DISTRIBUTION AND ABUNDANCE OF JUVENILE COHO AND STEELHEAD IN GAZOS, WADDELL AND SCOTT CREEKS IN 2010

Jerry J. Smith
Department of Biological Sciences, San Jose State University, San Jose, CA 95192
31 December 2010

ABSTRACT: In September and October 2010, previously sampled representative sites in the Gazos Creek, Waddell Creek and Scott Creek watersheds were evaluated for habitat conditions and sampled by electrofisher to assess distribution and abundance of coho (*Oncorhynchus kisutch*) and steelhead (*O. mykiss*). Based upon the near absence of juvenile coho in 2007, few if any coho adults were expected to return to any of the streams in winter 2009-10. In 2010 no juvenile coho were captured at 27 sites on Gazos, Waddell, and Scott creeks; this is the first year since sampling began in 1988 that juvenile coho were not captured. A few juvenile coho were observed by NOAA researchers at a single site that received captive-reared adults. Juvenile sampling in 2007-2010 has documented essentially the elimination of all 3 coho year classes, including the 2008 year class which had previously been very strong. The presence of strong year classes in the past indicates that summer/fall rearing habitat is not the limiting factor. Some year classes had previously been weak, due to delayed winter access or to redd destruction by winter storms. However, those year classes had twice been gradually built up to moderate abundance on Scott and Waddell creeks by conservation hatchery intervention (hatchery rearing of Scott Creek fish and precocial adult female returns). Continued hatchery intervention will be necessary to rebuild the populations of the 3 streams. However, captive brood stock and their progeny must provide the fish to accomplish the task.

Coho life history makes them more sensitive than steelhead to the effects of winter weather, and even during studies in the 1930's and 1940's on Waddell Creek coho showed high year to year population variability compared to steelhead. However, all year classes of coho persisted in at least 2 of the study streams until the present study began in 1988. Since then, year classes have been lost or weakened by floods and drought-caused delayed access, but such impacts may be widespread in California. Recent unusually harsh conditions may have resulted from a change in ocean surface temperature regime, resulting in more frequent and intense El Nino conditions and big storms later in winter, which are more likely to destroy coho redds. The lack of significant juvenile production following winters of 2006-7, 2007-8, 2008-9, and 2009-10 may have been at least partially due to poor and delayed adult access; the first 3 years were dry, and all 4 years had significant rains delayed until mid to late January or February. However, the near lack of successful coho spawning for the 3 streams over the last 4 years, and coast-wide coho (and Chinook, *O. tshawytscha*) declines, suggest a shift in ocean survival and reduced adult runs as the major cause.

Young-of-year (YOY) steelhead abundance in the Scott Creek watershed rebounded (45 / 100 feet) from unusually low densities in 2008 and 2009 (20-24 / 100 feet). Physical habitat conditions (pool and substrate conditions) did not appear to be affected in 2010 by the severe fire in the watershed the previous fall. However, stream flow in fall was similar to 2 of the 3 previous dry years, as were fish sizes. Stream flow and YOY fish sizes increased significantly in the other 2 streams, in response to greater rainfall and rain extending into early spring. On Gazos Creek YOY abundance was low (16 / 100 feet), as it has been since 2006 (17-21 / 100 feet). This is apparently at least partially due to adult

passage problems at 2 large logjams and 2 smaller logjams. YOY densities in the last 4 years have been less than half of the 1993-2010 mean, and have dramatically dropped upstream of the most downstream large logjam; upstream densities formerly were the highest on the stream.

The Waddell Creek main stem sites and 2 East Fork sites downstream of Last Chance Creek had very low steelhead densities (3 – 19 / 100 feet; mean 11 / 100 feet), probably due to the 12^{th} consecutive year of fish kills on the East Fork and main stem. Densities were higher (19-24 / 100 feet) on 2 West Fork sites, but still less than half of previous means. The decline on the West Fork apparently reflects the impact of past kills on overall adult abundance.

Yearling abundance of steelhead on Scott and Gazos creeks was reduced in 2010, as might be expected from a wetter/harsher winter. However, yearling abundance was not especially low considering the low YOY abundance on both streams in 2009. This presumably reflects strong density dependent limitation on over-winter survival (and smolt production).

Four major habitat restoration efforts are needed in the watersheds: 1) rebuilding the lost 2007-2010 coho year classes using the conservation hatchery and captive brood stock; 2) eliminating the apparent toxic kills on East Fork and main stem Waddell from pollution, possibly from within the Last Chance Creek watershed; 3) modifying several log jams to provide fish passage on Gazos and West Fork Waddell creeks, especially to provide potential coho passage to the best rearing habitats; and 4) addressing impacts to the lagoons during the replacement of the Highway 1 bridges at Scott and Waddell creeks and by preventing artificial sandbar breaching. Unfortunately, these were the same recommendations made last year.

INTRODUCTION

Since wild female southern coho usually spend one year in the stream and two years in the ocean prior to spawning (Shapovalov and Taft 1954), at least 3 consecutive years of study are necessary to determine the status of the three numerically independent year classes. This report presents the results of the 19th consecutive year of sampling for juvenile coho and steelhead on Scott, Waddell and Gazos creeks. The previous years of juvenile sampling have demonstrated the recent importance of winter weather on coho abundance, by affecting access or destroying redds or over-wintering juveniles (Smith 1992, 1994c, 1998c and 2001b). They have also demonstrated large differences in abundance between different coho year classes. Only a single year class (1993, 1996, 1999, 2002 and 2005) had been relatively strong on Waddell and Gazos creeks and especially strong on Scott Creek (Smith 2006a). However, that year class unexpectedly was apparently absent in Gazos Creek and extremely weak on Waddell and Scott creeks in 2008. Adult access should have been suitable in January and February, so the lack of successful spawning was apparently due to poor ocean survival when smolts entered the ocean (Smith and Leicester 2008). One of the other year classes (1992, 1995, 1998, 2001 and 2004) was usually weak in Scott and Waddell creeks and was apparently eliminated in Gazos Creek by 2001. That year class was strengthened on Scott and Waddell creeks and weakly restored on Gazos Creek in 2004, apparently by spawning by hatchery-reared females that returned precocially as 2 year old adults (Smith 2005). The year class was then nearly eliminated in 2007, also apparently by poor ocean conditions, although adult access was delayed until February (Smith 2007). No coho were collected on Gazos Creek, no young of year coho were collected on Scott Creek (2 yearlings were collected), and only 3 coho were collected at 1 of 12 sites on Waddell Creek (Smith 2007). The third year class (1994, 1997, 2000, 2003 and 2006) had survived only in Scott Creek, where it was extremely weak in 2000 and 2003 (Smith 2001a and 2003b); it rebounded due to hatchery-reared fish in 2006 (Smith 2006). However, the year class was represented by only 4 coho captured in 2009, but on Waddell Creek, rather than on Scott Creek (Smith 2009). Therefore, the 2007-2009 coho year classes were essentially eliminated in the wild, and few or no coho adults were expected in 2010.

Year classes have been weakened or eliminated during study years by winter stream flows (droughts and floods) (Smith 1992, 1994c, 1998c, 2001b, and 2003b), although the occasional strong juvenile year classes indicate that summer rearing habitat is suitable for coho and has not been the limiting factor on these streams (Smith 1994a, 1996 and 2002). The strong year class differences and recent effects of floods and droughts are not confined to the streams of the Santa Cruz Mountains, as the same impacts have produced year class effects at Redwood Creek in Marin County, 90 km further north (Smith 1994b, 2000, 2003a). The widespread, synchronous weather impacts also mean that straying of fish between nearby streams offers little help in rebuilding weakened or lost year classes. In 2007-2009 the effect of poor ocean conditions also apparently had severe coast-wide impacts on coho abundance and on coast and central valley Chinook (Smith 2007; Smith and Leicester 2008; Smith 2009).

Previous results in 1995, 1997, 2004 and 2006 (Smith 1995b, 1998a, 2005 and 2006) have shown that one mechanism to rebuild weak year classes is the return of hatchery-reared females as precocial (2-year old) fish. Precocial males (but not females) occur in the wild (Shapovalov and Taft 1954) and are common among hatchery-reared coho. However, hatchery rearing, especially among some of the larger hatchery-reared fish, also occasionally produces precocial females (Smith 1995b, 1998a, 2005). In addition, results in 2000, 2003 and 2006 (Smith 2003a, 2003b, 2006) showed that a small portion (2%) of coho can remain in the stream as yearlings. These can provide a small, but significant, increase in the "year class" strength of weak year classes, when strong year classes precede weak ones (Smith 2003b). Scott Creek also supports a captive brood stock program at the Kingfisher Flat Restoration Hatchery on Big Creek as a buffer against adverse environmental conditions in the stream or ocean. The fate of coho in these streams now rests with that captive brood stock program.

Juvenile coho production was relatively good in Scott, Waddell and Gazos creeks in 2005 (Smith 2006a). Waddell Creek had higher coho abundance (5.9 per 100 feet) than all but 1 previous year, 1996, when hatchery-produced coho fry were added to the main stem. Gazos had higher abundance (11.6 per 100 feet) than all but 1 previous year, 2002, when ideal winter conditions (early storms for access and no large late storms that would destroy redds) produced coast-wide highs in coho abundance. Scott Creek had high abundance (29.7 per 100 feet) similar to other years for the year class (27.2 – 33.0), with the exception of unusually high density in 2002 (79.2). This should have resulted in a substantial run of adult coho in winter 2007-8 at all three streams. However, the presence of only a few coho in Scott and Waddell creeks (Smith and Leicester 2008), and low coho production throughout central California indicate the widespread devastating impact of poor ocean conditions. The loss of that previously strong year class was especially devastating because its large size should have carried most of the remaining genetic diversity of these southern coho.

In September and October 2010 a portion of previously sampled sites on Scott and Waddell and Gazos creeks were re-sampled for juvenile steelhead and coho. Of particular interest were the strength of the coho year class in Scott Creek, the site of releases from captive brood stock production and on Waddell Creek were a few juvenile coho were present in 2007(Smith 2007). Also of interest was the abundance of steelhead in the Waddell Creek watershed, where fish kills have apparently occurred annually since 1999, and in Gazos Creek, where log jams have apparently restricted adult access in recent years (Smith and Leicester 2008; Smith 2009).

METHODS

Seven previously sampled sites on Gazos Creek were sampled by electrofishing (Table 1), including 6 of the most likely coho sites (Table 6). Ten previously sampled sites on Waddell Creek were sampled, including the 2 on the lower west fork, which most frequently have coho (Tables 2 and 7). Three sites on the upper West Fork were not sampled because of time constraints and difficult access; the upper West Fork sites often have coho when they are present elsewhere in the watershed (Table 7). Ten previously sampled Scott Creek watershed sites were sampled (Table 3). The uppermost Scott Creek site and two upstream sites on Big Creek were not sampled; these sites have lacked coho when they were absent or very scarce at adjacent sampled sites (Table 8). One other regularly sampled site on lower Scott Creek was also not sampled; it hasn't had coho when they have been scarce in the watershed, and sampling there might have interfered with more intensive NOAA sampling at the site. All 8 of the sites most likely to have coho in previous years were sampled (Table 8).

At sampled sites on each stream the same individual habitats were sampled as in previous years if possible. The length of stream sampled per site was usually similar or greater than previous efforts, and despite not sampling all previous sites, the total sampling length per stream was greater than almost all previous years (Table 4). The overall relative abundance of sampled habitat types was generally similar to recent years (Table 4).

The primary goal of the sampling by electrofisher was to look for the presence and abundance of coho, so sampling since 1992 has concentrated on pool and glide habitats, and riffles were seldom sampled. At each site usually 3 to 5 individual habitat units (a glide or pool, with its contiguous glide and run habitat) were block-netted and sampled by 2 to 3 passes with a backpack electrofisher (Smith-Root Type 7, smooth pulse). Sampled habitats were representative of those available, except for the exclusion of scarce large, deep pools on the main stems of Waddell and Scott creeks that could not be sampled by electrofishing. Length, width, depth, cover (escape and overhead), and substrate conditions were determined, and percentage of habitat types assigned for each sample unit. Rosgen channel types were determined, and relative abundance of pool, glide, run and riffle habitat types estimated for the vicinity of each site (Tables 1-3).

Juvenile fish were measured (standard length, SL) in 5 mm increments. YOY steelhead were separated from older fish based upon length-frequency at each site, and scales confirmed ages of intermediately-sized fish (scales were taken for 44 steelhead on Gazos Creek, 50 steelhead on Waddell Creek and 44 steelhead on Scott Creek); more scales were taken in previous years because of generally larger and more variable lengths than previously. Mortality was kept to a minimum by reducing electrofisher voltage (200-300 V) in shallow water and by immediately placing captured fish in a floating live car. Mortality was recorded at the time of length measurements.

RESULTS AND DISCUSSION

Habitat Conditions in 2009-2010

As in the previous 3 winters, early winter flows suitable for coho and steelhead access to the streams were substantially delayed in 2010. An unseasonably early substantial storm occurred on 13-14 October, prior to the adult migration period. However, the first rain sufficient to allow adult coho or steelhead migration was in mid January. However, unlike the restricted migration windows of the previous 3 years, once the rains started in January they continued to provide suitable conditions for adult migration and spawning through April. The wet and extended winter also resulted in higher than average spring and early summer stream flow in at least Gazos and Waddell creeks. This contrasts with the earlier than average declines in stream flow seen in the central coast in the previous 3 years (in 2009 stream flow was less than 3 cfs in San Gregorio Creek by 24 June). Fall flows were especially low in Scott Creek in 2007-2009 (Smith 2009), and they apparently did not rebound as substantially as did Waddell and Gazos creeks in response to higher and later rainfall in 2010. The especially dry conditions of the previous 3 years may have been partially responsible. In addition, hydrophobic surface soil conditions following the Lockheed fire in fall 2009 may have increased winter runoff, but reduced the infiltration that should have provided for higher spring and summer flows.

Despite the wetter winter, changes in channel configuration were relatively minor in 2009-10, as in the previous 3 winters. Only 3 individual habitats scattered in Scott and Mill creek sites were significantly changed by pool filling in 2010. Although many pools showed some scour or deposition, overall frequency of the different habitat types present and sampled was not significantly changed. The general lack of change was surprising in the face of the extensive wildfire through much of the upper watershed in fall 2009. On Gazos and Waddell creeks changes were similarly minor, with changes at only in 3 sample site habitats. This contrasts with the 2005-6 (wet year) changes in configuration, depth or complexity of individual re-sampled habitats at 20 of 26 sample sites on Gazos, Waddell and Scott creeks. Channel changes in that year were greater than any year since 1997-98, when severe El Nino storms substantially rearranged individual habitats and increased pool abundance on all 3 streams. More dramatic over the last several years has been the closure of alder canopy over individual habitats at 4 sites in the Scott Creek watershed, 5 sites on Waddell and 1 site on Gazos Creek. The very dense canopy that has gradually developed after it was opened by the severe storms of 1998 is capable of reducing aquatic insect production and reducing feeding by drift-feeding steelhead in spring and summer. This can result in substantial reduction in YOY steelhead abundance. For example, at the Big Creek site, habitats with 97-99% canopy closure had a steelhead YOY density of 21 / 100 feet, but the habitat with only 70% canopy closure had a density of 85 / 100 feet.

On all three streams substantial wood was added in 1998 (Smith 1998c), and large wood was reworked during large storms in 1999 and 2000. However, little wood (other than on Gazos in late summer 2008) was added in 1999-2005, 2007-10, or during the 1992-1997 period. The major change in 2008 was the toppling of 5 large redwood trunks at mile 4.4 on Gazos Creek; these were modified in October 2009 by San Mateo County Department of Public Works. Despite the substantial channel changes in 2005-6, large wood, from undercut streamside trees, was added at only 6 of 27 sample sites, including 4 on Scott Creek; 3 of the added trees were large multi-trunked bay trees. These trees from 2005-6 caught additional wood in 2006-9, resulting in the changes in habitats observed at Scott Creek sample sites. The scarcity of new wood since 1998 is because most of the vulnerable streamside trees were recruited during the severe storms of 1998. Large wood additions, especially from long-lasting conifers, apparently occur episodically only during extremely wet years. Then landslides deliver upslope trees to the channel, and large floods erode stream banks and topple large riparian trees. Some smaller streamside alders are added to the channel in most average or wet years, but they easily rearrange and break up quickly; habitat benefits, although important, are smaller and of rather brief duration (Leicester 2005).

The high flows in 2005-6 did move smaller wood around in the channel and substantially increased the size of existing logjams on Waddell and Gazos creeks. The jams changed little in 2007-10. On Gazos Creek a jam created by redwoods from a debris flow in 1999 (at about road mile 4.2) has probably been impassable to adult steelhead or coho except at extremely high flows since 2005. A smaller jam immediately downstream is also a partial barrier to migration, and could become bigger if wood is released from the larger jam. In 2006-7 sediment deposits upstream of the "smaller jam" indicated that the jam solidified, impounded water and then partially broke open again. Downstream of a large pullout at about road mile 2.4 a large fallen Douglas fir (from 2001) now anchors a large jam, which has also probably been impassable to adult migration, except at extremely high flows, since 2005. The jam may also present some problems for road stability. That jam substantially blocks adult access to most of the better spawning and rearing habitat on Gazos Creek. A large jam downstream (mile 2.2) that was present from 2001-2005 was gone in 2006. Both of the large, nearly impassable, logjams are immediately adjacent to the road, providing easy access for chain saw crews or winching equipment to partially modify the jams to improve fish passage. A log jam at road mile 3.25 is probably a partial migration barrier and could also be modified easily from the road; it is formed mostly from debris from a jam, immediately upstream, that rinsed out in 2005-6. A logjam formed by a downed multi-trunked maple in 2000 (at about mile 1.8, and not visible from the road) has enlarged and solidified. It is now possibly a substantial barrier to low flow fish passage, but may be passable beneath or over the jam at higher flows. These jams, and the newly fallen redwoods at mile 4.4, on Gazos Creek were inspected by CDFG in 2008, but permits for modification the jams have still not been issued or a source of funding found. They will remain barriers this winter. On West Fork Waddell Creek (about road/trail mile 3.6) a jam formed by fallen redwoods in 1998 has greatly enlarged and solidified; it may be a barrier to adult migration except at extremely high flows, when some of the wood may float. The barriers on both Gazos and Waddell creeks were probably partial passage problems during the wet winter of 2005-6, but were probably more of a problem in 2006-7, 2007-8 and 2008-9, because of the much shorter duration of high flows for passage in the dry winters. However, as indicated below, low steelhead abundance on Gazos Creek in 2010 probably reflects poor adult access, despite the higher sustained stream flows in 2010.

Coho

Gazos Creek. No coho were captured at the 7 re-sampled sites in 2010, which was not unexpected, as this brood year class has been missing since 2001 (Smith 2001b). Similarly, none were captured in 2009, but that brood year had been absent throughout the study years (Smith 2009).

No electrofisher sampling took place on Gazos Creek in 2008, but the stream was intensively snorkeled by NOAA without encountering coho (Brian Spence, pers. com). The apparent loss of the 2008 year class at Gazos Creek resulted in the extirpation of coho from the watershed. Only the single "viable" year class (defined as juveniles > 2 per 100 feet, capable of producing 10-12+ returning adults) had been recently present in Gazos Creek (1993, 1996, 1999, 2002, 2005) (Table 4). Even that year class had sharply fluctuated in abundance, apparently mostly due to winter stream flow conditions, and coho had generally been scarce downstream of silt-laden Old Woman's Creek (Table 6). After the ideal winter conditions of 2002, when rains were concentrated early in the season prior to coho spawning, juvenile coho abundance was high (27.7 / 100 feet) and rather uniformly high upstream of Old Woman's Creek (24 - 54 / 100 feet) (Tables 4 and 6). The good juvenile production in 2002, and the stocking of hatchery-reared smolts in spring 2003, should have resulted in a large run of adults in 2004-5. However, overall juvenile density was down (11.6 / 100 feet) in 2005, and densities upstream of Old Woman's Creek were uniformly lower (9-20 / 100 feet). This was presumably due to spring storms in 2005, which may have reduced redd survival or flushed emerging coho fry. Coho abundance in 1993, 1996 and 1999 was even lower (4.9-6.2 / 100 feet) and concentrated at upstream sites (Tables 4 and 6). The results in 2002 and 2005 show that even in "good" coho years juvenile coho abundance may be affected more by winter and spring conditions than by summer rearing conditions (Smith 2002, 2006a). However, the loss of the remaining year class was apparently due to the coast wide impact of poor ocean survival.

Waddell Creek Watershed. No juvenile coho were captured in 2010, although a small number of juvenile coho from that brood year were present in 2007 (Smith 2007; Table 4). However, sampling on the West Fork was conducted only at the 2 downstream sites. Coho have most frequently been captured in abundance on the West Fork, but have never been captured at upstream West Fork sites when they were absent at the downstream sites sampled in 2010 (Table 7).

Only 4 juvenile coho were captured in 2009, representing a brood year which previously had been absent since 1994 (Smith 2009); those fish apparently resulted from adult straying from Scott Creek. Adult trapping in 1991-92, 1993-4 and 1994-95 found that straying of adult coho from Scott Creek (as fin-clipped hatchery-reared fish) frequently occurred when access to Scott Creek was blocked by low flows or the sandbar (Smith 1992 and 1995b). However, straying apparently didn't occur when access to Scott Creek was open. The sandbar at Waddell Creek is open in winter, and a moderately deep residual lagoon is usually present to hold waiting adults. In 2008 coho were collected in low numbers at the 2 lowermost west fork sites (Smith and Leicester 2008), and were observed at very low densities further upstream during NOAA snorkel surveys (Spence, pers. com.). The 2008 year class had previously been the strongest on Waddell Creek (and at Gazos and Scott creeks) (Table 4). However, the low juveniles densities observed in 2008 are unlikely to produce a viable adult run in 2011.

Although, some coho juveniles have been present in Waddell Creek for 2 of the last 3 years, their numbers were apparently extremely low. Waddell Creek coho will not be viable without substantial intervention from captive brood stock and hatchery rearing of juveniles.

Fish kills on the East Fork and main stem since 1999 (see below in steelhead discussion) have been a factor in recent low coho abundance. However, even prior to the apparent first occurrence of fish kills in 1999, captured coho were usually most common on the West Fork (Table 7), where they were present at 23 of 28 sampled sites in 1992-1998. The East fork and the main stem are more flood-prone, and the main stem much sandier, than the West Fork and have had fewer and more scattered fish. Coho were present on the East Fork in only 3 of 5 years when coho were present elsewhere, and densities of coho on the main stem were always relatively low (≤ 4 / 100 feet per site) except in 1996 when hatchery-spawned fry were added (Tables 4 and 7). Therefore, if fish kills had not occurred, the total production of coho would have been higher, but possibly not dramatically higher. However, the larger channel on the main stem of Waddell Creek makes sampling of pool habitats more difficult. This may result in underestimates of Waddell Creek main stem coho abundance compared to upstream and also compared to Scott and Gazos creeks. Coho on all three streams have shown strong density-dependent habitat selection, with the fish concentrated in the largest, deepest, most complex pools when at low densities (Smith 1998a, 1999, 2002, 2003). At progressively higher densities coho habitat use expands to smaller, shallower and simpler (and easier to sample) pools, and then to glides and runs. At the highest densities, all habitats except shallow, fast riffles are heavily used. Waddell Creek has more deep, large pools, which cannot be sampled or can not be sampled effectively, than do Scott and Gazos creeks. For example, large, deep pools make up 5-15% of the habitat at sites 2-6 (main stem) and sites 8-9 (lower West Fork) on Waddell Creek, but these habitats cannot be sampled effectively. At Scott and Gazos creeks such habitats make up less than 5% of the habitat, except for sites 1, 2 and 11A on Scott Creek. In addition, both coho and steelhead usually tend to be larger on the main stem than in the West Fork (Figure 1), increasing their likelihood of surviving once they reach the ocean. Therefore the loss of coho to fish kills on the main stem of Waddell Creek may have greater impact than densities indicated by past sampling

Scott Creek Watershed. No coho were captured in the 10 re-sampled sites in 2010. The apparent lack of juvenile coho in Scott Creek in 2010 was not surprising, as only 2 coho yearlings were captured during 2007 sampling and hatchery production from captive brood stock was limited (Smith 2007; Table 4). The year class had been moderately strong in 2004, having been rebuilt for a second time from precocial hatchery-reared females (Smith 1995b and 2004). However, poor ocean conditions apparently resulted in the poor adult run in 2006-7 (Smith 2007 and 2009). Ocean conditions have apparently improved, and coast-wide adult coho runs were up in some watersheds in 2009-10. However, there were apparently no Scott Creek coho left in the brood year to take advantage of the improved ocean conditions. NOAA divers did observe several juvenile coho at one upper Scott Creek site in 2010; these may have been the result of spawning by captive-reared adults released near the site in 2010 (Sean Hayes, NOAA Santa Cruz Lab, pers. com.)

No coho were captured during sampling in either 2008 or 2009 on Scott Creek. However, sampling on Scott Creek was limited to only 6 likely coho sites in 2008 by illness during the allowable sampling period, and in 2009 some of the sites were sampled after the substantial October storm (Leicester and Smith 2008; Smith 2009).. In 2008, NOAA divers observed only a few juvenile coho on lower Scott Creek (Brian Spence, NOAA Santa Cruz Lab, pers. com.). The apparent very low abundance of coho in 2008 was especially disappointing, as this brood year class had been strong (27-79 / 100 feet) in all previous years of sampling since the study began (Table 4). It also should have been quite genetically diverse. The strong year class has also been a factor in "year class" abundance 1 year later in 1994, 2000, 2003 and 2006. Most of the juvenile coho in 1994 and 2003 and all of the coho in 2000 were apparently yearling coho (Table 3). In 2006 at least 11 of the 95 (12%) captured coho were yearlings (Table 3). Approximately 2% of the fish from the strong year classes have remained in the stream as yearlings, a low absolute number, but a significant relative addition to the following very weak year classes. The yearling coho in 2006 (and in 2003) were larger than YOY coho, but not dramatically so (Smith 2003b). In fact, although coho YOY have averaged somewhat larger than steelhead YOY within sites in all years, coho yearlings in 2003 and 2006 were smaller than most steelhead yearlings (Smith 2003b, 2006b). This is despite back calculations from scales in 2003 and 2006 (Smith 2003b, 2006b) that show that the holdover yearling coho were average in size in their first year (mean = 65 mm SL at annulus for 2006 yearlings), rather than the "runts." They merely grew very little as yearlings. The small relative size of yearling coho also means that scales must usually be used to identify yearlings, rather than site by site length-frequency plots, which can successfully separate most YOY and yearling steelhead.

The 2009 year class had often been weak in the past. Juvenile coho abundance in 1994, 2000 and 2003 was only 0.4 -1.5 coho / 100 feet (Table 4). The weak year class resulted from delayed storms in 1990-91, which prevented adult access until early March, after the normal coho spawning period (Smith 1994c). The year class rebounded in 1997 (9.3 / 100 feet), apparently due to spawning by adult returns of precocial hatchery-reared smolts (Smith 1998a). However, it was nearly eliminated by 2000 by poor overwinter survival in 1997-98 and/or poor ocean survival due to the severe 1997-98 El Nino (Smith 2001a). The year class again rebounded in 2006 (6.9 / 100 feet), apparently at least partially due to spawning by precocial returns of hatchery-reared smolts. The encouraging situation in 2006 was replaced by the dismal situation in 2009. The apparent lack of wild production in that year left only 1700 hatchery-reared juveniles produced by captive brood stock to represent the year class. Most of those fish were released in San Vicente Creek or transferred to the captive brood stock program in Santa Cruz, because of the potential threat to the Kingfisher Flat from mudslides following the Lockheed Fire (Michelle Leicester, DFG, pers. com.)..

In the 3 years prior to 2007 all 3 coho year classes were doing reasonably well in Scott Creek, and the 2005 year class had been strong throughout the study period (Tables 4 and 8). However, poor coast-wide coho and Chinook returns in 2007-2009 indicate that ocean conditions, that produced few adults, were primarily responsible for the near elimination of wild coho in the 3 streams (Smith 2007 and 2009; Leicester and Smith 2008)..

At the present time 4 consecutive years of little or no wild coho production in Scott Creek, once the core from which the central coast runs were being rebuilt, leaves southern coho in an extremely precarious situation.

Steelhead

Gazos Creek. YOY steelhead density in 2010 (16.7 / 100 feet) was substantially below the 1993-2007 average (40 / 100 feet), and similar to the low densities seen in 2006-2009 (16-21 / 100 feet) (Tables 1, 5 and 9). The low steelhead YOY densities since 2006 indicate that at least a major part of the cause is probably restricted adult access through the log jams at miles 1.8, 2.4, and 4.2, as ocean effects on coho were not even seen until 2007 and steelhead have shown much less effect of the change in ocean conditions. Low density downstream of the log jam at mile 1.8 is probably due to poor substrate conditions for egg survival downstream of Old Woman's Creek. In addition, the low densities at mile 1.8, and less dramatic reductions at mile 2.8 since 2007 (Table 9), may be due to the lack of substantial spawning and excess fry production upstream of the jam.

Despite the low YOY densities since 2006, yearling densities have not changed as much (Table 9), reflecting the strong density-dependent effect of over-wintering habitat on yearling abundance. Therefore, steelhead smolt production may not have been affected dramatically by the low abundance of YOY, as steelhead in Gazos Creek normally require 2 years to get big enough to smolt (Figure 1). However, the log jams may have been a significant factor in both coho spawning and smolting success.

Restriction of spawning to the lower portion of Gazos Creek might not have such severe watershed effects if the juvenile fish could rear in the lagoon. However, the small estuary/lagoon at Gazos Creek provides very limited summer rearing habitat, because the sandbar is seldom retained for long in summer, resulting in a small, shallow lagoon. When the sandbar is in place the lagoon normally backs up and floods the septic tank system at the house upstream of Highway 1; this may result in repeated artificial breaching of the sandbar. In spring, prior to partial sandbar development, there is little residual depth in the estuary, so opportunities for smolts to feed or adapt to saltwater in brackish habitat are absent. This probably reduces ocean survival of the relatively small smolts emigrating from the watershed (Bond 2006).

Steelhead YOY lengths were substantially longer than previous years (Figure 1), probably reflecting the combined effect of low fish density and the much higher spring and early summer stream flows in 2010. As a result, a substantial portion of YOY fish at most sites were at least 80 mm long, and, with good winter and spring conditions, might be large enough to smolt as yearlings in spring 2011.

Scott Creek Watershed. Overall YOY steelhead density on Scott Creek in 2010 (44.9 / 100 feet) represented a substantial improvement over the relatively low densities in 2008 and 2009 (20-24 / 100 feet) (Tables 1, 5 and 11). The density was also similar to the 1998-2010 mean, and densities were similar to long term means at all but one site (Table 10). The lowest previous years (34-35 / 100 feet) were in 1996, 2002 and 2005, when coho were very abundant (Tables 4 and 5). Low stream flows were probably a factor in both 2008 and 2009, with portions of Scott and Mill creeks becoming intermittent. However, stream flows in late summer were similar to 2007, and steelhead abundance in that year was only slightly below average (Tables 5 and 11). Poor adult steelhead access or low adult abundance might be suspected, but adult steelhead were not scarce during weir trapping and diving for hatchery brood stock in both years (Sean Hayes, pers. com.).

As in Gazos Creek, although YOY steelhead were unusually scarce in 2008 and 2009, yearling abundance was similar to other years (Tables 5 and 11), reflecting the strong density dependent limitation by overwintering habitat. However, in 2010 yearling abundance was below average, which might have reflected the wetter/harsher winter. As in Gazos Creek steelhead reared in the stream are mostly small at the end of their first summer (Figure 1) and require 2 years to reach smolt size. However, unlike at Gazos Creek, YOY steelhead and small yearlings can often move downstream and rear in the lagoon to smolt size (Bond 2006; Hayes et al. 2008); reduction in YOY can therefore affect watershed smolt production if the lagoon is not fully seeded.

Overall YOY steelhead abundance has usually been relatively low in past years with high coho abundance (34 – 39 / 100 feet in 1993, 1996, 2002, and 2005) (Tables 4 and 5). Only in 1999, when summer streamflows were relatively high, were both coho and steelhead YOY abundant.

Prior to 2008 steelhead YOY densities had been lowest when coho were abundant and streamflows were low, as in 1993, 1996 and 2002 (Table 5). In 2002 stream flows were relatively low and coho were especially abundant (Table 5 and Smith 2002). Overall YOY steelhead density at unchanged, identical habitat units in 2002 was 42% percent lower than in 2001, 53% lower than in 2003, and 20% lower than in 2004 (Smith 2005). It appears that coho were able to substantially depress steelhead YOY abundance in the pools and glides of Scott Creek, with the effect most pronounced at sites with very low summer stream flow. The effect of coho in 2002 was not to replace steelhead 1 for 1 within a stream reach, but to severely reduce steelhead in the open water of the larger pools and glides (Smith 2002). Steelhead densities changed relatively little in faster runs and at the heads and tails of pools. Overall, there was about 1 steelhead lost for each 4 coho gained (Smith 2002). The effect of coho on overall steelhead density was similar in 1993, 1996 and 2005 to that of coho in 2002, even though coho were about 2 ½ times as abundant in 2002 and had very high pool densities (Table 4). Apparently, the lower coho densities in the 3 other years were still sufficient to severely reduce YOY steelhead in larger pools. In 1999 summer stream flows were high, and steelhead numbers were also relatively high despite abundant coho. As appears to occur on Gazos Creek, higher stream flows may allow the two species to partition habitat and prevent coho from substantially reducing YOY steelhead. However, in the Scott Creek watershed those conditions are likely to occur only in Big Creek and on Scott Creek downstream of Big Creek, where coho are generally scarce anyway (Table 8).

Steelhead YOY were substantially smaller at all sites in 2007 and 2008 compared to previous years, but in 2009 they were not smaller (Figure 1), despite the unusually low summer stream flows in all 3 years. In 2010 YOY steelhead sizes were somewhat smaller than average, in contrast to size increases on Gazos and Waddell creeks, and despite what should have been higher stream flows in 2010. Changes in YOY steelhead sizes among years have usually occurred only in very wet years in this dry watershed (Smith 2001b and 2006). Late storms resulted in higher early summer stream flows in 2005 and 2006, and 1995 and 1998 were very wet; fish in those 4 years were larger than average. Otherwise little size change has been noted. Presumably this is because stream flows have usually declined substantially in late spring and early summer before many steelhead have emerged. At heavily shaded upstream sites emergence is usually after flows have substantially declined, so flow during most of the YOY growing season has varied little among years. However, the observed decline in fish size in 2007 and 2008 was probably because they were the first very dry sample years since 1988, when much of upper Scott Creek was intermittent (Smith 1994c). The lack of smaller size in 2009, when stream flows were also low, may have reflected a loss of the smaller fish at downstream sites and/or some growth during and following the October storm.

Yearling abundance in 2010 was relatively low in 2010 (Tables 5 and 11), but lengths were similar to previous years (Figure 1). The decline in yearling abundance may have been due to the wetter/harsher winter. However, yearling sizes might have been expected to increase with the higher with the wetter spring. Yearling abundance in 2008 and 2009 (7-8 / 100 feet) was near average (Tables 5 and 11), and yearling sizes were also near average (Figure 1), despite 3 consecutive dry years and early stream flow decline in spring 2008 and 2009. Earlier decline should cut off summer growth much earlier, substantially reducing growth. However, the mild conditions (and low turbidities) in late winter also probably allowed yearlings to start feeding earlier, as had been observed for San Lorenzo River smolts in 1987-89 (Smith, unpublished).

In most of the watershed only yearlings are likely to be large enough the following spring (as 2 year olds) to smolt and enter the ocean. However, in years when the sandbar forms and remains in place in summer to provide rearing habitat, yearling and YOY steelhead can rear to large size in the resulting lagoon. Such fish have a high probability of ocean survival and can contribute a large fraction of the total watershed production of returning adults (Bond 2006). However, over the last 2 decades the lagoon provided little summer rearing habitat in the majority of years because of heavy water diversion during dry years (as during the 1987-1991 drought) and because of artificial breaching of the sandbar, often to improve beach access. In addition, the straightened estuary (modified during the construction of the Highway 1 Bridge) at Scott Creek is normally very shallow and mostly fresh water in spring prior to sandbar formation. It usually provides little opportunity for either feeding or adapting to salt in a brackish environment by the relatively small emigrating smolts from the upper watershed, reducing their potential marine survival. If a deep, brackish habitat were provided in spring, such as in Pescadero or Waddell creek estuaries, than ocean survival and adult returns by yearling or 2 year old smolts from the upper watershed would be substantially improved.

Waddell Creek Watershed. Overall YOY steelhead abundance in the Waddell Creek watershed in 2010 (12.9 / 100 feet) (Table 2) was drastically below the values for 1992-1998 (54 – 80 per 100 feet) for the 12th consecutive year (Tables 5 and 10). Total densities of steelhead at the 6 main stem sites were extremely low in 2010 (3-19, with mean of 9.9 / 100 feet), as they have been since 1999 (Table 10). West Fork sites have been higher, and often near average, over that span, but in 2010 the density was only 19-24 / 100 feet, substantially below the previous mean (Tables 2 and 10). However, the West Fork densities were still better than on the main stem or on the 2 East Fork sites downstream of Last Chance Creek (9-18 / 100 feet; Tables 2 and 10). The abysmally low abundance appears to be the result of past fish kills that have substantially reduced adult returns to ongoing fish kills.

In 2006, 2007 and 2008, steelhead abundance sharply declined in the East Fork downstream of Last Chance Creek (Table 10; Smith 2006 and 2007; Smith and Leicester 2008). A reasonable explanation for the extremely low numbers on the East Fork and main stem of Waddell Creek in 2006 -2008 (and from 1999 – 2005) is highly toxic chemicals periodically coming down Last Chance Creek. Since about ¼ mile of spawning habitat is available on the East Fork upstream of Last Chance Creek, fry produced in that reach could disperse downstream after the fish kills. This would partially restore juvenile abundance in the East Fork, and also partially mask the source of the kills. Since fry dispersal appears to stop by early summer (Smith and Davis 1993), the kills may occur in late spring or early summer. However, the pattern was not as strong in 2008 (Table 10), and the low numbers throughout the watershed were similar to those of Scott Creek in 2008 (Tables 10 and 11). In 2009 only one site on the East Fork was sampled, near the confluence with the West Fork, and the October storm may have already affected fish distribution and abundance. Along with the low numbers throughout the watershed, the 2009 results added little to the understanding of this persistent watershed problem. The 2010 results again suggest that the problem is associated with impacts somewhere in the East Fork watershed.

In 2008 caged goldfish placed throughout the Waddell Creek watershed slowly had fish die, but no dramatic acute toxic event occurred. If toxins are responsible for the low fish numbers on the East Fork and Main Stem, they either occur at chronic levels or did not occur in 2008. Juvenile steelhead numbers appeared to be reasonably good in late spring, so the declines apparently took place in summer.

Although fish kills have apparently occurred every year since 1999, the degree of impact has varied (Table 10), which may have been due to the amount of toxic material, the timing of the plume(s) and/or to availability of backwaters as refuges (Smith 2006). In the severest years sculpins (*Cottus asper* and *C. aleuticus*) have also been decimated, but in other years they have remained relatively common. Such a result would occur if in some years the lightweight toxic plume (of a solvent like acetone) concentrated in the upper water column, and affected steelhead, but did not penetrate to or into the bottom substrate where the scuplins are found. Differences in kill impacts to steelhead among years and sites could also occur if a portion of the steelhead fry were still protected within the gravel at the time of toxic episodes.

The lower abundance of YOY steelhead in the main stem in the last 12 years has had even greater potential impact on steelhead smolt production than the density declines indicate. Main stem steelhead have regularly grown much faster than those in the forks have (Smith 1998c, 2002 and Figure 1), allowing smolting of a significant portion of the fish as yearlings. In addition, if the apparent fish kills extended to the lagoon, as appears likely in many of the years, they would have resulted in a substantial loss of potential smolts, as the lagoon normally produced numerous, very fast growing steelhead (Smith and Davis 1993; Smith 1996b and 1997). Main stem fish sizes since 1999 have generally been smaller than in 1992-1998, but often larger than on the shaded, cool low-flow West Fork (Figure 1). Therefore, some of the scarce YOY on the main stem were still sufficiently large in 2002, 2005 and 2006 to smolt as yearlings. However, in 2008 and 2009 the main stem steelhead were similar in size to the small fish on the West Fork (Figure 1). In 2010 YOY lengths were again bigger on the main stem than on the West Fork, but were also somewhat bigger throughout the watershed (Figure 1). The higher spring and summer stream flows were probably responsible for the increased sizes.

One effect of the low steelhead densities of the last decade has been the ability to observe how variation in steelhead density affected habitat use. When steelhead were abundant, they were found in all habitats, from riffles to pools. Highest densities, based upon habitat length, were often in pools, apparently because the pools supplied more habitat per length of stream (due to greater area and volume). At the low site densities observed over the last 12 years the steelhead showed much higher relative abundance in riffle and run habitats, where fast-water feeding opportunities were greater. Apparently YOY steelhead habitat preference for fast-water habitats on the main stem was obscured in Waddell Creek when fish were abundant. Therefore, although both coho and steelhead have shown microhabitat shifts in response to increased density, the shifts are in the opposite directions. Coho expanded from complex pools to shallower or simpler pools to glides and then runs at higher densities, while steelhead expanded from riffles and runs (and heads of pools) to glides and pools at higher densities. These habitat tendencies may explain the apparent coexistence of steelhead and coho in the generally smaller and faster habitats of Gazos Creek in 2002 and the substantial reductions of steelhead in the pools of Scott Creek due to coho in 1993, 1996, 2002 and 2005.

A sandbar closed the lagoon at Waddell Creek in 8 of the 9 years of the Shapavalov and Taft (1954) study in the 1930's and early 1940's, with 7 of the closures in July through September (Smith and Leicester 2008). However, since at least 1995 the sandbar had not permanently and fully closed in summer until July of 2008. The bar also closed between 19 and 25 July 2009 and remained closed until September. However, on 29 August 2009 an attempt at breaching the sandbar by a family with a shovel was stopped by the State Park Ranger. The ditch was filled in, but the incident shows that increased signage and patrols will be necessary to maintain summer sandbars. In 2010, with higher summer stream flow (and some evidence of artificial breaching), the sandbar never fully closed all summer. Summer stream flows have generally been higher than in the 1980's (when the bar normally closed in mid-May through July), because the appropriative water diversion to north coast farms was terminated. However, flows are still lower than Shapovalov and Taft (1954) reported, so the sandbar should have closed if stream flow was the only factor. Even in 2007 when streamflow was greatly reduced in late summer the sandbar did not close. However, the bar did close during 2008 and 2009, the second and third consecutive dry years. Beach sand supply or dynamics may have changed, including possible interaction with the confined channel at the Highway 1 bridge and/or the Highway 1 berm and the State Park parking lot. The flood flows through the lagoon upstream of Highway 1 recently eroded a deep scour hole at the first meander upstream of the bridge, and the hole now usually provides both a brackish saltwater adjustment habitat and a feeding habitat for coho and steelhead smolts in spring. However, the lagoon occupies an entrenched channel, with little backwater development or surface flooding of marshland, even when the water in the lagoon is high. Without winter flood refuges, tidewater goby (*Eucyclogobius newberryi*) were lost from the lagoon in 1973, and, after reintroduction in 1991, were lost again in 1996 – 1998.

MANAGEMENT IMPLICATIONS

Coho

Present Status and Restoration Actions. Apparently spawning by precocial hatchery-reared females partially restored weak coho year classes on Waddell and Scott creeks in 1995 and 2004 (Smith 1995b, 2005) and on Scott Creek in 2006 (Smith 2006). In addition, hatchery-reared coho from wild brood stock and from genetically diverse captive brood stock were used to supplement the wild 2006 production on Scott Creek and the apparent lack of wild production in 2007. All 3 year classes (2004-2006) appeared viable on Scott Creek (6.9 – 29.7 / 100 feet) (Table 4) before the 2006-7 winter. However, now the 2007-2010 wild year classes have been essentially extirpated on Scott Creek. At Waddell Creek two year classes (2004 and 2005) appeared marginally viable (3.9 – 5.9 / 100 feet), but both of those were also extremely weak (0.2 – 0.5 / 100 feet) in 2007 and 2008, and the 2010 year class was absent. The missing year class (1994 through 2003 and 2006) "reappeared" in 2009 as a few main stem fish apparently produced by stray adults from Scott Creek. On Gazos Creek only the 2002/2005 year class remained viable (11.6 – 27.7 / 100 feet) (Smith 2005) until it was apparently lost in 2008. Coho were found in 2008 in San Gregorio, San Vicente and Soquel creek watersheds (Spence, pers. com.), but the "core" streams, Gazos, Waddell and Scott creeks, that were to support southern coho restoration, can recover only with substantial artificial intervention.

In winter 2010-2011 few or no wild adult coho will return to Waddell and Scott Creek to support either wild spawning or as wild brood stock for hatchery production. The runs of southern coho will have to be sustained and rebuilt from captive brood stock and their progeny.

Suitability of Southern Streams for Coho. Populations at the edge of their range are sometimes in marginal habitat, and distribution boundaries can change with fluctuating climate patterns. During the period of this study (1988 to present) coho year classes have been weakened or eliminated by drought or floods, and year classes showed wide differences in abundance on all 3 study streams. Floods in 1992, 1995 and 1998 drastically reduced coho spawning success; the 1998 floods also apparently nearly eliminated the 1997 year class by reducing over-wintering survival (Smith 1992, 1995, 1998c and 2001a). Drought, possibly aggravated by stream diversion, blocked coho from entering Scott Creek until early March in 1991, nearly eliminating a previously strong year class (Smith 1994c). Similar situations occurred elsewhere on the central coast, including Redwood Creek in Marin County, where the 1988, 1994 and 2000 year classes were less than 5-10 percent as abundant as other year classes (Smith 2000). Redwood Creek also had very poor juvenile coho production in 2007, 2008 and 2009, apparently due to the same problems that affected Scott, Waddell and Gazos creeks (Darren Fong, National Park Service, pers. com.). These wide coho abundance differences occur because the restricted early winter spawning period, single spawning attempt and very rigid ages of smolting and spawning (Shapovalov and Taft 1954) make spawning success susceptible to drought, floods or other "disasters" within small watersheds (Smith 1994c). Coho life history and the recent weather impacts on coho have been used as one argument that coho are not native south of San Francisco (Kaczynski and Alvarado 2006). However, coho have declined *throughout* California in recent decades (Spence *et al.* 2001; Spence and Bjorkstedt 2005), resulting in their listing as Federally threatened north into Oregon; therefore the declines and susceptibility are not peculiar to streams south of San Francisco Bay. Adams *et al.* (2007) presented Indian midden, historical collection and other evidence that coho are native south of San Francisco.

Shapavalov and Taft (1954) reported relatively stable abundance (200-279) of trapped female Waddell Creek steelhead during the nine years of their study (Table 12). In contrast, the number of coho females fluctuated substantially (37-309). In addition, large late storms in winter 1939-40 probably destroyed many coho redds and fry, as few smolts were trapped the following spring (Table 13). Despite the variable coho abundance reported from the 1930's and 1940's, all coho year classes apparently persisted in Scott and Waddell creeks (and probably in Gazos Creek) until the 1990's (Smith 1994c).

Changes in sea surface temperature regimes (El Nino-Southern Oscillation) since the mid 1970's have resulted in a doubling of El Nino frequency and have also produced the most severe El Nino years of record (1982-3 and 1997-98) (Urban *et al*. 2000; McPhaden *et al*. 2006). El Nino storms in 1992, 1995, 1998 were associated with impacts to coho observed in Scott, Waddell and Gazos creeks (Smith 1992, 1995 and 1998c). These storms, and earlier storms in 1982 and 1983, along with droughts in 1976-77 and 1987-1991, have probably been major factors in the *coast-wide* decline of coho that resulted in their listing under the state and federal Endangered Species Acts. In addition, Coho and Chinook salmon runs in 2006-7 through 2008-9 were unexpectedly poor throughout much of California. These recently harsh climatic conditions are a challenge to maintenance and restoration of coho coast wide, especially if the conditions persist (such has being related to the general global warming trend [Urban *et al*. 2000]). The recent severe problems for southern coho are not evidence that coho were not native to Scott, Waddell and Gazos creeks. However, they may mean that coho cannot be sustained in the face of persistent newly hostile conditions.

Relative Past and Present Coho Status. The recent problems and present status of coho south of San Francisco have been used by some to argue that the fish are not native, and by others to argue that it is an "edge of the range effect" and that we should "pull the plug" on efforts to restore southern coho. However, southern coho made it through the 1976-77 and 1987-1992 droughts intact; all year classes were apparently present until 1991 in the 3 streams where they were collected in 1895. The situation south of San Francisco is not unique. At the time of listing, coho were scarce and consisted of missing year classes in the majority of streams throughout the evolutionarily significant unit

(ESU). The major captive brood stock effort for the Russian River pre-dates that for Scott Creek, and coho abundance in the south was probably then greater than that of the Russian River, where only a few coho were present in a few near-coast tributaries.

The recent collapse of coho populations has generally been coast wide and has been accompanied by dismal returns of Chinook salmon to coastal and Central Valley streams. It is not an edge of the range condition, unless most of California is considered edge of the range.

It is not yet known whether the recent ocean problems were a temporary event or mark a general shift to more frequent poor conditions, perhaps due to climate change. However, until it is demonstrated that climatic shift dooms the southern fish (and most of California coho), the modest effort to maintain and restore southern coho should not be abandoned.

In addition, with the exception of the captive brood stock effort, most of the actions that would be taken for southern coho will also benefit listed steelhead in those same streams. Those could include improving lagoon/estuary feeding and salinity transition conditions in spring to increase size and ocean survival of coho and steelhead smolts moving to the ocean from the upper watershed (but not summer lagoon conditions, as coho rarely rear in the lagoon in summer in San Mateo and Santa Cruz county lagoons).

Genetic Diversity of Southern Coho. Obviously, severely weakened coho year classes can bottleneck and have low genetic diversity. However, although wild females have a rigid 3 year life cycle, a significant portion of spawning males consists of 2-year old fish ("jacks"). Therefore genetic exchange among year classes can be substantial. Until 2008 the "strong" year class (1993, 1996…) apparently numbered in the mid hundreds in Scott Creek, so genetic diversity should have been relatively high in that year class (even with an effective population size of 20% of the adult numbers). That diverse year class was also exchanging genes with others because of spawning by jacks and because of some freshwater rearing of yearlings. Observations of spawning coho in 1993, 1996 and 2002 indicated that females frequently spawned with more than one male (often one male on each side) and often spawned with jacks.

The initial fish for the captive brood stock program were from juveniles taken from the wild, which potentially were a genetically diverse sample. However, restrictions on rearing capacity for captive brood stock, then and now probably resulted in bottlenecking of what may have been a relatively genetically diverse wild population. The Scott Creek brood stock for the 2011 spawning year now have very low genetic variation (based upon neutral genetic markers).

Adding fish from Marin County to the southern brood stock could be one way to increase genetic diversity. However, fish in Lagunitas Creek or Olema Creek (a derivative population) frequently enter the stream relatively early in the fall. This may be the result of early reservoir releases in Lagunitas Creek to attract them, but also is probably due to the lack of the sandbar closure and stream flow issues that affect the San Mateo and Santa Cruz streams. In the 1990's and 2000's coho adult migration and spawning in the southern streams rarely occurred until at least late December. The timing of spawning runs has recently been substantially later than Shapovalov and Taft observed in Waddell Creek in the 1930's and early 1940's. This later run time may reflect a general pattern of later storms in recent years. Therefore, if Marin County fish are introduced to the southern brood stock program they should be relatively late-run fish to match the prevailing habitat conditions.

If genetic diversity is increased, it will need to be maintained by a substantial expansion of rearing capacity for captive brood stock. An additional way to deal with the limited brood stock rearing capacity problem and maintain genetic diversity is, when egg production is sufficient, to plant surplus fry in portions of Scott, San Vicente and Gazos creeks or potentially to Pescadero or San Gregorio creeks. The high abundance of juvenile coho in some years has demonstrated that summer rearing habitat is quite good (the problems have been with adult access and redd survival). A drawback to planting of fry is that interferes with fall sampling assessments of natural spawning and rearing success. However, if fry were placed in streams or stream reaches that usually have few or no juvenile coho, because of lack of adults or redd survival, monitoring could still be reliably conducted in core areas. For example, coho are usually scarce in Big Creek above the hatchery and in Scott Creek downstream of Big Creek (due to flood peaks and poor spawning substrate).

Steelhead

Although also federally listed as threatened, steelhead in these streams appear to be doing relatively well compared to coho. Multiple spawning attempts, variable age of smolting and maturity and spawning by a majority of fish after peak winter storms (Shapovalov and Taft 1954) make them less sensitive to weather events. The fish kills on the main stem and East Fork of Waddell Creek in 1999-2010 raise the primary concern. A major effort should be made to track down and eliminate the toxic sources of the kills, which may originate in the Last Chance Creek watershed. Eliminating the kills could also significantly benefit coho. The unexplained low steelhead abundance in Scott Creek in 2008 and 2009 was cause for some concern, but numbers rebounded in 2010. Damage from the August 2009 fire in the Scott Creek watershed may degrade the habitat, but no apparent significant impacts were seen in 2010..

Two large logjams adjacent to the road on Gazos Creek (and possibly 2 others, see Habitat Conditions section) are apparently major barriers to adult steelhead and coho access to most of the best habitat in the watershed. Newly fallen (2008) redwoods at mile 4.4 that could have produced an additional jam were modified in October 2009. A logjam on the West Fork of Waddell Creek also appears to be a major potential barrier. Access to modify the Waddell Creek jam for passage would be much more difficult, but may be worth the restoration effort. Such an effort is especially important now because the West Fork has been providing most of the coho and steelhead rearing habitat since 1999, because of the fish kills on the East Fork and main stem.

Steelhead densities have generally fluctuated by only a factor of about 2 from year to year (Table 5), generally increasing in years of higher summer stream flow. Late-spawning steelhead have apparently not been impacted by floods as have coho. Streamflow appears to be a factor in the interactions between coho and steelhead in strong coho years. Where streamflows are high steelhead apparently still use the heads and tails of pools despite the presence of abundant coho in the pools. In addition, overall steelhead abundance is affected less because of their ability to use faster-water habitat in runs and riffles. However, where summer streamflows are very low most of the habitat is in slow water habitat, which can be dominated by coho.

Artificially breaching the lagoon sandbar has frequently impacted steelhead rearing habitat at Scott Creek, Waddell Creek and possibly at Gazos Creek. Posting signs (“Do not breach the sandbar – it will kill endangered fish”)and patrolling should be used to prevent artificial breaching at these streams, and elsewhere in San Mateo and Santa Cruz counties. Replacement of the Highway 1 bridges at Scott and Waddell creeks offers the opportunity to address past bridge impacts and improve lagoon habitat.

Monitoring

Fall monitoring of juveniles at representative, repeatable sites on the three streams has required about 200-250 man hours per year (using a 2-person sampling team) and has provided a valuable index to steelhead and coho status. Electrofishing is the only effective way to sample juveniles at many of the sites, because snorkeling would not be effective in shallow, small or complex habitats or at heavily shaded sites. Mortality from electrofishing has been low, averaging 0.5 % among captured steelhead in the 3 streams in 2010 (Table 12). Mortality in previous years has been similar, although it has sometimes exceeded 2 % in deeper, complex habitats or under warmer water conditions (Smith 1996-1999). In addition, since only 3-10 % of the habitat is sampled, the loss to the total stream population is less than 0.2%.

Trapping of adults or smolts on these streams, as was begun by NOAA on Scott Creek in 2003-2004 and Waddell Creek (smolts) in 2004, would provide valuable abundance data for other important life history stages. Trapping results would also provide comparisons to index the relatively inexpensive juvenile sampling results.

ACKNOWLEDGMENTS

I thank Ann Briggs, Bud McCrary and Brian Detterich who gave permission to sample sites on Waddell and Scott creeks. The California Department of Parks and Recreation gave permits for sampling on Waddell and Gazos creeks. Ruth Sundermeyer, Michelle Leicester, Matt Franz, and Michael Huynh assisted with the electrofishing.

LITERATURE CITED

Adams, P. B., L. W. Botsford, K. W. Gobalet, R. A. Leidy, D. R. McEwan, P. B. Moyle, J. J. Smith, J. G. Williams and R. M. Yoshiiyama. 2007. Coho salmon are native south of San Francisco Bay: a reexamination of North American coho salmon's southern range limit. Fisheries (32): 441-451.

Bond, M. H. 2006. The importance of estuary rearing to Central California steelhead (*Oncorhynchus mykiss*) growth and marine survival. M.A. Thesis, University of California, Santa Cruz.

Hayes, S. A., M. H. Bond, C. V. Hanson, E. V. Freund, J. J. Smith, E. C. Anderson, A. J. Amman, and R. B. MacFarlane. 2008. Steelhead growth in a small central California watershed: upstream and estuarine rearing patterns. Transactions of the American Fisheries Society. 137: 114-128.

Kaczynski, V. W. and F. Alvarado. 2006. Assessment of the southern range limit of North American coho salmon: difficulties in establishing natural range boundaries. Fisheries (31): 374-391.

Leicester, M. A. 2005. Recruitment and function of large woody debris in four coastal California streams. M.S. Thesis, San Jose State University.

McPhaden, M. J., S. E. Zebiak and M. H. Glantz. 2006. ENSO as an integrating concept in earth science. Science (314): 1740-1745.

Shapovalov, L. and A. C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*). California Department of Fish and Game Bulletin 98. 275 pp.

Smith, J. J. 1992. Distribution and abundance of juvenile coho and steelhead in Waddell, Scott and Gazos creeks in 1992. 8 page unpublished report.

Smith, J. J. 1994a. Distribution and abundance of juvenile coho and steelhead in Waddell, Scott and Gazos creeks in 1993. 15 page unpublished report.

Smith, J. J. 1994b. Abundance of coho and steelhead in Redwood Creek in 1994. Report to Golden Gate National Recreation Area, National Park Service. 10 pp.

Smith, J. J. 1994c. Distribution and abundance of juvenile coho and steelhead in Scott and Waddell creeks in 1988 and 1994: implications for status of southern coho. 12 page unpublished report.

Smith, J. J. 1995a. Distribution and abundance of coho and steelhead in Redwood Creek in August 1995. Report to Golden Gate National Recreation Area, National Park Service. 9 pp.

Smith, J. J. 1995b. Distribution and abundance of coho and steelhead in Gazos, Waddell and Scott creeks in 1995. 20 page unpublished report.

Smith, J. J. 1996. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 1996. 26 page unpublished report.

Smith, J. J. 1998a. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 1997 and the implication for status of southern coho. 23 page unpublished report.

Smith, J. J. 1998b. Distribution and abundance of coho and steelhead in Redwood Creek in Fall 1998. Report to Golden Gate National Recreation Area, National Park Service. 12 pp.

Smith, J, J. 1998c. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 1998. 27 page unpublished report.

Smith, J. J. 1999. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 1999. 26 page unpublished report.

Smith, J. J. 2000. Distribution and abundance of coho and steelhead in Redwood Creek in Fall 2000. Report to Golden Gate National Recreation Area, National Park Service. 8 pp.

Smith, J. J. 2001a. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2000. 20 page unpublished report.

Smith, J. J. 2001b. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2001. 22 page unpublished report.

Smith, J. J. 2002. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2002. 30 page unpublished report.

Smith, J. J. 2003a. Distribution and abundance of juvenile coho and steelhead in Redwood Creek in fall 2003. Report to Golden Gate National Recreation Area, National Park Service. 12 pp.

Smith, J. J. 2003b. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2003. 27 page unpublished report.

Smith, J. J. 2005. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2004. 32 page unpublished report.

Smith, J. J. 2006a. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2005. 32 page unpublished report.

Smith, J. J. 2006b/ Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2006. 34 page unpublished report.

Smith, J. J. 2007. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2007. 40 page unpublished report.

Smith, J. J. 2009. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2009. 48 page unpublished report.

Smith, J. J. and L. Davis. 1993. Distribution and abundance of juvenile coho and steelhead in Waddell Creek in 1993. 7 page unpublished report.

Smith, J. J. and M. Leicester 2008. Distribution and abundance of juvenile coho and steelhead in Waddell and Scott Creeks in 2008. 41 page unpublished report.

Spence, B. C. and E. P. Bjorkstedt. 2005. Central California Coast Coho Salmon ESU. *In* T. P. Good, R. S. Waples, and P. B. Adams (Eds.), Updated status of Federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. of Commerce, NOAA NMFS tech. Memo. NMFS-NWFSC-66.

Spence, B. C., T. H. Williams, E. P. Bjorkstedt, and P. B. Adams. 2001. Status review update for coho salmon (*Oncorhynchus kisutch*) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coast Evolutionarily Significant Units. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz Laboratory, California.

Urban, F. E., J. E. Cole, and J. T. Overpeck. 2000. Influence of mean climatic change on climate variability from a 155-year tropical Pacific coral record. Nature (407): 989-993.

Table 1. Site locations, habitat types present and sampled, number of steelhead collected and estimated density per 100 feet ( ) at sites on Gazos Creek in October 2010. Site #s agree with earlier reports.

Site	Mile >Hwy1	Chan Type	%Habitat Available PL	GL	RN	RF	% Habitat Sampled PL	GL	RN	RF	Sample Length (Feet)	#SHT +0	+1	Coho
1	0.9	C5												
2	1.8	C5	45	30	20	5	87	5	8	--	242	35 (15)	9 (4)	
Old Woman's Creek	2.05													
2A	2.1	C4	40	30	20	10	57	10	31	2	277	66 (25)	4 (2)	
2B	2.8	B4C	45	25	20	10	82	12	7	--	213	42 (20)	10 (5)	
3	3.15	B4C												
3A	3.9	B4C	40	30	20	10	67	25	8	--	300	44 (15)	4 (1)	
4	4.4	B4C	40	30	20	10	73	15	12	--	262	25 (10)	9 (4)	
5	4.85	B4C	35	25	30	10	52	37	11	--	160	22 (14)	8 (4)	
7A	5.3	B1	40	28	22	10	75	18	7	--	310	41 (14)	23 (8)	
Totals											1764	275	67	0
Mean of 7 Sites			41	28	22	9	70	17	12	+		(16.0)	(3.7)	

Table 2. Site locations, habitat types present and sampled, number of steelhead collected and estimated density per 100 feet ( ) at sites on Waddell Creek in September and October 2010. (Site #s agree with earlier reports).

Site	Mile	Chan	%Habitat Available				% Habitat Sampled				Sample	#SHT		Coho
	>Hwy1	Type	PL	GL	RN	RF	PL	GL	RN	RF	Length (Feet)	+0	+1	
1 First bridge	0.6	B4C	60	20	15	5	76	19	6	10	307	9 (3)	7 (2)	
2 < Alder Camp	1.2	B4C	55	30	10	5	76	5	13	6	350	13 (4)	0 (0)	
3 Twin Redwoods	1.8	B4C	55	25	15	5	50	39	11	--	228	40 (19)	3 (1)	
4 Periwinkle		B4C	45	30	20	5	65	17	11	7	295	36 (13)	1 (0.3)	
5 Road washout < Camp Herbert		B4C	55	20	15	10	62	17	8	13	324	10 (3)	3 (1)	
6 Camp Herbert	3.1	B3C	50	25	15	10	61	5	34	--	220	39 (18)	4 (2)	
7 East Fork > Confluence	3.2	B3C	45	25	20	10	69	6	24	--	327	30 (9)	7 (2)	
7A East Fork	0.2	B2												
7B East Fork < Last Chance	0.5	B2	45	5	40	10	55	--	45	--	273	49 (18)	2 (1)	
7C East Fork > Last Chance	0.8	B1/B2												
8 W Fork> Confluence	3.3	B4C	40	30	25	5	60	19	17	5	327	58 (19)	5 (2)	
9 WF Mill Site	3.9	B4C	50	30	10	10	64	6	29	1	336	77 (24)	1 (0.3)	
10 > Buck Creek	4.7	B4C												
11 < Henry Creek	5.25	B1												
12 Henry Creek	0.2	F1/4												
Totals											2987	361	33	0
Mean of 10 Sites			50	23	19	8	64	13	20	3		(12.9)	(1.1)	
Main Stem												(9.9)	(1.1)	
East FK												(13.6)	(1.5)	
West FK												(21.4)	(0.9)	

Table 3. Site locations, habitat types present and sampled, number of steelhead collected and estimated density per 100 feet ( ) at sites on Scott Creek in September and October 2010. (Site #s agree with earlier reports).

Site	Mile >Hwy1	Chan Type	%Habitat Available PL	GL	RN	RF	% Habitat Sampled PL	GL	RN	RF	Sample Length (Feet)	#SHT +0	+1	Coho
A Near Diversion	0.9	C3												
1 < Little Creek	1.9	C3	55	20	20	5	85	--	15	--	248	80 (34)	8 (3)	
Big Creek	2.15													
2 Pullout > Big Creek	2.55	BC4	60	20	15	5	92	8	--	--	219	148 (71)	10 (5)	
3 < Mill Creek	3.05	C4	50	30	15	5	67	22	11	--	224	150 (71)	8 (4)	
4 < Swanton Road	3.55	BC4	55	25	15	5	72	28	--	--	180	100 (57)	14 (8)	
5 Cattle guard	4.25	C4	50	30	15	5	79	13	8	--	232	89 (41)	11 (5)	
7 Pullout < Big Cr. Gate	4.9	B4C	50	30	15	5	86	8	6	--	207	103 (52)	9 (4)	
9 0.15 mile > bridge	5.15	B4C/F	50	20	20	10	85	10	6	--	126	28 (23)	11 (9)	
11 Upper Ford	5.85	C3/4	55	25	15	5	79	8	14	--	266	58 (22)	12 (5)	
12 Big Creek/ Swanton Road		C3	40	15	35	10	58	13	28	1	397	112 (30)	17 (5)	
13 Mill Creek <Swanton Road		C3	55	20	15	10	82	13	5	--	138	65 (49)	3 (2)	
Totals											2237	933	103	0
Mean of 10 Sites			53	24	18	7	79	12	9	+		(44.9)	(4.9)	

Table 4. Number of sites, amount and type of habitat sampled, number of coho collected and estimated density (per 100 feet) for Scott, Waddell, Gazos, and Redwood creeks in1988 and 1992 – 2010.

Stream and Date	Number of Sites Sampled	Length (feet)	Habitat Percent				% of Sites with Coho	# of Coho	Coho Density (/100')
			PL	GL	RN	RF			
Scott Creek									
Jul – Sep 1988	14	3535	41	25	21	12	84	384	15.5
Aug – Oct 1992	13	1624	66	30	4	0	46	42	4.3
Jan 1994	11	1554	49	32	19	0	100	376	27.2
Aug 1994	13	1744	59	36	6	0	46	17	1.1 most age 1+
Oct 1995	12	1686	59	32	8	1	92	223	14.2
Oct – Nov 1996	12	1684	62	30	8	1	100	473	33.0
Aug – Sep 1997	13	1865	64	24	11	0	62	145	9.3
Sep – Oct 1998	11	1753	77	16	6	1	64	34	1.8
Oct 1999	10	1430	81	17	2	0	90	328	29.2
Sep – Oct 2000	10	1810	81	13	6	0	40	7	0.4 all age1+
Sep – Oct 2001	12	2024	80	18	2	0	33	12	0.6
Sep – Oct 2002	14	2105	72	20	9	0	100	1492	79.2
Sep – Oct 2003	12	2193	65	25	9	1	58	33	1.5 most age 1+
Oct 2004	13	2237	72	19	9	1	85	174	8.6
Oct 2005	12	2142	67	23	10	1	100	582	29.7
Sep – Oct 2006	10	1777	76	13	11	0.3	80	95	6.9 12% 1+
Aug – Sep 2007	11	1859	69	21	9	1	9	2	0.1 all age1+
Oct – Nov 2008	6	1121	70	22	7	2	0	0	0
Oct 2009	9	1515	79	15	5	0	0	0	0
Sept-Oct 2010	10	2237	79	12	9	+	0	0	0

Table 4 (continued)

Stream and Date	Number of Sites Sampled	Length (feet)	Habitat Percent PL	GL	RN	RF	% of Sites with Coho	# of Coho	Coho Density (/100')
<u>Waddell Creek</u>									
Jun – Aug 1988	8	1817	54	19	23	5	63	19	1.3
Jul – Aug 1992	13	2858	67	31	2	0	38	19	0.6
Oct – Dec 1993	12	1857	38	21	28	14	75	58	3.6
July 1994	12	2367	66	24	7	2	0	0	0
Sep 1995	12	2498	64	24	10	2	58	24	1.1
Aug – Sep 1996	14	2491	69	21	8	2	93	302	12.5
Aug – Sep 1997	11	1873	58	32	8	1	0	0	0
Sep – Oct 1998	10	2083	76	18	5	1	20	7	0.3
Oct 1999	10	1558	78	19	4	0	40	66	3.1
Sep 2000	8	1511	65	19	13	3	0	0	0
Sep – Oct 2001	10	2234	81	14	2	3	20	13	0.5
Sep – Oct 2002	13	2693	77	12	10	1	69	130	4.7
Sep – Oct 2003	11	2512	71	13	13	4	9	1	0.1
Oct 2004	12	2726	74	17	7	3	67	82	age 1+ 3.9
Oct 2005	13	2577	60	18	21	1	69	149	5.9
Oct 2006	9	1650	68	8	16	8	0	0	0
Aug – Sep 2007	14	2817	65	12	23	+	7	3	0.2
Sep – Nov 2008	11	2429	62	10	22	6	18	13	0.5
Oct 2009	8	1741	64	17	16	4	25	4	0.2
Sept – Oct 2010	10	2987	64	13	20	3	0	0	0
<u>Gazos Creek</u>									
Aug 1992	2	275	44	56	0	0	0	0	0
Jan 1994	4	503	65	22	12	1	50	9	6.0
Nov 1995	4	425	58	19	21	3	25	1	0.2
Sep 1996	5	830	49	27	12	13	100	33	4.9

Table 4 (continued)

Stream and Date		Number of Sites Sampled	Length (feet)	PL	GL	RN	RF	% of Sites with Coho	# of Coho	Coho Density (/100')
Gazos Creek (cont.)										
Aug	1997	5	827	45	28	17	10	0	0	0
Aug – Sep	1998	8	1529	65	14	11	10	25	10	0.4
Sep – Oct	1999	9	1475	79	18	2	1	67	79	6.2
Sep – Oct	2000	7	1036	75	15	10	0	0	0	0
Sep	2001	10	1791	77	21	2	0	0	0	0
Sep	2002	11	1826	76	19	4	1	100	484	27.7
Aug – Sep	2003	9	1577	67	19	13	1	0	0	0
Oct	2004	9	1689	74	20	6	0	22	9	0.4
Oct	2005	9	1701	72	19	8	1	100	187	11.6
Oct	2006	8	1394	65	20	15	1	0	0	0
Sep	2007	6	1177	72	17	11	0	0	0	0
Oct	2009	6	1120	79	18	3	0	0	0	0
Oct	2010	7	1764	70	17	12	+	0	0	0
Redwood Creek										
Jun – Sep	1992	4	1032	37	40	5	7	100	426	45.3
July	1994	7	1287	58	25	12	6	43	24	1.9
Aug	1995	4	796	41	30	19	10	100	308	42.0
Nov	1996	3	604	51	31	11	7	100	214	38.8
Sep – Oct	1997	5	984	72	18	9	1	60	209	23.3
Oct	1998	5	1174	59	25	15	1	100	327	31.6
Oct	2000	6	1077	71	27	3	0	33	14	1.1
Oct	2001	5	956	78	15	0	7	60	242	26.8
Oct	2002	4	787	70	23	6	2	100	419	57.1

Table 5. Number of sites, amount and type of habitat sampled and estimated density (per 100 feet) of steelhead for Scott, Waddell, Gazos and Redwood creeks in 1988 & 1992 – 2010.

Stream and Date		Number of Sites Sampled	Length (feet)	Habitat Percent PL	GL	RN	RF	Density Age 0+	Age ½+
<u>Scott</u> <u>Creek</u>									
Jul – Sep	1988	14	3535	41	25	21	12	57	7
Aug – Oct	1992	13	1624	66	30	4	0	89	2
Jan	1994	11	1554	49	32	19	0	39	21
Aug	1994	13	1744	59	36	6	0	52	18
Oct	1995	12	1686	59	32	8	1	90	10
Oct – Nov	1996	12	1684	62	30	8	1	35	20
Aug – Sep	1997	13	1865	64	24	11	0	68	7
Sep – Oct	1998	11	1753	77	16	6	1	113	10
Oct	1999	10	1430	81	17	2	0	62	10
Sep – Oct	2000	10	1810	81	13	6	0	78	7
Sep – Oct	2001	12	2024	80	18	2	0	52	8
Sep – Oct	2002	14	2105	72	20	9	0	35	5
Sep – Oct	2003	12	2193	65	25	9	1	55	3
Oct	2004	13	2237	72	19	9	1	37	6
Oct	2005	12	2142	67	23	10	1	34	4
Sep - Oct	2006	10	1777	76	13	11	0.3	48	7
Aug – Sep	2007	11	1859	69	21	9	1	49	14
Oct – Nov	2008	6	1121	70	22	7	2	20	8
Oct	2009	9	1515	79	15	5	0	24	7
Sept – Oct	2010	10	2237	79	12	9	+	45	5

Table 5 (cont.)

Stream and Date	Number of Sites Sampled	Length (feet)	PL	GL	RN	RF	Age 0+	Age 1/2+
Waddell Creek								–
Jun – Aug 1988	8	1817	54	19	23	5	45	7
Jul – Aug 1992	13	2858	67	31	2	0	56	10
Oct – Dec 1993	12	1857	38	21	28	14	54	8
July 1994	12	2367	66	24	7	2	61	19
Sep 1995	12	2498	64	24	10	2	79	14
Aug – Sep 1996	14	2491	69	21	8	2	62	15
Aug – Sep 1997	11	1873	58	32	8	1	71	7
Sep – Oct 1998	10	2083	76	18	5	1	80	7
Oct 1999	10	1558	78	19	4	0	27	4
Sep – Oct 2000	8	1511	65	19	13	3	30	3
Sep – Oct 2001	10	2234	81	14	2	3	24	4
Sep – Oct 2002	13	2693	77	12	10	1	21	2
Sep – Oct 2003	11	2512	71	13	13	4	42	2
Oct 2004	12	2726	74	17	7	3	28	3
Oct 2005	13	2577	60	18	21	1	20	1
Oct 2006	9	1650	68	8	16	8	20	2
Aug – Sep 2007	14	2817	65	12	23	+	13	2
Sep – Nov 2008	11	2429	62	10	22	6	23	1
Oct 2009	8	1741	64	17	16	4	10	2
Aug – Sep 2007	14	2817	65	12	23	+	13	2
Sep – Nov 2008	11	2429	62	10	22	6	23	1
Oct 2009	8	1741	64	17	16	4	10	2
Sept – Oct 2010	10	2987	64	13	20	3	13	1

Table 5 (cont.)

Stream and Date	Number of Sites Sampled	Length (Feet)	PL	GL	RN	RF	Age 0+	Age 1/2+
Gazos Creek								
Aug 1992	2	275	44	56	0	0	24	12
Jan 1994	4	503	65	22	12	1	29	9
Nov 1995	4	425	58	19	21	3	68	14
Sep 1996	5	830	49	27	12	13	34	12
Aug 1997	5	827	45	28	17	10	36	8
Aug – Sep 1998	8	1529	65	14	11	10	53	7
Sep – Oct 1999	9	1475	79	18	2	1	51	8
Sep – Oct 2000	7	1036	75	15	10	0	37	6
Sep 2001	10	1791	77	21	2	+	45	11
Sep 2002	11	1826	76	19	4	1	49	5
Aug – Sep 2003	9	1577	67	19	13	1	39	7
Oct 2004	9	1689	74	20	6	0	43	5
Oct 2005	9	1701	72	19	8	1	30	4
Oct 2006	8	1394	65	20	15	1	19	5
Sep 2007	6	1177	72	17	11	0	21	4
Oct 2009	6	1120	79	18	3	0	17	9
Oct 2010	7	1764	70	17	12	+	16	4

Table 5 (cont.)

Stream and Date	Number of Sites Sampled	Length (Feet)	PL	GL	RN	RF	Age 0+	Age 1/2+
Redwood Creek								
Jun – Sep 1992	4	1032	37	40	5	7	23	4
Jun – Aug 1993	4	951	48	25	18	9	56	4
Oct 1994	5	1018	83	10	4	3	34	6
Aug 1995	4	796	41	30	19	10	96	4
Nov 1996	3	604	51	31	11	7	33	11
Sep – Oct 1997	5	984	72	18	9	1	15	5
Oct 1998	5	1174	59	25	15	1	47	4
Oct 2000	6	1077	71	27	3	0	39	15
Oct 2001	5	956	78	15	0	7	6	6
Oct 2002	4	787	70	23	6	2	11	3
Oct 2003	4	701	73	21	6	0	30	8

Table 6. Density of coho (#/100 feet) by site at Gazos Creek in 1992-2010 (no coho were captured in omitted years). Coho densities in 1996 were augmented by hatchery-spawned fry.

		Year Class							
Site	Mile > Hwy 1	1993	1995	1996	1998	1999	2002	2004	2005
A	0.25						8		
1	0.9	0	0	0.6	0	0	16	2	7
2	1.8	0	0.8	0.9	0.6		22	2	6
	2.05 Old Woman's Creek								
2A	2.1			8	0	0	55	0	15
2B	2.8					3	33	0	20
3	3.15	1	0	7	0	0.5	24	0	10
3A	3.9					0.7	46	0	
4	4.4	23	0	8	0		39	0	13
	4.4/4.6					10			
5	4.8/5.0				0				
	4.85					13	33	0	11
6	5.1/5.2				2.7				
7	5.3/5.45				0				
	5.3					28	29	0	9
7B	5.45					0	0.7		
Totals		6.0	0.2	4.9	0.4	6.2	27.7	0.4	11.6

Table7. Densities (#/100 feet) of coho by site in the Waddell Creek watershed in 1992-2010. Young-of-year coho were not collected in omitted years. *In 1996 sites downstream of the forks received plants of hatchery-spawned fry.

		Year Class												
Site	Mile > Hwy 1	1992	1993	1995	1996	1998	1999	2001	2002	2004	2005	2007	2008	2009
1 First bridge	0.6	0	1	0.5	16*	0	0	0	0	0	0	3	0	0
2 < Alder Camp	1.35	0	0.3	0.3	7*	0	0	0	3	0	0	0		0.7
3 Twin Redwoods	1.8	0	0	0	14*	0	0	0	10	4	16	0	0	0.7
4 Periwinkle	2.2	0	4	0	30*	0	0	0	0.4	3	3	0	0	0
5 Downstream of Camp Herbert	2.6	0.4	2	2	16*	0	0	0	0.6	4	4		0	
6 Camp Herbert	3.1	3		2	15*	0	0	0	0	0	0	0	0	0
7 East Fork > Ford	3.2	0	4	0	10	0	2	0	4	0	2	0	0	0
7A East Fk upper	3.7		4		4				0		0	0	0	
8 West Fork	3.3	0	7	3	13	0	14	2	7	2	8	0	2	0
9 Mill Site	3.9	4	4	3	23	3	11	3	18	3	17	0	3	0
10 at Buck Cr	4.7	0.5	0	3	18	0.4	8	0	8	11	9	0		
11 < Henry Cr	5.25	1	2	0	7				11	8	14	0		
13 Henry Creek >Trail Xing	0.2	1	16	0	3				0	12	6	0		
Totals		0.6	3.6	1.1	12.5	0.3	3.1	0.5	4.7	3.9	6.0	0.2	0.5	0.2

Table 8. Sample site locations and coho densities (# / 100 feet) in the Scott Creek watershed in September 1992, January 1994 (1993 year class), October 1995, October and November 1996 (*augmented with fry), August and September 1997, October 1998 and 1999, September and October 2000-2003 and 2006, and October 2004 and 2005. Omitted from the table are 5 years: in 2007 only 2 yearling coho were captured at site 4, in 1994 most or all coho were yearlings, and in 2008, 2009 & 2010 no coho were collected.

Site	Year Class Density													
(Mile > Hwy 1)	1992	1993	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
A. Near Diversion (0.9)		2	1	22*	0		5		3	38	0	1	8	1
1. at Little Creek (1.9)	2	7	14	33*	0	0	6	0	2	44	0	2	6	2
2. >Big Cr. (2.55)	0	31	29	31	30	1	35	1	1	82	4	12	21	3
3. < Mill Cr. (3.05)	1		28		29	0		0	1	83	1	14	37	5
4 .< Swanton Road (3.55)	0	86	26	37	20	3	45	0	0	156	1	22	36	18
5. Cattle Guard (4.25)	0				11	2		1	0	145	1	15	76	15
7. Pullout < Big Cr. Gate (4.9)	23	48	23	62	24	3	86	1	0	144	6	20	45	3
9. 0.15 mi > Bridge (5.15)	1	39	12	62	1	0	45	0	0	102	0	0		
11. Upper Ford (5.85)	2	41	5	33	0	8	22	0	0	48	1	2	45	0
11A 5th Trail Crossing (6.5)		16	3	31	1	3				63	0	0	18	
12. Big Cr. Swanton Rd	0	8	1	21	0	0	7	0	0	72	0	4	5	0
12A Big Cr. < Hatchery		9	0	30	0		0		0	31		2	11	
12B Big Cr. > Berry Cr.				11			0			13				
13. Mill Cr. < Swanton Rd.	0	12	28	24	6	0	42	1	0	88	3	17	49	24
Mean	4.3	27.2	14.2	33.0	9.3	1.8	29.2	0.4**	0.6	79.2	1.5#	8.6	29.7	6.9

**all age 1+
#majority age 1+

Table 9. Density of young-of-year steelhead (# / 100 feet sampled) for sites at Gazos Creek in 1995-2010. Value in () is density of yearling and older fish. Values with * indicate YOY density >40% below 1993-2010 mean.

		Year Class													
Site	Mile > Hwy 1	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2009	2010	Mean 1993-2010
A	0.25								33(8)						33(8)
1	0.9	57(22)	24(7)	15(3)*	14(7)*	23(10)	32(3)	44(6)	29(6)	21(5)					26(8)
2	1.8	52(12)	45(10)			33(10)	36(4)	32(5)	28(6)	16(4)	15(10)*	10(10)*	11(6)*	15(4)*	27(9)
2.05 Old Woman's Creek															
2A	2.1		53(7)	49(9)	28(8)	52(14)	60(6)	37(10)	32(7)	26(7)	24(5)	23(3)	13(5)*	25(2)	37(8)
2B	2.8			82(11)	32(4)	42(5)	68(2)	52(8)	52(5)	36(7)	44(6)	32(3)	27(13)*	20(5)*	46(6)
3	3.15	96(11)	64(3)	71(8)	30(4)	63(9)	70(4)	58(7)	70(4)	23(2)*	13(1)*				50(5)
3A	3.9			37(7)		71(11)	46(2)	38(7)	39(1)	32(2)	23(5)*	16(2)*	23(4)*	15(1)*	36(5)
4	4.4	68(10)	69(4)		56(6)			52(9)	37(5)	45(5)	13(5)*		20(6)*	10(4)*	52(7)
	4.4/4.6				94(6)		65(13)	48(4)							
5	4.8/5.0		37(8)												
	4.85			30(6)	34(7)	21(8)	37(6)	25(7)	41(6)	28(0)	4(1)*	23(2)		14(4)*	27(5)
6	5.1/5.2		67(9)												67(9)
7	5.3/5.45		61(8)												
7A	5.3			48(8)	66(8)	20(11)	55(4)	12(8)*	56(3)	41(5)	12(7)*	21(4)*	17(7)*	14(8)*	36(6)
7B	5.45			80(17)			55(9)								68(13)
Total		68(14)	53(7)	51(8)	37(6)	45(11)	49(5)	39(7)	43(5)	30(4)	19(5)*	21(4)*	17(7)*	16(4)*	38(7)

Table 10. Densities of YOY steelhead (number per 100 feet) at sites on Waddell Creek in 1995-2010. In 1996, 2002, 2004 & 2005 coho were also common at some sites and those totals are included with the YOY steelhead for that year. (*Indicates values that are >20% below 1995-1998 low and also > 40% below 1995-1998 mean).

			Year											
Site	Mile > Hwy 1	1995-98 Range(Mean)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
13 Henry Cr. > Trail		56-81(57)	--	--	--	32	28	39	30	--	13*			
11 < Henry Cr.	5.25	31-37(34)	--	--	--	28	51	38	55	--	15*			
10 < Buck Cr.	4.7	45-74(57)	39	--	42	40	67	50	37	--	29*			
9 Mill Site	3.9	47-60(53)	44	--	20*	44	44	36	53	34	31*	43	9*	24*
8 West Fork > confluence	3.3	42-60(52)	36	46	14*	27*	45	32	35	20*	15*	29*	12*	19*
7 East Fork > confluence	3.2	43-115(71)	67	51	21*	34*	22*	46	22*	19*	8*	16*	21*	9*
7B East Fork Upstream		43(43)	--	--	--	22*	--	--	21*	26*	8*	28		18*
7C East Fork > Last Chance										52	21	42		
6 Camp Herbert	3.1	42-128(76)	57	9*	10*	7*	31*	17*	6*	12*	9*	19*	8*	18*
lower			7*											
5 Pullout < Camp Herbert	2.6	83-138(100)	8*	23*	10*	8*	-	20*	11*	6*	--	10*		3*
4 Periwinkle	2.2	108-150(130)	9*	16*	1*	10*	35*	50*	7*	--	2*	13*	13*	13*
3 Twin Redwoods Camp	1.8	53-92(74)	9*	29*	27*	63	43*	24*	50	5*	8*	21*	10*	19*
2 <Alder Camp	1.35	78-131(110)	10*	46*	54*	24*	54*	26*	5*	--	11*	--	2*	4*
1 First Bridge	0.6	54-85(64)	8*	18*	36*	9*	39	0*	4*	6*	11*	3*	9*	3*
Total All Sites		62-80(73)	29*	30*	24*	27*	42*	32*	26*	20*	13*	23*	10*	13*
Total Main Stem		87-101(93)	17*	24*	23*	20*	40*	23*	14*	7*	8*	13*	8*	10*

Table 11. Sample site locations and steelhead densities (# / 100 feet) in the Scott Creek watershed since 1998 (in August and September 1997 and 2007, October 1998 and 1999, September and October 2000-2003, 2006, 2009 and 2010, October and November 2008 and October 2004 and 2005). Number in ( ) is density for yearling and older fish. Channel and LWD have been relatively stable since 1998. Values with * less than 50% of 1998-2010 mean.

.

Site (Mile > Hwy 1)	Year Class Density													1998-2010
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Mean
A. Near Diversion (0.9)		41(11)		22(3)	18(4)	13(2)	28(1)	15(3)	39(11)	47(7)		10(6)*		26(5)
1. at Little Creek (1.9)	73(7)	49(6)	15(2)*	66(3)	27(2)	16(1)*	14(5)*	14(5)*	23(3)	40(7)			34(3)	34(4)
2. >Big Cr. (2.55)	113(9)	82(8)	66(6)	73(8)	33(2)	58(4)	58(6)	31(4)*	53(7)	75(14)	23(2)*	17(6)*	71(5)	64(6)
3. < Mill Cr. (3.05)	114(7)		58(7)	73(6)	26(3)	80(3)	41(5)	49(2)	68(11)	62(12)		39(14)	71(4)	62(7)
4 .< Swanton Road (3.55)	128(10)	79(13)	65(10)	83(10)	39(11)	60(4)	41(6)	57(6)	60(9)	56(34)		36(12)	57(8)	63(11)
5. Cattle Guard (4.25)	166(14)		86(16)	27(14)	17(6)	79(6)	65(14)	45(5)	41(7)	26(9)		36(6)	41(5)	57(9)
7. Pullout < Big Cr. Gate (4.9)	172(10)	48(7)	149(7)	22(7)*	24(6)*	61(3)	35(8)	29(3)	61(5)	36(13)	34(5)	42(7)	52(4)	59(7)
9. 0.15 mi > Bridge (5.15)	138(16)	70(16)	137(12)	54(9)	49(2)	76(3)	31(7)*			29(26)*	19(12)*		23(9)*	63(11)
11. Upper Ford (5.85)	54(4)	26(3)	45(5)	13(4)*	20(5)	47(1)	18(5)	22(3)	37(4)	25(10)	13(5)*	10(3)*	22(5)	27(4)
11A 5th Trail Crossing (6.5)	67(14)				24(5)*	63(7)	60(6)	61(6)						55(8)
12. Big Cr. Swanton Rd	60(5)	67(8)	57(3)	72(13)	36(1)	57(5)	35(2)	30(2)	31(4)	69(11)	15(3)*	6(3)*	30(5)	43(5)
12A Big Cr. < Hatchery		67(12)		56(7)	58(5)		19(5)	36(3)						47(6)
12B Big Cr. > Berry Cr.					67(7)									67(7)
13. Mill Cr. < Swanton Rd.	158(10)	88(14)	103(7)	67(13)	54(5)	47(2)	39(8)	23(4)*	65(8)	71(11)	18(19)*	26(8)*	49(2)	62(9)
Mean	113(10)	62(10)	78(7)	52(8)	35(5)	55(3)	37(6)	34(4)	48(7)	49(14)	20(8)*	24(7)*	45(5)	52(8)

Table 12. Coho and steelhead killed and captured (/) by electrofishing and mortality rate (%) on Scott, Waddell and Gazos creeks in September and October 2010.

	--------------Steelhead------------------				Coho	
	Age 0+		Age 1+		Age 0+	
	Kill/Capt	%	Kill/Capt	%	Kill/Capt	%
Scott Creek	8 / 933	0.9	0 / 103	0	--	
Waddell Creek	0 / 361	0	0 / 33	0	--	
Gazos Creek	1 / 271	0.4	0 / 67	0	--	
Totals	9 / 1569		0 / 203	0	0 / 0	0
Overall			9 / 1772	0.5		

Figure 1. Standard lengths (mm) of YOY steelhead and coho from Scott, Gazos and Waddell creeks in 2010 versus previous years.
* = young of year o= yearling + = age 2+

Scott Creek (steelhead)

	----------2010----------						
	Big Creek	Site 1	Site 2	Sites 3 & 4	Site 5	Sites 7,9,11	Mill Cr
30 – 34				*3	1	1	
35 – 39				*****16	*3	**7	*3
40 – 44			**6	*********29	******19	********25	*5
45 – 49	**6		******19	**************44	****14	***************45	*****16
50 – 54	*****16	*3	********24	**************42	******18	****************49	*****15
55 – 59	*********27	****12	***********35	************40	****13	**********30	***11
60 – 64	*********27	*******22	******20	*********28	****14	*********29	*4
65 – 69	*******21	***9	*******22	****14	*5	**7	*4
70 – 74	****13	****13	*****17	****12	2	** o	**6
75 – 79	**8	****12	*5	*5	1	ooooo	1
80 – 84	2	*3		1	oooo	oo	
85 – 89	** o	*4	o	oo		ooo	
90 – 94			ooo	ooo	o	ooo	
95 – 99	ooo	o	o	ooo	o	ooooo	o
100-104	o		o	o	oo		o
105-109	oo	o	o	ooo			
110-114		o			o		
115-119			o	o		o	o
120-124	oo		oo	oo			
125-129	o	oo	o	oo		o	
130-134		o			o		
135-139		o					
140-144							
145-149		o					
150-154	o	o					
155-159				o			
160-164	+					+	
165-169							
170-174							
175-179	+						
180-184			+				
210-215				+(hatchery)			

Scott Creek (continued):

	--2009--				
	Big Creek	Sites A & 2	Sites 3 & 4	Sites 5,7,11	Mill Cr
35 – 39				******	*
40 – 44			*******	********************	****
45 – 49	**		*************	***************	*****
50 – 54	****	******	*******************	**********************************	********
55 – 59	****	*****	**************************	**********************************	*****
60 – 64	***	*******	********************	*******************	********
65 – 69		***********	**************	*****************	
70 – 74	*	*****		**	
75 – 79	o	***	***	o	o
80 – 84	o			oo	o
85 – 89			ooo	ooooo	o
90 – 94		o	oooo	oooooo	
95 – 99			ooo	ooo	
100-104		oooo	oooooooo	oooo	o
105-109			ooooooo	o	oo
110-114	o	o	ooo	oooo	
115-119	ooo	o	ooo	oo	o
120-124	o	oooo	ooo		o
125-129					
130-134					o
135-139		o			
140-144			ooo	+	
145-149		o	o		
150-154		oo			
155-159					
160-164		o	o		
165-169					
170-174			o		
175-179				+	
210-215			+		

Scott Creek (continued)

	Big Creek	Site 2	Site 7	Sites 9/11	Mill Cr
	------------------------------	------------------------------	------------------2008---------	------------------------------	------------------------------
30 – 34			**		
35 – 39	**	*	***	***	**
40 – 44	***	*******	***************	********	***
45 – 49	**	*********	*****************	***********	*****
50 – 54	******	*********	***********	********************	******
55 – 59	******	*********	*****	*******	***
60 – 64	********	*****	*******	*****	
65 – 69	***	***	**	**	
70 – 74	***			***	o
75 – 79	*		oo	ooooo	oooo
80 – 84				ooo	oo
85 – 89	o			ooooo	ooo
90 – 94	o		oo	ooooo	oo
95 – 99			oo	oooooo	ooo
100-104			oo		o
105-109	o	oo		ooo	oo
110-114			o	o	o
115-119					
120-124				o	
125-129					
130-134				+	
135-139					
140-144		o			
145-149	oo				
165-169					+

Scott Creek (continued)

	2007						
	Sites A & 1	Sites 2 & 3	Site 4		Site 5	Site 11	Mill Cr.
	Steelhead	Steelhead	Steelhead	Coho	Steelhead	Steelhead	Steelhead
25 – 29		1				1	
30 – 34		****13			2	**6	*3
35 – 39	**8	*****17	****12		*4	****13	****12
40 – 44	***11	***********34	***11		***9	****14	******18
45 – 49	********24	*************40	*****17		***9	*****16	****13
50 – 54	*******21	***********33	*****16		*4	****13	**8
55 – 59	**********30	*******21	**8		**7	**6	*5
60 – 64	*****16	**8			2	2	1
65 – 69	***10	*4	1		1		
70 – 74	*4		o				
75 – 79	2	o	ooooooooo			oooooo	o
80 – 84	o	ooo	oooooo		o	oo	
85 – 89	oo	oo	ooooo	o	oo	oo	oooo
90 – 94		oooo	ooooooo	o	oo	oo	o
95 – 99	oooo	ooooo	oooooo		ooo	ooooooo	oo
100-104	oooo	ooooooooo	oo		o	o	o
105-109	ooo	oo	ooo		o	ooo	o
110-114	ooo	o	oo		oo	o	
115-119	o	ooo	o				
120-124	o	o	ooo			o	
125-129	o	o			o		
130-134					o		
135-139	oo						
140-144	o		o				
145-149							
150-154	o						
155-159	o						
160-164							
165-169							
170-174	o						

Scott Creek (continued):

	2006									
	Sites A & 1		Sites 2 & 3		Site 4		Site 5		Mill Creek & Site 11	
	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho
35 – 39					1		2		*5	
40 – 44			*6		***9		*5	*	*****29	
45 – 49			****23		*****17		**11	*	******33	**
50 – 54	*3		*******36		******19		***15	*****	*****26	****
55 – 59	*4		********42		******19	*****	**12	*******	****20	*******11
60 – 64	*****16		*****28	*****	****13	******	*7	*******	*8	******
65 – 69	*******22		**14	**	*5	********	*7		**13	**
70 – 74	*******23	*	**13		*4	***		*	4	o
75 – 79	********25		oooooooo	ooo	oo	* oo	oooo	o	oooooo	
80 – 84	***10	**	oooooo		ooo		oo		oo	o
85 – 89	***9	*	oooo		o	o	ooo		oo	
90 – 94	**8		oo		ooooo				ooo	
95 – 99	*3		oo		oo				oo	
100-104	oo	o	o				o			
105-109	ooooo		oooo		o		o		o	
110-114	o		oo		o				o	
115-119	ooooooo									
120-124	oo		o		o					
125-129			oo		o					
130-134	oo									
135-139	ooo									
140-144										
145-149	oo						o			
150-154	o		o							

Scott Creek (Continued):

	2005						2002	
	Sites A & 1		Sites 2 & 3		Mill Cr. & Site 11		Site 4	
	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho
30 – 34					2		*5	2
35 – 39					*4	1	*6	*5
40 – 44					***10	*5	****1	***16
45 – 49			2	1	***10	********24	****14	*****27
50 – 54	2		******18	1	***9	*******21	**6	*******35
55 – 59	*3		***10	*3	**6	******18	*5	******30
60 – 64	*5		*****16	**7	*3	*****17	2	**12
65 – 69	***11	1	***10	***11		**6		2
70 – 74	***11	2	*4	****12	1	*3	2	
75 – 79	**7	***11	2	*5		1		
80 – 84	2	**6		2				
85 – 89	2	*3		1				
90 – 94	*3							
95 – 99	1							

	2004						1999	
	Sites A & 1		Sites 2 & 3		Mill Cr. & Sites 9-11		Site 4	
	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho
35 – 39			1		*4		*4	
40 – 44	2		***15		*****17		**8	
45 – 49	**7		***18		****14	1	***12	
50 – 54	**7		******32		*****15	*3	******27	**10
55 – 59	******18		***18	1	****13	*3	****18	*******28
60 – 64	***10		*6	*3	**7	***7	****17	****16
65 – 69	****12	*	*9	****13	**7	**4	*6	**9
70 – 74	*5	***	*5	***10		*2	3	**9
75 – 79	**7	*		1				
80 – 84	1							

Gazos Creek:

	2010 Steelhead						
	Site 2	Site 2A	Site 2B	Site 3A	Site 4	Site 5	Site 7
40 – 44							
45 – 49							
50 – 54						****	**
55 – 59		*	**	**	*	*****	*
60 – 64	**	******	****	*	******	********	*****
65 – 69	*	*******	***********	******	***********	***	*****
70 – 74	********	************	*********	***********	*****	*	**********
75 – 79	*********	*************22	*******	**************	*******	*	********
80 – 84	********	*********	*****	*********	***		*****
85 – 89	*****	*****	****	**		o	*** o
90 – 94	*	*	o		o	o	ooo
95 – 99	o	***			oo	oo	* ooo
100-104				o	oo	o	oo
105-109	ooo	o	oo	oo	ooo	o	oooo
110-114	o		o		oo	o	oo
115-119		o					oo
120-124	o		o	o	o		ooo
125-129			o		o		o
130-134			oo		o	o	o
135-139		o			o		
140-144		o					o
145-149					o		o
150-154	o		o				
155-159					o		
160-164					o		
165-169							
170-174							
175-179	+	+ `					
185-189						+	
190-194	+		+				
205-209							+

Gazos Creek (continued):

	Site 2	Site 2A	Sites 2B & 3A	Sites 4 & 7
	----------2009 Steelhead ----------			
40 – 44				
45 – 49			****	
50 – 54			*********	******
55 – 59			**********************	****************
60 – 64		**	********************************	****************
65 – 69		****	*******************	**************
70 – 74	**	****	***********	*****
75 – 79	oo	***	*	oo
80 – 84	oo	***		oo
85 – 89		oo	oooooo	
90 – 94	oooo	o	oo	ooo
95 – 99		o	oo	ooo
100-104	oo	o	oooo	o
105-109			ooo	o
110-114			ooooooo	ooooo
115-119	o	o	o	o
120-124			oooo	
125-129			o	o
130-134			o	
135-139		o		
140-144				
145-149				oo
150-154				
155-159			+	
160-164		o		+
165-169				
170-174				
175-179				+
200-204				+

Gazos Creek (continued)

	2006			2007		
	Steelhead			Steelhead		
	Site 2	Sites 2B & 3A	Sites 5 & 7A	Site 2	Sites 2B & 3A	Site 5 & 7A
30 – 34					4	
35 – 39					*8	
40 – 44					**11	*3
45 – 49			1		**12	*3
50 – 54			**7		****21	*******22
55 – 59	**5	*6	***9	*3	****20	*****17
60 – 64	***7	*9	**7	**4	***16	********24
65 – 69	**4	******33	*5	***6	**12	***11
70 – 74	**4	*****25	1	**5	**14	2
75 – 79		****23	2		2	1
80 – 84		***15	1			1
85 – 89		*9	1			

	2002				2005			
	Site 1		Site 4		Sites 1 & 2		Site 4	
	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho
30 – 34			1				1	
35 – 39			**7				2	
40 – 44	1		****14				*9	
45 – 49	**7		******18	1			***18	
50 – 54	****14	2	**6	****12			****20	*3
55 – 59	******19	***11	*3	****13	*5		***15	**7
60 – 64	***11	***10		****12	***16		**10	**8
65 – 69	*5	**6	1	**6	****20	***9	*6	**7
70 – 74	2	*3		1	***15	****12	*3	1
75 – 79		1		1	*7	2		
					1	1		

Waddell Creek:

	2010				
	Main Stem Sites 1,2,3	Main Stem Sites 4,5,6	West Fork Sites 8 & 9	East Fork Site 7	East Fork 0.5 mile
35 – 39				**	
40 – 44			*		*
45 – 49			**************	******	***
50 – 54			***************************	**	*********
55 – 59		******	***************************	*****	**********
60 – 64	**	*********	***********************************	****	*******
65 – 69	*********	**************	*************	******	**
70 – 74	********	************	******	***	*********
75 – 79	************	****************	********		*
80 – 84	**************	********	***	*	*****
85 – 89	***	*******	o	**	*
90 – 94	*******	******		*	*
95 – 99	*******	****			*
100-104	* o	***			
105-109	o		o	o	
110-114		o	o	o	
115-119			o		o
120-124			o		
125-129		o	o		
130-134	o	o		o	
135-139		o			
140-144					
145-149					
150-154		o		oo	
155-159					
160-164	o				
165-169					
170-174					
175-179					
180-184					
185-189		+			
200-204					
210-214		++			
260-264	o up from lagoon				

Waddell Creek (continued):

	---------------2009---------------				
	Main Stem Sites 1,2,3		Main Stem Sites 4 & 6	West Fork Sites 8 & 9	East Fork Site 7
	Steelhead	Coho			
40 – 44				*	*
45 – 49	***		*	*******	**
50 – 54	*****		****	*****	****
55 – 59	************		******	********************	******
60 – 64	********		******	******	*****
65 – 69	*****		***	********	*
70 – 74	****		****	***	
75 – 79	*** o	**	****	****	**
80 – 84	** o		***	ooo	
85 – 89		*			
90 – 94	oo	*	o	oo	
95 – 99				o	
100-104					
105-109	o		o	o	
110-114	o		o		o
115-119					
120-124	o				o
125-129					
130-134				o	
135-139				o	
140-144	o				
145-149					
150-154					
155-159					
160-164	o				
165-169					
170-174			+	+	
175-179			+		
180-184	o				
200-204	* moved up from lagoon				
230-234	*				

Waddell Creek (Continued)

	2008			2007			
	Sites 1-6	Sites 8-9		Sites 1-5		Sites 8-9	Sites 7A&B
	Steelhead	Steelhead	Coho	Steelhead	Coho	Steelhead	
30 – 34						*3	1
35 – 39	*5	*******21		*3		****12	2
40 – 44	*******21	**********30		***9		**********32	*4
45 – 49	***********35	************38		*4		*********27	**7
50 – 54	******20	************38		***11		*******22	2
55 – 59	******20	*********28		***9		*****17	**6
60 – 64	****12	**6	******	****12		***11	**6
65 – 69	****14	**8	******	**8	**	**6	*3
70 – 74	***9		*	***9	*	*3	2
75 – 79	*3			**7			
80 – 84	*4			*4			1
85 – 89	2			*5			
90 – 94	1			2			

	2006			2005			
	Sites 1-5	Sites 8-9	Sites 7A&B	Sites 3, 4 & 5		Sites 9, 10 & 11	
				Steelhead	Coho	Steelhead	Coho
35 – 39			1			1	
40 – 44		2	**4			**12	
45 – 49		**13	****8			********40	
50 – 54		*******37	*******14	2		***********59	*3
55 – 59	*3	******34	**5	*3		*********47	***11
60 – 64	*2	*****25	****9	***10	2	*****29	******20
65 – 69	***7	*8	*2	***10	***9	***17	*********28
70 – 74	1	2	**7	****13	****13	**14	******18
75 – 79	*2		1	**7	***9	4	****12
80 – 84	*2		1	*5	2	3	2
85 – 89	*2			**6		1	
90 – 94	1			*5		2	
95 – 99	1			*3			

Waddell Creek (continued)

	2004				2002			
	Sites 3, 4 & 5		Site 10		Sites 2 & 3		West Fork Sites 9-11	
	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho	Steelhead	Coho
30 – 34			1				2	
35 – 39			*5				2	
40 – 44	3		*6				**17	
45 – 49	**11		*****28			1	*******44	**6
50 – 54	****23		***19			*3	*********54	***10
55 – 59	*******37		***19		2	1	*********58	*****17
60 – 64	*****27	***	**12	1	**13	**6	****29	******20
65 – 69	***15	**	*7	****8	******24	*5	**13	*******24
70 – 74	*6	*******	*5	****9	**14	*3	**16	*****15
75 – 79	3	****		2	**13		5	***9
80 – 84	4	**		**4	**13		1	1
85 – 89					*9			1
90 – 94					*9			
95 – 99					3			
100-104					2			