SECTION E
STREAM CHANNEL CONDITION

INTRODUCTION

This report provides the results of an assessment of the stream channels of the Mendocino Redwood Company (MRC) ownership in the Southcoast Streams watershed analysis unit (WAU). This WAU includes MRC's ownerships in the Mallo Pass Creek, Lower Alder Creek, North Fork Alder Creek, Lower Brush Creek, Upper Brush Creek and Point Arena Creek planning watersheds. The assessment was done following a modified methodology from the Watershed Analysis Manual (Version 4.0, Washington Forest Practices Board). The stream channel analysis is based on field observations and stream channel slope class and channel confinement information developed from a digital terrain model in the company's Geographic Information System (GIS).

The goals of the assessment were to determine the existing channel conditions and identify the sensitivity of the channels to wood and sediment. Stream channels are defined by the transport of water and sediment. A primary structural control of a channel in a forested environment, besides large rock substrate, is from woody debris. Channel morphology and condition therefore reflect the input of sediment, wood and water relative to the ability of the channel to either transport or store these inputs (Sullivan et. al., 1986).

Stream channel conditions represent the strongest link between forest practices and fisheries resources. Changes in channel condition typically reflect changes to fish habitat. Because of this the fish habitat and stream channel assessments were done in the same reaches. The results for the fish habitat parameters are presented in Section F - Fish Habitat Assessment.

METHODS

The methods of the stream channel assessment are designed to identify channel segments that are likely to respond similarly to changes in sediment or wood and group them into distinct geomorphic units. These geomorphic units enable an interpretation of habitat-forming processes dependent on similar geomorphic and channel morphology conditions. The channels are also evaluated for current channel condition to provide baseline information for the evaluation of channel conditions over the long term.

Stream Segment Delineation

The stream channel network for the Southcoast Streams WAU was partitioned into stream segments based on three classes of channel confinement and several classes of channel gradient. These classifications were based on channel classifications prepared from digital terrain data in Mendocino Redwood Company's Geographic Information System (GIS). The slope classes used for delineation are 0-3%, 3-7%, 7-12%, and 12-20%. Channel confinement was classified by confined, moderately confined, and unconfined. Confined channels have a valley to channel width ratio of <2, moderately confined channels have a valley to channel width ratio of <4, and unconfined channels have a valley to channel width ratio of >4.

Channel segments were delineated based on either a change in slope class or change in channel confinement. The channel segments were numbered with a two letter code, corresponding to the planning watershed, followed by a unique number (*1 through n* for each planning watershed). The delineated stream segments are shown on Map E-1.

Field Measurements and Observations

Selection of field sites for stream channel observations was based on gathering a sample of response (0-3% gradient) and transport (3-20% gradient) channels. No attention was focused on the source reaches (>20% gradient).

For each channel segment the bankfull width, bankfull maximum depth, bankfull average depth, floodprone depth, floodprone width, and channel bankfull width to depth ratio are measured at a cross section representative of the channel segment. A pebble count of 50 randomly selected pebbles is counted at the cross section to determine the D_{50} (median particle size) of the streambed. Streambed sediment characteristics are interpreted from observations of gravel bars, fine sediment abundance and particle size of the stream bed material. The channel morphology is further interpreted by flood plain interaction for the segment (continuous, discontinuous, inactive, none) and channel roughness characteristics. Large woody debris (LWD) functioning in the channel was inventoried (presented in Section D, Riparian Function). The number and type of pools (LWD forced, bank forced, boulder forced, free formed) were observed. The field observations are summarized and defined in Table E-1.

Geomorphic Units

Channel segments were grouped into geomorphic units by similar attributes of channel condition, position in the drainage network, and gradient/confinement classes. The intent of the geomorphic units are to stratify channel segments of the WAU into units which respond similarly to the input factors of coarse and fine sediment, and LWD. These geomorphic units can then be interpreted to have similar habitat-forming processes.

Interpretations related to sediment supply, transport capacity and LWD response were the basis for development of sensitivity of geomorphic units to coarse sediment, fine sediment and LWD inputs. These interpretations were based primarily on existing conditions observed in the stream channels of the WAU. The channel sensitivity to changes to coarse sediment, fine sediment and LWD are based on how the current state of the channel is likely to respond to inputs of these variables.

Long Term Channel Monitoring Sites

One long-term stream channel monitoring segment was established in Mallo Pass Creek to monitor stream channel morphology conditions and stream sediment characteristics.

Longitudinal profiles, cross sections and streambed substrate measurements were surveyed in each segment. Permeability of spawning gravels was measured (methods and results presented in the Fish Habitat section). These monitoring segments will be re-surveyed and monitored over time to provide insight into changes in channel morphology, sediment transport and fish habitat conditions from our restoration work.

The stream monitoring segments are typically 20-30 bankfull channel widths in length. Permanent benchmarks (PBMs) are placed at the upstream and downstream ends of the monitoring segment. The PBMs are monumented with nails in the base of large trees along with a re-bar pin in the ground adjacent to the nail.

The longitudinal profile is a survey of the thalweg, the deepest point of the channel, excluding any detached or "dead end" scours and/or side channels. At every visually apparent change in thalweg location or depth, the station along the channel and the elevation is recorded. In the absence of visually apparent changes, thalweg measurements are taken every 15-20 feet along the channel. A profile graph of the channel's thalweg is created from the longitudinal survey (see Appendix E for longitudinal profiles for the Southcoast Streams WAU). A computer program (LONGPRO) developed by the USGS for Redwood National Park was used to analyze the profiles. This program converted the surveys into standardized data sets with uniform five-foot spacing between points and determined the residual water depth of each point. The residual water depth is the depth of water in pools of the channel segment defined by the riffle crest height at the outlet of the pool. No minimum pool depth is specified. The distribution, mean and standard deviation of the residual water depths for the longitudinal profile segment are calculated. This provides the ability to statistically evaluate changes in the residual water depths from the thalweg profile over time.

Along the longitudinal profile, three to five channel cross sections are surveyed (locations are permanently monumented). The cross sections are located along relatively straight reaches in the monitoring segment. Cross sections are surveyed from above the floodprone depth of the channel. A graph of the cross section is created from the survey (see Appendix E for cross sections graphs for the Southcoast Streams WAU). At each cross section a pebble count is done, to determine the particle size distribution and median particle size (D_{50}), by measuring 100 randomly selected pebbles along the cross section fall line.

Permeability Samples

Steam gravel permeability samples were collected on one stream monitoring segment in the Southcoast WAU, specifically in the Mallo Pass Creek watershed. The stream gravel permeability was measured using a 1-inch diameter standpipe similar to the standpipe discussed in Terhune (1958) and Barnard and McBain (1994) with the exception that our standpipe is smaller in diameter. We used the smaller diameter standpipe because we hypothesize that it creates fewer disturbances to the stream gravel when inserted.

An electric pump was used to create the water suction in the standpipe for the permeability measurements. The permeability measurements were taken at a depth of 25 centimeters, near the maximum depth of coho and steelhead spawning. The permeability measurements were taken in 15 randomly selected pool tail-out sections along the monitoring segment. At each pool tail-out sampled permeability measurements were taken at two randomly-selected locations within the tailout. Five repetition samples were collected and averaged to provide a representative sample in each of the random locations. This gave a total of 30 permeability sites within the monitoring reach (RJ02).

The median permeability measurement for each permeability site in the monitoring segment was used as representative of the site. To characterize the entire monitoring segment the natural log of the mean of the median permeability measurements was determined. The natural log of the permeability is used because of a relationship developed from data from Tagart (1976) and McCuddin (1977) (Stillwater Sciences, 2000) to estimate survival to emergence from permeability data. This relationship equates the natural log of permeability to fry survival (r^2 = 0.85, $p<10^{-7}$). This index needs further improvements, but is currently all we have for interpreting permeability information and biological implications. This relationship is:

Survival = -0.82530 + 0.14882 * ln permeability

It is important to understand that the use of this survival relationship is only an index of spawning gravel quality in the segment. The permeability measurements were taken in randomly selected pool tail-outs and are not indicative of where a salmon may select to spawn. Furthermore, spawning salmon have been shown to improve permeability in gravel where a redd was developed (MRC, 2000). Therefore the survival percentage developed is only indicative of the quality of potential spawning habitat and not as an absolute number.

V* - Fraction of pool volume filled with fine sediment (Hilton and Lisle 1993)

V* is estimated in a section of a stream channel by measuring the water and fine sediment volume in the residual pool in all of the pools in a study reach and then calculating the weighted average value of V*w for the reach.

The number of pools needed depends on the variability of V* between pools and on the desired accuracy of the estimate of V*w. In channels where V* does not vary greatly between pools, 10 to 15 pools are often sufficient.

A measurable pool is an area of channel which (1) has a significant residual depth (the deepest part of the pool must be at least twice as deep as the water flowing out of the pool at the downstream end); (2) has an essentially flat water surface during low flow (water surface slope <0.05 percent); and (3) includes most of the channel (it must include the thalweg and occupy at least half of the width of the low-flow channel). The specific criteria can vary, as long as they are repeatable and consistent across all reaches compared.

One should avoid measuring potential pools with unclear boundaries, such as long glides containing small deep areas or small deep areas in rocky channels, because it is difficult to measure such pools consistently. What constitutes fine sediment in a channel is determined by the distribution of particle sizes and patterns of fine-sediment deposition in the channel. Fine sediment is defined as the material forming the matrix among the gravel framework of the bed material.

Fine sediment in a reach is defined as material which (1) is distinctly finer than the bed surface (median particle size or D_{50}) of fine sediment approximately one tenth or less of the D_{50} of the bed surface) and (2) can be distinguished from underlying coarser sediment by probing with the rod. Deposits of fine sediment that are armored (covered by a layer of larger sediment) or densely occupied by roots of riparian plants are not considered available for transport and are not measured.

RESULTS

Stream Channel Observations

Field channel surveys or observations were taken on 17 stream reaches in the Southcoast Streams WAU during the summer of 2007. Table E-1 provides a summary of the data collected. Further detail specific to in-channel fish habitat relationships is found in Section F - Fish Habitat Assessment of this report. LWD measured and evaluated in stream channels is reported in the Riparian Function section.

Key to Table E-1.

Stream Channel Dimensions

Category	Description
ID #	The stream identification number (see Map E-1), two letter planning watershed code followed by unique number for the planning watershed. RC – Rockport Elk
Channel confinement	Confined-channel width to valley width ratio < 2, moderately confined-channel width to valley width ratio 2-4, unconfined-channel width to valley width ratio >4, based on the DTM in GIS.
Survey Length	Length of stream surveyed.
GIS slope category	Slope class as designated by DTM in GIS.
Field Observed Slope	Mean slope of segment as observed in field.
Maximum Bankfull Depth	Maximum bankfull depth of representative cross section.
Mean Bankfull Depth	Average bankfull depth of representative cross section.
Bankfull width	Bankfull width of representative cross section.
Width/Depth Ratio	Ratio of bankfull channel width to average bankfull depth.
Floodprone depth	Maximum depth during flooding estimated by 2 times max. bankfull depth (Rosgen, 1996).
Floodprone width	Width of water at floodprone depth (Rosgen, 1996).
Entrenchment Ratio	Ratio of floodprone width to bankfull channel width.

Sediment/Bedform Characteristics

Category	Description
Geomorphic Unit	Number of the geomorphic unit the channel segment is in.
Floodplain Continuity	Description of floodplain/channel interaction either: continuous, inactive, discontinuous or none.
D_{50}	Median gravel size of the stream bed particle distribution at a representative riffle.

Pool Characteristics

Category	Description
Free	number of free formed pools in segment.
LWD Forced	number of LWD forced pools in segment.
Boulder Forced	number of boulder forced pools in segment.
Bank Forced	number of bank forced pools in segment.
Mean Res. Pool Depth	average of all residual pool depths in segment (data collected by fisheries staff).

Table E-1. Stream Channel Observations for the Southcoast Streams Watershed Analysis Unit, 2007

Segment Name	ID #	Channel Confinement	Survey Length (ft)	GIS Slope Category (%)	Maximum Bankfull Depth (ft)	Mean Bankfull Depth (ft)	Bankfull Width (ft)	Width/Depth Ratio	Floodprone Depth	Floodprone Width	Entrenchment Ratio
Alder Creek	CA03	C	1500	0-3			56			85	1.5
Alder Creek	CA05	C	1500	0-3			50			65	1.3
Alder Creek	CA08	C	1200	0-3			54				
Alder Creek	CA10	MC	1000	0-3	5	2.7	56		10	85	1.5
Alder Creek	CA12	MC	1700	0-3	4.3		42		8.6	70	1.7
Alder Creek	CA14	MC	1600	0-3			49		0	90	1.8
Alder Creek	CA17	C	1000	3-7	2.2	1.8	12	6.7	4.4	14	1.2
Bee Tree	CA21	MC	970	3-7			20			22	1.1
Nye Creek	CA30	NO DATA									
John Creek	CA34	MC	950	3-7			24				
Mallo Pass	CM03	C	900	0-3	3.1	2.3	17	7.4	6.2	35	2.1
Mallo Pass	CM05	MC	1200	3-7			18				
Mills Creek	CM06	MC	950	7-12	2.5	1.7	12.5	7.4	5	25	2.0
NF Alder	CN01	NO DATA									
NF Alder	CN02	MC	1200	0-3	3	2.1	20.5	9.8	6	35	1.7
NF Alder	CN03	MC	892	3-7			20				
Schooner	GP01	C	620	0-3	3	2.1	21	10	6	50	2.4

Table E-1. Stream Channel Observations for the Southcoast Streams Watershed Analysis Unit, 2007.

Segment Name	ID #	Floodplain Continuity	Geo-mor-phic Unit	D_{50} (mm)	Pools (number by type)				Total number of pools	Mean residual pool depth[1] (feet)	Key LWD pieces per 100 meters (w/ debris jams)	% of LWD pieces in debris jams
					Bank	*Boulder*	*Free*	*LWD*				
Alder Creek	CA03	No floodplain	II	84	8	0	0	0	8	3.9	0.0	0%
Alder Creek	CA05	No floodplain	II	132	7	0	1	0	8	3.0	0.0	0%
Alder Creek	CA08	No floodplain	II	145	3	12	0	1	16	2.6	0.0	0%
Alder Creek	CA10	No floodplain	I	133	4	5	5		14	4.6	0.0	0%
Alder Creek	CA12	Discontinuous	I	128	6	1	0	1	8	3.4	0.6	0%
Alder Creek	CA14	Discontinuous	I	26	3	2	1	4	10	3.0	0.0	0%
Alder Creek	CA17	Discontinuous	III	33	6	13	0	3	22	1.3	0.7	0%
Bee Tree	CA21	Inactive	III	27	2	1	0	9	12	1.1	2.0	40%
Nye Creek	CA30	No data	No data	No data	2	19	0	1	22	1.1	1.8	0%
John Creek	CA34	No floodplain	III	No data	2	1	0	5	8	1.9	0.7	20%
Mallo Pass	CM03	No floodplain	II	41	3	1	0	10	14	1.6	2.9	40%
Mallo Pass	CM05	No floodplain	III	No data	4	0	0	10	14	1.3	9.3	60%
Mills Creek	CM06	Discontinuous	IV	21	3	0	0	14	17	1.0	3.5	0%

[1] - Residual pool depth information comes from the Fish Habitat surveys

Table E-1. Stream Channel Observations for the Southcoast Streams Watershed Analysis Unit, 2007.

Segment Name	**ID #**	**Floodplain Continuity**	**Geo-mor-phic Unit**	**D_{50} (mm)**	**Pools (number by type)**				**Total number of pools**	**Mean residual pool depth[1] (feet)**	**Key LWD pieces per 100 meters (w/ debris jams)**	**% of LWD pieces in debris jams**
					Bank	***Boulder***	***Free***	***LWD***				
NF Alder	CN01	No data	No data	No data	4	0	0	2	6	No data	0.7	0%
NF Alder	CN02	Discontinuous	I	56	1	11	1	3	16	No data	0.8	0%
NF Alder	CN03	Discontinuous	III		5	1	2	1	9	No data	0.4	0%
Schooner	GP01	Discontinuous	II	18	5	2		9	16	1.4	8.5	50%

Stream Geomorphic Units

Stream geomorphic units were developed for the stream network on the MRC property in the Southcoast Streams watershed. These units are general representations of stream channels with similar sensitivities to coarse sediment, fine sediment and large woody debris inputs. Four stream geomorphic units were developed for interpretation of stream channel response to forest management interactions in the Southcoast Streams WAU. The four stream geomorphic units are described below.

Geomorphic Unit I. Low Gradient, Moderately Confined Channels.

Includes Segments: CA10, CA12, CA14, CN02

***General Description*:**
The channels within this unit flow through short areas of unconfined to moderately confined canyons. Hillslopes or inner gorge topography typically controls the lateral edge of the floodplain. Some terraces are present and floodplains are present though discontinuously. The bankfull channel is typically between 15 and 60 feet in width. The channels in this unit are low gradient (0-2 percent, but usually <1 percent). These channels exhibit moderate sediment transport capacity. The meandering, low gradient pattern and profile facilitate sediment deposition. When terraces are present bank erosion is observed in this unit, particularly on the outside of meander mends and toes of large landslides.

Associated Channel Types:
This unit primarily exhibits pool/riffle morphology. The Rosgen classifications (Rosgen, 1994) for these channels are primarily C4, with some areas of F4 and DA4.

Fish Habitat Associations:
Spawning habitat and gravel are in moderate amounts in this unit, but spawning gravel quality is reasonably good where present. Rearing habitat availability can be good where sufficient LWD creates good pool habitat and shelter, however summer rearing can be absent because some of the streams in this unit can go subsurface during the summer rearing period. Young fish would have to migrate to other areas to survive through the summer months. Overwintering habitat is provided by large cobble/boulder and bedrock substrates. LWD when present in this unit also provides overwintering habitat for juvenile salmonids.

Conditions and Response Potential:
Coarse Sediment: High Response Potential
These channels are depositional areas for coarse sediment. The moderate sediment transport capacity makes these channels vulnerable to changes in supply of coarse sediment. Fluctuations of coarse sediment can occur that will surpass the transport capacity of the stream. When this occurs pools can be filled, the influence of large woody debris and bedrock controlled sections are lessened and the channels can aggrade. Aggradation of the channel can create greater bank erosion, or wider braided channels.

Fine Sediment: Moderate Response Potential
The channels of this unit have high fine sediment transport capacity due to high flow capacity of the channel. However, when there is a high fine sediment supply in transport, accumulations of fine sediment do occur in this unit. Sparse to moderate accumulations of fine sediment was

observed in this unit. These accumulations were observed in the gravel bars, along channel margins, and in some pools.

Large Woody Debris: High Response Potential
The alluvial composition of the bed material in conjunction with a low gradient channel makes these channels highly responsive to LWD inputs. LWD is a dominant influence for pool development, sediment storage behind LWD accumulations and stabilization of bank and bedforms within the channels in this unit.

Geomorphic Unit II. Confined Low Gradient Channel Segments.

Includes Segments: CA03, CA05, CA08, CM03, GP01

General Description: The channels within this unit meander through confined canyons. The channels are typically confined by hillslopes with a narrow floodplain occasionally present, typically on the inside of meander bends. Alternating gravel bars on meander bends often define the bankfull width. The bankfull channel is typically between 10 and 30 feet in width. These channels are often entrenched within terrace or landslide deposits. Bank erosion is high. The channels in this unit are low gradient (<3 percent), but sediment transport capacity is high due to the highly confined channel keeping water energy directed within the channel. The channel bed is composed of primarily gravel-sized particles.

Associated Channel Types:
This unit primarily exhibits pool/riffle morphology, however some step pool and forced pool/riffle morphology does occur. The Rosgen classification (Rosgen, 1994) for these channels is predominantly F4.

Fish Habitat Associations:
This unit is characterized by large substrate that provides an element of roughness to the stream. Larger sized cobbles break up the flow of water creating velocity breaks and bubble curtains. Velocity breaks are located directly behind (downstream) cobble and boulders and provide a resting place for fish. The white water or bubble curtains that are created by larger, exposed substrate are considered a valuable source of shelter for fish. This unit has low amounts of large woody debris, due the confined nature of the channels wood recruitment would have a positive effect on the quality of in-stream habitat by providing increased scour and shelter to pool habitat.

Conditions and Response Potential:
Coarse Sediment: Moderate Response Potential
These channels are not depositional areas for coarse sediment. Coarse gravel accumulations are common in point and medial gravel bars in this unit. The high confinement of these channels creates relatively high sediment transport capacity. However, if the supply of coarse sediment surpasses the transport capacity the impact can be filling of pools or increased scour of the bed.

Fine Sediment: Moderate Response Potential
The channels of this unit have high fine sediment transport capacity due to confinement of the channels. However, the watershed has a relatively high background sediment rate. This high rate of sediment input can result in pool filling or bed fining from high fine sediment accumulations. Fine sediment accumulations were observed in this unit on the top of gravel bars, accumulated in the bed of plane bed reaches, along pool margins, and in some pools.

Large Woody Debris: High Response Potential
The alluvial composition of the bed material in conjunction with a low gradient channel makes these channels highly responsive to LWD inputs. LWD is a dominant influence for pool development, sediment storage behind LWD accumulations and stabilization of bank and bedforms within the channels in this unit.

Geomorphic Unit III. Moderate Gradient Confined Transport Segments.

Includes Segments: CA17, CA21, CA34, CM05, CN03

General Description:
Stream channel segments in this unit are confined within canyons, though areas of moderate confinement occur locally. Typically entrenchment ratios (bankfull to floodprone width) are between 1 and 5 bankfull widths. This is sufficient to allow some isolated terrace formation and channel meandering, though not common. The channel segments in this unit are near the transition between deposition and transport channels. Due to the moderate gradient (3-7 percent) of the channels, they are responsive to aggradation and degradation from changes in the stream sediment supply. The stream bed of these channels varies from gravel to boulder sized particles. The terraces in this unit appear to be created from large episodic sediment loads such as frequent mass wasting. The gradient of the stream is high enough that stream segments in this unit easily down-cut through the terrace deposits when flow is concentrated.

Associated Channel Types:
This unit primarily exhibits step pool and forced pool/riffle morphology, with areas of cascade morphology. The Rosgen classifications (Rosgen, 1994) for these channels vary from G1-4 with areas of B4 and A4 depending on the bank configuration, slope and channel substrate.

Fish Habitat Associations:
Spawning areas in this unit are infrequent, due to lack of accumulations of gravel sized particles. The steeper gradient segments of this unit typically form step-pool, cascade, and some pool-riffle habitat. The step-pools that are typically boulder formed, and offer substrate refugia, which provide both rearing and overwintering habitat.

Conditions and Response Potential:

Coarse Sediment: Moderate Response Potential
The channels in this unit have relatively high sediment transport capacity. In the lower gradient sections of these channels coarse sediment can create pool filling and aggradation, resulting in increased bank erosion and poor stream habitat. The step pool sections of these channels have relatively stable cobble and boulder component that can remain relatively static except in extreme flows. Increased coarse sediment supply can create pool filling, but is only moderately influential on the morphology because pool filling at these moderate gradients creates lower channel roughness which in turn promotes more step pool or cascade development, provided high inputs of coarse sediment subside.

Fine Sediment: Low Response Potential
The channels of this unit have high fine sediment transport capacity due to high flow capacity of the channel. However, when there is a high fine sediment supply in transport, accumulations of

fine sediment do occur but typically have short residence times in this unit. Sparse to moderate accumulations of fine sediment was observed in this unit. These accumulations were observed in the bed and along channel margins.

Large Woody Debris: Moderate Response Potential
The high confinement or entrenchment of these channels provides little opportunity for the channel to meander or develop a floodplain. Water energy is concentrated within the confines of canyon walls or stream banks making the role of LWD less sensitive as channels with less confinement or entrenchment. LWD is less likely to enter the channel because it becomes suspended over the channels narrower bankfull width. The role of LWD is typically as sediment storage or forced step pool development in these channels. Bed morphology in channels with slope gradients of 4-10% is typically step pool (Montgomery and Buffington, 1993). The large bed forming material of step pool morphology is generally stable making the role of LWD in these channels less sensitive than other channel types.

Geomorphic Unit IV. High Gradient Transport Segments.

Includes Segments: CM06

General Description:
Channel segments in this unit are high gradient transport reaches from 7-20% with high sediment transport capacity. The channel segments in this unit typically flow through tightly confined, V-shaped canyons. These are typically zones of scour during high flows or debris flows. Stream substrate is typically from cobble to large boulders. Typically, there is no surface water flow in this unit in the summer drought season.

Associated Channel Types:
This unit varies its morphology from step pool to cascades with some occasional waterfalls. The cascades and waterfalls occur in the steepest segments of this unit and only during winter storm events. The Rosgen (Rosgen, 1996) classification for these channels varies between A2, A3, and AA2, AA3 depending on channel gradient and substrate composition.

Fish Habitat Associations:
Potential for steelhead trout utilization is low due to the high gradient; 8% to 20% and small channel sizes. Rearing would be unlikely because stream flow typically goes subsurface in the summer months.

Conditions and Response Potential:

Coarse Sediment: Low Response Potential
Typically the channel morphology in this unit is cascade, with some step pool morphology at the lower gradients observed in these channels. These channels have bed material that is coarse and relatively immobile. Down cutting or bank erosion are not common in these high gradient, large substrate dominated channels even with increases in sediment supply. Debris flows can cover the substrate creating the cascade morphology but this is generally short-lived due to the high sediment transport capacity of the channels.

Fine Sediment: Low Response Potential
The high gradient of the channels in this unit creates a high fine sediment transport capability. Pools or storage areas for fine sediment in these channels are limited making the impacts from

fine sediment minimal. Down cutting or bank erosion are not common in these high gradient, large substrate dominated channels even with increases in sediment supply.

Large Woody Debris: Moderate Response Potential
The role of LWD in these channels is to provide storage of sediment and also as a source for downstream LWD. LWD is needed in these channels however the need for LWD as a source for downstream LWD is episodic and therefore the least sensitive as other channel types. The storage of sediment by LWD in these channels is necessary, but can be accomplished by a range of size classes of LWD not necessarily very key LWD pieces.

Long Term Stream Monitoring

During the summers of 2007 and 2008 one long term channel monitoring segment in Mallo Pass Creek (CM01) was surveyed for longitudinal profiles, cross sections, large woody debris and streambed substrate particle size distribution. The particle size distribution of the bed was surveyed in four cross sections and ten pools were surveyed for fine sediment deposition utilizing the V-star methodology (Hilton and Lisle 1993). The plots of the surveys are included in the appendix of this module (Appendix E) for display. The results of the permeability measurements are presented in section F - Fish Habitat Assessment of this report.

Longitudinal profile data was analyzed using the LONGPRO software application (Goforth and Madej 1999). An additional longitudinal profile survey was conducted in 2011.

During the summer of 2008, approximately 23,000 acres of Mendocino Redwood Company forestlands burned due to an abnormally severe lightning storm that hit the North Coast region the evening of June 20th. A significant portion of the upper reaches of Mallo Pass Creek burned during these fires.

Mallo Pass Creek

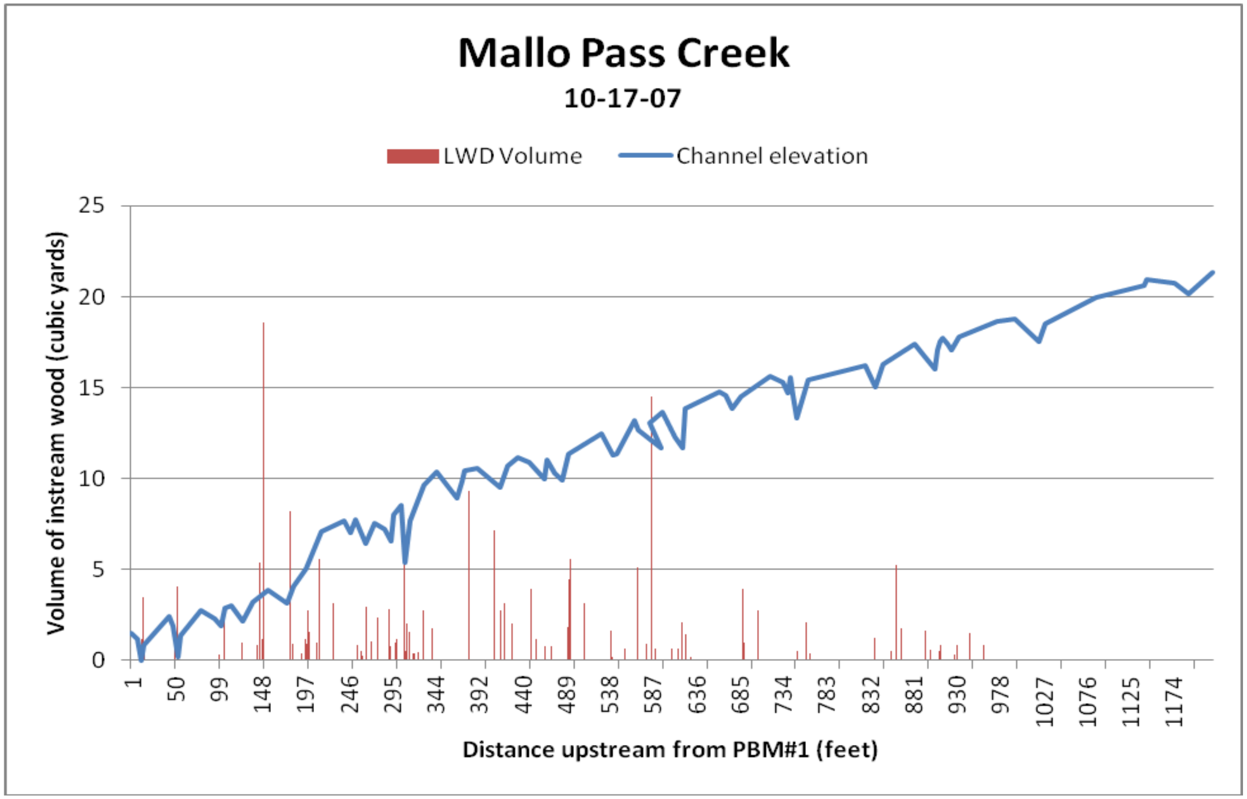
Longitudinal profile data (Table E-2) indicate that the reach (CM01) has a mean residual pool depth of less than two feet and maximum residual pool depths of about three feet indicating that there is a severe lack of deep pools within this reach.

In-stream large woody debris (Table E-3) data indicate nine key pieces in this segment, resulting in approximately 3 key pieces per 328 feet (1200 feet total surveyed). For this size channel (bankfull width of 35 feet), a target of at least four key pieces per 328 feet is desirable (Bilby and Ward 1989), thus this channel is slightly lacking in instream wood. The observed LWD data along with channel morphology and riparian stand data indicate that LWD demand is high (this channel segment has a high sensitivity rating and a low recruitment potential).

The mean of the V-star observations (Table E-5) indicate that this long term monitoring segment exhibits fine sediment deposition characteristic of regional index streams with little to moderate disturbance, as observed in the study by Knopp 1993. The index streams observed by Knopp 1993 indicated mean V-star values ranging from 0.17 to 0.28 whereas the moderately to highly disturbed watersheds resulted in mean values of 0.37 to 0.42. Another way of interpreting the V-star data is that this segment is not storing a significant amount fine sediment within the pools.

Table E-2. Longitudinal profile data in Mallo Pass Creek.

Year	*Pool count*	*Minimum pool depth (ft)*	*Maximum pool depth (ft)*	*Mean pool depth (ft)*	*Mean pool length (ft)*	*Mean distance between pools (ft)*	*Mean riffle length (ft)*	*Mean distance between riffles (ft)*
2007	21	0.5	3.15	1.42	28.92	50.66	21.34	49.51
2008	21	0.5	2.15	1.2	26.17	51.7	24.94	49.25
2011	20	0.5	3.54	1.45	32.54	62.45	29.51	62.74



Total LWD Volume (cubic yards)	215
LWD Pieces	101
Key pieces	9
Key pieces per 328 feet	3.1
Bankfull width (feet)	35
Key piece target per 328 feet	4

Table E-3. Large woody debris data in Mallo Pass Creek 2007.

Segment ID	Year	Segment length (ft)	Total number of pieces	Total LWD volume (yd^3)	Number of key LWD pieces per 100 m	LWD target (# key pieces per 100m)
CM01	2007	1200	101	215.5	3.1	3.9

Table E-4. Pebble count and cross-sectional data in Mallo Pass Creek 2007-2011.

Segment ID	Cross-section number	D_{50} (mm) 2007	D_{50} (mm) 2008	Cumulative net change in cross-sectional area since 2007 (ft^2)	Comment
CM01	1	25	21	14.5	Scour
CM01	2	20	21	6.2	Scour
CM01	3	21	30	1.3	Scour
CM01	4	22	20	4.3	Scour

Table E-5. V-star data in Mallo Pass Creek 2007.

Pool number	V*
3	0.60
4	0.60
5	0.42
7	0.26
10	0.36
11	0.44
12	0.52
17	0.33
18	0.50
20	0.47
High	**0.60**
Low	**0.26**
Mean	**0.37**
Variance	**0.0017**
Standard Error	**0.041**

Table E-6. V-star data in Mallo Pass Creek 2008.

Pool number	V*
1	0.23
2	0.22
9	0.38
11a	0.25
11b	0.28
13	0.15
14	0.24
15	0.40
16	0.21
17	0.25
High	**0.40**
Low	**0.15**
Mean	**0.24**
Variance	**0.0003**
Standard Error	**0.017**

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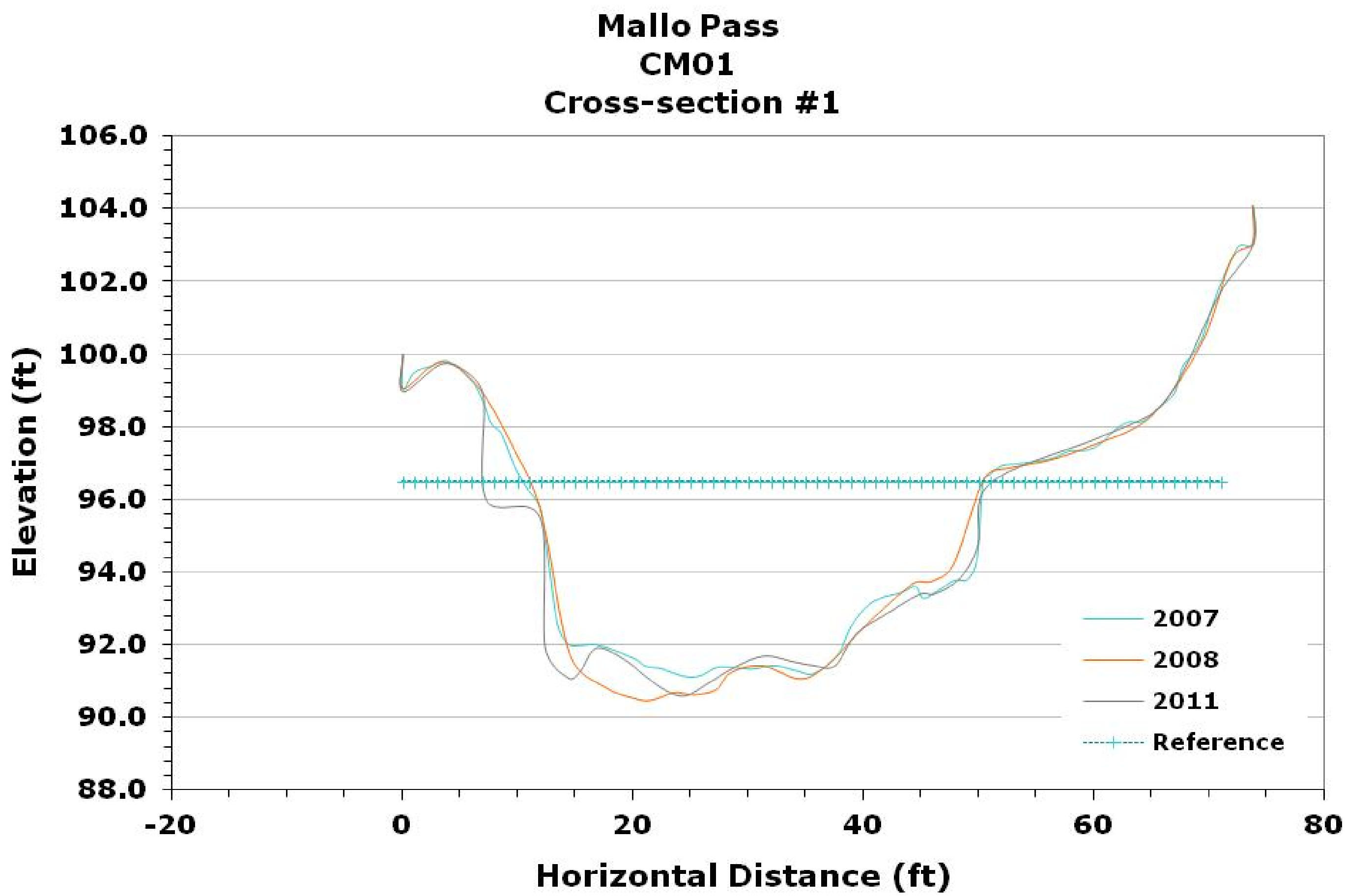
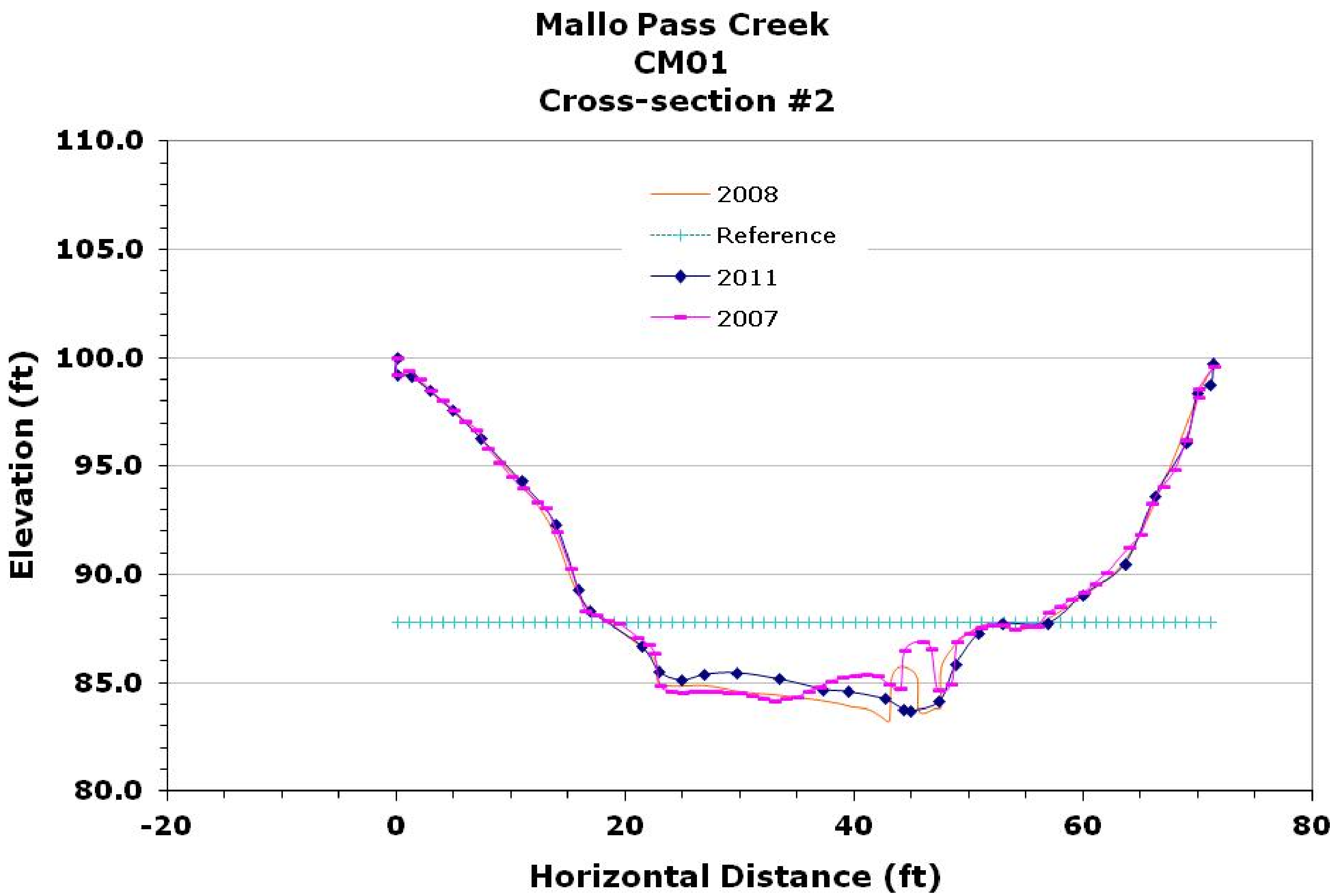
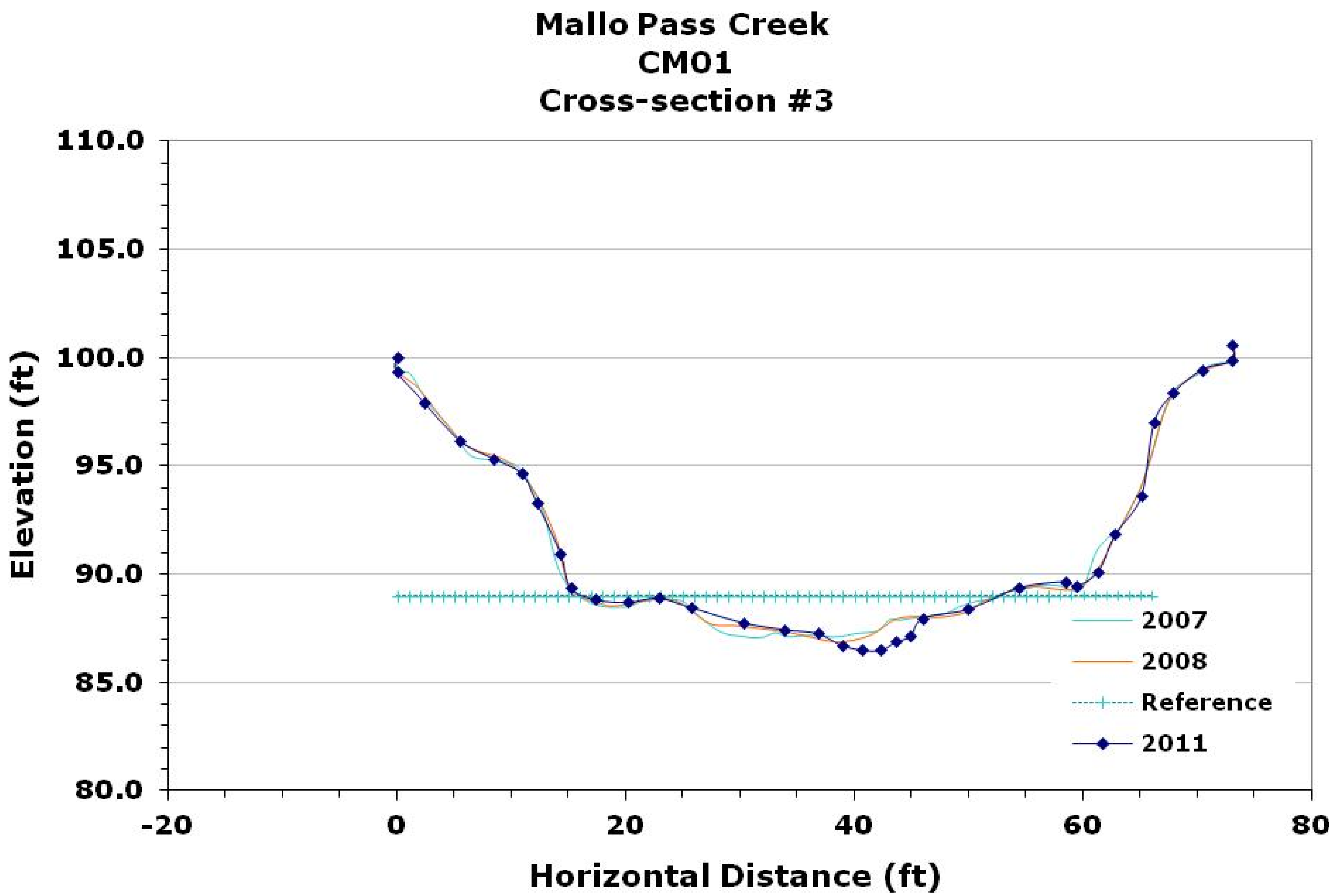
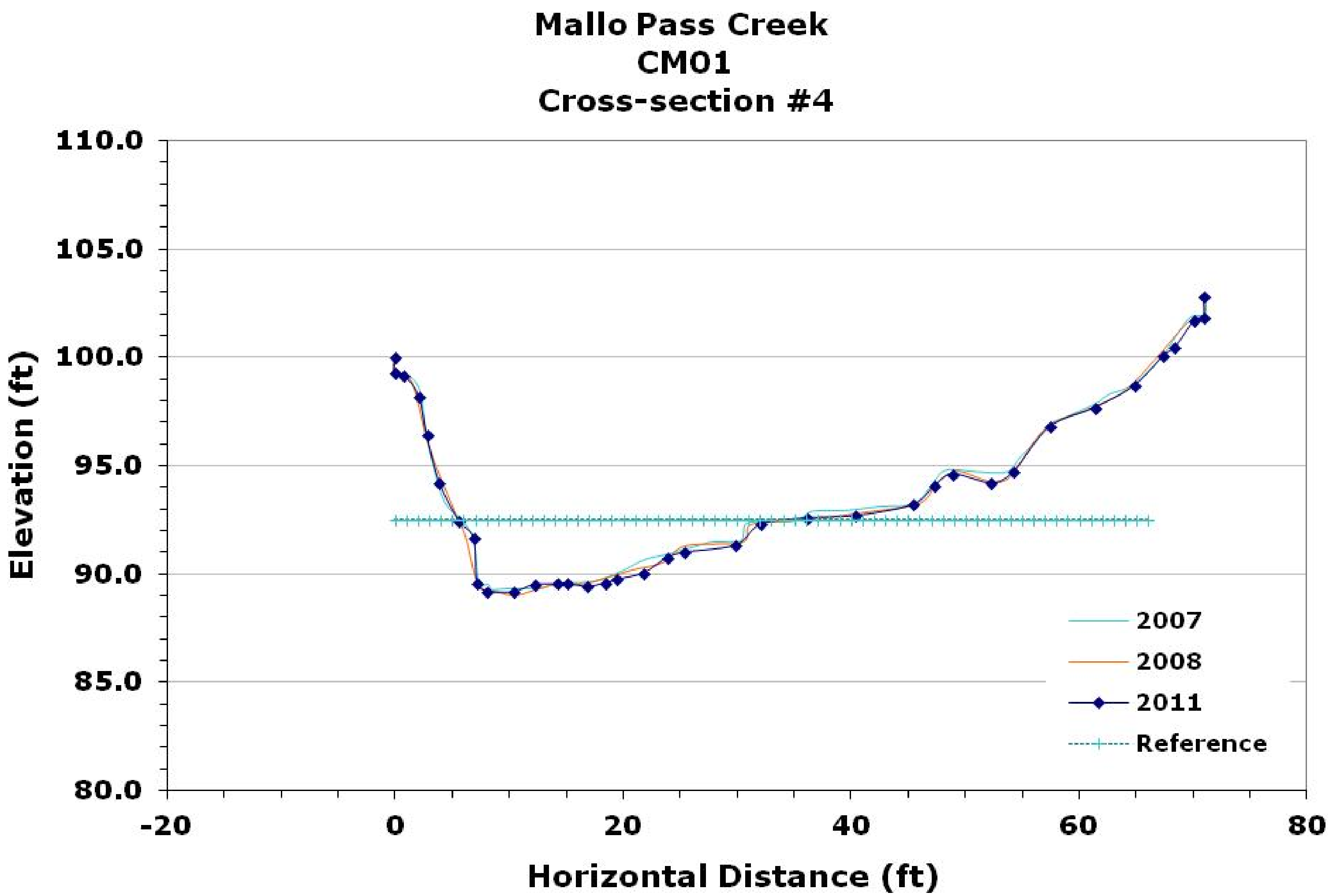
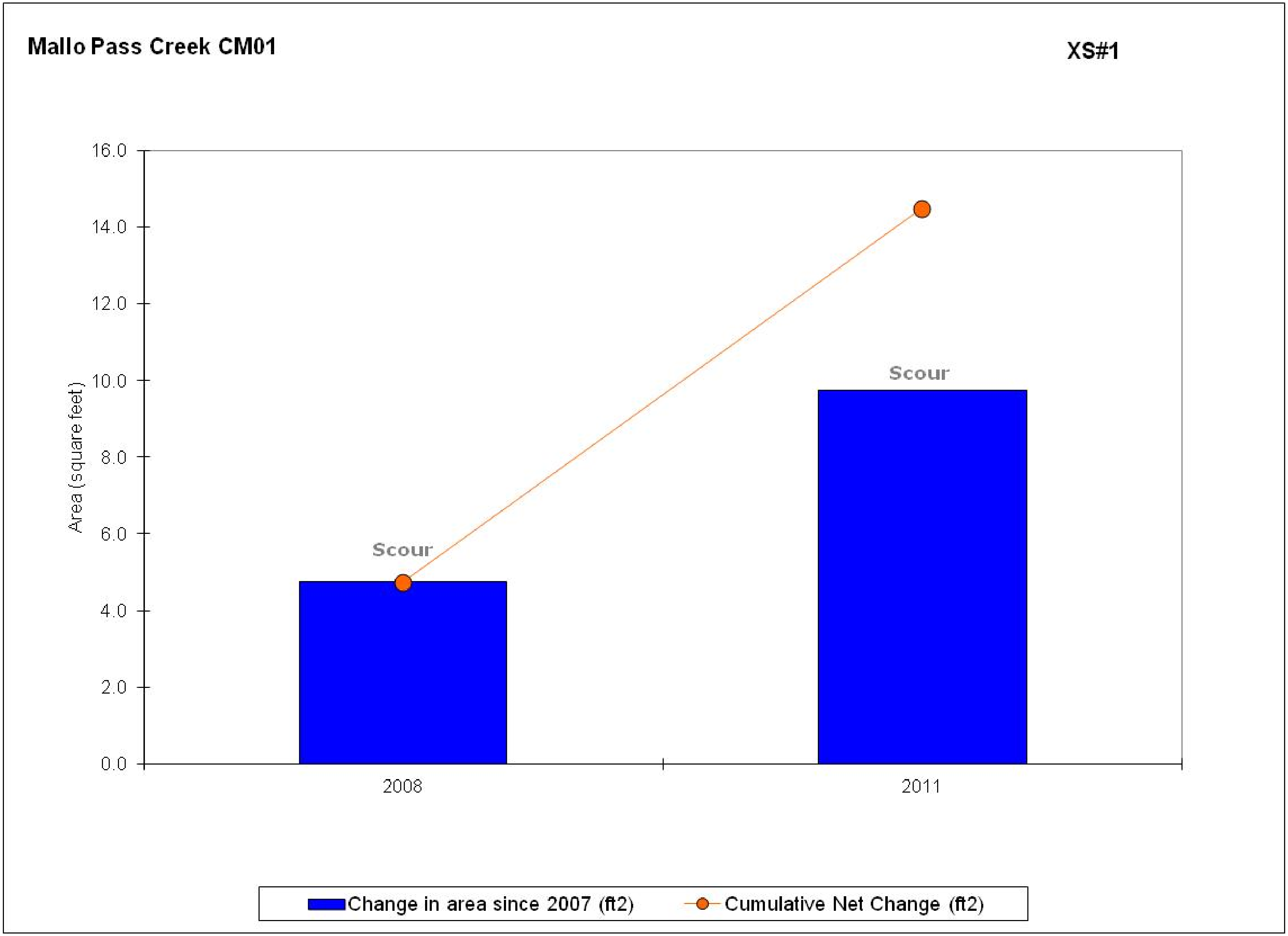
Appendix E


Mallo Pass
CM01
Cross-section #1
106.0
104.0
102.0
100.0
98.0
96.0
94.0
92.0
90.0
88.0
Elevation (ft)
-20
0
20
40
60
80
Horizontal Distance (ft)
2007
2008
2011
Reference

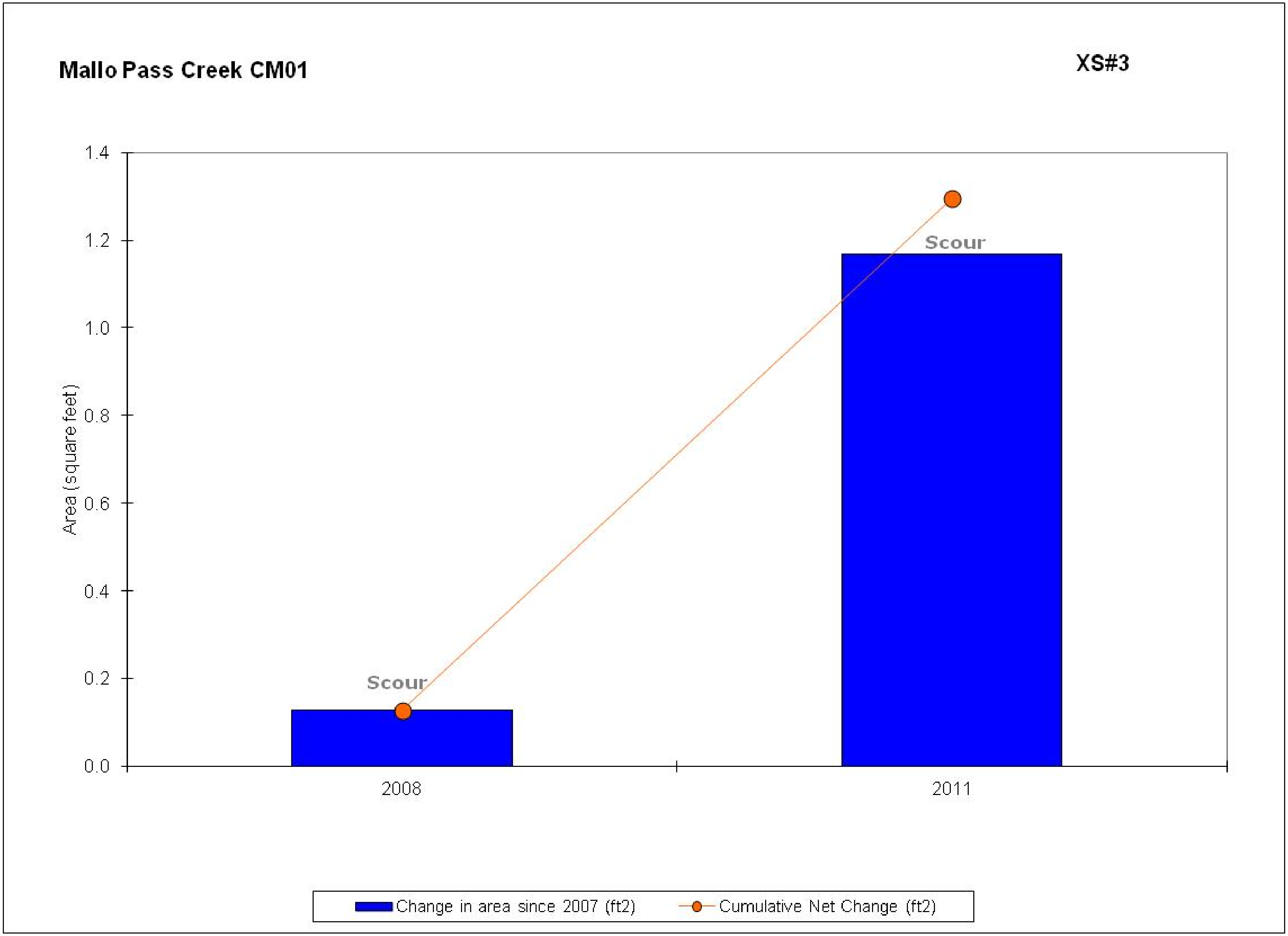

Mallo Pass Creek
CM01
Cross-section #2
2008
Reference
2011
2007
Elevation (ft)
110.0
105.0
100.0
95.0
90.0
85.0
80.0
-20
0
20
40
60
80
Horizontal Distance (ft)

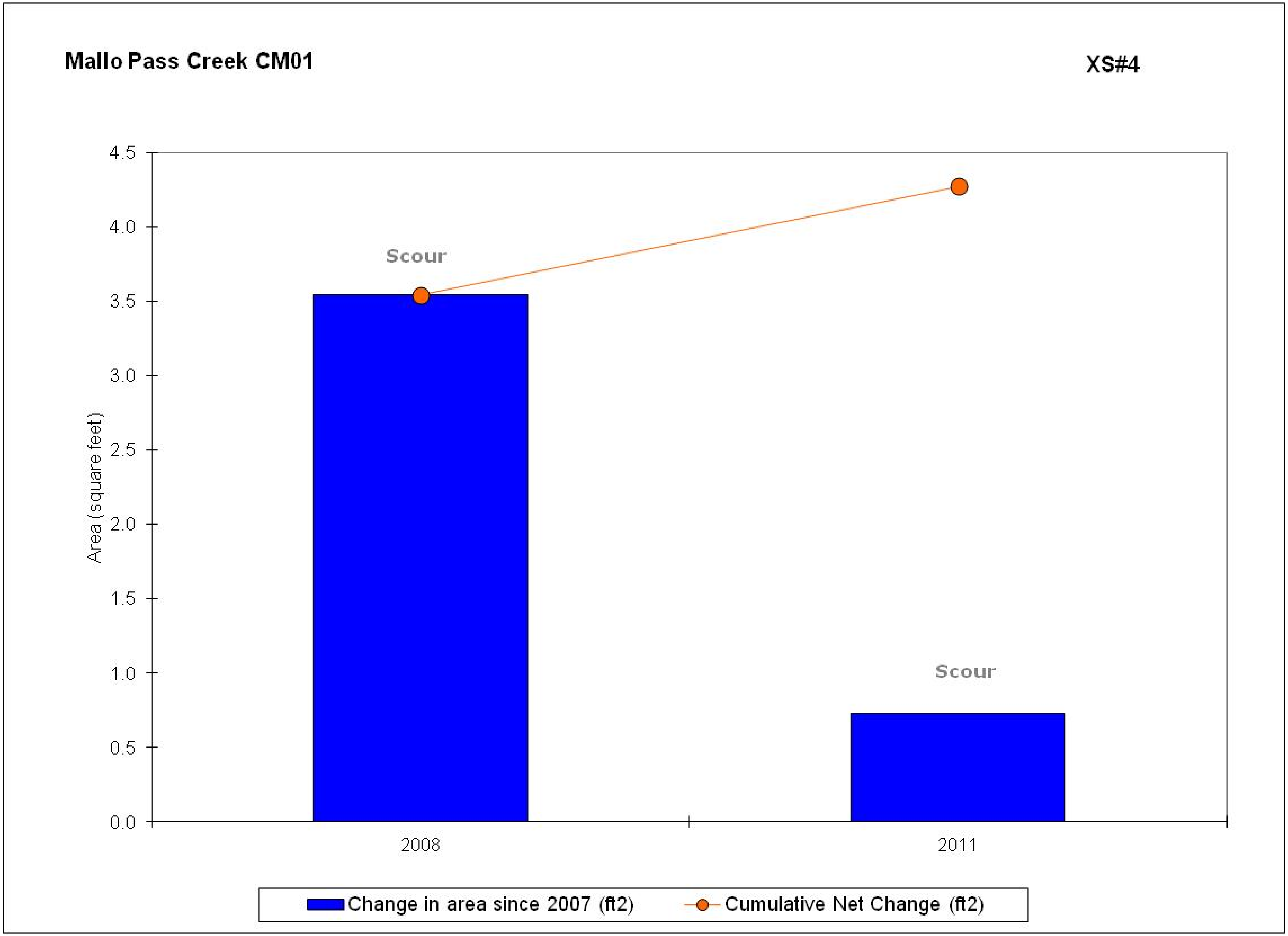

Mallo Pass Creek
CM01
Cross-section #3
110.0
105.0
100.0
95.0
90.0
85.0
80.0
Elevation (ft)
-20
0
20
40
60
80
Horizontal Distance (ft)
2007
2008
Reference
2011


Mallo Pass Creek
CM01
Cross-section #4
110.0
105.0
100.0
95.0
90.0
85.0
80.0
Elevation (ft)
-20
0
20
40
60
80
Horizontal Distance (ft)
2007
2008
2011
Reference

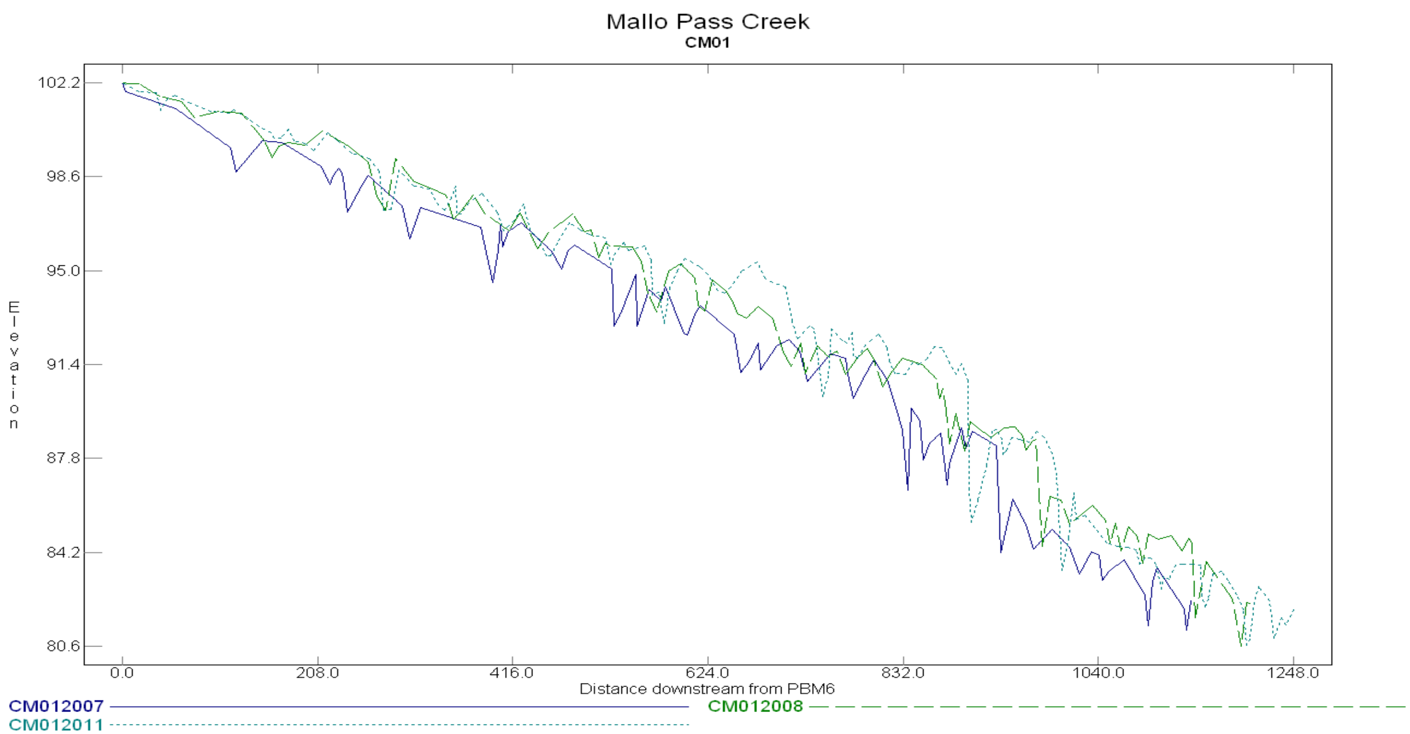

Mallo Pass Creek CM01
XS#1
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Area (square feet)
Scour
Scour
2008
2011
Change in area since 2007 (ft2)
Cumulative Net Change (ft2)

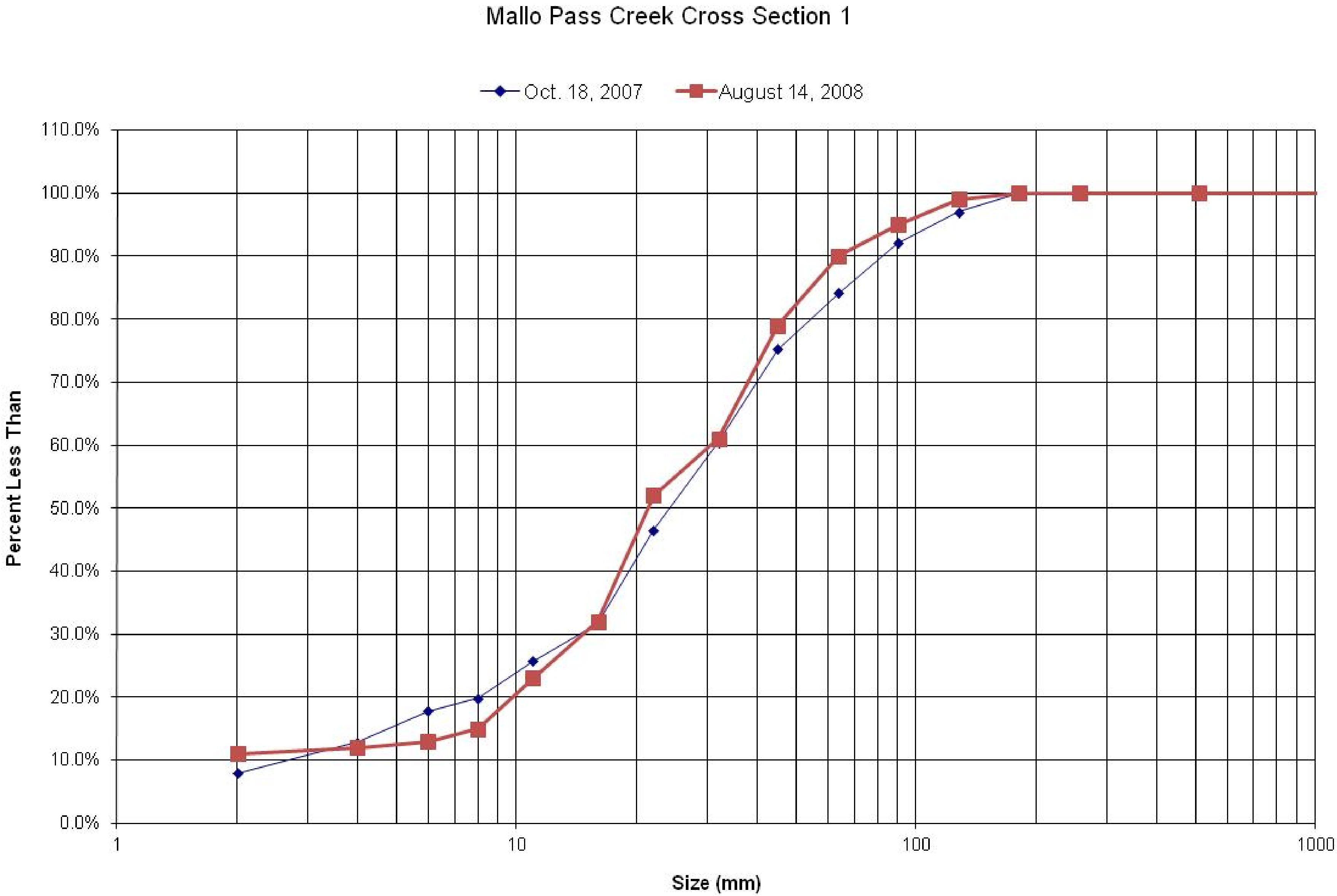

Mallo Pass Creek CM01
XS#2
15.0
10.0
5.0
0.0
-5.0
-10.0
Area (square feet)
Scour
Fill
2008
2011
Change in area since 2007 (ft2)
Cumulative Net Change (ft2)

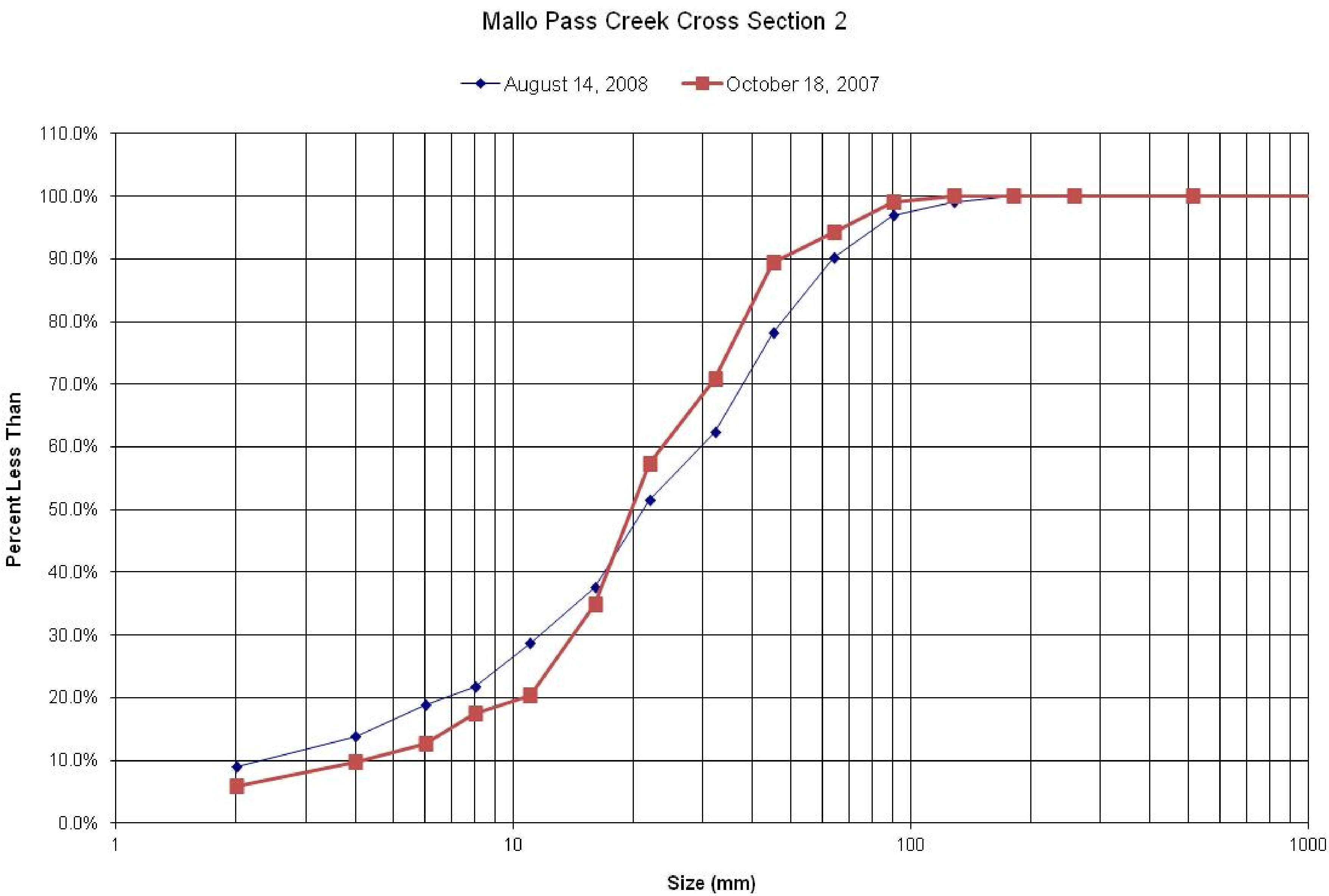

Mallo Pass Creek CM01
XS#3
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Area (square feet)
Scour
Scour
2008
2011
Change in area since 2007 (ft2)
Cumulative Net Change (ft2)

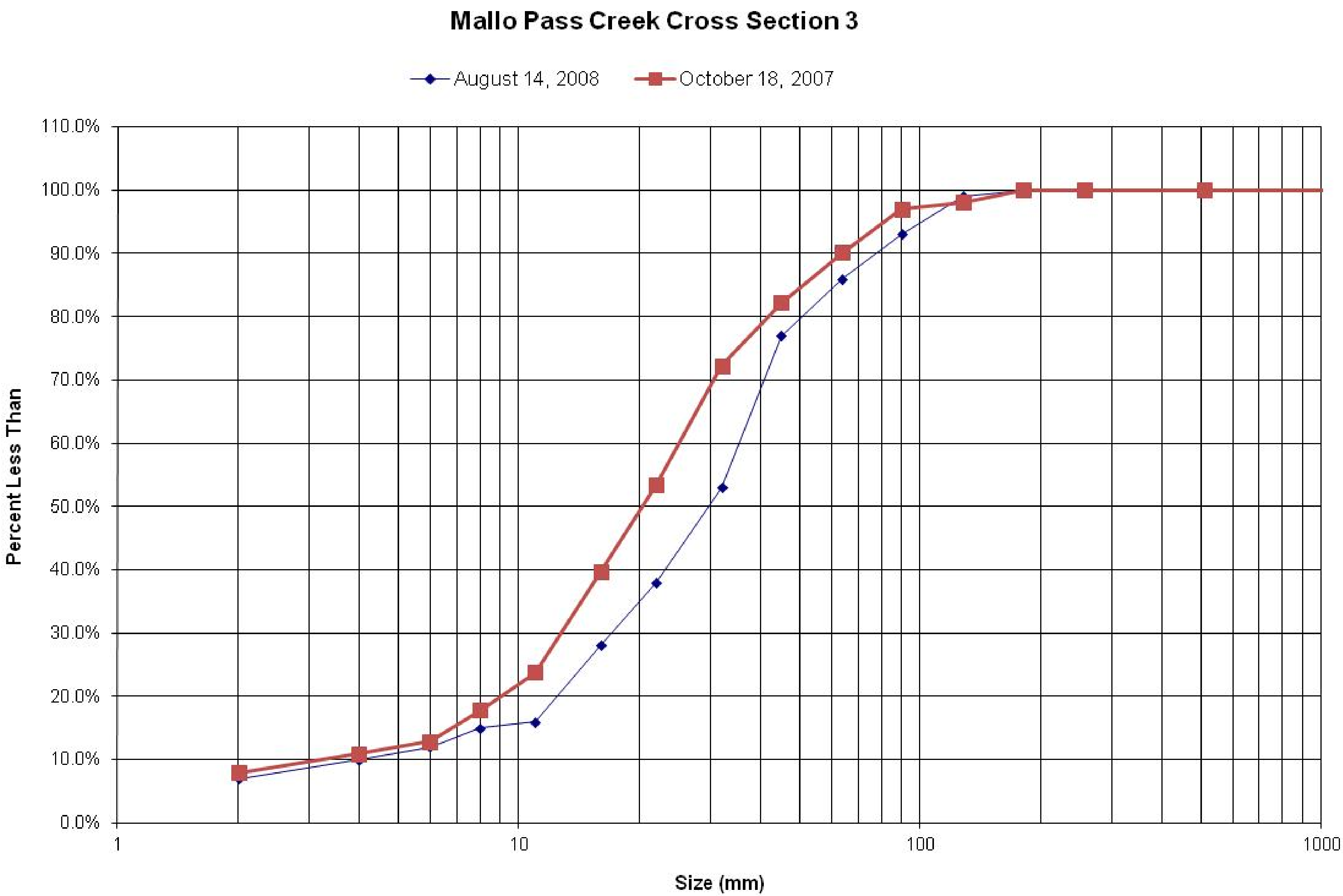

Mallo Pass Creek CM01
XS#4
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Area (square feet)
Scour
Scour
2008
2011
Change in area since 2007 (ft2)
Cumulative Net Change (ft2)

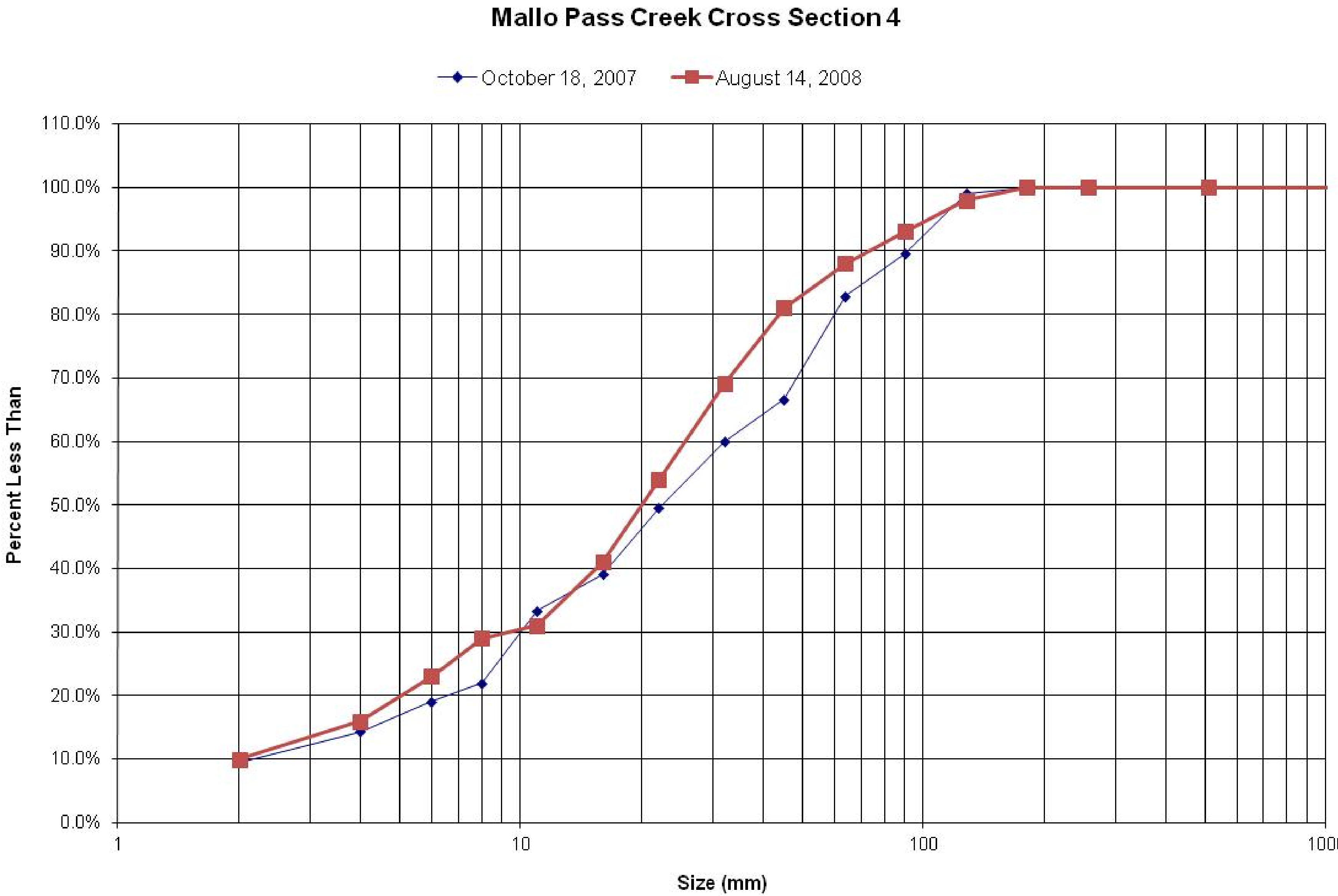
Longitudinal Profiles from LONGPRO




Mallo Pass Creek Cross Section 1
Oct. 18, 2007
August 14, 2008
110.0%
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Percent Less Than
1
10
100
1000
Size (mm)


Mallo Pass Creek Cross Section 2
August 14, 2008
October 18, 2007
Percent Less Than
110.0%
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
1
10
100
1000
Size (mm)


Mallo Pass Creek Cross Section 3
August 14, 2008
October 18, 2007
110.0%
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Percent Less Than
1
10
100
1000
Size (mm)

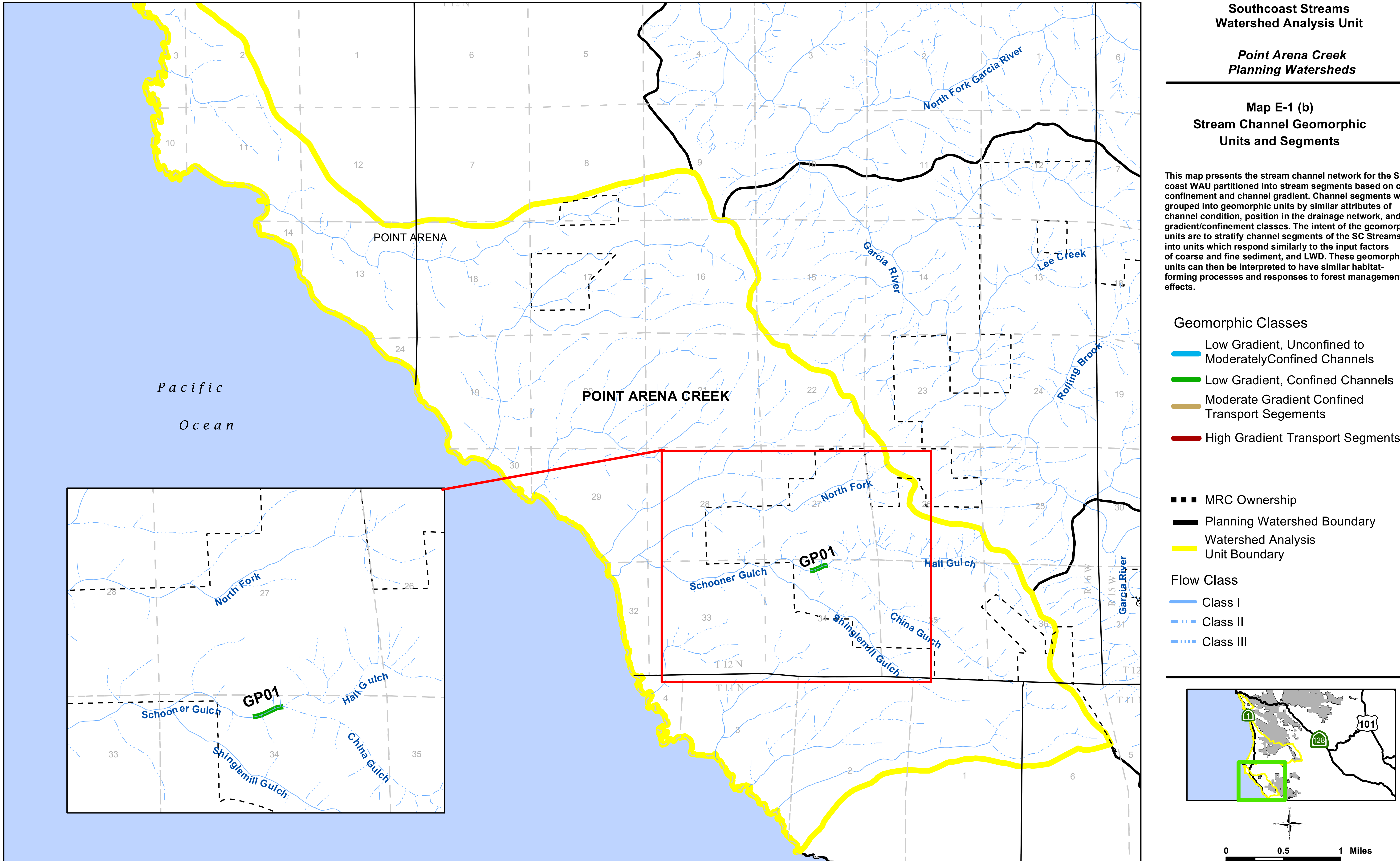

Mallo Pass Creek Cross Section 4
October 18, 2007
August 14, 2008
110.0%
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Percent Less Than
1
10
100
1000
Size (mm)

Southcoast Streams Watershed Analysis Unit

Point Arena Creek Planning Watersheds

Map E-1 (b) Stream Channel Geomorphic Units and Segments

This map presents the stream channel network for the Southcoast WAU partitioned into stream segments based on channel confinement and channel gradient. Channel segments were grouped into geomorphic units by similar attributes of channel condition, position in the drainage network, and gradient/confinement classes. The intent of the geomorphic units are to stratify channel segments of the SC Streams WAU into units which respond similarly to the input factors of coarse and fine sediment, and LWD. These geomorphic units can then be interpreted to have similar habitat-forming processes and responses to forest management effects.



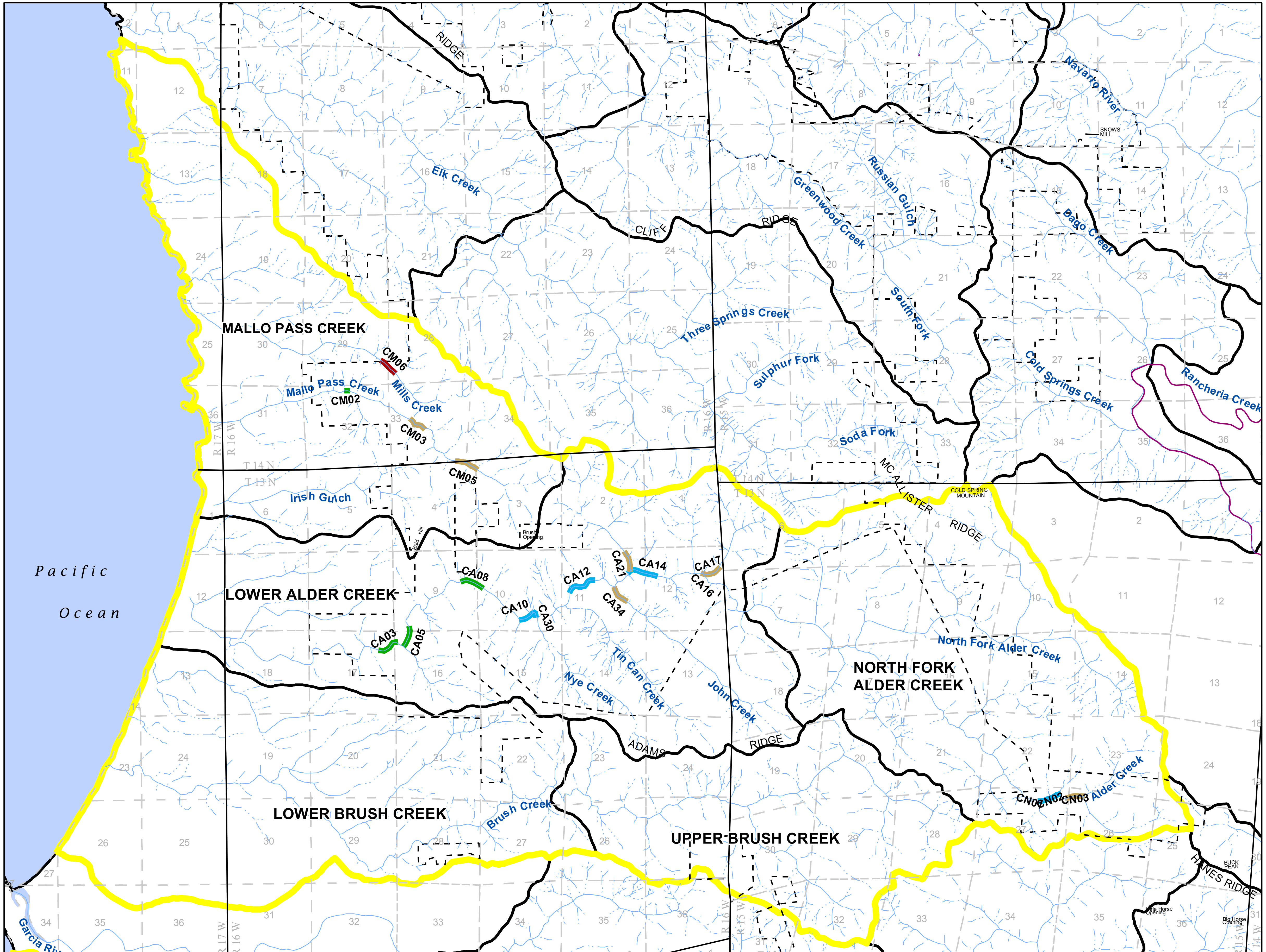
April 2014

Southcoast Streams Watershed Analysis Unit

Mallo Pass, Lower Alder and N.F. Alder Creeks Planning Watersheds

Map E-1 (a)
Stream Channel Geomorphic Units and Segments

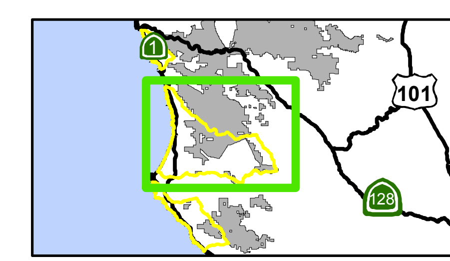
This map presents the stream channel network for the Southcoast Streams WAU partitioned into stream segments based on channel confinement and channel gradient. Channel segments were grouped into geomorphic units by similar attributes of channel condition, position in the drainage network, and gradient/confinement classes. The intent of the geomorphic units are to stratify channel segments of the SC Streams WAU into units which respond similarly to the input factors of coarse and fine sediment, and LWD. These geomorphic units can then be interpreted to have similar habitat-forming processes and responses to forest management effects.



Geomorphic Classes
- Low Gradient, Unconfined to Moderately Confined Channels
- Low Gradient, Confined Channels
- Moderate Gradient Confined Transport Segments
- High Gradient Transport Segments

- MRC Ownership
- Planning Watershed Boundary
- Watershed Analysis Unit Boundary

Flow Class
- Class I
- Class II
- Class III



0 0.75 1.5 Miles

April 2014