UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404

August 3, 2016

Refer to NMFS No: 150307WCR2016AR00269

Barbara Evoy, Deputy Director
Enforcement Unit 5, Division of Water Rights
State Water Resources Control Board
1001 I Street, 14th Floor
Sacramento, California 95814

Dear Ms. Evoy:

Thank you for requesting technical assistance from NOAA's National Marine Fisheries Service (NMFS) to develop a flow recommendation for Stanshaw Creek that will protect listed coho salmon and their habitat and other important aquatic ecosystem functions. Stanshaw Creek, a tributary to the Lower Klamath River, supports Southern Oregon/Northern California Coast (SONCC) coho salmon (*Oncorhynchus kisutch*) evolutionarily significant unit (ESU) (70 FR 37160, June 28, 2005) and SONCC coho salmon ESU critical habitat (64 FR 24049, May 5, 1999) designated under the Endangered Species Act (ESA) (Figure 1). Stanshaw Creek is a critical cold water tributary to the Klamath River. Protecting low flow has been identified in the SONCC coho salmon recovery plan as a priority in the Klamath River for coho salmon recovery (NMFS 2014). In addition to listed coho salmon, Stanshaw Creek also supports amphibians and other aquatic life.

In 2001, NMFS submitted a water right protest to the California State Water Resources Control Board, Division of Water Rights (Division of Water Rights) in response to the Marble Mountain Ranch application for an appropriative water right from Stanshaw Creek. The NMFS protest letter identified a minimum bypass flow protective of coho salmon and their critical habitat. Since the original application and NMFS protest, the Division of Water Rights completed the *Division of Water Right Report of Inspection, Registration: D030945*. The inspections occurred on December 17, 2014 and February 12, 2015. The Division of Water Rights investigated the water right and found that the Marble Mountain Ranch has a pre-1914 right to divert up to 3.0 cubic feet per second (cfs). In addition to this finding, the Division of Water Rights also described the Marble Ranch diversion as "a potential waste and unreasonable use of water, an unreasonable method of withdrawal, and a harm to public resources." The Division of Water Rights requested assistance from the California Department of Fish and Wildlife and NMFS to establish a bypass flow on Stanshaw Creek that is protective of listed coho salmon and riparian ecology, both of which are considered Public Trust Resources.

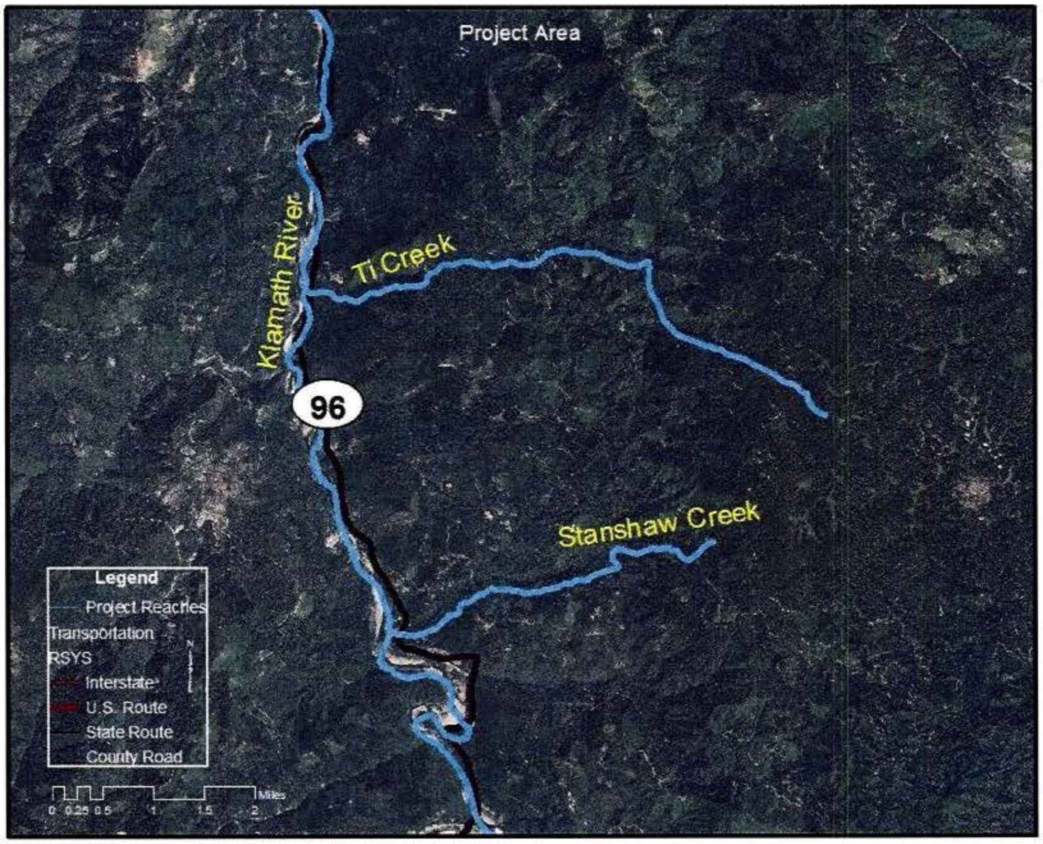

Figure 1 Stanshaw Creek Diversion Project Area.

Importance of Stanshaw Creek Flows to Coho Salmon and Stream Ecology

Juvenile coho salmon and other salmonids in the Klamath River rely on the cold water refugia provided by off channel habitat and tributaries such as Stanshaw Creek (NMFS 2014). When the mainstem Klamath River temperatures rise and flows recede, juvenile coho salmon seek cooler off-channel habitat where they may remain throughout the warm season (May through October). The off-channel pond at the Stanshaw Creek confluence with the Klamath River provides important rearing habitat for juvenile coho salmon, as well as for Chinook salmon and steelhead. In the Klamath River, mainstem temperatures can range from 21 – 27 °C in July and August with daily extremes as high as 29.5 °C (Belchick 1997, Bartholow 2005). Preferred temperature ranges for juvenile coho salmon rearing have been reported from 11.4 - 14.6 °C (Brett 1952, Coutant 1977, Beschta *et al.* 1987) with lethal temperatures occurring at 25.8 °C (Beschta *et al.* 1987) and cessation of growth at a temperature of 20.3 °C (Brett 1952, Reiser and Bjornn 1979). Besides directly causing physiological stress, elevated water temperatures in the Klamath River are correlated with an increased prevalence of diseases, including *Ceratonova shasta,* that cause mortality in Klamath River coho salmon (Hallett *et al.* 2012, Ray *et al.* 2012)

The flow volume in Stanshaw Creek is important during the late spring and summer to provide attraction flow and access for juvenile coho salmon and other salmonids to cold water refugia. Access to tributaries becomes increasingly important as water temperatures in the Klamath River begin to reach levels that cause stress and limit juvenile coho salmon growth, typically starting in mid-May and continuing through October (Bartholow 2005, Belchik 1997). Water temperatures lethal to coho salmon and other salmonids occur in the mainstem Klamath River in July and August, reaching exceedence levels of over 50 percent (Asarian 2013). As such, coho salmon and other salmonids need access to cold water tributaries before the mainstem water temperature reaches stressful or lethal levels if they are to survive in the Klamath River.

The connectivity between the Klamath River and the off-channel pond and stream is most important to coho salmon in this warm transition period, but coho salmon may continue to use the mainstem Klamath River for feeding opportunities even as the mainstem reaches lethal levels during some portions of the day. Witmore (2014) documented a daily migration pattern of juvenile coho salmon from Tom Martin Creek (a coldwater tributary) into the mainstem Klamath River, presumably to access food resources. This migration pattern continued throughout the summer as flows from Tom Martin Creek created a cold water plume in the mainstem Klamath River.

In addition to access to Stanshaw Creek, streamflow from Stanshaw Creek is important for coho salmon after flows recede below the point of connectivity to the Klamath River. The low flow in Stanshaw Creek maintains the off-channel pool water quality and provides a source of food supply to the pool.

Stanshaw Creek Stream Flow Estimate

The Stanshaw Creek watershed is almost 100% forested and flows in a westerly direction to its confluence with the Klamath River. The watershed area is 4.3 square miles above the confluence with the Klamath River and approximately 4.0 square miles above the point of diversion (POD). A diversion ditch runs from the POD on Six Rivers National Forest land to the Marble Mountain Ranch. Stanshaw Creek is ungagged, therefore, the low flow hydrograph was estimated by correlation with USGS hydrographic data for Ti Creek, located in a 9.46 square mile watershed to the east of Stanshaw Creek. The streams are expected to have a similar hydrologic response because of their similar size, elevations, vegetation, geology, soil type, and both flow in a westerly direction into to the Klamath River.

Daily average stream flow for Stanshaw Creek was estimated by prorating the Ti Creek flow data with the proportional watershed area (*i.e.*, $Q_{Stanshaw} = Q_{Ti} \times \frac{Area\ Stanshaw}{Area\ Ti}$). Table 1 lists the estimated minimum 7-day average flow for each low flow month and year. Based on this calculation, Stanshaw Creek has an estimated average annual flow of 10.1 cfs and an average 7-day minimum low flow of 2.6 cfs at the point of the Marble Mountain Ranch diversion. The lowest flow typically occurs in October though the estimates show that streamflow begins to recede toward low flow as early as May and the lowest flow may occur as late as November.

Table 1 Stanshaw Creek annual minimum 7-day average streamflow estimates based on prorating the Ti Creek flow data by proportional watershed area.

Minimum of 7-day average per year						
month	1960	1961	1962	1963	1964	Min. for month
May		11.3	4.7	14.1	7.6	4.7
June		6.3	4.6	8.9	5.2	4.6
July		4.2	3.2	5.7	3.9	3.2
August		3.5	2.8	4.3	3.3	2.8
September		3.2	2.5	3.9	2.7	2.5
October	2.4	3.2	1.5	3.5		1.5
November	2.7	3.7	1.3	4.9		1.3
December	5.1	4.7	9.1	8.0		4.7
Min. for year	2.4	3.2	1.3	3.5	2.7	1960-1964 Overall min. = 1.3 cfs Average annual min. =2.6 cfs

The Ti Creek daily streamflow record used for these estimates spans only four years (WY 1961-1964). Therefore, the Ti Creek data was further assessed to ensure that the period of record for Ti Creek did not represent an abnormal period of record for stream flow.

The water year type during the 1960 through 1964 period was evaluated by comparing to the full record of nearby longer term gages that included the many years before and after the 1960-1964 period. The gages used for comparison and their period of record are listed in Table 2.

Table 2 Period of record of long term gages near Stanshaw and Ti Creek.

USGS Stream gage	Period of record evaluated
# USGS 11521500 INDIAN C NR HAPPY CAMP CA	1957-2014
# USGS 11523000 KLAMATH R A ORLEANS	1927-2015
# USGS 11522500 SALMON R A SOMES BAR CA	1929-2015

Figure 2 shows the annual minimum 7-day average flow per square mile for the available stations. The figure includes the Stanshaw Creek estimates for 1960-1964. The data indicate that watershed area is negatively correlated with low-flow per square mile where there is a higher minimum flow per square mile in the smaller watersheds. The watershed area of Ti Creek is two orders of magnitude smaller than Indian Creek, which is reflected in the much higher minimum flows per square mile. Despite the differences in minimum low flow based on watershed size, the low flow for the all gages follow a similar pattern from year to year which helps verify that the streams have a similar hydrologic response based on the water year type. Redwood Creek, which is located on the coast of Northern California near Orick, is included on the figure to show that inland Klamath River streams have a higher and more constant low flow per square mile than the coastal streams.

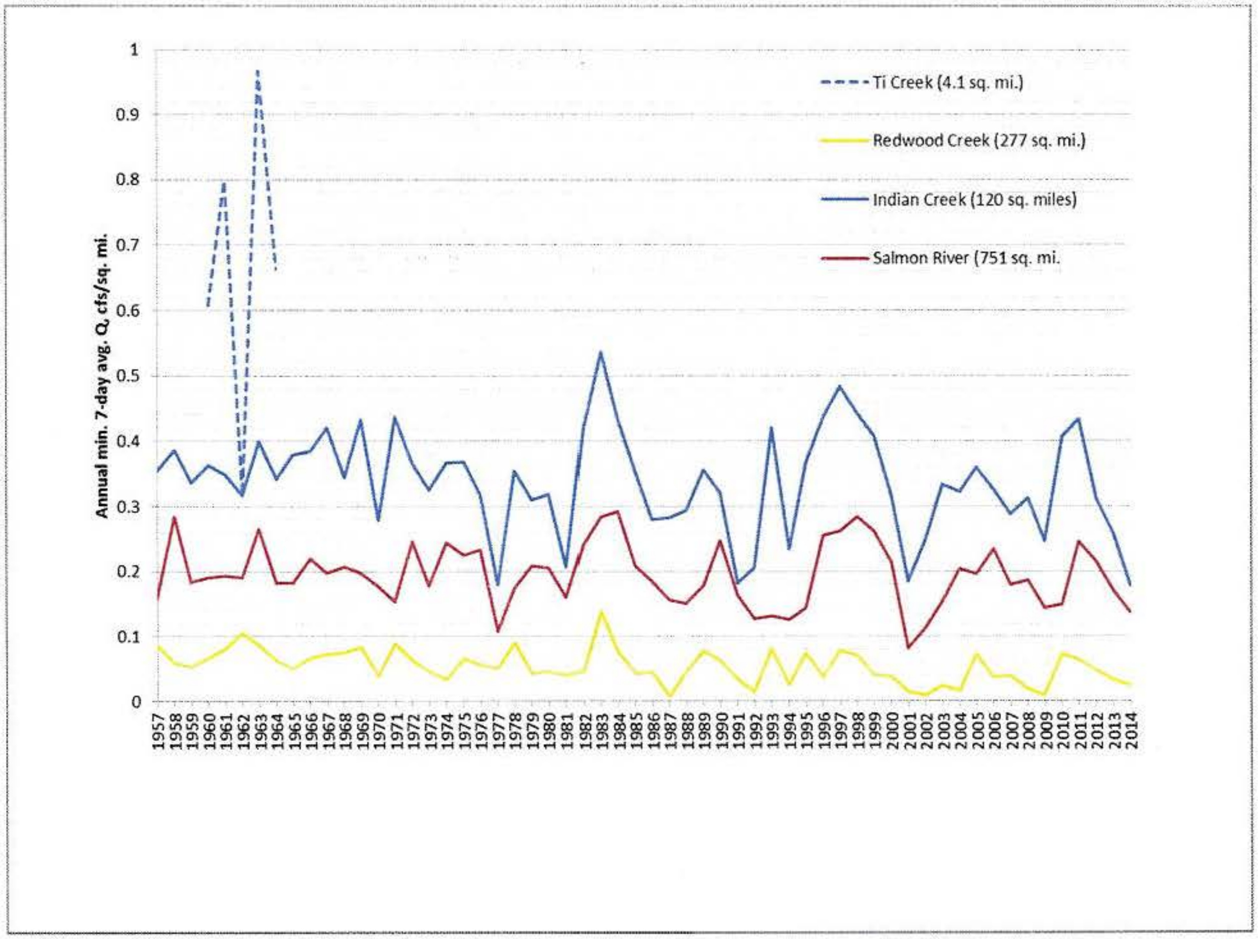

Figure 2 Comparison of annual minimum of 7-day average flow per square mile.

Flow duration curves were developed for the annual minimum 7-day average flow for each of the gages (Figure 3). The annual minimum 7-day average stream flows for 1960 through 1964 period are highlighted on each duration curve, and show the 1960 through 1964 period represents a range of moderate years in the low flow season. A flow duration curve for Redwood Creek is included on

Figure 3. Redwood Creek is located in the coastal range where snow has a much smaller effect on the hydrology and the geology is different. The figure helps verify that the hydrologic response of the inland streams is relatively similar, while the coastal Redwood Creek is different. The inland gages tend to have less variation at low flow from year to year. Figure 2 and Figure 3 work together to demonstrate that Stanshaw Creek has a similar hydrologic response as the other Klamath River watershed gages and that the 1960-1964 period represent moderate flow years and not an abnormal period of record.

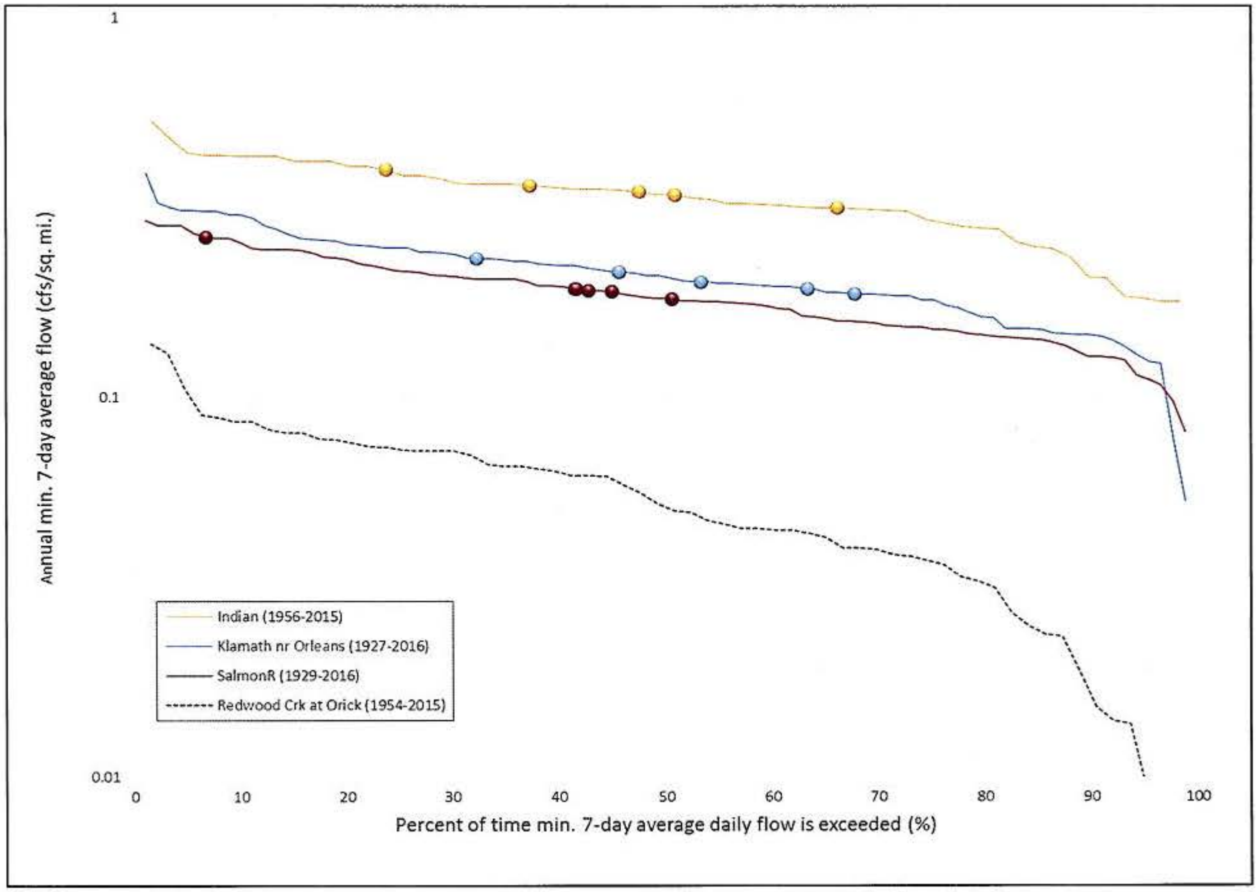

Figure 3 Annual Minimum 7-day average exceedence curves for long-term stream flow gages near Stanshaw and Ti Creek with years 1960-1964 marked.

Streamflow was measured in Stanshaw Creek several times from 2001-2014 above the POD (Table 3). Flow measurements were taken during low flow, but not necessarily at the lowest flow of the year. Two measurements were taken in 2012 showing a 0.5 cfs recession from September to October. Assuming recession at this rate from September to October, the lowest annual minimum flow for Stanshaw Creek in 2003 would have receded to 1.9 cfs, and the average of the years measured would have been 2.2 cfs. The average and minimum of the measured values are similar to the calculated average of 2.6 cfs and minimum of 1.3 cfs for Stanshaw Creek shown in Table 1 when using Ti Creek as a reference stream. The minimum flows of Salmon River and Indian Creek for each year from 2001 through 2014 are shown in Figure 4. From the Indian Creek and Salmon River comparison in Figure 4, the measured flows from 2001-2014 likely span a full range of water year types. Therefore, NMFS is confident that using Ti Creek hydrologic data prorated by proportional watershed area provides a viable surrogate to estimate low flows for Stanshaw Creek for wet through dry years.

Table 3 Stanshaw Creek flow measurements at the POD

Date	Stanshaw Creek flow above POD (cfs)	Measured by
9/4/2003	2.4	Orleans RD
9/13/2011	3.2	Karuk
9/20/2012	2.5	NMFS
10/4/2012	2.0	Orleans RD

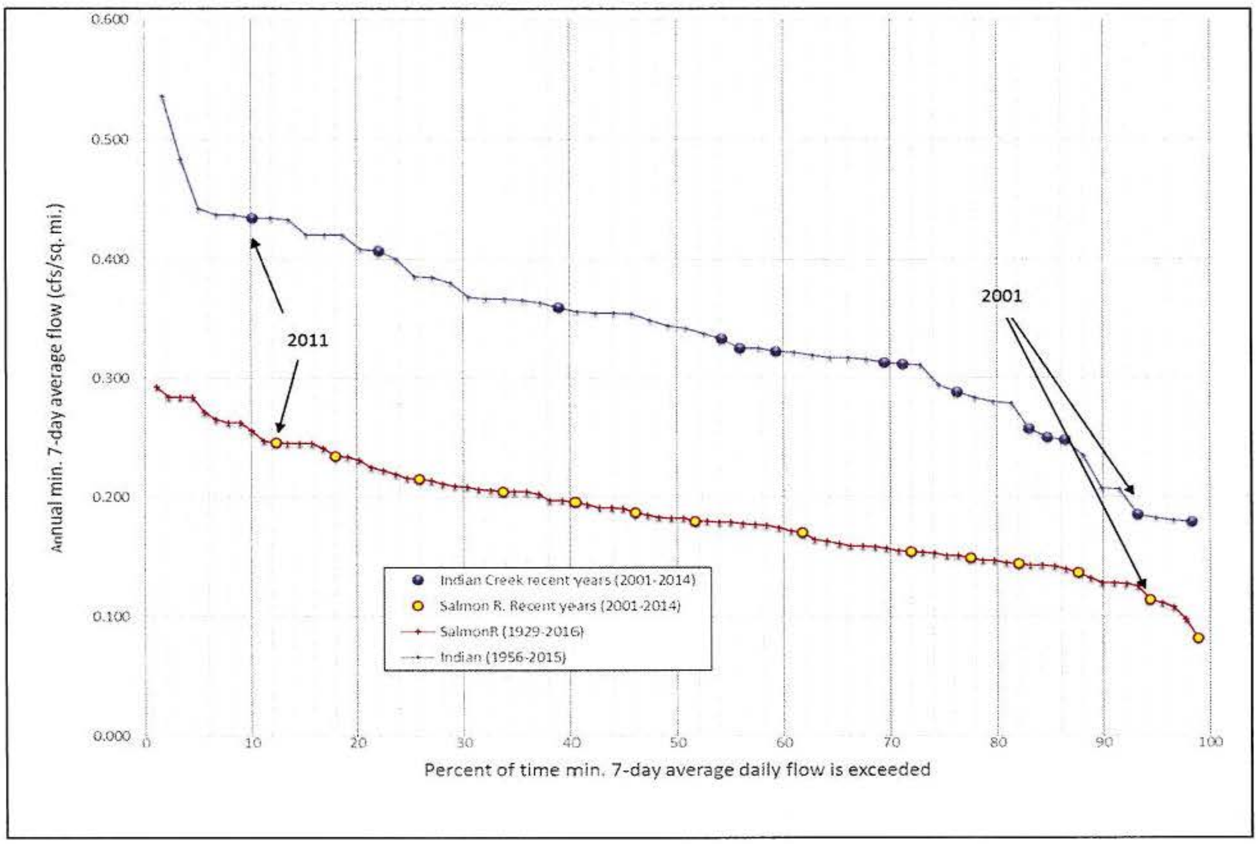

Figure 4 Data points for recent years are highlighted on the Salmon River and Indian Creek annual minimum 7-day average flow duration curve. The data show that 2001-2015 contained a full range of summer low flow from above average in 2011 to very dry in 2001.

Instream flow recommendation

The Marble Mountain Ranch diversion from Stanshaw Creek consists of both consumptive and non-consumptive use. The consumptive diversion is used to provide domestic and irrigation water for the Marble Mountain Ranch owners and business. The non-consumptive diversion is used to generate hydroelectric power. Currently, the diversion for hydroelectric generation is routed out of Stanshaw Creek watershed and discharged into Irving Creek, a tributary to the Klamath River to the west of Stanshaw Creek.

NMFS recommended bypass stream flow for the Marble Mountain Ranch diversion on Stanshaw Creek is based on an unimpaired hydrograph and includes rerouting the non-consumptive use back to Stanshaw Creek. Stanshaw Creek watershed is almost 100% forested with two small upstream diversions that State Water Board determined to be insignificant for this analysis. Based on this assumption, Stanshaw Creek streamflow just above the point of diversion is considered unimpaired for this bypass flow recommendation.

"Unimpaired hydrograph" is the term used to represent the hydrograph that should exist without diversions. The distinction between the term "unimpaired hydrograph" and the "natural hydrograph" (with no human caused alterations) is made to acknowledge that there may be human caused watershed-wide changes (*e.g.*, roads, vegetation changes, human caused climate change) that have also altered the natural hydrograph, but are not in direct control by the water users.

Reductions in the various components of the unimpaired hydrograph are assumed to correspond to reductions in stream habitat (Richter *et al.* 1996, Poff 1997). While any diversion may have an impact, a diversion of only a small percentage of unimpaired flow will maintain the natural variability of the hydrograph. A variable diversion rate that maintains the natural shape of the hydrograph is preferred over a minimum bypass flow recommendation that would flatten the receding part of the annual hydrograph. Diversions that "flatline" the receding part of the hydrograph, as is the case with a single bypass flow recommendation, will negatively affect juvenile fish outmigration as well as the quality of juvenile rearing habitat when their growth rate is high. Fish size is a critical factor in coho salmon smolt survival when migrating into the ocean (*Holtby et al.* 1990).

By analyzing case studies where ecologic goals were used to set the magnitude of water diversions, Richter *et al.* (2011) found that diversions limited to 6-20% of the unimpaired flow provided protection to the riverine ecology. For a high level of protection, the study suggested a presumptive standard of no more than a 10% diversion. A high level of protection is defined as minimal change to the natural structure and function of the riverine ecosystem. Klamath River SONCC coho salmon have a critical need for the cold water refugia provided by Klamath River tributaries such as Stanshaw Creek throughout the low flow season. Any loss of cold water during this time would decrease the quality and function of habitat. Because of the critically high summer Klamath River water temperatures, NMFS recommends a bypass flow that maintains at least 90% of the unimpaired flow. In addition to the critical need for cold water refugia in the Klamath, other considerations in setting this high standard for a bypass flow is that the actual flows at the point of diversion may already be somewhat impaired by existing and past land use, unaccounted diversions, and changing climate. Also, streamflow measurements used to direct the diversion could have measurement errors which may result in unintentionally diverting a higher percentage of flow.

Since the POD is above the anadromous reach, an additional non-consumptive diversion for hydropower generation may occur in the reach between the POD and upper limit of anadromy provided that a minimum bypass flow is maintained in this reach to protect the low flow channel and edgewater important for macro-invertebrate production. An additional requirement is that the non-consumptive portion of the diversion is returned to Stanshaw Creek at the upper limit of anadromy and that the stream water temperature remains consistent with the stream temperature above the diversion to maintain the low temperature benefit of the cold water refugia.

There is no single flow identified as the flow that maintains connectivity of Stanshaw Creek and the Klamath River since the connection depends on site features that vary with each water year (*e.g.*, groundwater flow, water level in both the Klamath and Stanshaw Creek, and the size of the sediment berm at the confluence). Taylor (2015) estimated a Stanshaw Creek flow of 1.3 cfs when the pond was not connected to the mainstem on November 17, 2014. The lowest flow in Stanshaw Creek that ensures connectivity is probably between 2.0 and 3.0 cfs considering the annual variation in the groundwater and berm configuration. Depending on the water year type and associated timing of the spring recession period, there is a large range of the annual 7-day low flow minimum and maximum from May through October which is the beginning and end of the warm season. For the moderate water year types analyzed, the pond may become disconnected by late July or the flow may stay connected to the Klamath throughout the low flow season during a wet year. Although connection to the pond would be beneficial at all times, it is most important at flows that occur in May and June as the Klamath River temperatures begin to rise when juvenile coho salmon are seeking refuge in the cooler water. Based on the flow analysis, an unimpaired Stanshaw Creek should stay connected to the Klamath River throughout May and June in all but the driest years.

Each component of the receding hydrograph has an important biological role to provide good water quality to the Klamath River, to provide an attractive flow and access for juvenile coho salmon to Stanshaw Creek and the off channel pond before temperatures rise in the mainstem, and to maintain good water quality and food supply to the pond and Stanshaw Creek throughout the low flow period. Flows need to be conserved on wet years to provide the tributary connection, improved water quality, and cold water attractive flow into the Klamath. Flows need to be conserved on dry years to maximize the water quality and food supply to the off-channel pond and cold water seep to the Klamath. Because of the thermal sensitivity and connectivity needed throughout the summer, the Marble Mountain Ranch diversion should be limited to zero or a small fraction of the flow as the flows recede and water temperatures rise. NMFS recommends that no more than 10% of the estimated unimpaired flow be diverted from Stanshaw Creek up to the limits of anadromy, throughout the low flow season, regardless of the water year to ensure water quality and food supply is maintained for the over-summering coho salmon in the pond. By design, a 10% diversion will decrease in size as the flow decreases. For example, as the flow drops from 3 cfs to 2 cfs the allowable diversion would decrease from 0.3 cfs to 0.2 cfs. As discussed previously, diversions of 10% or less of the unimpaired flow are considered to be protective of stream ecology (Richter *et al.* 2011).

The upper reaches of Stanshaw Creek provide important macro-invertebrate production and a food source to the Klamath River, the off-channel pond, and the anadromous reach of Stanshaw Creek. The topography of five cross sections were surveyed in 2002 in the reach above the Highway 96 culvert, above the assumed upper limit of anadromy. Hydraulic analyses of the five cross sections demonstrate the changing channel width as the flows recede. Figure 5, Figure 6, and Figure 7 show an inflection in the water surface width as the flows drop between about 1.5 to 2.0 cfs for three representative cross sections (the other two cross sections are more affected by assumed boundary conditions in the hydraulic analysis). The inflection on the curve represents the point where the wetted channel width drops off relatively quickly with flow. Maintaining a flow above the inflection point is important to protect macro-invertebrate production and to provide a minimum level of edge water rearing area. Based on this analysis, a two cubic feet per second bypass flow should protect the edge water in the reach between the POD and the upper limit of anadromy. The minimum bypass of 2.0 cfs at the POD assumes a that the non-consumptive diversion of up to 3.0 cfs will be returned to Stanshaw Creek above the upper limit of anadromy. Even with 2.0 cfs minimum bypass flow, NMFS anticipates natural variation in the bypass flow at the POD as demonstrated on the example diversion shown in Figure 8.

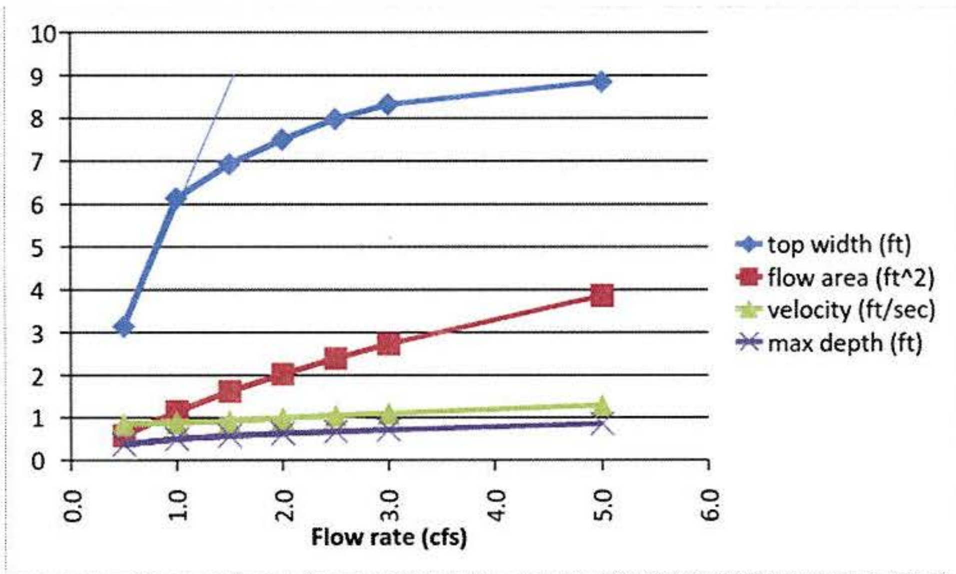

Figure 5 Cross Section 2 of Stanshaw Creek.

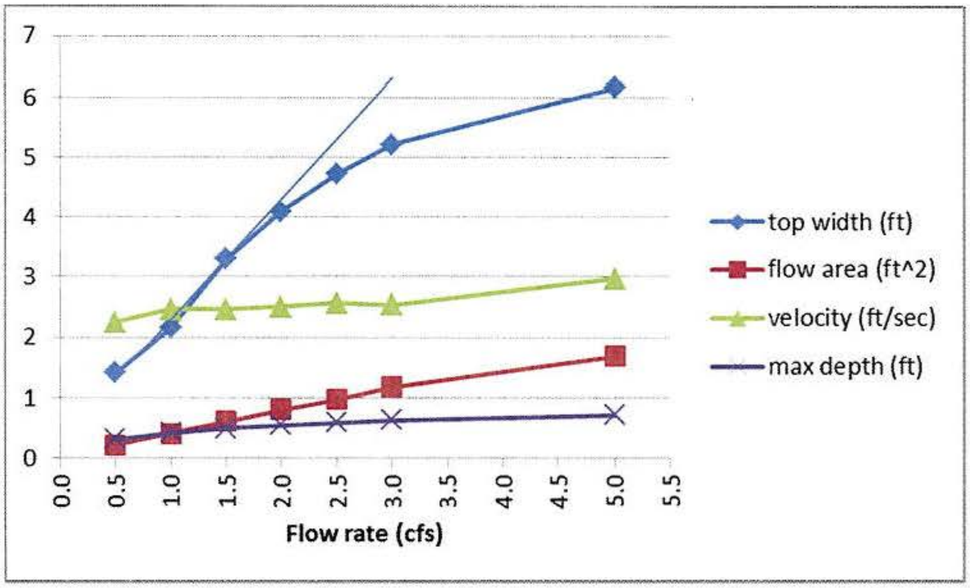

Figure 6 Cross Section 3 of Stanshaw Creek.

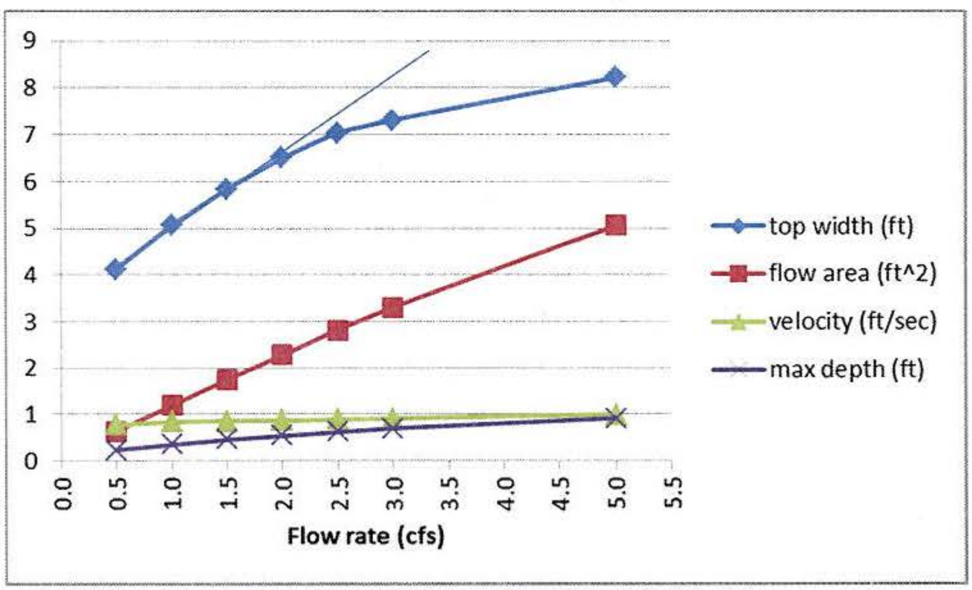

Figure 7 Cross Section 4 of Stanshaw Creek.

In summary, Stanshaw Creek low flows provide critical cold water to the Klamath River and access to cold water, off-channel refugia and food supply during low flow months. A maximum 3.3 cfs diversion that bypasses at least 90% of the unimpaired streamflow into the anadromous reach throughout the year will provide habitat to help conserve and protect listed coho salmon. In reaches above anadromy, a 2 cfs minimum bypass flow will be protective of listed salmonid habitat provided the non-consumptive diversion is returned to Stanshaw Creek with a negligible increase in water temperature. The non-consumptive (*i.e.*, hydropower) diversion is expected to only occur when streamflow is relatively high prior to the low flow season. The non-consumptive diversion is dependent on the ability to use the water and return it to Stanshaw Creek above the anadromous reach while maintaining a minimum of 2 cfs in the stream to maintain important ecosystem functions. The non-consumptive diversion used for hydropower would be limited to the minimum operating threshold of the turbine. After the threshold is reached, the non-consumptive diversion would cease, so the diversion would be limited to consumptive use and a 90% bypass would occur at the POD.

Figure 8 shows an example of the bypass flow recommendation using the Stanshaw Creek daily average stream flow estimates. The figure shows the estimated unimpaired hydrograph for the 1962 recession period and throughout the low flow season, along with the 90% bypass flow after the non-consumptive diversion is returned and the bypass at the POD with a minimum of 2 cfs. Also, shown are the diversions for consumptive and non-consumptive use. Under this bypass flow recommendation, at least 90% of the unimpaired hydrograph is preserved in the anadromous reach. This bypass flow recommendation has a daily variation as the flows naturally recede. If methods to control diversion on a real-time basis cannot be developed, further analysis could be done to establish seasonal diversions that would cover all water year type on a weekly or biweekly or monthly basis to allow manual control of the diversion.

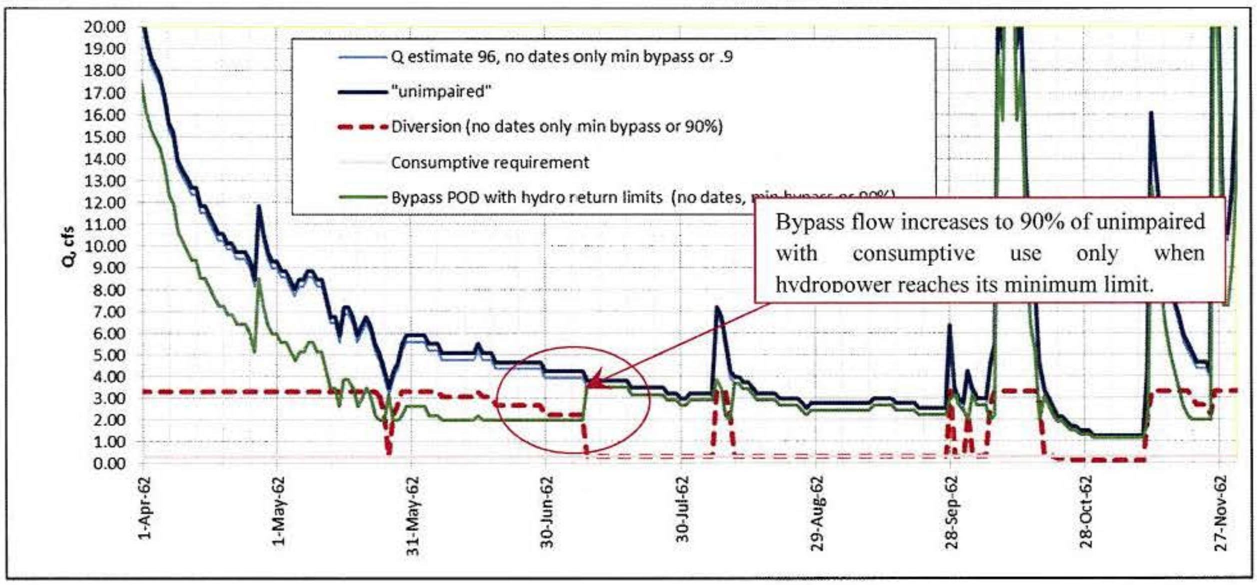

Figure 8 Example of bypass flow recommendation with assumed 0.3 cfs consumptive use and maximum 3.0 cfs non-consumptive use.

Please contact Margaret Tauzer, NMFS hydrologist/hydraulic engineer in Arcata, California at (707) 825-5174 for any additional questions concerning this flow recommendation.

Sincerely,

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

cc: Jennifer Bull, CDFW, Yreka, CA
Neil Manji, CDFW, Redding, CA

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