

Appendix B

Watershed Health Evaluation Memo

TECHNICAL MEMORANDUM

DATE: Friday, March 20, 2009

TO: Liz Lewis, Marin County Department of Public Works

FROM: Derek Booth, Maia Singer

SUBJECT: Draft Watershed Health Metrics for Evaluating Restoration Progress in the San Geronimo Creek Watershed

1 GENERAL CONSIDERATIONS FOR WATERSHED HEALTH METRICS

“Watershed health” is an important, but elusive, concept. As a descriptor of the comprehensive state of a stream, its tributaries, and its contributing land area, it evokes the goal of the Clean Water Act: the restoration and maintenance of chemical, physical and biological integrity of the Nation’s waters. If we are to evaluate the status of watershed health for San Geronimo Creek, and if we wish to track its change over time, this perspective suggests that any suite of indicators must encompass all three of these dimensions (i.e., chemical, physical, and biological). The purpose of this discussion is to use this overarching guidance to (1) explore general considerations in the selection of watershed health metrics; (2) identify those metrics that have been previously used or recommended for San Geronimo Creek, nearby watersheds, or elsewhere and with likely applicability here; and (3) make specific recommendations for the application of such metrics in the San Geronimo Creek watershed, particularly with respect to an integrated “channel condition” metric(s) as a surrogate for directly measuring hydrologic function and process. We also offer a few comments on the kind of management framework that can make best use of such information.

Although “stream monitoring” is a ever-more common activity of jurisdictions, many such monitoring efforts lack either a coherent conceptual framework or appropriately chosen methods, and, as such, do not produce adequate information to reach their intended goals. Furthermore, monitoring techniques developed in research settings or by large Federal agencies are simply not feasible for the vast majority of municipalities that are now initiating these programs. The problem is generally not with executing specific monitoring protocols—many guidance documents exist that specify proper techniques for data collection. Instead, the major shortcoming is in choosing an approach that will provide sufficient data to answer particular management questions and that is feasible for the institutional context and available resources. We note that not every published metric will be appropriate for the institution capacity and needs of Marin County and the San Geronimo community; that specific “management questions” need to be articulated before metrics can be selected; and that the imprecision imposed by measurement limitations and institutional constraints (particularly when coupled with natural variability) can yield results with no predictive power at all.

Scholz and Booth (2001) suggested a monitoring strategy, and specific existing monitoring protocols, that can be useful in the management of streams in urbanizing watersheds, such as San Geronimo Valley. The authors broke this strategy into several tasks:

1. Establish the monitoring strategy. This consists of
 - recognizing what management question(s) are being addressed by the monitoring;
 - determining the level of effort required to make particular kinds of measurements effectively; and
 - identifying what to measure.
2. Evaluate the utility of individual monitoring parameters to characterize particular features of the channel and provide measures of stream health.
3. Recommend a set of stream-monitoring protocols that will meet the needs of monitoring program.

Their suggested “management questions” are directly relevant to the needs and concerns of the San Geronimo Creek community. They are:

1. What is the current watershed health?
2. What are the trends in watershed condition?
3. How should planned stream restoration or rehabilitation efforts be ranked?

Although related, these questions require different types of measurements at different levels of detail and precision. The second (trends in watershed conditions) is the simplest to answer, because it requires only a set of measurements that show a response to watershed changes, repeated at the same location over time. The measurements need not be transferable, only reproducible. In contrast, the first question (and commonly the third) carries an implicit or explicit comparison to some reference condition that is presumed to be “good.” This requires not only that the measurements be accurate and transferable from one stream to another, but also that the chosen reference is truly applicable. The third question adds additional dimensions—how bad are conditions now? How good might they become? What elements of a healthy stream are most degraded? Can they be repaired? This demands the most comprehensive view of the channel, because streams can be degraded in many different ways. Accordingly, one of the tasks for a monitoring program seeking to guide restoration efforts is to gather data that will help identify the most likely approach for success.

Scholz and Booth (2001) also noted that many monitoring programs include unrealistically complex protocols for the level of staff or volunteers available. They divided the universe of monitoring capabilities into three “levels of effort”:

- 1 = Rapid, low cost, but likely to generate only qualitative or imprecise quantitative data. Level 1 measures are single snapshot evaluations and typically have modest utility because they can reliably offer only a coarse discrimination of aquatic-system quality or health. However, they may be useful in evaluating gross conditions (“good” vs. “bad”), and they are suitable for a wide range of volunteers with only minimal training.
- 2 = Nominal equipment, relatively rapid, and likely to generate reproducible (albeit coarse) quantitative results. These techniques require trained volunteers or professionals. At this level of effort, measures can be useful to classify a stream or reach, or to characterize conditions relative to some reference condition. As such, they can be used for both one-time and continuous monitoring programs, but most parameters will require substantial change for any difference to be detected.

3 = Similar requirements and applications as Level 2 but requiring more time and training in order to yield more precise results; discrimination of trends should be commensurately improved.

The following discussion of watershed health metrics for San Geronimo Creek does not presuppose a single “correct” level of effort, but it does note where this potential constraint must be acknowledged.

2 METRICS OF WATERSHED HEALTH WITH APPLICATION TO SAN GERONIMO CREEK

Effective monitoring requires knowledge of *what* to measure. We begin this analysis with a compilation of various stream and watershed indicators from throughout the region, emphasizing those that have been specifically developed or widely applied for relatively small lowland streams that support anadromous fish. We have organized this compilation in accord with the proposed habitat protection and improvement goals for the Salmon Enhancement Plan for San Geronimo Creek. The goals fall into the following seven habitat-attribute categories:

1. Water quality
2. Streamflow
3. Channel morphology
4. Riparian vegetation
5. Channel connectivity
6. Sediment dynamics
7. Biological communities

Table 1 displays a list of commonly considered indicators grouped in accord with these seven categories. Specific applications are highlighted on this table, not necessarily because these are the “best” indicators but because they have previously been found particularly suitable for certain purposes.

Monitoring activities in and around San Geronimo Valley have been ongoing for many years, although their purposes have been varied and not all metrics are equally well-suited to the management questions that may be posed here. For the greater Lagunitas Creek watershed (which includes San Geronimo Creek), the monitoring data clearinghouse KRIS (Klamath Resource Information System; http://www.krisweb.com/kris_wms/krisdb/webbuilder/selecttopic_lagunitas_creek.htm) has archived a variety of monitoring data: aquatic invertebrates (7 individual metrics in 1999 and 2001; see also Karr and Chu 1999), fish population and abundance over multiple years and locations, redd surveys, measures of fish habitat (type, bank vegetation, cover, substrate, and pool depth 1998–1999), sediment composition (multiple locations and years), temperature, and water quality (SFBRWQCB 2007). Other measures of sediment conditions in Lagunitas Creek, and its tributaries, both one-time and long-term, are reported in Stillwater Sciences (2007a) and Balance Hydrologics (2008).

Additional watershed indicators, particularly as they may pertain to the condition and the support of anadromous salmonid populations, are being developed by NMFS. A preliminary list of

indicators being considered for recognizing “properly functioning conditions” is included as Table 2. Indicator criteria corresponding to watershed health status (i.e., poor/fair/good/very good) are currently evolving, and revised or updated criteria will be included in the NMFS Draft Coho Recovery Plan, which is targeted for release in late April 2009. The criteria shown in Table 2 are based on a statewide compilation of CDFG habitat typing data for the Russian River and Marin County coastal streams, which represents a spatially broad and long-term dataset (C. Ambrose, pers. comm., 2009). CDFG habitat typing data are currently being analyzed by NMFS, both for use as single parameters linked to specific indicators and as multiple parameters to support the development of integrative indicators. For example, relationships between channel entrenchment, channel type, backwater habitat, and 100-year floodplain width could yield an integrative indicator for channel connectivity.

Many of the preliminary NMFS criteria shown in Table 2 are based on the “intrinsic potential” (IP) model, a spatially-based fish habitat model that uses a reach-based IP score multiplied by the length of the reach to arrive at IP-km values; these values can be applied to a watershed, population, or other area of interest, but they always refer to reaches where salmonid habitat would have been reasonably supported under historical conditions. Reach-based IP-scores can be either integrative or based on a single parameter (i.e., water temperature).

Table 1. Stream and watershed health indicators from the City of Seattle (Stillwater Sciences 2007b). Of the 30 total indicators, 10 were selected as “primary” (yellow shading) and two as “secondary” (green shading) for that study; six heavy boxed indicators were recommended by Scholz and Booth (2001) for their “Level 1” and “Level 2” monitoring efforts (physical channel parameters only).

Habitat attribute	Indicator metric	Popular term for indicator	Anticipated ranges of indicator values	Ecological health threshold ¹
1. Water quality	Maximum temperature (7-day average)	Maximum weekly maximum temperature (MWMT)	Measures the moving average of 7-day maximums (June through September). High water temperatures during the summer increase fish metabolism and induce stress. High temperatures > 22°C can become lethal. Preferred temperatures for salmonids generally range between 12 and 14°C (Spence et al. 1996). Temperatures between 10 and 17°C are common for acceptable summer habitat use (Poole et al. 2001). Washington State criteria (proposed) for salmon and trout spawning, core rearing, and migration is 16°C (60.8°F).	< 16°C
	Instantaneous rate of change in stream temperature	Rate of temperature change	Measures the rate of change in water temperature as one more indicator of how sensitive stream is to solar radiation input or other factors (such as reduced flows) that affect stream temperatures. Useful in tracking improvements over time from riparian shade and low-flow restoration strategies	< 0.5 °C/hr
	Dissolved oxygen	Dissolved oxygen	Measures DO, in mg/L at specified temperature. Dissolved oxygen concentrations vary with stream water temperatures. However, DO concentrations below 6.5 to 7.0 mg/L greatly impaired adult salmon performance (regardless of temperature) (Spence et al. 1996). DO levels must average greater than 8.0 mg/L for embryos and alevins to survive. For Class AA streams, Washington State criteria include DO > 9.5 mg/L (criteria under revision).	DO > 9.5 mg/L
	Total suspended solids and/or turbidity	TSS and/or turbidity	Suspended solids and turbidity can provide insight into full complement of transported fines within the stream water column. Deposition of larger fraction of fines (Suttle et al. 2004) can affect benthic invertebrates and fish spawning areas. Potential pollutants can also attach suspended solids, leading to accumulation in watercourses. Specific metrics to measure suspended solids could include suspended sediment concentrations, total suspended solids or turbidity. Criteria are based on storm flows, and are a maximum increase over background levels. Usually measured during high runoff events. Interpretation of full meaning of SS data needs refinement through correlation and experience.	< water quality criteria under Washington State WQ Standards (currently in revision)

Habitat attribute	Indicator metric	Popular term for indicator	Anticipated ranges of indicator values	Ecological health threshold ¹
	Water Quality index	Water quality	Index based on composite values for temperature, dissolved oxygen, pH, fecal coliform bacteria, total nitrogen, total phosphorus, total suspended sediment, and turbidity. Values range from 1 to 100, with higher scores indicating better water quality. For Washington State Department of Ecology, scores >80 are of "lowest concern," scores 40 to 80 indicate "marginal concern," scores below 40 are of "highest concern." This index may not be a good fit for urban streams, where fecal coliform bacteria, TN and TP can drive low scores, even though TN and TP values are not necessarily problematic. Could be modified to work better in Seattle's urban environment and be responsive to management actions.	> 60
	Dissolved metals		Dissolved metals that affect aquatic life include copper, arsenic, cadmium, chromium III and IV, copper, cyanide, dieldrin, endrin, lindane, mercury, nickel, parathion, pentachlorophenol, selenium, and zinc. Water quality standards are developed to protect aquatic life. Dissolved metal concentration should be measured during peak flow events and their effect is hardness-dependent.	< water quality standard
	Aquatic health toxicity		Toxic pollutants in the water column or stream sediments, such as metals, PCBs, and pesticides, can affect the survival and growth of aquatic animals. Methods to evaluate this could include sediment bioassays with <i>chironomids</i> or <i>Hyallela</i> exposed to stream sediments or in-situ trout egg incubation boxes to look for normal development and survival to emergence.	< water quality standard
	Fecal coliform (or other human health indicator)	Human health – contact recreation	Measures the number of fecal coliform colonies per 100 mL of water. The existing standard (secondary contact) is that fecal coliform organism levels must not exceed a geometric mean value of 200 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 400 colonies /100 mL. Fecal coliform can make people sick. Seattle streams all exceed standards for primary recreation, with pets and urban wildlife (rodents, birds) being the most significant sources.	< water quality standard

Habitat attribute	Indicator metric	Popular term for indicator	Anticipated ranges of indicator values	Ecological health threshold ¹
2. Streamflow and hydrologic integrity	T _{Q mean}	Flashiness	Higher T _{Q mean} values are associated with streams exhibiting sustained storm flow periods and gradual flow recession rates (see Konrad and Booth 2005). Lower T _{Q mean} values are associated with brief but high peak flow periods and rapid recession rates. T _{Q mean} values decrease with increasing effective and total impervious area (Cassin et al. 2005). In general, values above 0.3 are associated with greater B-IBI scores (> 30), and presumably greater stream health.	> 0.3
	T _{0.5 yr}	Flood Duration	Measures the fraction of time that a stream channel is exposed to flows whose magnitude exceeds a more significant, less common flow (Booth et al. 2004). The “half-year flood” is associated with streambed sediment transport and occurs often enough to exert persistent effects on stream biota (Booth et al. 2004). This metric is evaluated on a log scale, with increased values associated with higher B-IBI scores. A T _{0.5 yr} threshold for urban vs. suburban stream is 0.01 (Konrad 2000). In general, values above 0.01 are also associated with higher B-IBI scores (>30) (Booth et al. 2004).	> 0.01
	High pulse count	Flood Frequency	Measures the number of times the daily hydrograph rises above the high-flow threshold (200% of the average flow rate under forested conditions). Higher pulse counts are associated with greater urbanization. High pulse counts below 10 appear associated with higher B-IBI scores (> 30), but variation in the relationship is high (see Cassin et al. 2005, Figure 10).	< 10 events
	Q ₂	2-year storm event flows	Measures flow at a two-year return period. Higher Q ₂ values are associated with increased urbanization. A decreasing trend, moving toward forested Q ₂ values, would improve stream health. A 75% decrease toward forested values is assumed to be beneficial.	0.75 x Q _{2forested}
3. Channel morphology	Bank stability index		Captures the relative stability of stream banks in terms of erosion state. Application in urban streams must be tempered with an understanding of the influence and spatial extent of bank armoring, which nominally limits erosion, as well as the positive role bank erosion may play in terms of providing much needed coarse gravels to a given stream. Generally, it is thought to be desirable to have > 50% of banks stable and vegetated. With no more than 20% of banks at erosion risk to very unstable. Alternatively, over time, reaching a goal of having no more than 10% of a given stream artificially armored would be desirable in the first two decades, with incremental improvements over time. These expectations need to be refined for each stream of interest to reflect present state and what might be attainable.	> 50%

Habitat attribute	Indicator metric	Popular term for indicator	Anticipated ranges of indicator values	Ecological health threshold ¹
	Bank armoring (%)		Measures percent of bank hardened or “armored”. Bank armoring limits sediment recruitment and floodplain connections, and is often associated with fill. There is no identified threshold at which bank armoring becomes more or less problematic. Same as bank stability description above.	< 10% of entire length of stream
	Entrenchment ratio	Width : depth	Measures the channel width to depth ratio and tracks changes over time. Ratio scaled to localized channel gradient and confinement. Recommend range from 16–28 depending on location. Width:depth ratios range from 7.5 (25th Q) to 14 (median) to 24 (75th Q) (Buffington et al. 2003). Urban streams present challenges to making appropriate expectations in that width is often artificially constrained by bank armoring, which under highly altered flood flow regimes, can precipitate bed scour and channel incision. This measurement repeated over time at fixed locations provides a highly reliable indicator of those changes. Done as part of a long-term monitoring program that includes several fixed-station channel cross sections and a longitudinal profile survey, done every few years. (see discussion in Bauer and Ralph 1999 p 44).	highly variable; can be inferred from regional indices of channel geometry derived from relationship of basin area to channel dimensions; but these are highly modified in urban streams; calibrate to stream of interest
	Frequency of woody debris	LWD (large woody debris)	Measures the frequency of woody debris in the stream, per size class (# per 100m; size classes as small, medium and large). Piece size should be scaled to channel dimensions, but generally of sufficient size to remain stable under typical Q ₂ flow events. LWD per 100 m ranges from 26 (25 th Q), to 29 (median), to 38 (75 th Q) (Fox et al. 2003).	29 to 38+ LWD/100m Increasing trend in larger size classes
	Instream wood (%)	Location within channel	Measures the position of wood in the active channel to assess interaction with low flow wetted width (%) and subsequent contribution to summer pools. > 50% of pieces within wetted width during summer low flow period source (Ralph et al. 1994; Fox 2002)	> 50%
	Pool frequency		Habitat complexity is measured by the relative number and location of pools within a given stream. Pools provide critical rearing and holding habitats for native fish, especially juvenile salmon and trout. Pool habitat is generally considered to be lost as urbanization increases over time. Therefore, some measure of pools seems appropriate. In this instance, measure the # of pools (> 0.5 m depth) per unit length of stream channel. Pool frequency depends on channel type and needs to be scaled to the relative gradient and confinement of a given stream reach. Pool to riffle ratio should approach 50% of stream length for streams > 2% gradient; ~ 25% in streams < 2%. (Peterson et al 1992)	Increasing trend

Habitat attribute	Indicator metric	Popular term for indicator	Anticipated ranges of indicator values	Ecological health threshold ¹
	Pool spacing		The distance between pools is a critical feature that directly affects overall stream productivity. Streams with too few pools, spaced too far apart will fail to support many juvenile salmon and trout. A simple measure of the number of pools per channel width can be inferred from a longitudinal profile as part of a long term monitoring program. See Montgomery et al. 2003	> 2 to > 4 pools/ channel width
	Residual pool depth		Pool depth is a critical factor in determining relative quality of aquatic habitat and is positively correlated with large wood within the channel. Especially in urban streams pools of sufficient depth must be maintained or enhanced to support a sustainable population of native fishes. Residual pool depths sufficient for migrating adult salmon (> 0.7 ft) and rearing juveniles (>2.0 ft; Bjornn and Reiser 1991, Ralph et al. 1994).	Increasing trend
4. Riparian vegetation	Canopy cover		Loss of shade from denuded riparian zones allows increased solar radiation to warm stream temperatures, especially during critical summer months when juvenile fish are rearing. Simple measures of view to sky or, conversely percent shade will provide an indirect measurement of solar input levels. Various techniques are available, some more accurate than others. The specific method and locations at which measures will be made will be defined during the design phase of the extensive monitoring program. Baseline measurements for each stream will allow progress in increasing shade to occur through directed restoration. Coincidence of lack of shade with elevated stream temperatures will promote making wise investments in riparian restoration.	>80% canopy cover throughout a give stream course; may not be attainable in some reaches of urban streams due to hard constraints
	Dominant stream bank vegetation		The dominate canopy species are important for providing canopy cover and woody debris to the stream, while understory species can either support or limit future tree regeneration. Mixed hardwood-conifer forest numerically dominated by hardwoods (red alder, big leaf maple, cottonwood, willow, vine maple). Biomass dominated by a mix of hardwoods and conifers, mostly cedar, sitka spruce, Douglas fir and hemlock.	Canopy: Native conifer/ mixed Understory: native shrubs/ groundcover
	Average riparian width and standard deviation		Measures the width of the riparian zone, perpendicular to the stream channel. An intact riparian corridor is important for protecting instream habitat and supporting adequate riparian functions and processes. Riparian widths can vary by surrounding landform (e.g., canyon versus valley). Generally, recommended riparian widths range between 50 and 200 feet to maintain stream water quality for salmonids, provide LWD recruitment, maintain stream temperatures, and benthic communities (City of Seattle 2005). Wildlife habitat is provided when riparian widths range from 100 ft to over 300 ft.	Park lands: > 200 ft Other lands: > 75 ft

Habitat attribute	Indicator metric	Popular term for indicator	Anticipated ranges of indicator values	Ecological health threshold ¹
	Riparian wetland area		Measured in acres, relative to appropriate channel types. Riparian wetlands are important for filtering surface runoff, storing water, and providing habitat diversity for aquatic and terrestrial species.	Increasing trend
5. Channel connectivity	Fish barriers		Physical barriers to upstream migration interrupt the free flow of organisms throughout a stream channel. Identification and eventual elimination of all possible barriers to fish migration is part of the overall restoration strategy of all streams, not just those in urban environments. A simple stream specific inventory of the number of full and partial man-made barriers will be completed for each stream within Seattle. Tracking improvements over time is an important factor to ensure progress and accountability.	0
6. Sediment dynamics	Bed surface particle size distribution	Sizes of gravels on streambed	<p>Streambed gravels provide important structural elements of aquatic habitats and are used by primary and secondary producers, stream insects and related invertebrates and provide spawning substrate for adult fish and amphibians and hiding places for juvenile fish and amphibians. Being able to efficiently characterize bed substrate in a way that is repeatable will provide a reliable means to track status and trends in this key habitat component over time.</p> <p>A simple technique, referred to as Wolman pebble counts is used to determine D₅₀ and D₈₅ particle size (average values for the “b-axis” diameter of the 50% and 85% particles) at reference locations for each stream. These size fractions of streams can then be assessed in terms of those sizes known to be suitable for spawning and rearing (see Kondolf and Wolman 1993, Suttle et al. 2004).</p> <p>Ranges of expected values are a function of both localized geology (source characteristics) and the frequency of flows of a sufficient magnitude to transport bed particles downstream. Instream channel roughness elements such as wood and boulders can help retain substrates by minimizing localized shear forces associated with flood flows. Expectations for predominant substrates in Puget Sound lowland streams can be generally characterized as follows: In low gradient headwaters/wetlands – predominantly sand/fines In low gradient floodplain reaches < 2% – predominantly gravel In higher gradient reaches > 2% – predominantly gravel and cobble</p> <p>Decreasing trend over time in % fines (grain size < 0.85 mm); ideally < 10% in low gradient riffles; median D50 grain size in spawning habitats ~ range established in literature. See (Kondolf and Wolman 1993; Chapman 1988; Bunte and Abt 2001)</p>	Decreasing trend over time in % fines, at locales where it is deemed to be a problem. In addition, want to see increasing input and retention of coarse sediments of suitable size distribution to satisfy life history requirements of native fishes for spawning and rearing refuge habitats. Where input sources are limited or non-existent, may want to test effectiveness of gravel replacement.

Habitat attribute	Indicator metric	Popular term for indicator	Anticipated ranges of indicator values	Ecological health threshold ¹
7. Biological communities	B-IBI		B-IBI scores indicate the degree of human impact on streams, calibrated for the Puget Sound lowland. Scores ranges from 10 to 50 and are categorized as very poor (10–16), poor (18–26), fair (28–36), good (37–44) and excellent (>44). Used to compare locally.	Park lands: > 36 Other lands: > 30
	RIVPACS		Multivariate approach that compares the observed (sampled) benthic macroinvertebrate community to that of a reference collection collected in a minimally disturbed site. The value produced is expressed O/E, (observed over expected.) A relatively pristine site might score a 1.0 or higher, where a degraded site would score much lower. A reference collection for Western Washington streams has been developed, and data can be entered and calculated using University of Utah’s RIVPACS software. Other metrics (% filterers, temperature preference, fines indicators, tolerance metrics) also available. Used to compare regionally.	> 0.8
	Salmon productivity		Measures the ratio of redds to the summer standing juvenile salmon stock. Different from usual salmon productivity measures because we are concerned with the ability of salmon to withstand winter and spring high flow events once out of the gravel. Ranges for expectations of productivity will need to be established from reference streams and tempered by actual data collected over the first few years of a monitoring program specific to each stream.	Increasing trend
	Fish Biomass		Routine fish sampling surveys done periodically as part of the extensive monitoring program will establish year to year estimates of distribution, abundance and growth for both native and non-native fish within Seattle urban streams. Tracking this over time will provide evidence of increasing or decreasing trends in overall condition of native salmon and trout, and overall species composition of the stream community.	Increasing trend over time indicating improving habitat conditions overall

¹ Thresholds are based on best scientific judgment about what is needed to sustain benthic communities and salmon spawning and rearing. The spatial and temporal extent to which hydrologic, water quality, physical habitat, and biological processes must work together, at the recommended thresholds, is uncertain. Therefore, these thresholds are put forward as goals to guide study designs and management actions. Threshold values will be revised as knowledge is gained through observation and monitoring about the constraints and opportunities for urban stream restoration.

Table 2. Preliminary, partial list of indicators being considered for recognition of “Properly Functioning Conditions” (PFC) in the greater San Francisco Bay region by the National Marine Fisheries Service, organized by habitat attribute for use in the San Geronimo Salmon Enhancement Plan.

Habitat attribute	Indicator ¹	Poor	Fair	Good	Very good
1. Water Quality	Temperature (MWAT or MWMT) ²	<50% IP-km ⁶ (<15°C MWAT)	50–70%	70–90%	>90%
	Toxicity	Acute	Sub-lethal or Chronic	No Acute or Chronic	No evidence of toxins or contaminants
2. Streamflow and hydrologic integrity	Baseflow ³	Not Defined			
	Impervious surfaces ⁴	>12.01% of watershed by area	7.01–12%	3.01–7%	0-3%
	Road density ⁴	>3 miles/sq. mile	3–2.5	2.5–1.6	<1.6
	Road density 100 ^{4,5}	>1 mile/sq. mile	1–0.5	0.5–0.1	<0.1
3. Channel morphology	Frequency of primary pools ⁶	<30% pools by order and length	30–40%	40–50%	>50%
	LWD Frequency (BFW 0-10m)	<4 key pcs/100m	4 to 6/100m	6 to 11/100m	>11/100m
	LWD Frequency (BFW 10-100m)	<1/100m	<1 to 1.3/100m	1.3 to 4/100m	>4/100m
	Floodplain Connectivity	<50%	50–80%	>80%	Not defined
4. Riparian vegetation	Canopy cover	<75% avg. over IP-km ⁷	75–85%	85–95%	>95%
	DBH (North) ⁸	<39% class 5&6 ⁹	40–54%	55–69%	>69%
	Species composition	<25%	25–50%	>50%	Historical conditions
5. Channel connectivity	Physical barriers	<50% of IP-km ⁶	50–70%	70-90%	>90%
6. Sediment dynamics	Gravel quality (Bulk)	>17% (D ₅₀ =0.85)	15–17%	12–14%	<12%
	Gravel quality (Embeddedness)	<25% of scores are Category 1 or 2 ¹⁰	25–50%	>50%	Not defined

Habitat attribute	Indicator ¹	Poor	Fair	Good	Very good
7. Biological communities ¹¹	Spawning adults	Watershed-specific NMFS calculation			
	Summer juvenile rearing density	< 0.2 fish/m ²	0.2–0.7	0.5–1.0	>1.0
	Smolt abundance	Watershed-specific NMFS calculation			

¹ Final PFC indicators will be included in the Draft Recovery Plan for Central California Coast coho salmon (NMFS *in prep*).

² MWAT = Maximum weekly average temperature or moving average of 7-day average water temperature; MWMAT = Maximum weekly maximum temperature or moving average of 7-day maximum water temperature.

³ Direct measure of streamflow and hydrologic integrity.

⁴ Indirect measure of streamflow and hydrologic integrity.

⁵ Road density 100 = road density within 100 m of stream channel.

⁶ Primary pools = pools possessing average depth > 2 ft.

⁷ IP-km = Intrinsic potential score x reach length (km).

⁸ DBH (North) = Diameter at breast height from CDFG data collected in watersheds located north of San Francisco Bay.

⁹ Riparian vegetation “Class” designations are as of yet undefined.

¹⁰ CDFG Category 1=0-25% embeddedness; Category 2=25-50%; Category 3=50-75%; Category 4=75-100%; Category 5=unsuitable.

¹¹ Multiple life-stages will be included in the final set of indicators, with only three examples shown here.

3 SPECIFIC RECOMMENDATIONS FOR METRICS IN THE SAN GERONIMO CREEK WATERSHED

Two related uses of indicators are recommended for application in the San Geronimo Creek watershed. One set of indicators, those intended to evaluate “watershed health,” obviously require an explicit criteria for what does (and does not) constitute a healthy watershed. They do not need to be particularly precise, but they do need external benchmarks that have been established from prior work, and that are applicable to the specific geologic and climatological setting of San Geronimo Creek. A good example is any indicator being used to define Properly Functioning Conditions (Table 2). However, not every such metric will be equally well-suited to the physical and biological conditions, and the institutional opportunities and constraints, of this specific watershed.

From the prior compilation of prospective indicators, the candidate indicators shown in Table 3 are particularly well-suited for assessing watershed health for San Geronimo Creek.

Table 3. Potentially suitable indicators for evaluating the health of the San Geronimo Creek watershed.

Habitat attribute	Indicator
1. Water quality	Water temperature
	Turbidity
	Dissolved oxygen
	Toxicity
2. Streamflow (indirect measures)	Watershed imperviousness
	Road density

Habitat attribute	Indicator
3. Channel morphology	Frequency of pools
	Frequency of LWD
	Floodplain connectivity
4. Riparian vegetation ¹	Riparian corridor width
	Canopy cover
	Species (native/introduced) and size composition
5. Channel connectivity	Physical barriers to migration
6. Sediment dynamics	Gravel quality (bulk)
	Gravel quality (embeddedness)
7. Biological communities	Benthic macroinvertebrates ²
	Fish density or biomass at selected life stages

¹ Indicators may apply to both the riparian corridor and the Stream Conservation Area.

² Measured using standard bioassessment protocols.

A second set of indicators are recommended to track changes in watershed health, presumably as a consequence of management activities arising out of the Salmon Enhancement Plan. These indicators need to be sensitive to change and responses to likely management activities, but they do not need a numerical criterion for “good”—only knowing the direction of beneficial change is required. This list includes some of the watershed-health indicators (above), and in total the following candidate indicators are suitable for tracking changes in stream and watershed conditions over time and for ultimately distinguishing genuine trends from natural variability. We also anticipate that they fall within the likely institutional capacity and constraints for collecting some or all of these data:

Table 4. Potentially suitable indicators for tracking changes in watershed health for the San Geronimo Creek watershed.

Habitat attribute	Indicator
1. Water quality	Water temperature
	Toxicity
	Dissolved oxygen
2. Streamflow	Watershed imperviousness
	Baseflow or low flow
3. Channel morphology	Frequency of pools
	Frequency of LWD
	Channel cross-sectional area
	Channel erosion/stability
4. Riparian vegetation ¹	Canopy cover
5. Channel connectivity	Physical barriers to migration
6. Sediment dynamics	Gravel quality (embeddedness)
	Bed-sediment cementation
7. Biological communities	Benthic macroinvertebrates ²
	Fish density or biomass at selected life stages

¹ Indicators may apply to both the riparian corridor and the Stream Conservation Area.

² Measured using standard bioassessment protocols.

Given a single site of long-term stream gauging in the watershed and the importance of hydrology in determining stream conditions, supplemental indicators for tracking changes in the flow regime are probably going to be needed for the foreseeable future in San Geronimo Creek. Watershed imperviousness (using the more easily measured Total Impervious Area [TIA] or the more relevant, but difficult-to-quantify, Effective Impervious Area [EIA]) is the most widespread metric (e.g., Center for Watershed Protection 2003). Channel stability is commonly included as a reasonable proxy for the effects of hydrologic alteration (particularly high flows), and with caveats this is probably justified because rapid channel erosion, particularly during the early stages of urbanization when land use (and consequently flow regime) is changing rapidly, is ubiquitous and readily measured by even crude (but rapid) metrics (e.g., McBride and Booth 2005). As channels adjust and the pace of land-use changes slows, however, the degree of channel instability also slows and can stop altogether. This condition of “restabilization” (Henshaw and Booth 2000) does not imply a return to healthy watershed conditions or the presence of a flow regime supportive of healthy biota—it merely heralds a new state in the evolution of an urban stream, one where “channel stability” is no longer a useful indicator of more general conditions. Thus, alternatives to directly measuring flow have significant long-term limitations.

A “channel conditions metric” can therefore be a worthwhile surrogate for direct measurement of the high-flow hydrologic regime, but it is probably too crude to properly evaluate whether watershed-scale measures to limit or reduce effective impervious area are being effective over a period of years. In addition, over a decade of research has demonstrated that imperviousness, although an important determinant of watershed and instream conditions, is a poor predictor of these metrics (e.g., Morley and Karr 2001, Booth et al. 2004, Alberti et al. 2007), particularly in the range of development that characterizes all of the San Geronimo Creek watershed. It is for exactly this reason that the Center for Watershed Protection (2003), probably the best-known and most widely-cited “authority” for using imperviousness as a measure of stream conditions, reminds its followers:

“Quite simply, the influence of IC [“impervious cover”] in the one to 10% range is relatively weak compared to other potential watershed factors, such as percent forest cover, riparian continuity, historical land use, soils, agriculture, acid mine drainage or a host of other stressors. Consequently, watershed managers should never rely on IC alone to classify and manage streams in watersheds with less than 10% IC. Rather, they should evaluate a range of supplemental watershed variables to measure or predict actual stream quality within these lightly developed watersheds.” (CWP. 2003, p.6)

It is also with this guidance that TIA is not recommended here as a component of an “integrated ‘channel condition’ metric”, again following the direction of CWP (2003), who note that any measure of imperviousness “...does not currently predict the impact of watershed treatment.” (p. 3).

If the in-stream effectiveness of management proscriptions must be measured directly in order to be meaningful, then a significant effort of long-term continuous flow gaging will be necessary. Given the likely pace of such changes and the variability of weather, however, detecting change (or proving the absence of change in the face of continued development) is likely to take a decade or more. Note also that any changes in other elements of an urban-altered flow regime, not expressed by changes in peak discharge but potentially even more significant to biota (e.g., Konrad et al. 2005), will not be revealed by a channel conditions metric at all.

In Marin County and the San Geronimo Creek watershed, another monitoring issue of particular concern is the status and trend of Stream Conservation Areas (SCAs), which have been designated to protect streams and riparian habitat and the watershed functions they provide (Marin Countywide Plan Policy EQ-2.1 [Marin County CDA 2005]). SCAs are defined as extending laterally outward from the top of the incised stream valley (i.e., “top-of-bank”), on both sides of the creek, for 50 feet on each side of the valley in city corridor reaches and 100 feet on each side in rural reaches (from Marin Countywide Plan Policy EQ-2.3 [Marin County CDA 2005]). Conditions common throughout the watershed, notably the incision of many stream valleys, have resulted in a narrow strip of riparian vegetation that is limited to streamside areas below the top-of-bank, typically within about 50 ft [15 m] of the bankfull channel (Stillwater Sciences 2009). Where the channel is incised, these riparian zones are adjacent to the stream but they are not included within the SCA. The adjacent upland surface, which does encompass the SCA, is often observed to be partly to totally modified by structures and non-native landscaping. The zone of riparian vegetation does not consistently extend beyond the top-of-bank and into the SCA, although the SCA and the riparian corridor do overlap to varying degrees in multiple locations in the watershed (Stillwater Sciences 2009). These varied spatial relationships, which all affect the integrity and the function of a healthy riparian zone, suggest the importance in this watershed of developing riparian health indicators that can be applied across the entire riparian corridor and greater SCA.

In total, a suite of metrics are recommended for further consideration when developing a monitoring program for the San Geronimo Creek watershed. This suite is based on the various metrics from the literature (above), those known to be relevant to conditions in San Geronimo Creek (Stillwater Sciences 2009), and practical opportunities and limitations known from prior experience (Roper and Scarnecchia 1995, Myers and Swanson 1997, Poole et al. 1997, Scholz and Booth 2000, McBride and Booth 2005, Stillwater Sciences 2007b). In support of the continued development of a San Geronimo Valley Salmonid Enhancement Plan, indicators, specific parameter(s) and candidate criteria are presented in Table 5. In several cases, the criteria are drawn directly from NMFS PFC criteria (see Table 2), including the specification of reaches possessing an intrinsic potential to support salmonids based on available historical information. However, the criteria presented below are not based on an intrinsic potential (IP) model per se, and the more general watershed health categories used by NMFS (poor/fair/good/very good) are replaced by San Geronimo Creek watershed-specific criteria categories (minimum acceptable/target range/ideal). The latter categories are designed to support forthcoming recommendations in the San Geronimo Salmonid Enhancement Plan, which will rely on targets or criteria that are linked to recommended habitat enhancements. The final determination of the watershed health criteria and measurement techniques, including location, frequency of measurement, and degree of precision for each parameter, must await the final recommendations of the Salmon Enhancement Plan and the initial planning of specific management actions intended to improve watershed health.

Table 5. Recommended watershed-health indicators, parameters, and candidate criteria for the San Geronimo Creek watershed.

Habitat attribute	Existing watershed data		Indicator	Parameter(s)	Candidate Watershed health criteria ³		
	San Geronimo Creek ¹	Adjacent/ Near ²			Minimum acceptable	Target range	Ideal
1. Water Quality	X	X	Water temperature*	MWAT (°C) during summer rearing periods (May-October)	>50% of suitable reaches ^{4,5} (MWAT <15°C)	70–90%	>90%
	X		Toxicity	Bioindicator tissue concentrations (mg/kg)	No acute toxicity (no samples > TEC)	No acute, sublethal or chronic toxicity (no samples >TEC or PEC)	No evidence of toxins or contaminants
	X	X	Turbidity	TSS (mg/L), including high flow peak values	80% of samples < 100–500 mg/L, with peaks corresponding to high flow events ^{5,6}	80–95%	95%
	X ⁷		Dissolved oxygen (D.O.)	Continuous D.O. (mg/L)	7.0–9.0 mg/L and 3-month (consecutive) median D.O. ≥80% of saturation ⁸	7.0–9.0 mg/L and 3-month (consecutive) median D.O. ≥80% of saturation	> 9.0 mg/L and 3-month (consecutive) median D.O. ≥90% of saturation
2. Streamflow	X		Watershed imperviousness	Cumulative TIA	Specific thresholds not supported by literature values (see CWP 2003)		
			Road density 100	Road density 100 (mi roads/mi ² area within 100 m of bankfull channel)	1 mi/mi ²	0.5–0.1 mi/mi	<0.1 mi/mi ²
	X		Baseflow or low flow*	Annual average daily mean flow (cfs) June-September	Watershed-specific trend analysis required at selected monitoring sites		

Habitat attribute	Existing watershed data		Indicator	Parameter(s)	Candidate Watershed health criteria ³		
	San Geronimo Creek ¹	Adjacent/ Near ²			Minimum acceptable	Target range	Ideal
3. Channel morphology	X	X	Frequency of pools w/min. depth scaled by channel size**	# pools/channel widths ⁹	<0.25 ¹⁰	0.25–0.50 ¹⁰	>0.50 ¹⁰
	X	X	Frequency of LWD**	key peices/100m	<4/100m	4 to 11/100m	>11/100m
	X	X	Channel cross-sectional area	Surveyed channel width, depth, and area	Watershed-specific trend analysis required at selected monitoring sites		
	X		Channel erosion/stability**	Relative bank stability and/or armoring	Watershed-specific trend analysis required at selected monitoring sites		
4. Riparian vegetation ¹¹			Riparian corridor width	Average riparian corridor width perpendicular to channel	Open space reaches = 200 ft Rural & developed reaches = 80 ft ¹²	Open space reaches 200–300 ft Rural & developed reaches 80–100 ft	Open space reaches > 300 ft Rural & developed reaches > 100 ft
	X	X	Vegetation cover (by layer)**	<ul style="list-style-type: none"> • % canopy cover (tree & shrub layers) • % cover (absolute) of invasive non-native species rated as ‘high’ or ‘moderate’ negative overall ecological impact (Cal-IPC 2009) • % cover (absolute) of native species 	<ul style="list-style-type: none"> • 75% average canopy cover across suitable reaches • <50% cover invasive species • >50% cover native species 	<ul style="list-style-type: none"> • 85-95% average canopy cover across suitable reaches • 20–30% cover invasive species • 75–85% cover native species 	<ul style="list-style-type: none"> • >95% average canopy cover across suitable reaches • <5% cover invasive species • >95% cover native species

Habitat attribute	Existing watershed data		Indicator	Parameter(s)	Candidate Watershed health criteria ³		
	San Geronimo Creek ¹	Adjacent/ Near ²			Minimum acceptable	Target range	Ideal
	X		Riparian vegetation species* and size composition	<ul style="list-style-type: none"> Native species richness (R) Diameter at breast height (DBH) for primary LWD-recruitment species 	Watershed-specific trend analysis required at selected monitoring sites ¹³		
5. Channel connectivity	X		Physical barriers to migration (longitudinal connectivity)	Unimpeded passage	Unimpeded passage to more than 70% of suitable reaches	80–90%	>90%
6. Sediment dynamics	X	X	Gravel quality (bulk)	<ul style="list-style-type: none"> D₅₀ in low gradient riffles (surface and subsurface) % fines (D₅₀ < 0.85 mm) in low gradient riffles 	<ul style="list-style-type: none"> D₅₀ = 2 mm for coho¹⁴ D₅₀ = 10 mm for steelhead¹⁴ D₅₀ = 13 mm for Chinook¹⁴ 15–20% fines 	<ul style="list-style-type: none"> D₅₀ = 2–35 mm for coho¹⁴ D₅₀ = 10–46 mm for steelhead¹⁴ D₅₀ = 13–75 mm for Chinook¹⁴ 10–15% fines 	<ul style="list-style-type: none"> D₅₀ = 2–35 mm for coho D₅₀ = 10–46 mm for steelhead D₅₀ = 13–75 mm for Chinook <10% fines
			Gravel cementation**	Categorical measure of bed-sediment cementation (e.g., McBride and Booth, 2005)	Watershed-specific trend analysis required at selected monitoring sites		
			Gravel quality (embeddedness)	% of cobble or larger sediment embedded in finer sediment	<25% of scores are Category 1 or 2 ¹⁵	25–50%	>50%

Habitat attribute	Existing watershed data		Indicator	Parameter(s)	Candidate Watershed health criteria ³		
	San Geronimo Creek ¹	Adjacent/ Near ²			Minimum acceptable	Target range	Ideal
7. Biological communities	X	X	Benthic macroinvertebrates (bioassessment)	Taxa richness, composition, tolerance, functional feeding groups	BMI metric values correspond to “minimally disturbed stream” conditions (regional comparison)	BMI metric values correspond to “minimally disturbed stream” conditions (regional comparison)	BMI metric values correspond to “unimpacted stream” conditions (regional comparison)
	X	X	Fish density or biomass at selected life stages	Watershed-specific trend analysis required at selected monitoring sites			

* Suggested components of an ecosystem resiliency/climate change metric.
 ** Suggested components of an “integrated channel condition” metric.
¹ See Appendix Table B-1 for data information and sources.
² See Appendix Table B-2 for data information and sources. Watersheds “near” San Geronimo include Lagunitas Creek and Walker Creek watersheds.
³ Parameters and criteria values will be re-evaluated during completion of State/Federal Recovery Planning and should be re-evaluated following release of the California Coastal Monitoring Plan for Salmonids (C. Ambrose, pers. comm., April 2009).
⁴ “Suitable reaches” are reaches possessing an intrinsic potential to support salmonids based on available historical information.
⁵ Based on observed 10% mean reduction in growth at 14.8°C MWAT for coho (Sullivan et al. 2000). Observed steelhead growth reductions are less stringent at 17.0°C MWAT.
⁶ Based on range of anticipated sublethal effects for adult and juvenile salmonids (McLeay et al. 1987, Noggle 1978, Sigler et al. 1984, Sykora et al. 1972 as cited in Stillwater Sciences 2009).
⁷ Only discrete, rather than continuous, D.O. data available.
⁸ CRWQCB (California Regional Water Quality Control Board). 1995. San Francisco Bay basin, (Region 2) water quality control plan. Prepared by CRWQCB, Oakland, California.
⁹ “Channel widths” is defined as representative channel length normalized by average bankfull channel width (see Stillwater Sciences 2009).
¹⁰ Johnston and Slaney (1996).
¹¹ Indicators may apply to both the riparian corridor and the SCA. This is particularly relevant in cases where 1) the existing riparian corridor extends beyond the top-of-bank and into the SCA, and 2) the existing riparian corridor, if increased in width, would necessarily extend into the SCA. In the SCA, riparian vegetation indicators would be applicable for the remaining distance up to the target width of the riparian corridor.
¹² The minimum acceptable range extends to 80 ft, or the upper end of the height range of California bay laurel, the most common tree observed in the riparian corridor during recent San Geronimo Valley surveys (Stillwater Sciences 2009).
¹³ R_{native} and DBH criteria should be determined by community type.
¹⁴ Kondolf and Wolman 1993.
¹⁵ CDFG Category 1=0-25% embeddedness; Category 2=25-50%; Category 3=50-75%; Category 4=75-100%; Category 5=unsuitable.

4 INTEGRATION OF MONITORING INTO WATERSHED MANAGEMENT

Although a synoptic snapshot of “watershed health,” using some or all of the indicators recommended above for that purpose, will provide information desired by both Marin County and the community, such information rarely influences management actions very effectively by itself. For accomplishing beneficial change in the watershed, monitoring must be incorporated into the management plan itself, not after-the-fact. This paradigm was first called “adaptive management” by Hollings (1978), but the term has long since been diluted to apply to almost any association of “management” and “monitoring,” however disconnected the two may be. As we recommend it here, however, adaptive management requires that the management action (be it a restriction on development in the SCA, an instream installation of LWD, or a buffer-replanting project) be treated as an experimental action; that the monitoring be understood as the necessary observation of experimental outcomes; and that sub-optimal experimental performance will become the basis for changing the management prescription (Ralph and Poole 2003). The most suitable indicators for this type of application will obviously vary with the management “experiment” being undertaken, but they will all share the following characteristics:

- They will be place-based, focused on the location(s) and at the spatial scale(s) where the management action is anticipated to show its greatest influence;
- They will be drawn from the list of indicators that are sufficiently precise to show change; and
- They are feasible to undertake, such that resources can be made available to maintain data collection for a sufficient time to demonstrate change (or its absence).

We emphasize Karr’s (1998) reminder that the ultimate goal of most stream evaluation and subsequent rehabilitation is improved biological health. Physical and chemical conditions are but subsets of what determines biological health, and so measuring only physical or chemical parameters cannot provide an accurate characterization of biological conditions. In consort with careful biological monitoring, however, these measurements can efficiently provide both evaluation of overall stream “health” and guidance on how to identify (and ultimately improve) the most likely causative factors in urban and urbanizing systems.

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Appendices

Appendix A

Task Scope of Work

TASK SCOPE OF WORK

Evaluation of Watershed Health

Watershed health metrics will be developed to serve as indicators of watershed health for the San Geronimo Creek watershed. The watershed health analysis will include:

- determination of the efficacy of applying an integrated “channel condition” metric(s) as a surrogate for hydrologic function and process in the San Geronimo Creek watershed and linking of this metric to TIA quantified in the ECR
- evaluation of the suitability of other commonly applied metrics, such as indices of biological integrity for benthic macroinvertebrates (e.g., BIBI) and/or fish, aquatic habitat, water quality, and geomorphic conditions, instead of, or in addition to, an integrated “channel condition” metric

Watershed health metrics will be developed in coordination with the project management team, Executive Committee, and Salmon Advisory Committee, so that they may eventually be used as a tool for County planners. The form and type of recommended metrics will be developed under this task, as well as recommendations for valuations of the watershed health metrics themselves. It is expected that recommended values for these metrics will evolve during the enhancement planning, which may include changes to integrated metrics (i.e., channel condition) and any component metrics.

Task Deliverable

List or table summarizing watershed health metrics, along with supporting text and a graphic representation of how an integrated channel condition metric (if applicable) might be applied to the San Geronimo Creek watershed, to be included in the final Enhancement Plan.

Appendix B

Existing Data in the San Geronimo Creek Watershed

Table B-1. Existing data in the San Geronimo Creek watershed, organized by habitat attribute.

Habitat attribute	Data description and hyperlink to data and/or map representation
Water quality	<p>San Geronimo Cr Floating Weekly Ave @ Ink Wells 1999-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct137.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m89.htm</p> <p>San Geronimo Cr Floating Weekly Ave @ Trt Plnt 1999-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct138.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m90.htm</p> <p>San Geronimo Cr Min, Max and Average @ Ink Wells 2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct139.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m91.htm</p> <p>San Geronimo Cr Min, Max and Average @ Trt Plnt 2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct140.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m92.htm</p> <p>Dissolved Oxygen in San Geronimo Creek 2000-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct147.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m95.htm</p> <p>PH in Lower Lagunitas Cr Watershed 1995-2002 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct152.htm</p> <p>Total Suspended Solids in Lower Lagunitas Cr Watershed 1995-2002 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct157.htm</p> <p>Turbidity in Lower Lagunitas Creek Watershed 1995-2002 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct159.htm</p> <p>Copper in Lower Lagunitas Cr Watershed 1995-2002 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct141.htm</p>
Streamflow	<p>San Geronimo Cr at Lagunitas Rd Bridge - Annual Peaks 1980-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct79.htm</p> <p>San Geronimo Cr at Lagunitas Rd Bridge - Monthly Ave 1980-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct80.htm</p>
Channel morphology	<p>Lagunitas, SG & DG Creeks Percent Habitat by Length 1998-1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct86.htm</p>
Riparian vegetation	<p>Lagunitas & San Geronimo Cr Percent Bank Vegetation 1998-1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct82.htm</p> <p>Lagunitas & San Geronimo Cr Percent Fish Cover 1998-1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct83.htm</p>
Channel connectivity	None

Habitat attribute	Data description and hyperlink to data and/or map representation
Sediment dynamics	<p>Lagunitas & San Geronimo Cr Substrate Percent 1998-1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct84.htm</p>
Biological communities	<p>Abundance (Fish/30m) in San Geronimo Creek 1982-1986 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct26.htm</p> <p>Abundance (Fish/30m) Juv Salmonids in San Geronimo Cr 1993-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct19.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m27.htm</p> <p>Abundance (Fish/30m) Juvenile Coho Basinwide 1970-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct16.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m25.htm</p> <p>Abundance (Fish/30m) Juvenile Steelhead Basinwide 1970-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct17.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m25.htm</p> <p>Population Estimates 1 Basinwide 1982 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct32.htm</p> <p>Population Estimates 5 San Geronimo Creek 1982 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct36.htm</p> <p>Population Estimates Juv Salmonids San Geronimo Cr 1995-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct39.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m33.htm</p> <p>Spawner Survey, Adult Live Coho Basinwide 1997-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct49.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m34.htm</p> <p>Spawner Survey, Adult Live Coho San Geronimo Creek 1997-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct51.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m36.htm</p> <p>Spawner Survey, Coho Redds Basinwide 1995-2001 by Week http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct52.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m37.htm</p> <p>Spawner Survey, Coho Redds Basinwide 1997-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct53.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m38.htm</p> <p>Spawner Survey, Coho Redds San Geronimo Creek 1997-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct55.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m40.htm</p>

(source: KRIS clearinghouse)

Table B-2. Existing data near the San Geronimo Creek watershed, organized by habitat attribute (includes data not listed in Table B-1 but located within the Lagunitas Creek and Walker Creek watersheds).

Habitat attribute	Data description and hyperlink to data and/or map representation
Water quality	<p>All MMWD Sites, MWAT by Year 1997-2002 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m66.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct114.htm</p>
	<p>Bear Valley Creek Min, Max and Average 1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct115.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m67.htm</p>
	<p>Devils Gulch Min, Max and Average 2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct116.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m68.htm</p>
	<p>John West Fork Lower Min, Max and Average 2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct117.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m69.htm</p>
	<p>John West Fork Pipe Trap Min, Max and Average 2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct118.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m70.htm</p>
	<p>John West Fork Upper Min, Max and Average 1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct119.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m71.htm</p>
	<p>John West Fork Upper Min, Max and Average 2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct120.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m72.htm</p>
	<p>Lagunitas Cr Floating Weekly Ave @ Gallagers 1998-2002 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct121.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m73.htm</p>
	<p>Lagunitas Cr Floating Weekly Ave @ Kent 1997-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct122.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m74.htm</p>
	<p>Lagunitas Cr Floating Weekly Ave @ SPT St Park 1997-2002 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct123.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m75.htm</p>
	<p>Lagunitas Cr Floating Wkly Ave @ Several Sites 2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct124.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m76.htm</p>
	<p>Lagunitas Cr Min, Max and Average @ Gallagers 2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct125.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m77.htm</p>

Habitat attribute	Data description and hyperlink to data and/or map representation
Water quality (continued)	Lagunitas Cr Min, Max and Average @ Kent 2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct126.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m78.htm
	Lagunitas Cr Min, Max and Average @ SPT St Park 2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct127.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m79.htm
	Olema Creek Lower Min, Max and Average 2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct128.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m80.htm
	Olema Creek Floating Weekly Ave @ Several Sites 1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct129.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m81.htm
	Olema Creek Floating Weekly Ave @ Several Sites 2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct130.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m82.htm
	Olema Creek Lower Middle Min, Max and Average 1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct131.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m83.htm
	Olema Creek Middle Min, Max and Average 2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct132.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m84.htm
	Olema Creek Upper Middle Min, Max and Average 1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct133.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m85.htm
	Olema Creek Upper Min, Max and Average 1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct134.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m86.htm
	Olema Creek Upper Min, Max and Average 2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct135.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m87.htm
	Quarry Gulch Lower Min, Max and Average 2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct136.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m88.htm
	Copper in Upper Lagunitas Cr Watershed 1995-2002 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct142.htm
	Dissolved Oxygen (Average) in Lagunitas Creek 2002 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct143.htm
	Dissolved Oxygen (Minimum) in Lagunitas Creek 2002 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct144.htm

Habitat attribute	Data description and hyperlink to data and/or map representation
Water quality (continued)	Dissolved Oxygen in Lagunitas Creek 2000-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct145.htm
	Dissolved Oxygen in Olema Creek 1999-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct146.htm
	Fecal Coliform in Lagunitas Creek Small Tribs 1999-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct149.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m96.htm
	Fecal Coliform in Lagunitas Creek Watershed 2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct150.htm
	Fecal Coliform in Olema Creek 1999-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct151.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m97.htm
	PH in Upper Lagunitas Cr Watershed 1995-2002 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct153.htm
	Specific Conductance in Olema Creek 1999-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct154.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m98.htm
	Total Suspended Sediments in Olema Creek 1999-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct155.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m99.htm
	Total Suspended Solids in Lagunitas Creek Small Tribs 1999-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct156.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m100.htm
	Total Suspended Solids in Upper Lagunitas Cr Watershed 1995-2002 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct158.htm Turbidity in Upper Lagunitas Creek Watershed 1995-2002 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct160.htm
Streamflow	Lagunitas Creek at Pt Reyes Station 1975-1978 (Comparison) http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct58.htm
	Lagunitas Creek at Pt Reyes Station 1979-1982 (Comparison) http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct59.htm
	Lagunitas Creek at Pt Reyes Station 1983-1986 (Comparison) http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct60.htm
	Lagunitas Creek at Pt Reyes Station 1987-1990 (Comparison) http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct61.htm

Habitat attribute	Data description and hyperlink to data and/or map representation
Streamflow (continued)	Lagunitas Creek at Pt Reyes Station 1991-1994 (Comparison) http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct62.htm
	Lagunitas Creek at Pt Reyes Station 1995-1998 (Comparison) http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct63.htm
	Lagunitas Creek at Pt Reyes Station 1999-2001 (Comparison) http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct64.htm
	Lagunitas Creek at Pt Reyes Station, Monthly Average 1975-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct65.htm
	Lagunitas Creek at Pt Reyes Station, High Flow Days 1975-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct66.htm
	Lagunitas Creek at Pt Reyes Station, Median/Tenth 1975-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct67.htm
	Lagunitas Creek at Pt Reyes Station, Season 5/1-6/15, Medians http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct68.htm
	Lagunitas Creek at SPT State Park 1983-1986 (Comparison) http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct69.htm
	Lagunitas Creek at SPT State Park 1987-1990 (Comparison) http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct70.htm
	Lagunitas Creek at SPT State Park 1991-1994 (Comparison) http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct71.htm
	Lagunitas Creek at SPT State Park 1995-1998 (Comparison) http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct72.htm
	Lagunitas Creek at SPT State Park 1999-2001 (Comparison) http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct73.htm
	Lagunitas Creek at SPT State Park, Monthly Average 1983-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct74.htm
	Lagunitas Creek at SPT State Park, High Flow Days 1983-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct75.htm
	Lagunitas Creek at SPT State Park, Season 5/1-6/15, Medians http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct76.htm
Lagunitas Creek at SPT State Park, Season 6/16-10/31, Medians http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct77.htm	
Lagunitas Creek Watershed Reservoir Capacity 1872-1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct57.htm	
Nicasio Creek at USGS Station 1954-1960 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct78.htm	

Habitat attribute	Data description and hyperlink to data and/or map representation
Channel morphology	<p>Lagunitas Creek Average Pool Depths 1998-1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct85.htm</p> <p>Lagunitas Creek Percent Habitat by Length 1992 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct81.htm</p>
Riparian vegetation	None in Lagunitas
Channel connectivity	None in Lagunitas
Sediment dynamics	<p>Below Shafter Br - Bed Sub Surface Composition 1981-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct98.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m52.htm</p> <p>Below Shafter Br - Bed Surface Composition 1981-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct99.htm</p> <p>Kelley's Upper - Bed Sub Surface Composition 1980-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct100.htm</p> <p>Kelley's Upper - Bed Surface Composition 1981-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct101.htm</p> <p>Taylor State Park - Bed Sub Surface Composition 1981-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct102.htm</p> <p>Taylor State Park - Bed Surface Composition 1980-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct103.htm</p> <p>Big Rock - Bed Sub Surface Composition 1980-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct104.htm</p> <p>Big Rock - Bed Surface Composition 1980-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct105.htm</p> <p>Big Bend - Bed Sub Surface Composition 1980-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct106.htm</p> <p>Big Bend - Bed Surface Composition 1981-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct107.htm</p> <p>Cheda Ranch Road - Bed Sub Surface Composition 1980-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct108.htm</p> <p>Cheda Ranch Road - Bed Surface Composition 1981-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct109.htm</p> <p>Kelley's Tocaloma - Bed Sub Surface Composition 1980-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct110.htm</p> <p>Bed Sub Surface Composition - D50, Summary 1995-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct90.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m44.htm</p>

Habitat attribute	Data description and hyperlink to data and/or map representation
Sediment dynamics (continued)	<p>Bed Surface Composition - D50, Summary 1995-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct91.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m45.htm</p> <p>DG to TB - Bed Surface Composition D50 1980-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct92.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m46.htm</p> <p>SG to DG - Bed Surface Composition D50 1980-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct96.htm</p> <p>SG to DG - Embeddedness 1979-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct97.htm</p>
Biological communities	<p>Abundance (Fish/30m) in Devils Gulch 1982-1986 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct23.htm</p> <p>Abundance (Fish/30m) in Lagunitas Creek 1982-1986 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct24.htm</p> <p>Abundance (Fish/30m) in Olema Creek 1982-1986 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct25.htm</p> <p>Abundance (Fish/30m) Juv Salmonids in Devils Gulch 1993-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct18.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m26.htm</p> <p>Abundance (Fish/30m) Juv Steelhead 0+ in Lagunitas Cr 1993-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct20.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m28.htm</p> <p>Abundance (Fish/30m) Juv Steelhead 1+ in Lagunitas Cr 1993-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct21.htm</p> <p>Abundance (Fish/30m) Juvenile Coho in Lagunitas Creek 1993-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct22.htm</p> <p>Migrant Adult Salmonid Catch in Nicasio Creek 1961-1971 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct27.htm</p> <p>Outmigrant Catch Lagunitas Creek 1983 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct28.htm</p> <p>Outmigrant Catch Lagunitas Creek 1984 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct29.htm</p> <p>Outmigrant Catch Lagunitas Creek 1985 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct30.htm</p> <p>Outmigrant Salmonids Lagunitas Creek 1983-1985 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct31.htm</p> <p>Population Estimates 2 Lagunitas Creek 1982 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct33.htm</p>

Habitat attribute	Data description and hyperlink to data and/or map representation
Biological communities (continued)	Population Estimates 3 Olema Creek 1982 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct34.htm
	Population Estimates 4 Devils Gulch 1982 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct35.htm
	Population Estimates Juv Salmonids Devils Gulch 1995-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct37.htm
	Population Estimates Juv Salmonids Lagunitas Cr 1995-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct38.htm
	Spawner Survey by Kilometer, John West Fork Coho Redds 1997-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct40.htm
	Spawner Survey by Kilometer, Olema Creek 1997-1998 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct41.htm
	Spawner Survey by Kilometer, Olema Creek 1998-1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct42.htm
	Spawner Survey by Kilometer, Olema Creek 1999-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct43.htm
	Spawner Survey by Kilometer, Olema Creek 2000-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct44.htm
	Spawner Survey by Week, Olema Creek 1997-1998 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct45.htm
	Spawner Survey by Week, Olema Creek 1998-1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct46.htm
	Spawner Survey by Week, Olema Creek 1999-2000 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct47.htm
	Spawner Survey by Week, Olema Creek 2000-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct48.htm
	Spawner Survey, Adult Live Coho Lagunitas Creek 1997-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct50.htm
	Spawner Survey, Coho Redds Lagunitas Creek 1997-2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct54.htm
Stocking in Lagunitas Creek 1958-1987 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct56.htm	
Lagunitas Creek EPT Taxa 2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m8.htm	

Habitat attribute	Data description and hyperlink to data and/or map representation
Biological communities (continued)	Lagunitas Creek Percent Dominant Taxa 2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct1.htm
	Lagunitas Creek Taxa Richness 2001 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct2.htm
	Olema Creek EPT Taxa 1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct3.htm http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_m11.htm
	Olema Creek Percent Dominant Taxa 1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct4.htm
	Olema Creek RRIBI Scores 1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct5.htm
	Olema Creek Taxa Richness 1999 http://www.krisweb.com/kris_wms/krisdb/webbuilder/lc_ct6.htm

(source: KRIS clearinghouse)