Fish Migration Barrier Severity and Steelhead Habitat Quality in the Malibu Creek Watershed

Produced for California State Coastal Conservancy and
California Department of Parks and Recreation

By: Heal the Bay June 23, 2005
Analysis conducted by Mark Abramson and Mike Grimmer

The following analysis ranks the severity of steelhead trout migration barriers that block potential spawning and rearing habitat in the Malibu Creek watershed and then rates the pool habitat quality to be gained by removal of each barrier. Heal the Bay's Stream Team has mapped potential fish barriers, in-stream pool habitat, pool substrate quantities, pool substrate embeddedness, percent pool shelter cover, and exotic predator species observed on approximately 70 linear miles of streams in the watershed. A total of 201 potential barriers were mapped over the course of this project.

Barrier Severity- Barrier severity was evaluated based on swimming and leaping ability of adult steelhead trout. McEwan 2001 states that adult steelhead can maintain a speed of 6.0 feet per second (ft/sec.) for 30 minutes and a burst speed of 10.0 ft/sec. for 5 seconds until they reach exhaustion. The maximum jump speed is stated as 12 ft/sec. and the depth of a pool below an obstruction that requires a jump should be 1.25 times greater than the jump height of the structure from the surface of the pool. Heal the Bay's Stream Team barrier mapping data includes jump height (height a fish must jump to pass over a barrier), plunge depth (depth of pool below an obstruction), and the percent slope of cascades, culverts, or crossings. The barrier severity of all culverts were evaluated using "1st phase passage evaluation filter" from California Department of Fish and Game (CDFG) California Salmonid Stream Habitat Restoration Manual. Culverts that were considered "red" (***Fails to meet passage criteria)*** or "grey" (***Partial or temporal* barrier)** were then further evaluated using FishXing V 2 software. Each barrier received one of the following rankings: (Table 1)

Barrier Severity Rankings

Barrier Severity	Description	Color Code
Passable during most flows	passable during flows > 5 cfs.	Green
Passable during moderate flows	passable at some range of stream flows between 5 and 50 cfs.	White
Passable at moderate/high flows	passable at some range of stream flows greater than 50 cfs.	Light Grey
Passable at high flows*	potentially passable at some range of stream flows greater than 100 cfs.	Dark Grey
Not Passable	impassable by adult steelhead	Red
Natural Not Passable	natural impassable upstream limit	Black
Replaced Barrier	former barrier that has been replaced with a passable structure	Orange +
Project limits	Analysis limited to downstream of this location	Blue X

* Southern California rainfall events generally provide substantial rain over short periods of time. It is not unusual to get a storm providing 3-5 inches of rainfall in a 24-48 hour period. It is believed these large rainfall events may allow steelhead trout to overcome what are deemed more significant barriers during low or moderate flows. The true severity of these barriers can only be determined by watching fish try to overcome the specific barrier or evaluating flow levels and velocities at varying flood stages at each barrier. This category was used for natural barriers with less than 9ft jump height, and man made barriers requiring a substantial rise in stream water surface elevation to allow passage. Natural barriers with less than 4ft jump height were considered passable at moderate and

high flows. Passable high flow barriers provide a very limited window of time for adult steelhead migration and may be impassible barriers during most years.

Stream Reaches – Streams were divided into reaches by cutting the stream layer at Red (Not Passable) or Dark Grey (Passable at high flows) barriers. These stream reaches were then used to calculate the length and quality of stream habitat between the significant migration barriers. Palo Comado and Cheseboro Creeks were not included in the analysis because they contain very little habitat with continuous flow throughout the spring. We also stopped our analysis of upper Medea and Lindero Creeks at their first impassible barrier. If fish passage could be accomplished above Malibou Lake the lower reaches of these streams possess good habitat. Providing passage to reaches above these first barriers would require large scale restoration and concrete removal and were not included in this analysis

Habitat Quality Rating- The in-stream pool habitat quality between barriers was evaluated using the following criteria.

1. Pool to reach ratio
2. Continual flow through May 31.
3. Average depth of pools
4. Percent in-stream pool shelter cover
4. Percent available gravel [0.25 inches- 2.5 inches diameter] as pool substrate
5. Percent of substrate embeddedness [surrounded by sand or fines].
6. Number of exotic invasive known steelhead predator species

1. A stream reach is categorized according to its percentage of pools by length and assigned a score. This resulting score qualifies the reach's pool-to-reach ratio.

Pool to Reach Ratio	**Pool Ratio score (factor)**
<5%	0.00
≥5% and <10%	0.25
≥10% and < 20%	0.50
≥20% and < 30%	0.75
> 30%	1.00

2. Continual or connected stream flow was evaluated for each reach based on intimate knowledge of these reaches, survey data, or water quality and/or benthic macroinvertebrate sampling data. Continual flow through a given reach of stream is evaluated according to whether or not flow exists through the end of May. This variable is important for evaluating the connectivity of stream reaches, migration ability, and the value of a reach for juvenile fish. First year juvenile fish are often found in habitats other than pools. This criteria scores stream reaches with available spawning habitat and rearing habitat through May but that don't provide year round refuge for steelhead. This variable assigns value to streams where steelhead could spawn in late winter to early spring with enough time for eggs to hatch, fry to emerge and grow, while being sheltered from larger predators and competition, and still provide a migration corridor to larger streams that provide refuge

over the long summers. Reaches with continual flow through May were assigned a score (factor).

Continual Flow through May 31	Pool area score (factor)
Yes	1.00
No	0.00

3. Pools in a given reach of stream are categorized according to their average depth and assigned a score (factor). The corresponding factor is multiplied by the pool area resulting in the weighted pool area by depth.

Range of Average Pool Depths	Pool area score (factor)
< 1.5 feet	0.25
≥1.5 and < 2.5 feet	0.50
≥2.5 and < 4.0 feet	0.75
> 4.0 feet	1.00

The sum of the reach's weighted pool areas is divided by the reach's total pool area. The resulting value represents a reach's pool depth quality. For example, a reach that happened to have half of its pool area with depths of less than 1.5 ft. and the other half of its pool area was over 4 ft, its Pool area score would be 0.625. [(.25x + 1x)/2] Of course, most reaches have more diversity in its pool depths and areas than this example.

4. **Percent Pool Shelter Cover-**Pools in a given reach of stream are categorized according to their Percent Instream Shelter Cover and assigned a score (factor). The corresponding factor is multiplied by the pool area resulting in the weighted pool area by Percent Cover. Pool Shelter Cover is defined as any cover within a pool that provides areas to hide, escape, and/or shields fish from avian, aquatic or terrestrial predators. Field crews documented the percent of boulders that provide cover, large woody debris (large wood with a diameter greater that 12 inches and/or accumulations of small debris creating a large debris pile), small woody debris (diameter less than 12 inches), aquatic vegetation that provides cover from overhead including emergent vegetation and algae, undercut banks that fish can hide below without being seen from above, and bubble curtain or turbulent water that obscures fish from being seen from above.

Percent Cover Range	Pool area score (factor)
< 5%	0.00
≥5% and < 20%	0.25
≥20% and < 40%	0.50
≥40% and < 60%	0.75
>60%	1.00

The sum of the reach's weighted pool areas is divided by the reach's total pool area. The resulting value represents a reach's percent pool shelter cover quality.

5. **Percent Available Pool Gravel-**Pools in a given reach of stream are categorized according to their Percent Available Gravel and assigned a score (factor). The corresponding factor is multiplied by the pool area resulting in the weighted pool area by Percent Available Gravel. Field crews measured the available gravel substrate within each pool and quantified the percentage of each substrate type. Course gravel is considered gravel larger than a ladybug (0.25 inches) and smaller than a tennis ball (2.5 inches).

Percent Gravel	Pool area score (factor)
< 1%	0.00
≥1% and < 10%	0.25
≥10% and < 30%	0.50
≥30% and < 50%	0.75
>50%	1.00

The sum of the reach's weighted pool areas is divided by the reach's total pool area. The resulting value represents a reach's percent available pool gravel quality.

6. **Percent Available Pool Embeddedness**-Pools in a given reach of stream are categorized according to the Percent Embeddedness and assigned a score (factor). The corresponding factor is multiplied by the pool area resulting in the weighted pool area by Percent Embeddedness. Embeddedness was measured by randomly collecting various size substrate particles and evaluating how much of each particle was surrounded by fine sediment or sand at each pool tail and averaging the results.

Percent Embedded	Pool area score (factor)
90-100%	0.00
70-90%	0.25
60-70%	0.50
40-60%	0.75
<40%	1.00

The sum of the reach's weighted pool areas is divided by the reach's total pool area. The resulting value represents a reach's percent available pool gravels embeddedness quality.

7. Pools in a given reach of stream are categorized according to the presence of known invasive aquatic steelhead predator species (Crayfish, bull frogs, largemouth bass, and sunfish) and assigned a score (factor). The number of different predator species observed in a reach was counted as the ***Number of predator species observed*** (#PSO). The assumption is the higher the number of different predator species observed the higher the risk of steelhead predation, especially for first year juvenile fish. This resulting score qualifies the number of observed steelhead predator species in the stream reach.

# Predators Species Observed (#PSO)	Pool area score (factor)
4	0.00
3	0.25
2	0.50
1	0.75
0	1.00

Each reach's categorical score was weighted in regard to its relative importance in determining habitat quality as follows:

Pool to Reach ratio **P/R** (0.3x) – This ratio helps indicate the amount of available pool habitat in proportion to the total reach length. It was considered in this analysis to be the most important indicator of steelhead habitat.

Consistent Flow **CF** (0.2x) – Flow Duration- One of the most important factors of steelhead habitat suitability in southern California is surface stream flow. Each stream was evaluated to determine if surface flow was maintained from the first large storm event of the season (> 2 inches) through May. This metric was considered critical in determining whether a stream would support steelhead trout at any level. Streams that dry out before May were deemed not suitable for steelhead trout.

Average Pool depth **APD** (0.2x) – Pool depth directly contributes to both habitat quantity and quality. As a result, this category's score was weighed twice as heavily as the following categories.

Percent Instream Pool Shelter Cover **PSC** (0.1x) – Percent instream pool shelter cover is an important factor for determining pool habitat quality and a fish's ability to hide or escape predation.

Available gravel **AG** (0.1x) – Available gravel substrate is important for accessing spawning potential at a given pool. These categories are believed to carry equal weight for determining habitat quality and half the weight of pool depth.

Embeddedness **EMB** (0.05x) – While embeddedness is a factor in overall habitat quality, our field observations demonstrate that thresholds developed for northern California and streams in other regions do not adequately represent southern California conditions. We have seen gravels cleaned and redds dug in areas where adjacent substrates were highly embedded (up to 70%). For this reason, embeddedness was given half the weight of gravel availability.

Predator Species Observed **PSO** (0.05x) – This score indicates the number of known exotic invasive steelhead predators observed in a given reach. It is intended that this variable represents increased risk to the survivability of steelhead eggs and first year juvenile fish. This variable was weighted lower because management practices could dramatically reduce the presence of these predator species and their impacts on steelhead trout.

The weighted scores from the 7 categories are then summed, resulting in the weighted pool habitat quality (**wPHQ**) of a given reach using the following formula:

[**P/R** (0.3) + **CF** (0.2) + **APD** (0.2) + **PSC** (0.1) + **AG** (0.1) + **EMB** (0.05) + **PSO** (0.05) = (**wPHQ**)]

Weighted Pool Habitat Quality (wPHQ) ratings	
≥ 0 and < 25	Poor
≥ 25 and < 50	Fair
≥ 50 and < 75	Good
≥ 75 to 100	Excellent

Chemistry Rating- Monthly water chemistry data and bi-annual benthic macroinvertebrate surveys have been conducted at 18 sites throughout the watershed over the course of this project. These sites were evaluated in terms of water temperature, dissolved oxygen, pH, and Ammonia-Nitrogen, and availability of benthic macroinvertebrate food supply (midge, dragonflies, mayflies and caddisflies). While there is not a water quality or benthic macroinvertebrate monitoring site within each reach, monitoring sites are located at the outlet of each creek and major tributary.

Water temperature can be a limiting factor for both egg survival and time of incubation. High temperatures can reduce a steelhead's ability to feed or even swim (Stoeker et. Al from Tebo 1974) Rainbow trout/juvenile steelhead have been observed in Santa Barbara County streams with water temperatures greater than 81 F (Stoeker et. Al 2002) Heal the Bay's water temperature data is collected monthly between 9:30 am and 2:00 pm from glides (shallow slow moving areas of the stream). While this temperature data does not capture the highest temperatures in the late afternoon, we have examined the data for any measurements above 81 F. All sites showed temperatures below 81 F and were considered to maintain water temperatures supportive of steelhead trout.

NH3 is the principal form of toxic ammonia. It has proved toxic to fresh water organisms at concentrations ranging from 0.53 to 22.8 mg/L. (Kentucky Water Watch Website http://kywater.org/ww/ramp/rmnh4.htm) Our analysis showed no data within this range for ammonia and all water chemistry sites were considered to maintain ammonia levels supportive of steelhead trout.

Steelhead trout tolerate a range of pH from 5.8-9.6 and prefer slightly alkaline water in the range of 7-8 (Moyle 2002) The lowest pH in all of our site's data was 6.7 and the highest recorded was 9.3 at a site in Malibu Lagoon. All sites recorded pH levels well within the acceptable range, and were deemed supportive of steelhead trout.

Acceptable levels for dissolved oxygen (DO) range from 3-15 mg/l. (Dagit 2003) Overall dissolved oxygen levels were well within range to support steelhead except for on 4 occasions: Site 1 on 8/8/04 (2.81 mg/l), Site 11 on 7/14/02 (1.9 mg/l), and Site 17 on 10/5/03 (2.55 mg/l) and 8/8/04 (2.17 mg/l). Because DO levels were within range for the entire migration period under analysis, dissolved oxygen was considered supportive of steelhead trout at all chemistry sites in the Malibu Creek watershed. Figure 1 is a map documenting the barrier severity and habitat quality between barriers.

Figure 1

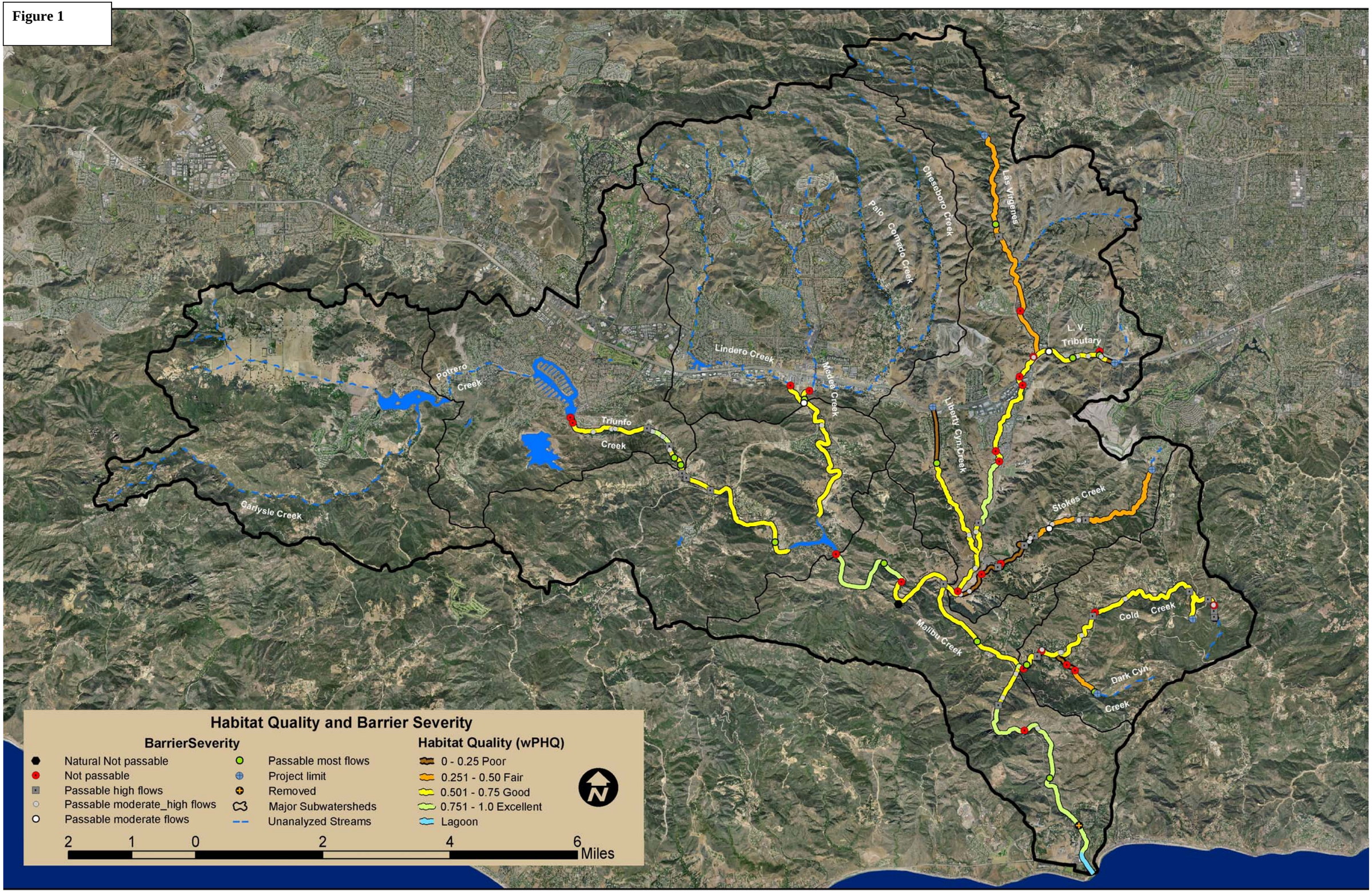
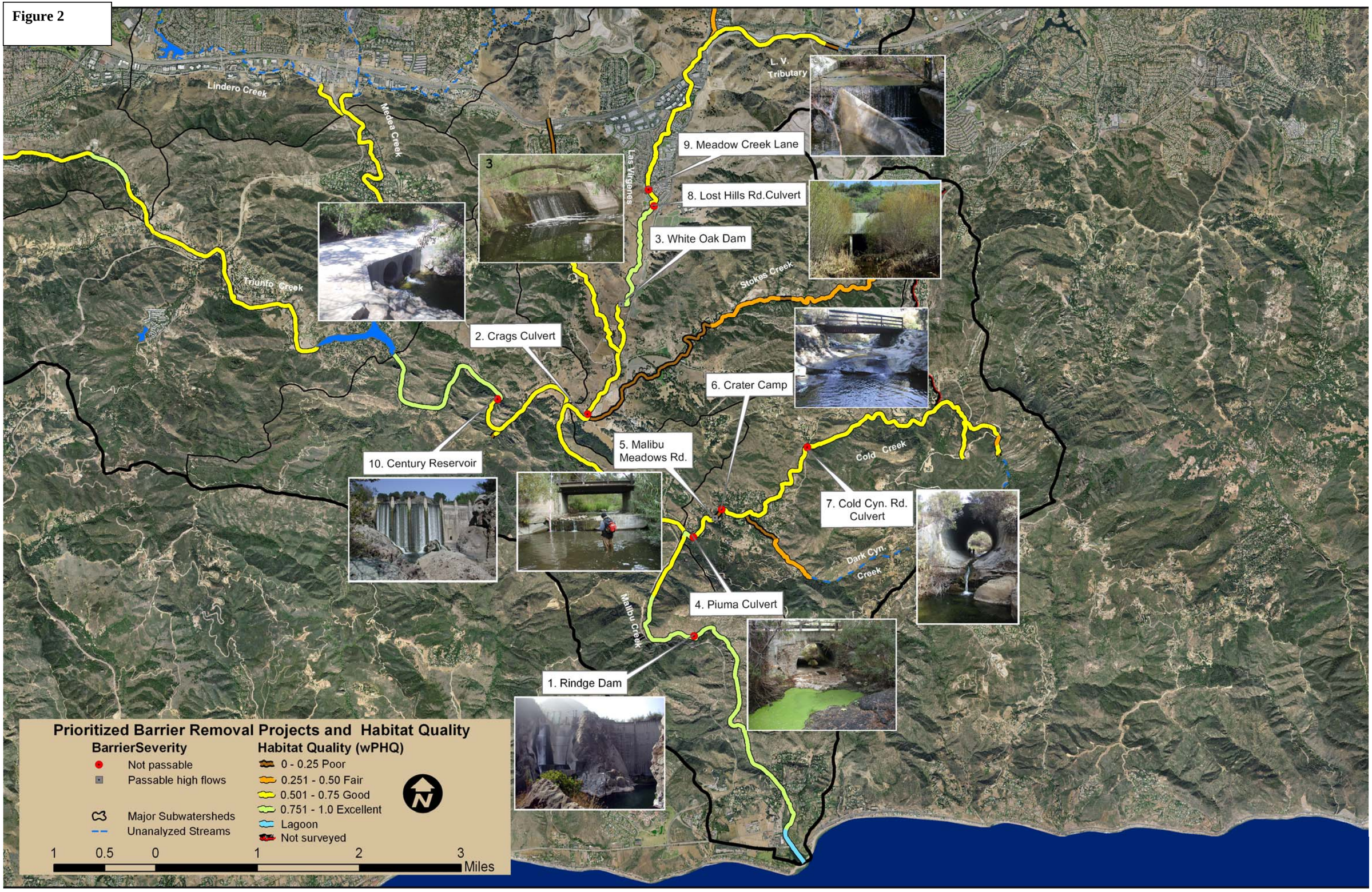

Las Virgenes
Cheseboro Creek
Palo Comado Creek
L. V. Tributary
Lindero Creek
Medea Creek
Liberty Cyn Creek
Potrero Creek
Triunfo Creek
Carlysle Creek
Stokes Creek
Cold Creek
Malibu Creek
Dark Cyn Creek
Habitat Quality and Barrier Severity
BarrierSeverity
Natural Not passable
Not passable
Passable high flows
Passable moderate_high flows
Passable moderate flows
Passable most flows
Project limit
Removed
Major Subwatersheds
Unanalyzed Streams
Habitat Quality (wPHQ)
0 - 0.25 Poor
0.251 - 0.50 Fair
0.501 - 0.75 Good
0.751 - 1.0 Excellent
Lagoon
N
2 1 0 2 4 6 Miles

Figure 2


Lindero Creek
Medea Creek
Triunfo Creek
Las Virgenes
L. V. Tributary
Stokes Creek
Cold Creek
Dark Cyn. Creek
Malibu Creek
9. Meadow Creek Lane
8. Lost Hills Rd.Culvert
3. White Oak Dam
2. Crags Culvert
6. Crater Camp
5. Malibu Meadows Rd.
10. Century Reservoir
7. Cold Cyn. Rd. Culvert
4. Piuma Culvert
1. Rindge Dam
Prioritized Barrier Removal Projects and Habitat Quality
BarrierSeverity
Not passable
Passable high flows
Major Subwatersheds
Unanalyzed Streams
Habitat Quality (wPHQ)
0 - 0.25 Poor
0.251 - 0.50 Fair
0.501 - 0.75 Good
0.751 - 1.0 Excellent
Lagoon
Not surveyed
N
1 0.5 0 1 2 3
Miles

Steelhead Trout Recommendations: Figure 2

Recommendations for Malibu Creek

1. Providing passage upstream of Rindge Dam is the highest priority for steelhead trout restoration in the Malibu Creek watershed. The Malibu Creek steelhead trout population currently has access to only 16,138 ft. or 3 miles of habitat from Malibu Lagoon up to Rindge Dam. Malibu Creek upstream of Rindge Dam has two impassable dams that create Century Reservoir and Malibou Lake. Two barriers that are only passable by adult fish at high flows occur at Tunnel Falls (a steep tiered 10 ft. tall cascade) and the failed Texas Crossing in Malibu Creek State Park. The Texas Crossing will be removed in the summer of 2005. Providing passage over Rindge Dam would allow steelhead trout access to an additional 4886 ft. of 'excellent' habitat up to Tunnel falls and 21,294 ft. of 'good' habitat upstream of Tunnel Falls to the 45 ft. tall Century Reservoir Dam. This additional steelhead habitat access above Rindge Dam on Malibu Creek comes to a total of 26,262.30 ft. (5 miles) of high quality habitat. Access to habitat above Rindge Dam would also allow direct tributarial access to Cold Creek, Las Virgenes Creek, and Stokes Creek. Cold Creek provides access to 693.33 ft of 'excellent' habitat before hitting an impassable box culvert that takes the creek under Piuma Road. Las Virgenes Creek provides steelhead access to 1687 ft. of 'good' habitat before hitting a double culvert that allows Las Virgenes Creek to flow under the State Parks access road (Crags Road). Stokes creek would provide access to 3053 ft of 'poor' quality habitat up to a barrier where Stokes Creek flows under Las Virgenes Road. Steelhead access over Rindge Dam opens up a total 31,695.07 ft. (6 miles) of additional habitat--tripling what is currently available.

2. Replace the Las Virgenes Creek-Crags Rd. double culvert at the trailhead of Malibu Creek State Park with a larger free span bridge. Replacement of this impassable culvert would allow access to one year or older fish up to the 6 ft. tall dam at White Oak Farms and would provide an additional 1.3 miles on Las Virgenes Creek and 1.8 miles on Liberty Canyon Creek or 3.1 miles of "good" quality steelhead habitat. It is believed that large adult fish could jump the White Oak Farms Dam during years with exceptional flows.

3. Lower the height of the dam at White Oak Farms by notching it over three consecutive years; 1.5 ft. per year. Lowering the height of this "high flow" barrier from 6 ft. to 1.5 ft. would allow upstream passage by one year or older fish. This could be accomplished very inexpensively and would provide steelhead access up to the box culvert at Lost Hills Rd (De Anza Park) an additional 1.2 miles of "excellent " quality habitat.

4. Replace the culvert at Piuma Rd. and Cold Creek with a free span bridge. This undersized box culvert has only a 1 ft. jump height but has very shallow depths of less than 3 inches during most flows and when the depth is high enough for fish to swim the velocity of the water is too great. This should be immediately replaced with a larger free span bridge. Access above this culvert would open an additional 0.13 miles of 'excellent' habitat.

5. Reinforce bridge piers and remove the bottom and apron on the Malibu Meadows Road bridge on Cold Creek. This bridge has a solid concrete bottom which is downcut and requires a 3 ft. jump and then a 41 ft. swim through very shallow fast moving water. We believe that large adult fish could pass this barrier during high flows. Removing the concrete bottom and

reinforcing the existing piers will provide one year and older fish access to an additional 0.36 miles of 'good' quality habitat.

6. Replace Crater Camp Rd. bridge with free span natural bottom bridge on Cold Creek. This bridge is severely undercut and failing. The channel has downcut requiring a minimum 2 ft. jump and a swim over 47 ft. of steep concrete. This bridge is a depth barrier during all but the highest flows and is a velocity barrier at high flows. Replacement of this barrier provides access to 1.3 miles of "good" quality habitat and 0.24 miles of "poor" habitat on Dark Canyon Creek.

7. Replace round culvert with bottomless culvert or free span bridge at Cold Canyon Rd. This culvert has severely downcut the channel and requires a 7 ft. jump followed by a 130 ft. swim through shallow fast moving waters. This culvert is a jump, depth and velocity barrier at most flows. Predominantly natural small waterfalls exist above this barrier and are believed passable during high flows. Removal of this barrier would provide a minimum access to 2.9 miles and access to the Dry Canyon Tributary which was not surveyed during this project.

8. Create a low flow channel for fish passage or replace the Lost Hills Rd. Box Culvert upstream of De Anza Park with a wider bridge or bottomless culvert. The obstruction includes an inlet apron and 4 square box culvert openings 14 ft. x 14 ft. by 300 ft long including inlet apron. We believe it is possible to utilize one of these 14 ft. openings for fish passage by creating a low flow channel. Two of the current openings are collecting sediments. The culvert is currently a depth and velocity barrier. Passage upstream of this barrier gives steelhead access to 0.21 miles of "good" quality habitat up to Meadow Creek Lane.

9. Meadow Creek Lane drop structure 5 ft. jump, 4 opening box culvert 14ft. x14 ft. and concrete channel aprons upstream and downstream 480 ft. long. This whole stretch is in a state of serious failure and has severe undercutting and leaning wingwalls. It will need to be replaced in the near future or will completely fail. It is recommended that the stream channel and banks be restored to have an appropriate meander pattern and more gently sloping streambanks. This should be done without any armoring as was done just downstream by the Resource Conservation District of the Santa Monica Mountains. This project will reduce the massive downstream bank scour on State Parks property, improve flood control, and allow fish passage. It will also be a significant cost savings over replacement of the armored channel and banks. Providing Passage through this area would open up access of 1.3 miles of "good" quality habitat up to Agoura Rd.

SPECIAL NOTE(9A)The City of Calabasas has funds to remove a 400ft. section of concrete channel just upstream of Agoura Rd. It is recommended that this project include no armoring and provide fish passage. Using no armoring is critical to protect downstream banks from lateral scour and to begin the dissipation of energy as far upstream as possible. An appropriately designed stream channel with proper meander wave length and habitat is highly desirable for this site.

10. Remove the Century Reservoir Dam and restore the natural stream channel. Century Reservoir is within Malibu Creek State Park and is nearly full with sediment. It will need to be dredged in the near future. It currently prevents course sediments from replenishing steelhead habitat downstream. If State Parks were to dredge the reservoir they would be required to

provide for fish passage over the dam. This would likely involve an extensive fish ladder that would need constant maintenance and would be costly to build. It is recommended that the structure be removed and the stream channel be restored. This solution will be more cost effective for the long term. Passage above Century Dam would open up 1.9 miles of “excellent” quality steelhead habitat.

Addressing these 10 barriers (Figure 2) will add 6.86 miles of additional habitat on Malibu Creek, 4.39 miles on Las Virgenes Creek and 4.83 miles on Cold Creek. In addition, steelhead trout will have access to 0.58 miles of Stokes Creek, 1.78 miles on Liberty Canyon Creek. 0.24 miles on Dark Canyon Creek and undetermined amount of habitat on Dry Canyon Creek, a tributary of Cold Creek that was not mapped. This would provide a minimum of 18.68 additional miles of available habitat for steelhead trout.(622% increase) This increase would meet a minimum of 93% of the Santa Monica Bay Restoration Commission’s overall goal of increasing steelhead trout habitat in the Santa Monica Mountains by 20 miles.