project the juvenile salmon biomass for Secret Ravine in 2002 using a larger system, Bay Delta estuary, with data in 2002 as a model.



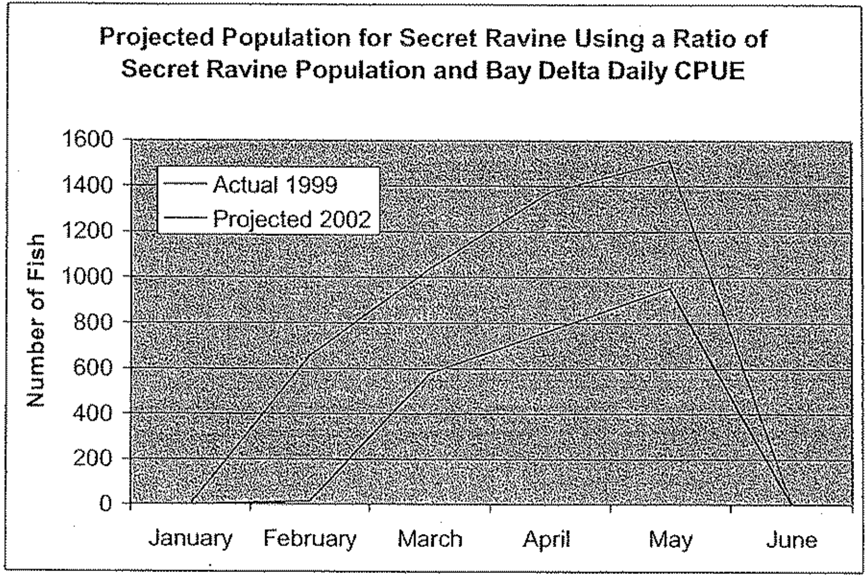
REAL TIME MONITORING DATA FROM DEPARTMENT OF FISH AND GAME, BAY DELTA BRANCH

Figure 2 shows the real time monitoring data from Department of Fish and Game, Bay Delta Branch. The real time system provided the fishing statistics, catch per unit effort, for Chipps Island from March to June for 1998 to 2002. Trawling has been conducted at Chipps Island since 1976, in most years from April through June during peak fall run out-migration. The Chipps Island data sampled the population of fish that the Secret Ravine salmon joined in the Bay Delta estuary and this data represents the most complete information readily available.

We used the ratio between the population values observed in Secret Ravine in 1999 compared to the larger system of the Bay Delta to translate the population numbers for the Bay Delta in 2002 into estimates of the number of out-migrating chinook salmon in 2002 in Secret Ravine. Figures 2 and 3 show the data trends at the estuary and the data simulated in Secret Ravine for 2002. Comparing the peak out-migration period in Secret Ravine to the peak out-migration period in the estuary generated the ratios used to translate migration at the Bay Delta to estimates on Secret Ravine. Then by working back from the peak out-migration, two-week averages for the Chipps Island data was correlated to the preceding month in Secret Ravine.



AVERAGE CATCH PER UNIT EFFORT FOR 1999 AND 2002 FOR CHIPPS ISLAND, BAY DELTA FROM THE REAL TIME DATA SET.



ACTUAL AND PROJECTED INITIAL POPULATIONS OF OUT-MIGRATING JUVENILE SALMON FOR SECRET RAVINE IN 1999 AND 2002.

Salmon Biomass

The projected biomass of salmon in the stream during the spring months of March to June came from the integration of five different types of data: screw trap data from the confluence of Secret Ravine in 1999, projection data from 2002, a growth function from the San Francisco estuary, monitoring data of out-migrating juvenile numbers from daily monitoring done by midwater trawl by California Fish and Game, and Bay Delta branch and juvenile survival rates developed by National Marine Fisheries for sub-yearling chinook salmon.

So the Secret Ravine screw trap data from 1999 and the projected 2002 data was used to estimate the numbers of juvenile fish hatched in Secret Ravine. The raw screw trap and projected screw trap data was then corrected for the size of the trap and the hours of operation (Table 3). Roughly these correction factors mean that the monthly screw trap sample represented one eighth of the juvenile salmon out-migrating from Secret Ravine.

Gear	Secret Ravine Conditions	Correction Factor
Screw Trap Diameter = 5ft	Creek Width = 15ft	2 * screw trap sample
Fished 40 Hours a Week	Continuous Migration	4 * screw trap sample

TO ESTIMATE THE POPULATION OF OUT-MIGRATING SALMON A CORRECTION FACTOR DUE TO GEAR SIZE AND HOURS OF OPERATION WAS USED.

To project the initial numbers of fish emergent in Secret Ravine, a survival of sub-yearling salmon from the Draft Biological Opinion conducted by NMFS on the Columbia River was necessary (NMFS 2000). This value of .599 came from the mean survival of fish from 1994 to 1999 through the pool reach prior to any dam passage. By dividing the corrected screw trap sample numbers by this survival value, an initial number of fish was approximated.

$$\text{INITIAL POPULATION}_{\text{CHINOOK SALMON}} = \text{CORRECTED SCREW TRAP NUMBERS}/.599$$

Equation 10: Determining Initial Population of Chinook Salmon in Secret Ravine (NMFS 2000)

Table 4 reports the initial population of fish in Secret Ravine for 1999 using the corrected screw trap values and the survival value. The next step in the salmon biomass assessment was to determine the median age of the fish in Secret Ravine. The MacFarlane study indicates that the average age of a salmon entering the San Francisco estuary was 136±2 days and given that it takes approximately a month for the fish to reach the estuary, the median fish age in the creek is 106 days (MacFarlane 2002). Once the median age was determined the initial population was 'grown'. Using Equation 2 developed by MacFarlane relating growth rate to age, the biomass of the initial population was determined.

$$\text{Mass of Salmon} = 2.68 + .029 * (\text{Age in Days})$$

Equation 11: Juvenile Chinook Salmon Growth Rate (attributed MacFarlane 2002)

	1999 Sample	Corrected Sample	Initial Population	Age(d)	Weight(g)	Biomass(g)
February	658	5264	8782	15	3.115	27,356
March	1038	8304	13854	45	3.985	55,208
April	1375	11000	18352	76	4.884	89,630
May	1513	12104	20194	106	5.754	116,194
					Total:	288,387

Sample values, corrected values, and initial population values for 1999.

	2002 Projected Sample	Corrected Sample	Initial Population	Age(d)	Weight(g)	Biomass(g)
February	14	116	193.4109	15	3.115	602
March	578	4627	7719.116	45	3.985	30,761
April	766	6130	10226.13	76	4.884	49,944
May	953	7625	12721.47	106	5.754	73,199
					Total:	154,591

Projected values, corrected values, and initial population values for 2002.

Biomass Consumed by Spotted Bass

The consumption of salmon by spotted bass utilize several sources of information, the biomass survey on Secret Ravine from the Titus survey and consumption rates of salmonids by bass based on weight from a study by Vigg. The amount of juvenile salmon consumed by small mouth bass on the Columbia River ranged from 1% to 7% of the overall diet of the fish and the overall diet of the fish is .0287of prey per day per gram of body weight (Vigg 1991). The spotted bass, a closely related fish, exhibits similar biology to the small mouth bass; indeed, in some California streams, the small mouth and spotted bass hybridize, so the use of these values seems justified (Dill 1997). Given the weight of the spotted bass and the 97 fish in the 30 meters of Secret Ravine surveyed, the consumption of the spotted bass was calculated (Table 1). The section surveyed, of Secret Ravine, only includes a small section of the lower reach of Secret Ravine where spotted bass is the dominant predator. In consequence to estimate the consumption value for the entire lower reach the biomass consumed was normalized for the 9,763 meters of the lower reach or risk regions A and B.

	Spotted Bass Consumption of Salmonids (g)		
	1%	4%	7%
March	7,302	29,210	51,117
April	7,067	28,268	49,468
May	7,302	29,210	51,117
June	7,067	28,268	49,468

CONSUMPTION OF SALMONIDS BY SPOTTED BASS GIVEN THE PROJECTED ABUNDANCE OF BASS IN SECRET RAVINE.

Percent of Juvenile Chinook Salmon Consumed By Spotted Bass

Once the consumption rates and the biomass of salmon have been calculated, the reduction of chinook salmon can be estimated. For the 1999 population of salmon, the effect of the 2002 population of bass would be approximately 8% to 53% reduction. Additionally, if the salmon population of 2002 followed the same trends as observed in 1999, which the real time out-migration data seem to indicate, then the rate of consumption could be from 14% to 98% of the total population.

	Salmon Consumed/Biomass Juvenile Salmon	
Consumption Rate	1999	2002
1%	8%	14%
4%	30%	56%
7%	53%	98%

THE PERCENT REDUCTION OF JUVENILE SALMON BY SPOTTED BASS PREDATION 1999 & 2002

Discussion

For the MRRM and the SDRM, the lowest percent consumption rate (1%) by spotted bass seems appropriate for two reasons: the relatively small size of the spotted bass (26 g) mean that the amount of larger prey should be a low percent of the bass diet and the cool temperatures of the creek that tend to depress bass activity. This rate was calculated for the years of 1999 and 2002 and compared with the estimated initial biomass of chinook salmon to produce the 8-14% rates reported in Table 7.

Appendix K: Stressor Risk Characterization

Category	Stressor	Filter	Characterization Risk Region				
			A	B	C	D	E
Physical	Sediment	Water Column=1	2	6	2	2	2
		Benthos=1	2	4	6	4	4
	Flow	Water Column=1	6	6	6	6	6
		Benthos=1	4	4	6	2	2
	Morphology	Water Column=1	6	4	6	6	6
		Benthos=1	6	4	6	6	6
	Temperature	Water Column=1	4	4	4	4	4
		Benthos=1	4	4	4	4	4
	Altered Riparian Vegetation	Water Column=1	4	2	2	2	2
		Benthos=1	4	2	2	2	2
	Reduced Access	Water Column=1	4	6	0	0	0
		Benthos=1	4	6	0	0	0
Chemical	Toxicity	Water Column=0	0	0	0	0	0
		Benthos=1	2	6	4	2	6
	Metals	Water Column=0	0	0	0	0	0
		Benthos=1	6	6	6	6	6
Biological	Food Supply	Water Column=1	2	2	2	2	2
		Benthos=0	2	2	2	2	2
	Predation by Fish	Water Column=1	4	4	2	2	2
		Benthos=1	4	4	2	2	2

Appendix L: ECORP Habitat Survey Data

This data was used in the analyses for Morphology (MRRM and SDRM) and Reduced Access (MRRM).

Date	ID	Type	Length	Average Depth
7/25/2002	srf001	RIF	75.5	0.50
7/25/2002	srf002	RUN	38.9	0.87
7/25/2002	srf003	RIF	33.3	0.33
7/25/2002	srf004	RUN	15.1	1.07
7/25/2002	srf005	POOL	56.5	1.07
7/25/2002	srf006	RIF	43.9	0.43
7/25/2002	srf007	POOL	42.7	1.03
7/25/2002	srf008	RUN	222.9	0.37
7/25/2002	srf009	RIF	87	0.70
7/25/2002	srf010	RUN	35.7	0.63
7/25/2002	srf011	POOL	42	2.20
7/25/2002	srf012	POOL	60.7	2.57
7/25/2002	srf013	RUN	600.8	0.37
7/25/2002	srf014	RIF	44.3	0.53
7/25/2002	srf015	RUN	39.8	0.73
7/25/2002	srf016	POOL	25.8	2.23
7/25/2002	srf017	RIF	199.1	0.63
7/25/2002	srf018	POOL	30.8	1.00
7/25/2002	srf019	RIF	32.1	0.40
7/25/2002	srf020	RIF	75.2	0.43
7/25/2002	srf021	RUN	180.3	0.73
7/25/2002	srf022	POOL	25.1	2.20
7/25/2002	srf023	RIF	208.1	0.47
7/25/2002	srf024	RUN	289.8	0.80
7/25/2002	srf025	POOL	20.4	1.57
7/25/2002	srf026	RUN	615.7	0.40
7/25/2002	srf027	RIF	72.2	1.13
7/25/2002	srf028	POOL	15	1.23
7/25/2002	srf029	RIF	80.4	0.73
7/25/2002	srf030	RUN	263.3	0.83
7/28/2002	srf031	POOL	21.4	1.63
7/28/2002	srf032	RUN	190.7	0.93
7/28/2002	srf033	RIF	21.1	0.43
7/28/2002	srf034	RUN	164.5	0.60

Date	ID	Type	Length	Average Depth
7/28/2002	srf035	POOL	25	1.50
7/28/2002	srf036	RIF	33.6	0.43
7/28/2002	srf037	RUN	112.8	0.50
7/28/2002	srf038	POOL	28.6	2.10
7/28/2002	srf039	RIF	45.7	0.50
7/28/2002	srf040	RUN	158.3	0.87
7/28/2002	srf041	POOL	78.9	2.00
7/28/2002	srf042	RUN	50.8	0.73
7/28/2002	srf043	RIF	22.6	0.63
7/28/2002	srf044	RUN	54	1.03
7/28/2002	srf045	RIF	15.4	0.50
7/28/2002	srf046	RUN	128.7	0.80
7/28/2002	srf047	RIF	28	0.47
7/28/2002	srf048	RUN	194	0.60
7/28/2002	srf049	RIF		0.43
7/28/2002	srf050	RUN	293.7	0.60
7/28/2002	srf051	RIF	26	0.47
7/28/2002	srf052	RUN	241.2	0.83
7/28/2002	srf053	RIF	91.1	0.47
7/28/2002	srf054	RUN	23.4	0.87
7/28/2002	srf055	RIF	83.3	0.47
7/28/2002	srf056	POOL	39.6	2.13
7/28/2002	srf057	RUN	56.7	0.63
7/28/2002	srf058	POOL	23.4	1.63
7/28/2002	srf059	RIF	36.2	0.60
8/13/2002	srf060	POOL	22.2	1.07
8/13/2002	srf061	RIF	115.5	0.67
8/13/2002	srf062	POOL	14.3	0.93
8/13/2002	srf063	RIF	69.9	0.57

8/13/2002	srf064	RIF	29.5	0.43
8/13/2002	srf065	POOL	18.6	2.03
8/13/2002	srf066	RUN	49.6	0.90
8/13/2002	srf067	POOL	30.5	1.70
8/13/2002	srf068	RIF	18.5	1.33
Date	ID	Type	Length	Average Depth
8/13/2002	srf069	RUN	144.4	0.70
8/13/2002	srf070	POOL	34.8	2.07
8/13/2002	srf071	RIF	32.3	0.33
8/13/2002	srf072	RUN	16	0.70
8/13/2002	srf073	POOL	22.7	1.30
8/13/2002	srf074	RUN	82.3	0.53
8/13/2002	srf075	POOL	17.5	1.53
8/13/2002	srf076	RUN	96.7	0.90
8/13/2002	srf077	POOL	39.8	2.07
8/13/2002	srf078	RUN	141.4	1.00
8/13/2002	srf079	RIF	20.4	0.50
8/13/2002	srf080	POOL	24.6	1.17
8/13/2002	srf081	RIF	99.2	0.57
8/13/2002	srf082	RUN	77.7	0.60
8/13/2002	srf083	RIF	9	0.33
8/13/2002	srf084	RUN	20.6	0.70
8/13/2002	srf085	RIF	96.4	0.50
8/13/2002	srf086	RUN	153.9	1.00
8/13/2002	srf087	POOL	16.1	1.03
8/13/2002	srf088	RIF	65.3	0.47
8/13/2002	srf089	RUN	70.3	0.57
8/13/2002	srf090	RIF	29.1	0.50
8/13/2002	srf091	RUN	475.4	0.57
8/13/2002	srf092	POOL	27.6	1.47
8/13/2002	srf093	RIF	47.1	0.57
8/13/2002	srf094	RUN	151.2	1.47
8/13/2002	srf095	RIF	42.4	0.40
8/13/2002	srf096	RUN	71.3	0.77
8/13/2002	srf097	RIF	34.5	0.83
8/13/2002	srf098	RUN	44	0.70
8/13/2002	srf099	POOL	171.9	1.40
8/13/2002	srf100	RIF	8.2	0.70
8/13/2002	srf101	POOL	27.1	1.30
8/13/2002	srf102	RIF		0.73
8/13/2002	srf103	RUN	37.8	0.93
8/13/2002	srf104	RIF	31.1	0.37
8/13/2002	srf105	RUN	24.9	0.87
8/13/2002	srf106	POOL	17.4	1.20
8/13/2002	srf107	RIF	10.5	0.43
8/13/2002	srf108	POOL	17.4	2.13
8/13/2002	srf109	RIF	12	0.77
8/13/2002	srf110	POOL	33	1.57
8/13/2002	srf111	RUN	48.8	1.30
8/13/2002	srf112	RIF	33.4	0.37
Date	ID	Type	Length	Average Depth
8/13/2002	srf113	RUN	48.2	1.07
8/13/2002	srf114	RIF	55.8	0.47
8/13/2002	srf115	RUN	23.1	0.73
8/13/2002	srf116	POOL	44.6	1.43
8/13/2002	srf117	RUN	45.9	1.27
8/13/2002	srf118	RIF	24.5	0.53
8/13/2002	srf119	RUN	32.9	1.03
8/13/2002	srf120	POOL	22.2	1.67
8/13/2002	srf121	RUN	108.2	1.10
8/13/2002	srf122	RIF	65.6	0.47
8/13/2002	srf123	RUN	42.9	0.73
8/13/2002	srf124	RIF	61.6	0.47
8/17/2002	srf125	RUN	94.5	1.23
8/17/2002	srf126	POOL	45.3	2.03
8/17/2002	srf127	RIF	61.9	0.70

8/17/2002	srf128	POOL	47.9	1.77
8/17/2002	srf129	RIF	30.1	0.50
8/17/2002	srf130	RUN	62	0.83
8/17/2002	srf131	POOL	26.8	1.83
8/17/2002	srf132	RIF	62.4	1.07
8/17/2002	srf133	POOL	99.9	1.83
8/17/2002	srf134	RIF	68.7	0.50
8/17/2002	srf135	POOL	96.6	1.50
8/17/2002	srf136	RIF	116.4	0.53
8/17/2002	srf137	RUN	29.4	1.17
8/17/2002	srf138	POOL	76.3	2.63
8/17/2002	srf139	RUN	49.7	0.63
8/17/2002	srf140	POOL	31.4	1.70
8/17/2002	srf141	RIF	39.7	0.57
8/17/2002	srf142	POOL	94.9	2.07
8/17/2002	srf143	RIF	25.2	0.53
8/17/2002	srf144	RUN	47.8	0.83
8/17/2002	srf145	POOL	108.6	1.70
8/17/2002	srf146	RUN	154.6	0.80
8/17/2002	srf147	RIF	120.1	0.73
8/17/2002	srf148	POOL	41.8	1.37
8/17/2002	srf149	RIF	39.6	0.47
8/17/2002	srf150	POOL	19.1	1.17
8/17/2002	srf151	RUN	37.7	0.87
8/17/2002	srf152	POOL	55	1.67
8/17/2002	srf153	RIF	92.7	0.57
8/17/2002	srf154	RUN	47.4	1.13
8/17/2002	srf155	POOL	58.1	1.50
8/17/2002	srf156	RIF	26.6	0.57
Date	**ID**	**Type**	**Length**	**Average Depth**
8/17/2002	srf157	POOL	39.8	3.80
8/17/2002	srf158	POOL	53.7	1.20
8/17/2002	srf159	RUN	584	1.03
8/17/2002	srf160	POOL	28.2	1.53
8/17/2002	srf161	RUN	244.7	0.83
8/17/2002	srf162	POOL	45.2	1.27
8/17/2002	srf163	RUN	100.6	0.50
8/17/2002	srf164	POOL	41.6	2.33
8/17/2002	srf165	RIF	56.1	0.73
8/17/2002	srf166	RUN	84.1	0.57
8/17/2002	srf167	POOL	42.4	1.23
8/17/2002	srf168	RIF	90.6	0.43
8/17/2002	srf169	POOL	35.7	1.53
8/17/2002	srf170	RIF	26.4	0.37
8/17/2002	srf171	RUN	26.2	0.70
8/17/2002	srf172	POOL	25	1.67
8/17/2002	srf173	RUN	67	0.97
8/17/2002	srf174	POOL	17	1.30
8/17/2002	srf175	RUN	22.8	0.70
8/17/2002	srf176	POOL	16.9	1.23
8/17/2002	srf177	RUN	73.1	0.40
8/25/2002	srf178	RIF	29	0.73
8/25/2002	srf179	POOL	33	1.40
8/25/2002	srf180	POOL	108	1.80
8/25/2002	srf181	RUN	31.2	1.23
8/25/2002	srf182	POOL	40.1	2.27
8/25/2002	srf183	RIF	47.5	0.63
8/25/2002	srf184	RUN	34.5	0.87
8/25/2002	srf185	RIF	43.3	0.47
8/25/2002	srf186	POOL	34.5	2.37
8/25/2002	srf187	RIF	63.8	0.60
8/25/2002	srf188	RUN	484.9	0.97
8/25/2002	srf189	POOL	32.6	1.17
8/25/2002	srf190	RUN	28.2	0.83
8/25/2002	srf191	RIF	24.1	0.60
8/25/2002	srf192	RUN	25.7	0.60

8/25/2002	srf193	POOL	37.6	1.57
8/25/2002	srf194	RUN	45	0.60
8/25/2002	srf195	POOL	65.3	1.60
8/25/2002	srf196	RIF	37.8	0.73
8/25/2002	srf197	POOL	42.3	2.10
8/25/2002	srf198	POOL	23.8	2.00
8/25/2002	srf199	RUN	80.9	1.00
8/25/2002	srf200	RIF	33.2	0.63

Date	ID	Type	Length	Average Depth
8/25/2002	srf201	RUN	35.9	0.67
8/25/2002	srf202	POOL	20.8	1.40
8/25/2002	srf203	RUN	42.5	0.83
8/25/2002	srf204	POOL	7.6	1.40
8/25/2002	srf205	RIF	13.2	0.43
8/25/2002	srf206	POOL	140.8	2.37
8/25/2002	srf207	POOL	51.1	1.30
8/25/2002	srf208	POOL	49.7	1.77
8/25/2002	srf209	POOL	32	1.53
8/25/2002	srf210	POOL	65.8	2.00
8/25/2002	srf211	POOL	22.3	1.63
8/25/2002	srf212	RUN	36	1.57
8/25/2002	srf213	POOL	69.8	3.47
8/25/2002	srf214	RUN	16.5	1.30
8/25/2002	srf215	POOL	97.6	1.83
8/25/2002	srf216	POOL	41.9	1.37
8/25/2002	srf217	RIF	13.7	0.47
8/25/2002	srf218	RUN	34	0.97
8/25/2002	srf219	POOL	24.2	1.90
8/25/2002	srf220	RUN	29.3	0.83
8/25/2002	srf221	POOL	66.7	1.90
8/25/2002	srf222	RIF	23.3	0.60
8/25/2002	srf223	POOL	46	1.47
8/25/2002	srf224	POOL	42.7	2.03
8/25/2002	srf225	RUN	24.4	1.30
8/25/2002	srf226	POOL	113.8	2.30
8/25/2002	srf227	RUN	15.6	1.00
8/25/2002	srf228	POOL	72.5	2.90
8/25/2002	srf229	RIF	42.8	0.97
8/25/2002	srf230	POOL	11.1	1.77
8/25/2002	srf231	RIF	26.1	1.30
8/25/2002	srf232	RIF	29.5	0.57
8/25/2002	srf233	RIF	28.9	0.90
8/25/2002	srf234	POOL	46	1.67
8/25/2002	srf235	RIF	99.6	0.67

END OF RISK REGION A

8/25/2002	srf236	RUN	51	0.97
8/25/2002	srf237	POOL	39.1	1.37
8/25/2002	srf238	RIF	37.7	0.93
8/25/2002	srf239	POOL	20.5	1.63
8/25/2002	srf240	RUN	38.8	0.97
8/25/2002	srf241	POOL	69.5	2.73
8/25/2002	srf242	RUN	87	1.20
8/25/2002	srf243	RIF	60.8	0.40

Date	ID	Type	Length	Average Depth
8/25/2002	srf244	POOL	46.7	1.13
8/25/2002	srf245	RIF	29.6	0.70
8/25/2002	srf246	POOL	83.2	2.73
8/25/2002	srf247	RUN	31	0.43
8/25/2002	srf248	RIF	52.5	0.67
8/25/2002	srf249	POOL	33.4	3.30
8/25/2002	srf250	RUN	27	0.53
8/25/2002	srf251	POOL	82.7	2.50
8/25/2002	srf252	RUN	25.4	1.30
10/10/2002	srf253	POOL	60	2.63
10/10/2002	srf254	RIF	35.3	1.10
10/10/2002	srf255	RUN	63.6	0.80

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Date	ID	Type	Length	Average Depth
10/10/2002	srf256	RIF	40.7	0.80
10/10/2002	srf257	POOL	46.6	1.90
10/10/2002	srf258	RUN	164.1	1.30
10/10/2002	srf259	POOL	149.9	2.57
10/10/2002	srf260	RUN	22.5	1.40
10/10/2002	srf261	POOL	26.8	2.83
10/10/2002	srf262	RUN	42.2	1.03
10/10/2002	srf263	POOL	24.8	2.30
10/10/2002	srf264	RUN	31.5	1.87
10/10/2002	srf265	POOL	71.7	2.73
10/10/2002	srf266	POOL	60	1.70
10/10/2002	srf267	RUN	26.6	1.53
10/10/2002	srf268	POOL	33.1	2.67
10/10/2002	srf269	RUN	29.4	1.03
10/10/2002	srf270	POOL	15	2.00
10/10/2002	srf271	RIF	67.6	1.10
10/10/2002	srf272	POOL	24.2	2.03
10/10/2002	srf273	RIF	10.6	0.73
10/10/2002	srf274	POOL	33.9	2.13
10/10/2002	srf275	POOL	23.5	2.27
10/10/2002	srf276	RUN	39.2	1.57
10/10/2002	srf277	RIF	92.8	0.67
10/10/2002	srf278	RUN	101.2	1.07
10/10/2002	srf279	POOL	56.7	1.83
10/10/2002	srf280	POOL	65.7	2.33
10/10/2002	srf281	RUN	93.8	1.50
10/10/2002	srf282	POOL	49.8	2.13
10/10/2002	srf283	RUN	26.3	0.73
10/10/2002	srf284	POOL	33	1.77
10/10/2002	srf285	RIF	54.5	1.17
10/10/2002	srf286	POOL	50.8	1.53
10/10/2002	srf287	RIF	49.3	0.90
10/10/2002	srf288	RUN	61.9	1.20
10/10/2002	srf289	POOL	83.9	1.77
10/10/2002	srf290	RUN	57.8	1.60
10/10/2002	srf291	POOL	130	2.93
10/10/2002	srf292	RIF	38.1	1.13
10/10/2002	srf293	RUN	130.3	1.33
10/10/2002	srf294	POOL	62.1	2.37
10/10/2002	srf295	RUN	45.1	0.83
10/10/2002	srf296	POOL	37.4	2.23
10/10/2002	srf297	RUN	41.7	0.73
10/10/2002	srf298	POOL	26.4	1.90
10/10/2002	srf299	RIF	106.2	1.07
10/10/2002	srf300	RUN	70	1.10
10/10/2002	srf301	POOL	41.5	2.13
10/10/2002	srf302	RUN	66.9	1.07
10/10/2002	srf303	POOL	26.3	2.13
10/10/2002	srf304	RIF	107.6	0.73
10/10/2002	srf305	POOL	39.2	2.70
10/10/2002	srf306	POOL	41.6	2.40
10/10/2002	srf307	RIF	51.5	1.13
10/10/2002	srf308	RUN	37.8	1.93
10/10/2002	srf309	RIF	29.4	0.77
10/10/2002	srf310	POOL	49.6	2.40
10/10/2002	srf311	RIF	50.6	0.93
10/12/2002	srf312	RUN	49.3	1.13
10/12/2002	srf313	RIF	9.3	0.50
10/12/2002	srf314	RUN	51.7	1.50
10/12/2002	srf315	RIF	14.6	0.70
10/12/2002	srf316	RUN	46	1.17
10/12/2002	srf317	POOL	39.8	1.63
10/12/2002	srf318	RUN	37.1	1.63
10/12/2002	srf319	RIF	12.8	0.37

10/12/2002	srf320	POOL	59.6	2.17
10/12/2002	srf321	RIF	43.9	0.53
10/12/2002	srf322	RUN	87.5	0.77
10/12/2002	srf323	POOL	26.3	1.83
10/12/2002	srf324	RIF	38.3	0.60
10/12/2002	srf325	RUN		0.83
10/12/2002	srf326	POOL		1.90
10/12/2002	srf327	RUN	27.9	1.20
10/12/2002	srf328	RIF	11.1	0.47
10/12/2002	srf329	RUN	35.6	1.33
10/12/2002	srf330	POOL	40.9	1.67
Date	ID	Type	Length	Average Depth
10/12/2002	srf331	RUN	40.8	0.87
10/12/2002	srf332	POOL	13.9	1.60
10/12/2002	srf333	RIF	57.7	0.63
10/12/2002	srf334	RUN	67.7	1.23
10/12/2002	srf335	POOL	29.6	1.67
10/12/2002	srf336	RIF	27.6	0.73
10/12/2002	srf337	RUN	37.7	0.73
10/12/2002	srf338	RIF		0.43
10/12/2002	srf339	RUN		1.17
10/12/2002	srf340	RIF	85.4	1.17
10/12/2002	srf341	POOL	47.6	2.27
10/12/2002	srf342	RIF	22.9	0.47
10/12/2002	srf343	RUN	84.8	1.10
10/12/2002	srf344	POOL	21.2	2.17
10/12/2002	srf345	RIF	20.7	0.67
10/12/2002	srf346	POOL	20.8	2.17
10/12/2002	srf347	RIF	20.9	0.63
10/12/2002	srf348	RUN	41.9	1.27
10/12/2002	srf349	POOL	22.1	1.83
10/12/2002	srf350	RIF	19.2	0.70
10/12/2002	srf351	POOL	31.5	1.23
10/12/2002	srf352	RUN	53.1	1.20
10/12/2002	srf353	POOL	19.3	1.93
10/12/2002	srf354	RUN	35.5	1.77
10/12/2002	srf355	RIF	50.2	0.43
10/12/2002	srf356	RUN	159.8	0.83
10/12/2002	srf357	POOL	21.6	2.40
10/12/2002	srf358	RIF	24.6	0.50
10/12/2002	srf359	RUN	252.5	0.83
10/12/2002	srf360	POOL	36.8	1.60
10/12/2002	srf361	RUN	276.1	0.90
10/26/2002	srf362	POOL	54.6	1.20
10/26/2002	srf363	RIF	143.1	0.83
10/26/2002	srf364	RUN	64.8	0.77
10/26/2002	srf365	POOL	39.8	2.97
10/26/2002	srf366	RUN	73.6	0.93
10/26/2002	srf367	RIF	42.1	0.40
10/26/2002	srf368	RUN	39	0.87
10/26/2002	srf369	RIF	23.2	0.33
10/26/2002	srf370	RUN	65.8	0.67
10/26/2002	srf371	POOL	19	1.80
10/26/2002	srf372	RIF	49	0.43
10/26/2002	srf373	RUN	70.5	0.90
Date	ID	Type	Length	Average Depth
10/26/2002	srf374	POOL	34.172	1.97
10/26/2002	srf375	RUN	375	0.87
10/26/2002	srf376	POOL	18.6	1.43
10/26/2002	srf377	RUN	297.1	0.67
10/26/2002	srf378	RIF	89.5	0.47
10/26/2002	srf379	RUN	102	0.53
10/26/2002	srf380	RIF	58.3	0.70
10/26/2002	srf381	RUN	30.2	0.90
10/26/2002	srf382	RIF	51.7	0.37
10/26/2002	srf383	RUN	19.7	1.03

10/26/2002	srf384	RIF	30.1	0.63
10/26/2002	srf385	POOL	31.2	1.50
10/26/2002	srf386	RUN	57.3	0.70
10/26/2002	srf387	POOL	43.7	2.13
10/26/2002	srf388	RUN	62.6	0.40
10/26/2002	srf389	RIF	91.2	0.43
10/26/2002	srf390	POOL	40.1	1.17
10/26/2002	srf391	RIF	13.9	0.37
10/26/2002	srf392	POOL	24	1.40
10/26/2002	srf393	RIF	57	0.47
10/26/2002	srf394	POOL	30.4	1.23
10/26/2002	srf395	RIF	28.2	0.40
10/26/2002	srf396	RUN	46.7	1.03
10/26/2002	srf397	POOL	34.9	1.13
10/26/2002	srf398	RUN	32.1	0.83
10/26/2002	srf399	POOL	12.6	1.27
10/26/2002	srf400	RIF	19.2	0.80
10/26/2002	srf401	RUN	23.2	0.77
10/26/2002	srf402	RIF	57.2	0.77
10/26/2002	srf403	RUN	94	0.53
10/26/2002	srf404	RIF	49.5	0.30
10/26/2002	srf405	RUN	98.4	0.57
10/26/2002	srf406	POOL	31.7	1.70
10/26/2002	srf407	RUN	36.5	0.73
10/26/2002	srf408	RIF	28.6	0.43
10/26/2002	srf409	POOL	18.3	1.63
10/26/2002	srf410	RIF	111.1	0.53
10/26/2002	srf411	POOL	45	0.63
10/26/2002	srf412	RIF	26.4	0.27
10/26/2002	srf413	POOL	16.2	1.13
10/26/2002	srf414	RIF	26.5	0.70
10/26/2002	srf415	POOL	40.6	0.93
10/26/2002	srf416	RIF	13.5	0.50
10/26/2002	srf417	POOL	40.4	1.27
Date	ID	Type	Length	Average Depth
10/26/2002	srf418	RIF	40.4	0.63
10/26/2002	srf419	POOL	381.6	2.20
10/26/2002	srf420	RIF	9.9	0.60
10/26/2002	srf422	RIF	10.9	0.57
10/26/2002	srf421	RUN	30.2	0.73
10/26/2002	srf423	POOL	128	1.50
10/26/2002	srf424	RUN	53	0.77
10/26/2002	srf425	POOL	33.9	1.80
10/26/2002	srf426	RUN	86.7	0.50
10/26/2002	srf427	RIF	20.4	0.57
10/26/2002	srf428	RUN	19.4	0.80
10/26/2002	srf429	RIF	21.8	0.40
10/26/2002	srf430	POOL	31.5	1.00
10/26/2002	srf431	RIF	20.1	0.53
10/26/2002	srf432	RUN	26.6	0.83
10/26/2002	srf433	RIF	25	0.40
10/26/2002	srf434	RUN	94.6	0.37
10/26/2002	srf435	RIF	16.9	0.27
10/26/2002	srf436	RUN	30.8	1.03
10/26/2002	srf437	RIF	89.9	0.40
10/26/2002	srf438	RUN	54.6	0.83
10/26/2002	srf439	RIF	13.1	0.53
10/26/2002	srf440	RUN	56.7	0.80
10/26/2002	srf441	RIF	47.5	0.40
10/26/2002	srf442	RUN	42.6	0.73
10/26/2002	srf443	RIF	78	0.37
10/26/2002	srf444	RUN	34.9	0.63
10/26/2002	srf445	RIF	51.7	0.47
10/26/2002	srf446	RUN	40.6	0.93
10/26/2002	srf447	RIF	50.9	0.30
10/26/2002	srf448	RUN	46.4	0.77

10/26/2002srf449	RIF	24.4	0.37
10/26/2002srf450	RUN	51	0.67
10/26/2002srf451	RIF	23.2	0.53

Appendix M: Stressor Risk Analysis and Characterization (SDRM)

Appendix M-1: Reduced Access

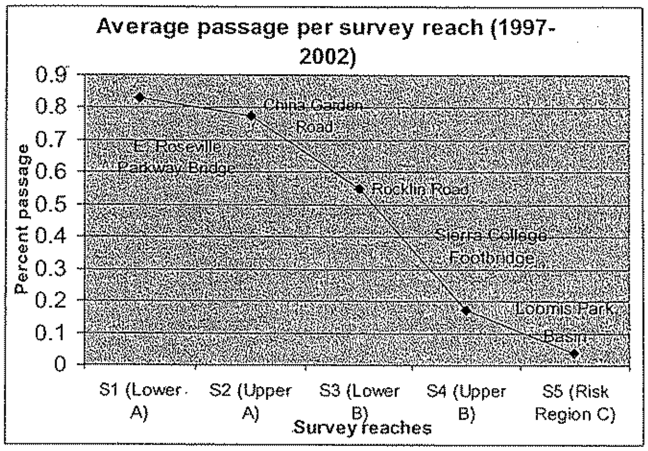
Risk Characterization for Reduced Access (SDRM)

Raw Data and Mathematical Models for Characterizing Reduced Access

Total counts (carcass +live)					
1997	54				
1998	115				
1999	114				
2000	344				
2001	no data				
2002	213				
average	168				
Risk region averages (1997-2002, live only)					
S1 (Lower A)	9				
S2 (Upper A)	38				
S3 (Lower B)	63				
S4 (Upper B)	23				
S5 (Risk Region C)	6				
Average occupancy per month (1997-2002, live only)					
Late October	0				
Early November	27				
Late November	26				
Early December	48				
Late December	2				
Yearly counts per survey reach (1997-2002, live only)					
	1997	1998	1999	2000	2002
S1	8	5	3	31	0
S2	7	29	46	63	43
S3	0	0	0	40	86
S4	0	0	15	10	44
S5	0	5	0	14	0
Average passage (1997-2002, live only)	P	NP			
through S1	0.83	0.17			
through S2	0.77	0.23			
through S3	0.55	0.45			
through S4	0.17	0.83			
through S5	0.04	0.96			

Average passage ('Risk Region A')	0.72	0.28
Average passage ('Risk Region B')	0.11	0.89
Average passage ('Risk Region C')	0.04	0.96

ADULT COUNT DATA FOR SECRET RAVINE (1997-2002)



AVERAGE ADULT PASSAGE PER SURVEY REACH (1997-2002)

Water Resources Center Archives
Restoration of Rivers and Streams
(University of California, Multi-Campus Research Unit)

Year 2003 *Paper debarruel*

A benthic macroinvertebrate survey of Secret Ravine : the effects of urbanization on species diversity and abundance

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University of California, Berkeley

A benthic macroinvertebrate survey of Secret Ravine : the effects of urbanization on species diversity and abundance

Abstract

The population in Placer County, California, is growing four times faster than the state of California. With the increase in population comes a large increase in impervious surfaces such as residential developments, strip malls, roads, and a probable decline in local stream water quality. To test whether the recent developments have impacted a local stream, we compared macroinvertebrate populations in an undeveloped (upstream) and a developed (downstream) reach of Secret Ravine. We sampled macroinvertebrates with a Surber sampler, following the EPA Rapid Bioassessment Protocols. The mean number of 55 organisms per sample downstream was significantly higher ($p=0.02$) than the mean number of 23 organisms per sample upstream. Although there was not any significant difference between the mean %EPT (pollution sensitive organisms) at the upstream and downstream sites, there was a significant difference between moderately sensitive ($p=0.01$) and tolerant ($p=0.01$) organisms. The percent moderately sensitive organisms was 32% upstream and 6.8% downstream. The percent tolerant organisms was 52% downstream and 17% upstream. Further indication that the downstream site was impacted by development was the abundance of filamentous algae that indicate a eutrophic (nutrient-rich) stream. Another difference between the two sites was the lack of red Chironomid (midge) larvae upstream, compared to 49% of the downstream organisms as midge larvae. Midge larvae, which tolerate oxygen as low as 20% of saturation, indicated the sediment under the algae and pebbles was anoxic downstream. In addition, the upstream community contained 22% dragonfly larvae, which require high levels of oxygen, while the downstream site was only 4% dragonfly larvae. The abundance of pollution tolerant organisms and filamentous algae indicates the downstream site is receiving nutrient-rich urban

runoff, but contained little or no toxins. Further studies should focus on measuring temperature, dissolved oxygen, and nutrient content of the upstream and downstream runoff to determine the extent of eutrophication due to urbanization of the watershed.

A Benthic Macroinvertebrate Survey of Secret Ravine:

The Effects of Urbanization on Species Diversity and Abundance

Abstract

The population in Placer County, California, is growing four times faster than the state of California. With the increase in population comes a large increase in impervious surfaces such as residential developments, strip malls, roads, and a probable decline in local stream water quality. To test whether the recent developments have impacted a local stream, we compared macroinvertebrate populations in an undeveloped (upstream) and a developed (downstream) reach of Secret Ravine. We sampled macroinvertebrates with a Surber sampler, following the EPA Rapid Bioassessment Protocols. The mean number of 55 organisms per sample downstream was significantly higher ($p=0.02$) than the mean number of 23 organisms per sample upstream. Although there was not any significant difference between the mean %EPT (pollution sensitive organisms) at the upstream and downstream sites, there was a significant difference between moderately sensitive ($p=0.01$) and tolerant ($p=0.01$) organisms. The percent moderately sensitive organisms was 32% upstream and 6.8% downstream. The percent tolerant organisms was 52% downstream and 17% upstream. Further indication that the downstream site was impacted by development was the abundance of filamentous algae that indicate a eutrophic (nutrient-rich) stream. Another difference between the two sites was the lack of red Chironomid (midge) larvae upstream, compared to 49% of the downstream organisms as midge larvae. Midge larvae, which tolerate oxygen as low as 20% of saturation, indicated the sediment under the algae and pebbles was anoxic downstream. In addition, the upstream community contained 22% dragonfly larvae, which require high levels of oxygen, while the downstream site was only 4% dragonfly larvae. The abundance of pollution tolerant organisms and filamentous algae indicates the downstream site is receiving nutrient-rich urban runoff, but contained little or no toxins. Further studies should focus on measuring temperature, dissolved oxygen, and nutrient content of the upstream and downstream runoff to determine the extent of eutrophication due to urbanization of the watershed.

Monique de Barruel
Nicole West

LAEP 227 – Dr. Kondolf – December 5, 2003

Introduction

Cities in western Placer County, California, are some of the fastest growing regions in the state. For example, the county increase in population from April 1, 2000 to July 1, 2001 was 8.1%, more than quadruple that of the state of California's 1.9%. The total population in 2000 was 248,399--more than a 30% increase from the population count of 172,796 in 1990 (U.S. Census, 2003). With the increase in population comes an increase in residential development, strip malls, and roads.

Part of the Dry Creek Watershed is located in the middle of this extensive development. This watershed, located in Sacramento and Placer Counties, is approximately 101 square miles of rural, agricultural regions as well as high-density residential and commercial developments. The extent of development increases in the downstream direction. Secret Ravine, one of six tributaries to Dry Creek, traverses the Cities of Roseville, Rocklin, and Loomis (Figure 1)– allcities planning a great deal of future development. The cities of Roseville and Rocklin forbid development within the 100 year floodplain.

The Dry Creek Parkway Citizens Advisory Committee has proposed the establishment of many additional parks to preserve open space near the creek. Debra Bishop, author of *An Evaluation of Dry Creek and its Major Tributaries in Placer County*, states that "all local governmental entities in the region support the preservation of open space and riparian habitat in their planning documents" (Bishop, 1997).

Even though developments are not within the 100 year floodplain, the nearby development likely impacts the creek. Urbanization of a stream's watershed can result in decreased water quality, increased temperatures, sedimentation, loss of habitat, and loss of fish populations (USEPA, 2003). The increase in impervious surfaces (e.g. roads,

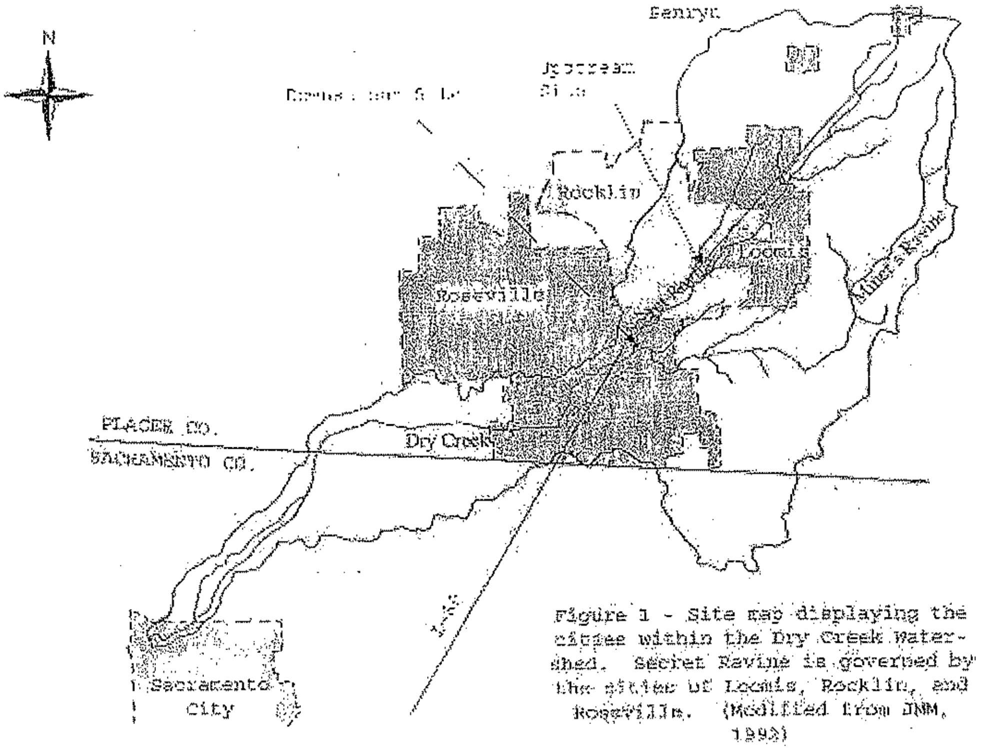

Figure 1 - Site map displaying the cities within the Dry Creek Watershed. Secret Ravine is governed by the cities of Loomis, Rocklin, and Roseville. (Modified from JMM, 1993)

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parking lots, roofs, etc) increases the volume and velocities of runoff (Davis et al, 2003). These hydrologic changes impact water quality by increasing sedimentation and water temperature (USEPA, 1997). Conversion of agricultural areas to urban development can cause a decline in water quality by increasing the loading of oil, grease, nutrients, and heavy metals (Barbour, 1996).

Macroinvertebrates are important because they are a food source for Chinook salmon and steelhead, which spawn in Dry Creek (AFRP, 2003). In addition, differences in benthic macroinvertebrate populations can indicate perturbations such as pollution (Barbor et al, 1999). Aquatic macroinvertebrates are good indicators of stream quality because they have limited migration patterns and cannot escape pollution, so they show cumulative impacts of pollution as well as impacts of habitat loss not detected by traditional water quality assessments (McCarron et al, 1996; Horne, 2003). To better understand the effects of urbanization on the density and abundance of benthic macroinvertebates, we examined a rural upstream location and an urbanized location three miles downstream in Secret Ravine. Our purpose is to document the existing conditions and to determine whether Placer County has preserved the creek habitat despite extensive development. In addition, we will compare our results with a macroinvertebrate study of Truckee River, California.

Site Description

Despite paralleling Interstate 80, Secret Ravine, in comparison to the other tributaries to Dry Creek, has an overall exceptional habitat value (Bishop, 1997) including abundant riparian vegetation. The upstream site (Figure 2), located just south of Sierra College, is in a relatively open space area consisting mainly of rural residential

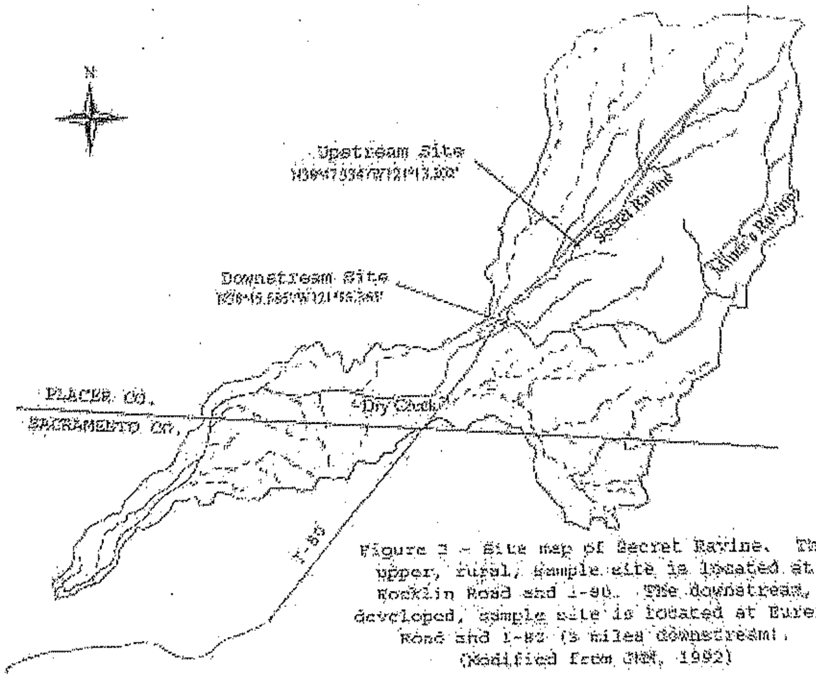

Figure 2 – Site map of Secret Ravine. The upper, rural, sample site is located at Rocklin Road and I-80. The downstream, developed, sample site is located at Eureka Road and I-80 (3 miles downstream). (Modified from JMM, 1992)

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land-uses. There is abundant riparian vegetation including mint, alder, and native grasses, but also a considerable amount of non-native and invasive Himalayan blackberry and star-thistle. The substrate of the stream-bed consists of gravel to boulder-sized rocks. The water flowed faster and appeared much clearer than at the downstream site. Salmon are reported to spawn in this location (Gregg Bates, Dry Creek Conservancy, personal communication).

The downstream site, just before the confluence with Miner's Ravine, is in an urbanized area. Recent developments in the stretch between the two sample sites have included residential communities, and strip malls, as well as a water park. This downstream site has considerable riparian overstory, but the understory is very disturbed and weed infested. The substrate consists of sand and fist-sized cobbles coated with decomposing filamentous algae. Abundant debris and trash has been deposited along the banks and within the stream. Bishop (1997) reported homeless impact at this site as well. There are four bridges, including a new major road crossing, between the two sample sites.

Materials and Methods

Pebble Counts

We conducted a pebble count in each riffle to compare the habitat available for benthic macroinvertebrates at each location. Using the protocol outlined by Brooke and Kondolf (2003), we randomly selected 100 pebbles from each riffle and categorized them according to the length of their intermediate axis.

Measurement of Physical/Chemical Characteristics

We used a measuring tape to estimate the length and width of both riffles and measured the depth at three points along each cross section selected for invertebrate sampling. We used a dissolved oxygen (DO) meter to measure temperature and DO and estimated water velocity by timing the speed of a floating leaf.

Macroinvertebrate Sampling

We followed the EPA Rapid Bioassessment Protocols for Use in Streams and Wadeable Waters (Barbour, et al 1999) with modifications from Karr and Chu (1999) for quantitative instead of qualitative data. We used 500-um-mesh Surber sampler to collect three samples across two-cross sections in each riffle. Placing the Surber sampler on the streambed, which marks off a one-foot square area, we disturbed the enclosed sediment for three minutes while brushing off the large cobbles by hand to remove any attached invertebrates. Using clean stream water, we emptied the contents of the Surber sampler into a white tray and visually inspected the net to ensure that all attached organisms were removed. We collected all the invertebrates from each sample and preserved everything except the Chironomid (midge) larvae, which were counted on site, in Formalin for later identification in the laboratory. We then emptied the tray and rinsed the Surber net in the stream. Using Merritt and Cummins' *An Introduction to the Aquatic Insects of North America* as a guide, we identified the invertebrates to the level of Order.

Statistical Analysis

Benthic macroinvertebrate data is usually analyzed by relative abundance, taxa richness, and perturbation tolerance/sensitivity in accordance to EPA protocols (Barbor et al, 1999). To measure abundance, we analyzed the number of total organisms in each sample. Richness measures the diversity of the aquatic assemblage. To measure species richness, we used the Simpson's index of diversity (1-D), which measures the probability that two randomly selected individuals in a community are of different categories (Horne, 2003). Simpson's index of diversity is calculated using the equation:

$$1 - D = 1 - \sum_{n=1}^{i} \frac{n_i(n_i - 1)}{N(N-1)}$$

where N is the total number of organisms in a sample and n is the total number of individuals in each category.

To measure tolerance we divided the organisms into three categories according to their sensitivity to perturbation. Community sensitivity is usually expressed as %EPT (the percent of total organisms from the orders *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies), and *Tricoptera* (caddisflies)). We classified all other organisms as either moderately sensitive or tolerant according to Barbor et al (1999) (Table 1). Regional tolerance values for Heminoptera and Lepidoptera are not listed in the EPA Rapid Bioassessment Protocols, so we did not include them in the analysis of sensitivity (Barbor et al, 1999). We performed statistical analyses (t-tests, 10 degrees of freedom) to determine if the means of the six samples differed between the developed and undeveloped riffles with respect to macroinvertebrate abundance, diversity, and tolerance/sensitivity.

Table 1. Collected benthic macroinvertebrates, categorized by their perturbation sensitivity/tolerance as defined by the EPA (Barbour, 1999).

Scientific Taxonomy	Common Name	Sensitivity to Perturbation
Ephemeroptera	mayflies	sensitive
Plecoptera	stoneflies	sensitive
Tricoptera	caddisflies	sensitive
Crustacea (amphipoda)	Shrimp	moderately sensitive
Diptera (excluding Chironomidae)	black flies	moderately sensitive
Odonata	damsel and dragon flies	moderately sensitive
Mollusca (corbicula)	clams	tolerant
Oligochaetae	worms	tolerant
Diptera (Chironomidae)	midges	tolerant

Results

The downstream site was shallower, wider, warmer, with lower dissolved oxygen (DO) and slower velocity than the upstream site (Table 2). However, the pebble count indicated the gravel within each riffle were similar. Size classes for both sites ranged from <8 to 128mm. The D_{50} (median diameter) was 35 mm downstream and the D_{50} was 42 mm upstream (Figure 3). While sampling, we observed the downstream pebbles were covered in filamentous algae, probably *Cladophora* (blanket weed) whereas the upstream pebbles were not.

Table 2. Measurement of physical characteristics at the two sample locations. Depth, width, length, and temperature were all higher at the downstream site. Dissolved oxygen and velocity were higher at the upstream site.

	Downstream	Upstream
Average Depth (feet)	1.2	1.4
Width (feet)	21	15
Riffle Length (feet)	27	16
Temperature (°C)	14.2	12.9
Dissolved Oxygen (mg/L)	8.6	9.9
Velocity (ft/s)	0.7	1.5

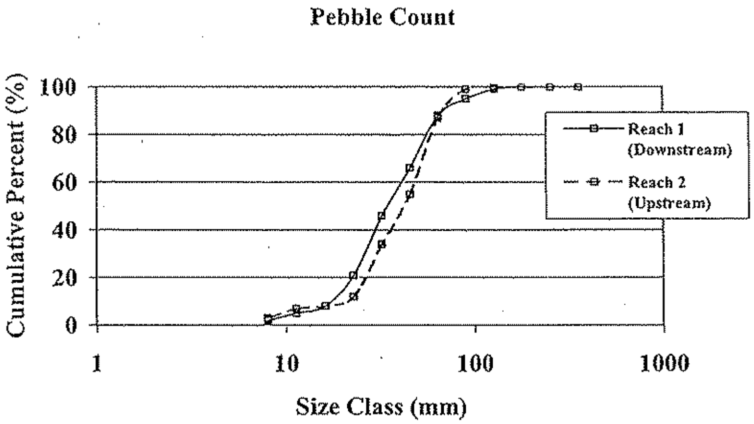

Figure 3. Cumulative pebble count graphs showing that the size distribution of the pebbles in both sites are similar.

The mean number of 23.0 organisms per sample at the upstream site was much lower and significantly different (p=0.02) than the mean number of 54.8 organisms per sample at the downstream site (Figure 4, Table 3). However, diversity between the two sites was not significantly different according to the t-test (p=0.2). The Simpson's Index of Diversity (1-D) was 0.7 at the upstream site and 0.6 at the downstream site (Figure 5, Table 3).

Table 3. Mean ± standard deviation of taxa richness, relative abundance, and perturbation tolerance/sensitivity of the macroinvertebrate populations in the upstream and downstream locations.

	Downstream	Upstream
% EPT	37.0 ± 24.0	51.5 ± 28.2
Moderately sensitive	6.8 ± 3.7	31.8 ± 19.1
Tolerant	51.7 ± 25.8	16.5 ± 12.2
Abundance	54.8 ± 24.4	23 ± 14.8
1-D (Diversity)	0.6 ± 0.2	0.7 ± 0.2
% Chironomid	48.9 ± 25.3	0
% Dragonfly	5.3 ± 3.8	22.2 ± 13.6

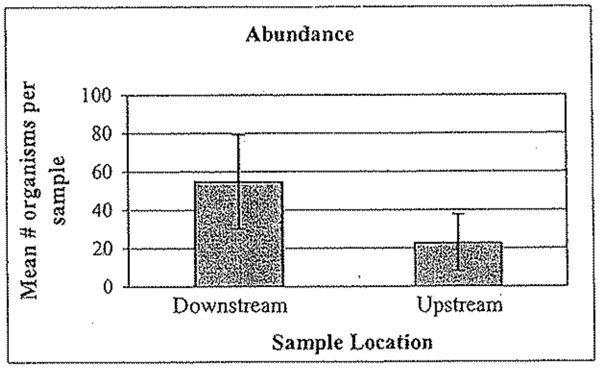

Figure 4. Mean number of organisms found in six samples at the upstream and downstream site. The mean number of organisms in each sample was significantly higher at the downstream site (p=0.02).

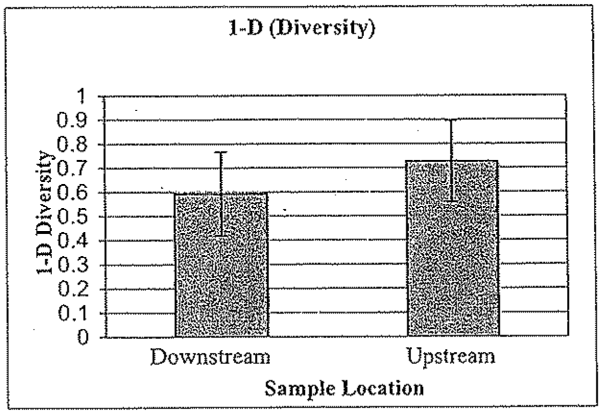

Figure 5. Simpson's index of diversity. Although diversity was higher at the upstream site, t-test showed no significant difference (p=0.2)

The mean percent *Ephemeroptera, Plecoptera,* and *Tricoptera* (%EPT) was 51.5% at the upstream site and 37.0% at the downstream site (Table 3, Figure 6). Results of the t-test indicate that the %EPT was not significantly different (p=0.36) between the sites. The mean percent of moderately sensitive organisms was 31.8% at the upstream site and 6.8% at the downstream site. The mean percent of tolerant organisms was much lower at the upstream site, 16.5%, than the 51.7% at the downstream site (Table 3, Figure 6). The t-test showed a significant difference of moderately sensitive organisms (p=0.01) and tolerant organisms (p=0.013) between the two sites.

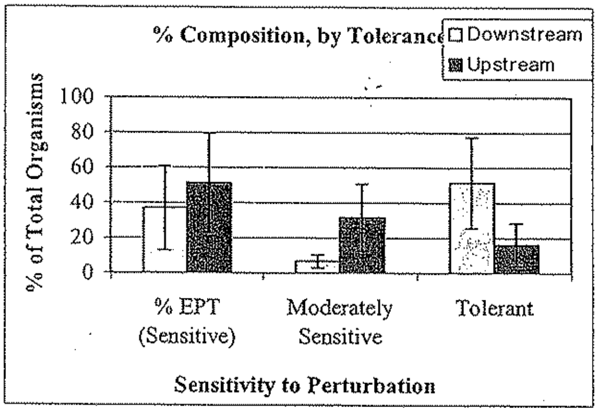

Figure 6. Mean percent sensitive (%EPT), moderately sensitive, and tolerant organisms. %EPT was not significantly different between the two sites. In contrast, the percent moderately sensitive organisms was significantly higher at the upstream site (p=0.01). The percent tolerant organisms was significantly higher at the downstream site (p=0.013).

One obvious difference between the two sites was the abundance of Chironomid (midge) larvae that were red in color at the downstream site. An average of 48.9% of the organisms in the downstream site were midge larvae. In contrast, no midge larvae were found in the upstream site (Table 3). A t-test showed a significant difference in the

Chironomid populations with a p-value = 0.001. Another significant difference (p=0.015) was the number of dragonfly larvae at the two sites. The upstream community was 22.2% dragonfly larvae while the downstream site was 3.5% dragonfly larvae.

Discussion

While both sites had bed material sizes in the range considered ideal for macroinvertebrate habitat, 1-128 mm (Gore et al, 1998), water quality was not as good at the downstream site. The abundance of filamentous green algae, *Cladophora*, was indicative of eutrophic conditions, specifically high nitrate. In low nutrient streams, the spring algal growths are eaten at the rate of production by insect larvae. At elevated nutrient levels attached algae grow faster than they can be grazed by invertebrates, resulting in mats of algae that last throughout the summer (Horne and Goldman, 1994). High concentrations of nitrogen and phosphorus in runoff from the surrounding development could cause high algal production in Dry Creek.

The total number of organisms at the downstream site was significantly greater than at the upstream site. Death (2002) showed a positive correlation between primary productivity and the number of benthic macroinvertebrates. Because some macroinvertebrates are grazers and scrappers that feed on filamentous algae, the number of macroinvertebrates would be expected to increase as their food source increases. These results also indicate that the runoff, although rich in nutrients, is not high in toxins. Urban runoff often contains high levels of heavy metals, pesticides, and polycyclic aromatic hydrocarbons (PAHs) from automobile emissions, streets, parking lots, rooftops, and construction sites. These toxins have a detrimental impact on aquatic organisms, including the number of benthic macroinvertebrates (Crunkilton et al, 1996).

The number of organisms would be expected to be lower at the downstream site if the urban runoff into Secret Ravine contained high levels of toxic compounds. With a few exceptions, urban runoff in California is not acutely toxic to aquatic organisms (Horne, 2003).

There was not a statistically significant difference in diversity between sites. Increasing diversity correlates with increasing community health, which indicates that the niche space, habitat, and food sources are adequate for the survival of many species (Barbour et al, 1999). In many situations, diverse populations are more stable because they are less affected by disturbance (Horne, 2003). However, some natural productive aquatic environments have low diversity and high productivity, e.g. estuaries where a stress (variable salt concentrations) is the cause of low diversity.

Although a difference in diversity could not be shown, the type of taxa in each population differed between the two sites. The mean percent *Ephemeroptera, Plecoptera,* and *Tricoptera* (%EPT) was lower at the downstream site, but due to the difference in population composition between the three samples in each cross section, the t-test did not show a significant difference between the two sites.

The percent of tolerant organisms at the downstream site was significantly higher due to the abundance of red Chironomid larvae. The percent midge larvae is expected to increase with increased perturbation (Barbour et al, 1999) and are typically abundant in eutrophic environments. Hemoglobin, present as Chironomids' blood pigment, binds oxygen and allows them to survive anoxic (low oxygen) environments; as little as 20% DO can be tolerated. Red chironomids, instead of brown, tend to dominate the benthos when DO is low. Hemoglobin production increases in response to a low oxygen environment (Horne and Goldman, 1994). Almost half of the downstream macroinvertebrate population was red-colored midge larvae, which indicates the sediment under the algae and pebbles was anoxic. Because the water in Secret Ravine is not anoxic, the decomposing filamentous algae mats must be using all the available oxygen or be preventing oxygen from reaching the sediments.

The percent of moderately sensitive species was significantly higher at the upstream site due to the presence of dragonfly larvae. Anoxia also explains the lack of dragonfly larvae at the downstream site. Oxygen is vital for dragonfly larvae, which crawl along the bottom under the pebbles (O'Toole, 1995). Therefore, dragonfly larvae are limited to the higher reach of Secrete Ravine where filamentous algae is not abundant.

Similar results were found in a 1977 macroinvertebrate study on the Truckee River, also located in Placer County. In this study, macroinvertebrate populations were sampled in both upstream and downstream sites (McLaren, 1977). The upstream, undeveloped site was located approximately three miles above the town of Truckee. The downstream site, located approximately 30 miles downstream of Truckee, was impacted by rapid development in the 1960's and 1970's.

As with Secret Ravine, the abundance of organisms at the downstream site was higher (Figure 7) although there was no difference in the macroinvertebrate diversity between the two sites (Figure 8). The %EPT (sensitive species) was higher at the upstream site (Figure 9), indicating less pollution. The percent tolerant species was higher at the downstream site (Figure 9), indicating higher perturbation and pollution. At the upstream site, Chironomid larvae were 16.3% of the macroinvertebrate population.

In contrast, the downstream site was 48.9% Chironomid larvae, a further indication of urban pollution (McLaren, 1977).

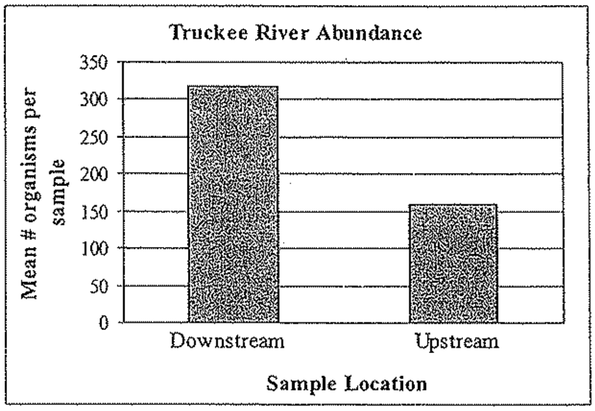

Figure 7. Mean number of organisms found at the upstream and downstream site in Truckee River. The mean number of organisms in each sample was higher at the downstream site (data from McLaren, 1977).

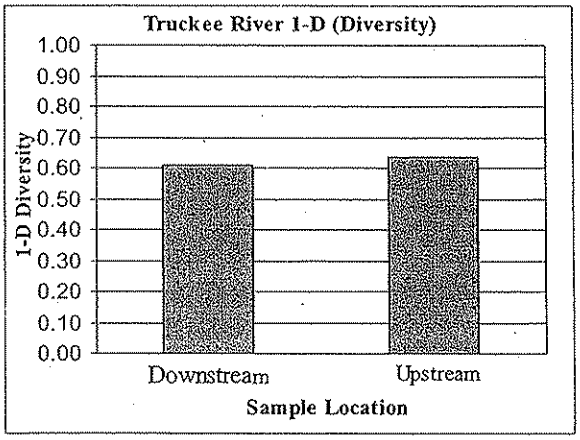

Figure 8. Simpson's index of diversity. There was no difference in diversity of macroinvertebrate communities in Truckee River (data from McLaren, 1977).

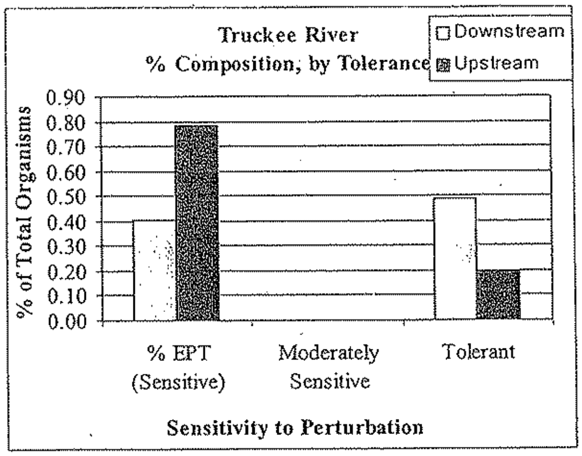

Figure 9. Mean percent sensitive (%EPT), moderately sensitive, and tolerant organisms. %EPT was higher at the upstream site. In contrast, the percent tolerant organisms was higher at the downstream site (data from McLaren, 1977)

Nutrient loading into the Truckee River began increasing in the 1960's. Increased nitrogen levels resulted in increased growth of attached algae (SWRCB, 2002). Plant respiration and decaying biomass decreased dissolved oxygen levels in the river (NDEP, 1994). The low DO levels have negatively impacted the threatened Lahontan cutthroat trout and the endangered cui-ui fish (NDEP, 1994).

Conclusion

Our results indicate that the macroinvertebrate populations in Dry Creek have been negatively impacted by urban development. The high algal productivity, probably in response to nutrient addition from runoff, in the downstream site has shifted the community to dominantly anoxia tolerant species. Further studies should focus on measuring the temperature, dissolved oxygen, and nutrient content of the upstream and downstream runoff to determine the extent of eutrophication due to urbanization of the watershed.

In addition, because the mean number of individuals and the species composition varied greatly along a cross section, future studies should use a stratified sampling method instead of the random sampling method recommended by the EPA (Barbour et al, 1999). In a stratified method, all samples would be taken at the same depth and location across the channel. Depth, velocity, and pebble size, which can vary across a channel, could all affect the macroinvertebrate populations (Horne and Goldman, 1994) and explain the variation observed along the cross sections of Dry Creek. Samples collected in the center of the channel at both sites would be compared together and/or samples collected at the edges would be compared in order to eliminate the difference in macroinvertebrate populations across the channel.

The results of this, and future, studies of macroinvertebrates may provide useful information for preservation efforts. Community groups such as the Dry Creek Conservancy have formed to promote the preservation and restoration of parts of the Dry Creek watershed. To help preserve the creek habitat, urban runoff should be treated before entering the creek to remove nutrients, toxins, and sediment. Natural treatment systems (treatment wetlands) could be constructed to treat runoff before it enters the creek. Any preservation project should also consider monitoring changes in the macroinvertebrate populations, because they are good indicators of pollution and perturbation as well as a food source for salmon. The goal in a preservation or restoration project in Secret Ravine would be to maintain a healthy macroinvertebrate population like that found in the upstream, rural site.

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Letter
10
Response

Arlan and Janette Cokeley
1/19/08

10-1 The impacts of the Rocklin 60 project as they relate to the Rocklin Crossings project were included in the Draft EIR, where appropriate. For example, in the noise analysis (Section 4.4, Noise, of the Draft EIR), the noise effects on future residents within the Rocklin 60 project were specifically identified. In addition, a detailed discussion of the cumulative development impacts associated with the Rocklin 60 project and other proposed projects within the region is provided in Section 6, Cumulative and Growth Inducing Impacts, of the Draft EIR.

10-2 The Rocklin Crossings project provides a pedestrian/emergency access to the proposed Buttonbush Lane in the Rocklin 60 residential project. The Rocklin Crossings project does not have a direct pedestrian/emergency or vehicular access to Dias Lane. As such, the project would not generate additional vehicular traffic on Dias Lane. Therefore, the project should not affect maintenance of Dias Lane.

10-3 For a discussion of the current status of special-status fish and benthic macroinvertebrates (BMIs) in Secret Ravine Creek and the project's effect on their habitat and water quality in Secret Ravine Creek, see Master Response regarding Secret Ravine Creek and the technical memorandum on Secret Ravine Creek prepared by ECORP (Appendix A).

10-4 The approach taken with respect to mitigating wetlands impacts is consistent with City wetland protection policies and is indeed very common, especially for properties for which existing general plan and zoning designations contemplate relatively intense land uses. The project applicant proposes to compensate for wetland removal through the purchase of appropriate wetland credits (i.e., 0.426 acre of seasonal wetlands) from an agency-approved mitigation bank or through a contribution to an In-lieu Fee Fund. The resource agencies typically require that the mitigation bank be located within the same region as the wetlands being removed in order to maintain the region's biological resource diversity.

10-5 The commenter's concerns regarding the loss of biological resources are noted. The commenter is referred to Section 4.12, Biological Resources, of the Draft EIR for a discussion of mitigation measures for the project's significant biological resource impacts. While the implementation of the proposed project would result in the removal of common plant and wildlife species, these effects would not substantially reduce the habitat of any common species, cause a species to drop below self-sustaining levels, or threaten to eliminate a plant or animal community. Annual grassland is considered a common community both locally and regionally. Moreover, mobile wildlife currently using the project site, such as those species mentioned by the commenter, could potentially move into adjacent rural residential and undeveloped areas. Therefore, the project's impact on common plant and wildlife species is considered less than significant.

The Draft EIR also concluded that with implementation of the identified mitigation measures, the majority of the project's biological resource impacts (including impacts to wetlands, native oak and heritage trees, valley elderberry longhorn beetle habitat, raptors and migratory birds, and Chinook salmon and steelhead trout habitat) would be reduced to less-than-significant levels. In addition, impacts to other biological resources (including special-status plant species, California re-legged frog habitat, western pond turtle habitat, and burrowing owl habitat) would be less than significant without mitigation. In the short-term, the project would result in significant and unavoidable impacts associated with the loss of oak trees. However, in the long-term, the trees removed with site development would be replaced at a minimum of a 2:1 ratio and/or the project applicant would be required to contribute to the City of

Rocklin's Oak Tree Preservation Fund, consistent with the City's Oak Tree Preservation Ordinance. The commenter is referred to Response to Comment 9-4 for more information regarding the City's Oak Tree Preservation Ordinance and its applicability to the proposed project. In addition, because the General Plan EIR for the City of Rocklin identifies the impacts on biological resources due to cumulative development within the City and western Placer County as significant and unavoidable, and because the proposed project would contribute to this change, the EIR concluded that on a cumulative basis, the project would result in a cumulatively considerable contribution to the significant and unavoidable loss of biological resources associated with long-term planned growth within the City.

10-6 As a component of the cultural resource investigations, ECORP's cultural resource specialists consulted with the NAHC concerning potential areas of Native American concern regarding the Rocklin Crossings project area. The NAHC conducted a search of the Sacred Lands File and provided a list of appropriate regional Native American tribal contacts and individuals with a potential interest in the project. Contact letters were mailed to the NAHC-suggested contacts and they were provided with an opportunity to comment on the proposed project and contribute information on cultural resources or areas of concern potentially located within and in the vicinity of the project area. No responses were received. However, the United Auburn Indian Community of the Auburn Rancheria did provide written comments on the Draft EIR. These comments are included within this Final EIR under the category of regional and local agencies.

10-7 The EIR analyzes an alternative similar to that suggested by the commenter, the Reduced Size Alternative. This alternative is discussed in detail commencing on page 7-4 of the Draft EIR, and includes a 50% reduction in the project's proposed square footage and the elimination of one of the two primary tenants. This alternative would also allow sensitive resource areas to be preserved (i.e., oak trees and wetlands). At the time of action on the project, the feasibility of this alternative and the other alternatives presented in the EIR will ultimately be determined by the lead agency's decision-making body, here the Rocklin City Council. (See Pub. Resources Code, Section 21081, subd. (a)(3).) The determination of the feasibility of an alternative may be made based on a "reasonable balancing of the relevant economic, environmental, social, and technological factors." (*City of Del Mar v. City of San Diego* (1982) 133 Cal.App.3d 401, 417; see also *Sequoyah Hills Homeowners Assn. v. City of Oakland* (1993) 23 Cal.App.4th 704, 714-716 (court upholds findings rejecting alternatives for not fully satisfying project objectives).)

11

January 23rd, 2007

Sherri Abbas
Development Services Manager
3970 Rocklin Road
Rocklin, CA 95677

Ms. Abbas,

I regularly commute up and down Highway 180 and it bothers me greatly that after all that has been spent to upgrade the on/off ramps at Sierra College Blvd. that the city would consider putting a major shopping center, the Rocklin Crossings Project, at that spot and erase the progress that will be made to alleviate traffic congestion. 11-1

The city shouldn't look at new infrastructure as a means to make a buck – it should look at it as a long overdue solution to bad traffic problems. Now, we're back to square one.

Sincerely,

Muriel E. Doran
5641 Montclair Cir.
Rocklin, Ca. 95677
Muriel E. Doran

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By SEA