Testimony of Steve Cramer, Cramer Fish Sciences

I. Background

I am the founder and principle consultant of Cramer Fish Services. I have over 43 years of experience in the design and analysis of research efforts to resolve fishery issues related to fish passage at dams, stream habitat productivity, hatchery supplementation, and harvestable surplus. I attended Oregon State University, where I received a Bachelor of Science and a Master of Science in Fisheries Science. I then served 14 years with the Oregon Department of Fish and Wildlife ("ODFW"), where I directed major research programs on salmon and steelhead populations in the Rogue and Columbia basins. I founded Cramer Fish Services in 1987, and served as lead scientist and President until 2010. I have continued in my role as a senior scientist, although I retired in late 2016, and now work a somewhat reduced schedule.

I have authored numerous peer reviewed journal articles and over 130 reports on a variety of fishery topics. The focus of my research and consulting work has been the quantitative analysis of population dynamics for salmon and steelhead. This research has included determining the probability of extinction and methods of prevention, effects of environmental variation, impacts of flow and stream habitat alteration, interactions of hatchery and wild fish, impacts of harvest, and solutions for passing fish around diversions and dams. Through this research, I pioneered the development of several analytical approaches for estimating habitat carrying capacity for fish, survival rate for migrating juveniles, and relative importance of key factors that determine productivity of fish populations. Of particular relevance to ESA-listed Coho salmon in the Klamath Basin, I led a multi-year study under contract to the US Bureau of Reclamation to develop a life-cycle model of Coho salmon production throughout the Klamath Basin. That model, which included tributary populations, was used to simulate the effects of water management scenarios on Coho populations.

II. Review of the National Marine Fishery Services ("NMFS") Recommended Bypass Flow

In anticipation of providing this testimony, I reviewed the NMFS bypass flow recommendation, as outlined in NMFS's August 3, 2016 letter, and available data on flows, temperatures, and habitat conditions for Stanshaw Creek. The review included data and modeling provided by NMFS and the California Department of Fish and Wildlife as well as discussions with the owner and operator of Marble Mountain Ranch, Douglas Cole. NMFS 2016 letter provides reasonable modeling of flow frequencies expected in Stanshaw Creek, but relies on general concepts and assumptions about fish uses as the basis for its recommendation for the magnitude of bypass flows that are needed to protect fish. I find that these concepts and assumptions about fish use deserve more careful consideration against available data. The bypass flow recommendation requires: (1) a minimum 2 cfs bypass flow at the point of diversion; (2) at least 90% of unimpaired flow be returned to the anadromous reach throughout the year; and (3) water not used for consumptive purposes to be returned to Stanshaw Creek with a negligible increase in the water temperature.

Based on my background and experience, I find that some revision of the bypass flow recommendation could achieve the same protection of fishery resources. While the pool that Stanshaw Creek feeds on the Klamath River floodplain provides desirable habitat for a small number of juvenile salmonids, available evidence (including my own site survey) suggests the remainder of Stanshaw Creek provides minimal habitat for salmonids. Further, all evidence suggests that the juvenile Coho in the floodplain pond were not produced in Stanshaw Creek, but rather migrated into the pond from the Klamath River.

I find from the available evidence of sampling and observations in Stanshaw Creek that:

1. I agree that the floodplain pool fed by Stanshaw Creek near its confluence with the Klamath River provides refuge habitat during summer and winter for juvenile salmonids that enter from the Klamath River. As identified by NMFS, the key months during which juvenile salmonids will seek access to this refuge are in the spring during May and June, and again in the fall and winter when streamflows rise in response to rainfall.
2. Access to the floodplain pool should be possible at flows between 2 and 3 cfs and greater. Natural variation in flow will provide substantially more flow than this minimum during multiple episodes in most spring and fall seasons.
3. Access to the floodplain pool in summer provides little added benefit to salmonid populations, because few fish move at that time.
4. Stanshaw Creek is not suitable for spawning of Coho salmon;
5. Stanshaw Creek is unlikely to support a self-sustaining population of steelhead, although small numbers could be supported in some water years;
6. Stanshaw Creek can support a small population of small-sized resident trout;

III. Evidence in Support of Revised Recommendations

In the following, I summarize the evidence I found that supports the above recommendations.

A. Cold Water Refuge

Multiple sampling events have established that the floodplain pool near the mouth of Stanshaw Creek maintains a cooler temperature than the Klamath River, and supports rearing of juvenile Coho through the summer (NMFS 2014; Whitmore 2014, Krall 2014). The number of Coho using these refuges varies between years and between tributaries. Krall (2016) found less than 10 Coho in the Stanshaw pond in summer 2014. Their mean length (110 mm) was larger than in any other seven tributary ponds that were sampled (means ranged 67 to 77mm). In summer 2012, Whitmore (2014) estimated from mark-recaptures that 140 Coho were in the Stanshaw Creek pond.

On October 3, 2017, (this week) I surveyed habitat in the creek and one of my assistants in a wetsuit snorkeled the pond to observe fish. He made two circuits around the pond, swimming very slow so as not to frighten away any fish. He swam near all areas of underwater cover while visibility and lighting were good. He observed 9 juvenile steelhead (age 0+) and 2 Coho (age 0+) on the first circuit. After waiting about 10 minutes, he made a second circuit and counted 15 juvenile steelhead (14 age 0+ and 1 age 1+). Most fish ere in groups and it appeared he saw mostly the same fish on the two circuits. Given the slight variance in counts, it is likely that he observed at least half of the fish present. Thus, the pond likely contained less than 5 Coho and 30 steelhead juveniles.

Data also show that temperatures in the Stanshaw Creek pond have remained suitable for Coho through the summer. The NMFS (2016) letter presents a graph showing the cooler temperatures in Stanshaw Creek (~15C) than in the adjacent main-stem Klamath River (~20C) in summer 2006. NMFS (2014) presents temperatures in summer 2012 for Stanshaw Creek in comparison to other tributaries and the main stem Klamath River, again showing that temperatures in the floodplain pond are maintained similar to those in other coldwater refuges in same area of the Klamath Basin (Figure 1).

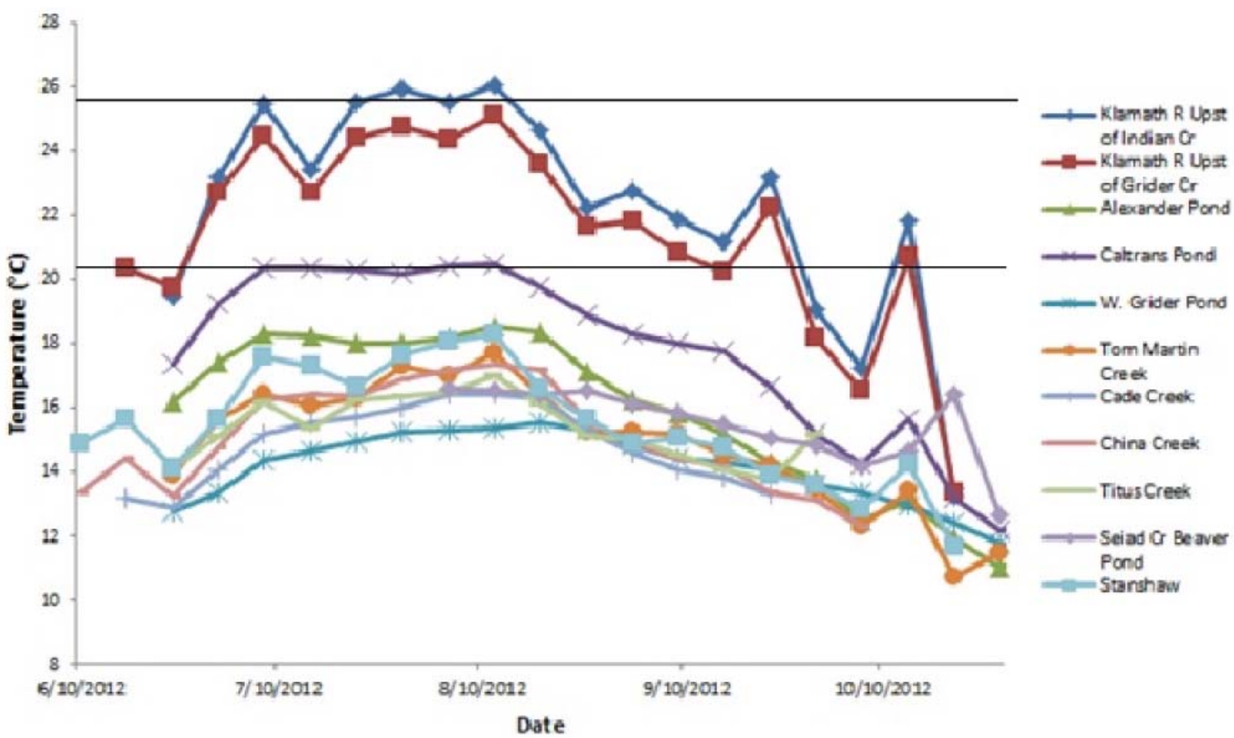

Figure 1. Mean weekly maximum temperatures during summer 2012 in the main stem Klamath River and tributary study sites. Note Stanshaw Creek in light blue is in the range of other small tributaries that provide refuge for juvenile Coho. Horizontal line

at 25.8C represents potentially lethal temperatures and at 20.3C represents cessation of growth. From NMFS (2014)

These observations reflect, as NMFS (2016) describes, that when the main-stem 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). In order for the off-channel habitat to suffice as a refuge, it must sustain suitable temperatures for juvenile salmonids throughout the summer. Available evidence indicates that Stanshaw Creek has met that purpose.

Studies by Witmore (2014) in the summer of 2012 also showed that juvenile Coho in the Stanshaw Creek were rearing in the pond all summer and through the next fall and winter (Table 1). During that extended use of the refuge, the juvenile in Stanshaw Creek showed the greatest growth among the six streams sampled (Figure 2)

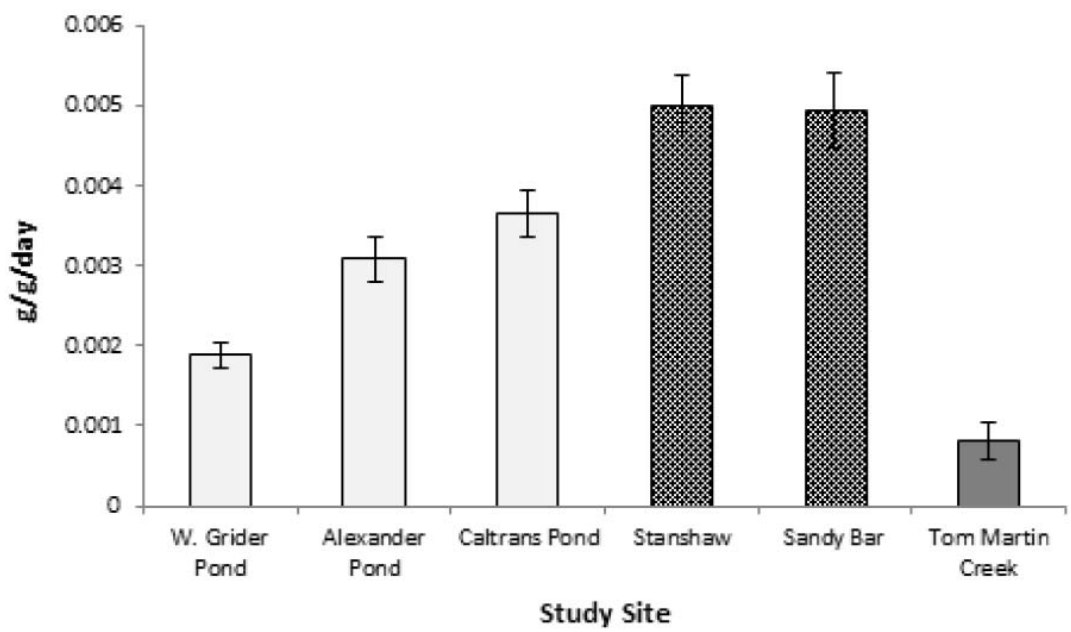

Figure 2. Average growth rates (+/- standard error) for individual juvenile Coho salmon occupying the same habitat both in the summer and winter. Constructed ponds are shown in white, beaver-influenced sites are shown as patterned, and tributaries are shown in gray. (From Witmore (2014)

These past observations were made while water diversions at Marble Mountain Ranch were being operated in their typical manner. These observations show that water temperatures, fish use, and fish growth are on par with other tributaries in the middle Klamath Basin that are providing coldwater refuge habitat to juvenile Coho salmon. Thus, evidence does not indicate that water diversion at the Marble Mountain Ranch has impaired the value of the floodplain pond as a seasonal coldwater refuge.

Table 1. Total number of fish tagged at each study site having both summer and winter occupancy, and the proportion of tagged fish that remained both seasons. (From Whitmore 2014)

Study Site	Total No. Tagged	Total No. Captured Summer & Winter	Proportion Retained Both Seasons
W. Grider Pond	155	45	29%
Alexander Pond	400	52	13%
Caltrans Pond	669	13	2%
Stanshaw	135	13	10%
Sandy Bar	322	6	2%
Tom Martin Creek	450	37	8%

B. Access to the Refuge

Multiple observers have estimated the minimum flow of Stanshaw Creek entering the floodplain pond that will sustain overflow and provide juvenile fish access to the Klamath River is probably between 2.0 and 3.0 cfs. According to the NMFS 2016 letter, the flow required to maintain connectivity to the Klamath River is likely to vary, depending on annual variation in the groundwater and berm configuration. NMFS (2016) concluded, "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."

Similarly, Taylor (2015) found in 2014 when flow entering the pool was 1.3 cfs, there was no outflow, and the outflow sill was approximately 0.1 ft higher than the pond's water surface. Taylor gave a preliminary recommendation that a flow of 2.0-2.5 cfs into the pool would provide outflow sufficient for access by juvenile salmonids.

Maria (2000) measured habitat and sampled fish in Stanshaw Creek on May 25, 2000, and reported that the 2.3 cfs he measured entering the pool, "appears to provide the needs of juvenile steelhead at this time but is close to the minimum flow required to maintain fish access near the mouth."

C. Stanshaw Creek is Not Suitable for Coho Spawning

The behavior and life history of Coho salmon is such that they consistently spawn in low gradient streams, quite different from Stanshaw Creek. Taylor (2015) surveyed the Stanshaw Creek from its mouth up to the water diversion in November 2014, and reports, "The first 2,500 feet has a channel slope of approximately 9% and the next 3,000 feet has an overall slope of nearly 11%." Taylor measured 27 habitat units that appeared to provide potential fish habitat, but they comprised only 8.4% of the surveyed reach. Taylor reports that the other 91.6% of the channel, "consisted of high-gradient riffles, step-runs/step-pools, and cascades. The small pools present within the step-runs/step-pools and many of the high-gradient riffles were too short in length to separate out as individual habitat." These are high velocity habitats that are typical of small high-gradient streams, but are highly atypical of the low velocity pool habitats that juvenile Coho strongly prefer. I have not had opportunity to analyze the habitat measurements I made on October 2 and 3, but they will generally agree with the findings of Taylor (2015) that the majority of the stream is fast-water habitat. These habitat features in the stream are a sharp contrast to the large, calm, floodplain pool near the stream mouth.

Further, Taylor (2015) found suitably-sized spawning substrate (gravel patches) at only two locations downstream of Highway 96 culverts (judged impassible), and at three locations upstream of that highway crossing. I took further measurements of any patches of suitably-sized gravel for spawning during my site survey on October 2 and 3, but found none of quality to support salmon spawning. The few patches that were mostly gravel were generally above the water level by 1-12 inches, included greater than 15% fines, and about half of the gravel was angular rather than rounded. Due to the fines and the high velocity of the stream, gravel patches were not loose, but were somewhat cemented in. Substantial inputs of fine sediment and fine gravels was evident from the recent forest fire that burned much of the reach surveyed. Gravel patches were generally sloped laterally to the current, rather than perpendicular, and studies show that salmon avoid spawning on lateral slopes. Regarding spawning potential, Taylor concludes from his survey, "the creek's moderate channel slope and relative lack of suitably-sized substrate diminishes its importance as a significant spawning stream within the Klamath River watershed."

All references I found that reviewed mid Klamath River tributaries in which juvenile Coho have been found did not list Stanshaw Creek as among the tributaries that supported Coho spawning. These references include Corum (2010), Krall (2016), NMFS (2014), and Witmore (2014). Spawning surveys have been conducted in Stanshaw Creek, but no Coho spawners have been observed.

The naturally high stream gradient in Stanshaw Creek is the primary factor driving the lack of suitable habitat for Coho spawning. Montgomery et al. (1999) analyzed the characteristics of stream reaches where several species of salmonids spawn. They found that spawning areas in Pacific Northwest streams could be classified into three gradient categories:

<1%, 1-3%, and >3%. These classifications were useful in predicting species spawning distribution as follows:

>3% correlates with Cutthroat only zone

<1% correlates with the Chinook zone

1-3% correlates with the Coho zone

Further, Montgomery et al. (1999) found that no Coho spawned in step-pool channel types, which is the channel type for Stanshaw Creek (Taylor 2015).

I have previously analyzed the extensive database assembled by ODFW on Coho streams in Oregon, and they affirm the conclusions of Montgomery et al. ODFW invested extensive research in the 1990's to determine what habitat factors describe Coho preferences and to develop a model to predict stream carrying capacity for producing Coho smolts.[1] From their data, the developed the Habitat Limiting Factors Model (HLFM) (Nickelson 1998). The research showed there were consistent differences in smolt densities between channel unit types (e.g. pools, riffles, beaver ponds). Further, the research showed that habitat use by juvenile Coho changed over the course of a year as fish grow and flow conditions change. Average densities were calculated by channel unit type and season for the entire set of study streams combined. Thus, average densities were determined for fry during spring, parr during summer, and presmolts during winter.[2] Pools and beaver ponds were found to support the highest densities of Coho parr during summer, and beaver ponds and alcoves support the highest densities of Coho during winter. This reflects the behavior of Coho to utilize different reaches within a watershed at different times and for different biological functions (i.e., spawning, rearing, etc.).

Because Coho have a specific set of habitat requirements and preferences, there are certain types of streams where they are produced and others where they are not. ODFW follows a consistent protocol for measuring stream habitat (Moore et al. 1997) and has surveyed thousands of stream miles in the Oregon coast range during the 1990s. Their data show that stream gradient (steepness of the streambed) is a useful physical attribute for distinguishing streams likely to produce Coho. I used the ODFW database of habitat surveys, and segregated out the set of streams designated as having Coho present. The habitat data shows that 80% of stream reaches with coho present are under 3% gradient, and about 95% are under 5% gradient. A stream segment or "reach" with a 5% gradient is one that rises 1 foot vertically in every 20 feet of length.

Next, I evaluated what proportion of the total carrying capacity for Coho lies within stream reaches of various gradients. I applied the HLFM model developed by ODFW to the

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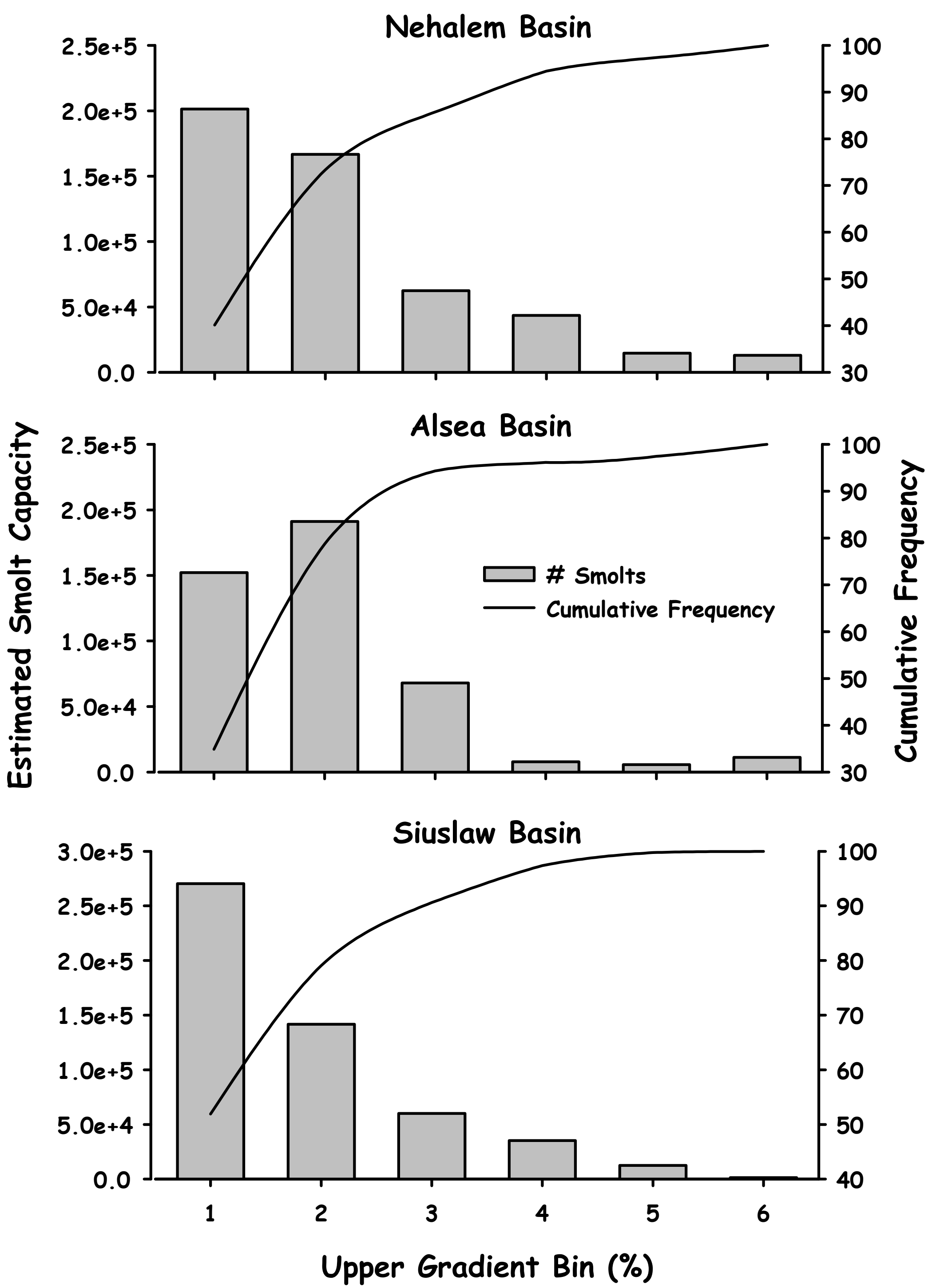
[1] Smolts are juvenile fish that have grown from fry to the point where they are large and mature enough to "outmigrate" from freshwater into the ocean.

[2] When coastal Coho emerge from their eggs in the early winter, they are termed "fry"; by the following summer they grow into "parr". They later develop into what fisheries biologists refer to as "pre-smolts" in the fall and then migrate out to the ocean as smolts in the spring.

habitat measurements in three major basins on the Oregon Coast (Nehalem, Alsea and Siuslaw) to estimate the carrying capacity for Coho. I estimated smolt capacity in stream reaches where Coho were present, and I assumed, as did Nickelson (2001), that the set of stream reaches surveyed were a representative sample of all reaches that support Coho salmon on the Oregon coast. The ODFW database includes habitat survey data for the Nehalem, Alsea, and Siuslaw basins, covering 46%, 59%, and 31% of the stream miles where coho are distributed, respectively. The results of these data show that in each of the three basins, over 85% of the carrying capacity of the stream network to produce coho smolts is located in streams under 3% gradient and over 95% is located under 5% gradient (Figure xx)



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D. Natural flows for ecological function

Figure xx Estimated carrying capacity for coho smolts (based on HLFM) in stream reaches of various gradients in the Nehalem, Alsea, and Siuslaw basins. Habitat data from ODFW Aquatic Inventories Database. All surveyed reaches that have coho present are included.

Bypass Flows in Stanshaw Creek

I realize that limited data available on site-specific circumstances in Stanshaw Creek necessitated that NMFS apply a generalized approach (i.e. Richter et al. 1996) for designing minimum bypass flows. I believe that additional measurement and analysis of stream dimensions and flows can help insure that a minimum flow plan is conceived based upon best scientific evidence that accounts for the site-specific circumstances affecting the quality of aquatic habitat the stream provides in balance with the beneficial use represented by the Cole's water right.

The scientific literature recommending maintenance of a proportional flow regime presents supportive evidence that the strategy can benefit the objective (biological productivity) in many circumstances. That said, the theory is far from validated, and the circumstances that might detract from the theory are not well established, nor have they been thoroughly reviewed. I consider it to be useful default proposition when site specific data are not available as a basis to consider otherwise.

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 circumstances, to ensure water quality and food supply is maintained for the over-summering Coho salmon in the pond. However, as I have previously cited, the available evidence indicates that water temperatures and growth of juvenile Coho has been very good through the summer, during years when water diversions were operated in their typical manner. There is no indication that conditions for Coho rearing through summer stand out as worse than other streams and floodplain ponds in the middle Klamath Basin. Those observations were obtained while that water diversion at Marble Mountain Ranch was being operated in its typical fashion.

Bradford and Heinonen (2008) reviewed the impacts of low flows on aquatic resources in small streams, and the empirical support for methods to predict the effects of low flows. In order to facilitate comparisons among streams, they calculated reductions in flow as a percentage of the mean annual discharge (MAD). Here is their summary of experiments in which flows were experimentally reduced:

> *"A few studies have experimentally reduced flows during the summer low-flow period in small streams and monitored the short-term response of biota to the change. The results of those studies are fairly consistent in revealing little change to invertebrate or fish populations with the diversion of 50-75% of the summer low flows, which leave approximately 10-20% of MAD in the channel (Kraft, 1972; Rimmer, 1985; Nuhfer and Baker, 2004; Wills et al., 2006; Dewson et al.,*

2007). Decreases in abundance or production were observed when most (>75%) of the summer flow was diverted (usually leaving <10% MAD residual flow). The absence of a response in the fish populations were attributed to the relatively small changes in wetted width with flow, and the preference of some of the target species for pool habitats, which are little affected by flow reductions (Kraft, 1972). Nuhfer and Baker (2004) and Wills et al. (2006) note little correspondence between the predictions made by the PHabSim modelling tools and the observed responses."

Bradford and Heinonen (2008) also reviewed studies where flows were increased, not decreased. Here is their summary of those studies:

"*There is a small body of published case histories where instream flows have been increased below diversion projects as a river restoration strategy and the response of fish and other biota has been monitored. Examples from smaller streams are summarized in Table 1.*

Table 1. Case studies of small (MAD <10 m^3/s) streams where the minimum instream flow was increased and the response of biota was monitored. Flows are indicated as m'/s, and as a percentage of MAD where possible. Examples in larger rivers are provided by Jowett and Biggs (2006) and Lamouroux et al. (2006).

Stream	MAD	Flow Before	Flow After	Response
Barrows Stream[1]	N/A	0.02	0.10	40% increase in age 0+ salmon abundance, increased growth
Candover Brook[2]	0.7	≈0.2 (28%)	≈0.4 (57%)	No change in trout abundance or survival
Douglas Creek[3]	0.89	0.03 (3.2%)	0.16 (18%)	4-5 fold increase in trout abundance
Roizonne[4]	2.4	0.07 (2.5%)	0.28 (12.5%)	Decrease in trout abundance
Lignon[4]	2.9	0.08 (2.5%)	0.35 (12.5%)	3-fold increase in trout abundance
Aude[4]	7.3	0.20 (2.5%)	0.63 (12.5%)	No change in trout abundance
Moawhango[5]	9.6	0.06 (0.6%)	0.6 (6.3%)	Restoration of invertebrate populations

[1]Havey (1974); [2]Soloman and Paterson 1980; [3]Wolff *et al.* (1990); [4]Sabaton *et al.* (2004); [5]Jowett and Biggs (2006).

Bradford and Heinonen (2008) point out that many authors of these studies deduced that physical habitat conditions during low flow periods may not always be the key factor limiting abundance…there was a range of responses to the flow change highlighting the importance of site-specific factors in determining the outcome of an instream flow change. Bradford and Heinonen conclude that substantial uncertainty remains in the prediction of impacts of flow reductions or diversions. They found this to be true for salmonid populations as well as for populations of aquatic invertebrates.

E. Fish Value of Stanshaw Creek

The fact that few fish have been observed in Stanshaw Creek upstream of the floodplain pond indicates that numbers are low. The small proportion of habitat composed by pools and the high proportion of high-velocity habitats (Taylor 2015) also indicate that most of the stream has limited suitable habitat for salmonids. As an example, Taylor (2015) observed only two fish (both upstream of Highway 96) during his survey that covered one mile of stream that was rarely over 2 ft deep or 10 ft wide. My team of two associates and I observed no fish during our survey from the point of diversion (POD) all of the way to the stream's confluence with the Klamath River.

The journey of climbing down the stream channel from the POD helps one understand why there are few fish. This is a steep, high-energy stream that even at its summer low flow has substantial transport power, Substrate is predominantly boulders and cobles. Pools are sparse, small, and have substantial velocity even at low flow. The stream channel is highly confined by steep banks on both sides over most of its course. It is obvious that high flow events during fall through spring will mobilize most gravels, all of the fines and even much of the cobbles. Much of the gravel is angular rather than rounded, indicating that has been transported rapidly, entrained by flow, rather than being gradually tumbled down the stream course. The stream's steep, confined morphology coupled with substantial flow make it a very difficult place for fish to survive through the high flow season. In this stream, the low flow season would provide the most capacity and productivity for fish survival as stream velocity slows and allows pockets of livable habitat to develop. However, the steep gradient also results in several barriers to upstream migration, which we documented by measurement. The barriers to migration greatly limit the utility of habitat that becomes suitable for salmonids during the low flow season. Maria (2000) conducted a short electro-shocking survey in lower Stanshaw Creek beginning from the large pool located created by the outfall from the twin concrete box culverts beneath State Highway 96. Several juvenile steelhead were captured in that pool, most of which were young of the year (about 2-3 inches in length). Approximately 150 feet below this pool a single juvenile Coho was captured. Several other juvenile Coho were visually sighted using a facemask. It is not unusual to find juvenile Coho substantial distances up cool water streams where they were not born. It is typical behavior of juvenile Coho to seek off-channel habitat where they prefer to take up residence in pools. It is also quite typical in a headwater stream to find the highest concentration fish in the last pools below the final limit to upstream migration. Thus, the few and small fish captured by Maria (2000) are consistent with a low density of fish populating Stanshaw Creek. Some fish have also been observed upstream of migration barriers in the creek, which indicates that some reproduction is occurring in the creek. Together, the habitat measurements and fish observations indicate the stream has very limited capability to support fish populations.

A reasonable way to evaluate the fishery contribution from the pond near the mouth of Stanshaw Creek is to consider the expected survival to adulthood for the number of smolts that rear there. The smolt-to-adult survival of wild Coho smolts has been estimated for several years by California Department of Fish and Wildlife for the Shasta and Scott River Basins. In both basins, weirs are operated to obtain a full count of returning adults, and downstream-migrant traps are operated to estimate smolt abundance. On the Shasta River, smolt-to-adult survival has ranged from 0.61% to 10.06%, but was less than 4% in 7 of 8 years sampled (Knechtle 2012). On the Scott River, survival over the 5 years sampled ranged from 1.49% to 16.1%, but was 2.16% or less in 3 of 5 years. Thus, smolt-to-adult survival of wild Coho is highly variable, and most commonly in the range of 2% to 4% (Kechtle 2012). This means in most years, it will take 25 to 50 smolts to produce one returning Coho. Only in one year has the pond been found to hold over 25 Coho smolts (2012), and that was a year in which diversions were operated in their typical manner. Thus, the numbers of juveniles that use the pond are likely to contribute 0 to 2 adult returns in most years, and a dozen Coho in occasional years.

If the pond were absent, would all of the coho that have used it have been lost? No. There are multiple other cold-water streams that enter the Klamath River within 10 miles of Stanshaw Creek, and some, if not most of the juveniles that found Stanshaw Creek would have found one of those creeks. Juvenile coho PIT tagged at locations well upstream of Stanshaw Creek have been detected entering streams within a few miles of the Klamath River mouth. Between May 2007 and May 2008, 2.5% of coho tagged in the Mid Klamath as part of the Klamath River Coho Ecology Project were recaptured in Lower Klamath tributaries including McGarvey Creek (Hillemeier et al. 2009). I have not seen any evidence that the number of juvenile coho and steelhead entering streams in the vicinity of Stanshaw Creek are taxing the carrying capacity of those streams. Although the pond may have desirable temperatures, velocity refuge, and cover, it has a water source that apparently does not provide the scent that non-natal Coho key on when investigating possible refuge habitats along the river margin. The ability of Coho to detect and choose habitats containing bogs, and beaver ponds is well established and has been substantiated by the much higher numbers of Coho juveniles detected entering specific small streams in the lower Klamath Basin that have such features. Throughout their range, Coho have been found to have a high affinity for beaver ponds, and their ability to find such ponds up tiny channels of water indicates that the scent of beavers or the organic silt their ponds collect must be a key to attracting Coho. Water from Stanshaw Creek would not carry a strong scent of such features.

IV. My Initial Recommendations

As an alternative to the NMFS' recommendations, the bypass flow criteria should account for variable low and high flow periods. During low flow periods of 5 cfs of less, typically associated with summer, the diversion could be limited to 10 percent of flow in Stanshaw Creek with a minimum bypass amount of around 2 cfs. This would allow the Coles to divert at least 0.3 cfs for their consumptive and domestic needs, not accounting for ditch loss. Sampling in 2012 demonstrates that such flows will sustain water quality and volume in the manmade pool sufficient for non-natal rearing of juvenile salmonids and to support juvenile growth.

During high flow periods, restricting diversions to no more than the full water right (within reasonable operating constraints), and also to provide a minimum of 2 cfs to the floodplain pool, will sustain water quality, invertebrate production, and growth opportunity of non-natal salmonids. It will also allow for increased and variable flows in the bypass reach sufficient to maintain sediment transport, maintain fish life, and provide periodic opportunities for upstream migration during periods of modestly elevated runoff. Upstream migration is likely blocked during highest flows by velocity barriers.

Note that this recommendation would not require the return of water used in hydroelectric power generation to Stanshaw Creek. The requirement for minimum bypass flows would incidentally halt diversion of water for power generation during low flows in order to satisfy the minimum bypass flows. As described for my site visit during the week of October 1-7, 2017, I will be evaluating stream habitat in lower Irving Creek in addition to that in Stanshaw Creek, to determine what tradeoffs in fish benefits might occur by delivering the water used for power generation to one stream or the other. Available information does not substantiate that notable ecological function would be lost by the initial flow recommendation I have described. I will re-examine that recommendation following analysis of habitat data I gathered during my site survey.

V. Site Survey

During October 2 and 3, 2017, I visited Marble Mountain Ranch to conduct a site orientation and stream survey of Stanshaw Creek. During the visit, I conducted observational and survey studies of the Stanshaw Creek system. The observations and habitat measurements I made will provide the basis for a more explicit and quantitative analysis of the flows needed to sustain the key functions the stream provides as habitat for fish and other species. As part of my visit, I engaged in the following activities:

1. Walking Stanshaw Creek from the point of diversion to the Klamath River;
2. Measuring the area and location of spawning gravel patches;
3. Measuring the jump height and horizontal distance, as well as jump pool depth, at potential passage barriers;
4. Measuring the depth and area dimensions of the pond at the mouth;
5. Measuring the elevation, length, and width of the pond outlet to the Klamath River;
6. Visiting Irving Creek and taking measurements of reach below the inflow from the diversion;
7. Discussed Stanshaw Creek history, the findings of the survey, and diversion management with the property owners, Douglas and Heidi Cole.

My observations at the stream entry onto the active Klamath River floodplain (distinguished by open sand and boulders) revealed a different view of the pond's function than was portrayed by brief accounts I have read about the pond. Of the streamflow arriving from Stanshaw Creek at the Klamath floodplain, about two thirds of the flow on October 3, 2017 was not entering the pond, but was flowing straight across the cobbles and sand bar to the Klamath River. All flow that was entering the pond was artificially directed there by hand built rock berms that formed miniature levees leading water to the pond (Photos 1-3). This berm was no more than a few cobbles high, and would be completely washed away by high flows from Stanshaw Creek during fall through spring. The confined channel of Stanshaw Creek is not directed at the pond, but is directed about 45° to the left looking downstream (to right in Photo 1 looking upstream). Thus, flow entering the Klamath floodplain must make a sharp right turn to reach the pond, which is located about 45 feet to the sharp right of the floodplain entry point.

Thus, it appears that flow from Stanshaw Creek to the off-channel floodplain pool is not naturally sustainable, but requires annual human intervention to redirect some of the low-season flow to the pool. The rock berms and dam are necessary to ensure connectivity between the pool and Stanshaw Creek, even while the Coles are only diverting water for domestic and consumptive use.

It was also a surprised to find that the extensive berms of hand-stacked rocks, while directing flow to the pool, were ironically blocking any fish passage between the pool and the Klamath River. I carefully inspected all flow paths out of the pond, and they all passed through pores in the stacks of rocks that blocked fish passage to the pond. An especially tall berm of rocks was stacked at the pond outflow (perhaps as part of the restoration), and flow emerged through the rocks rather than over it (Photo 4). Thus, there was more than sufficient flow from Stanshaw Creek to enable juvenile salmonids to access the stream and pond, but porous rock berms that allow seepage back to the river were blocking any fish access to or from the Klamath River. Clearly, providing more flow from Stanshaw Creek was not the answer for providing fish access between the pond and Klamath River.

My testimony may be amended to include additional detail and data beyond that contained here following an opportunity to analyze the data collected during my site visit to Marble Mountain Ranch.

Photo 1. View looking upstream at the location where Stanshaw Creek emerges from its confined channel and enters the active floodplain of the Klamath River. The velocity energy of the channel is toward the right in this picture, but rocks were hand-placed at the head of that channel to block its flow, and a continuing berm of rocks was placed along flow directed toward the left in this picture. The floodplain pond is about 45 feet to the left and 5 to 8 feet downslope from this picture.

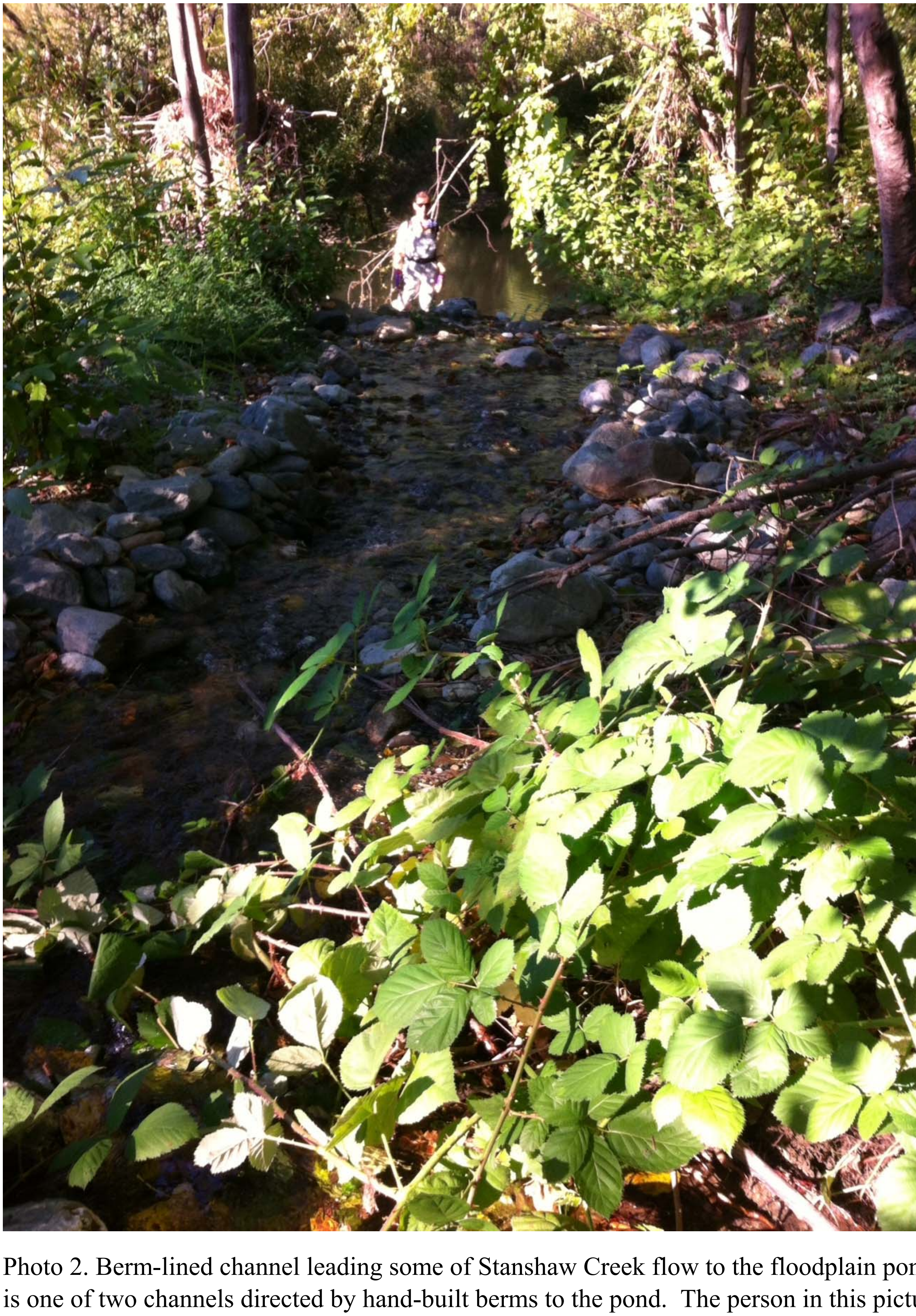

Photo 2. Berm-lined channel leading some of Stanshaw Creek flow to the floodplain pond. This is one of two channels directed by hand-built berms to the pond. The person in this picture is standing at the edge of the pond.

Photo 3. Downstream view of second berm-lined channel directing portion of Stanshaw Creek flow to the floodplain pond. The pond outflow, obscured by bushes, is to the left.

Photo 4. Rock berm at the floodplain pond outflow. I am standing in Klamath River backwater where some of Stanshaw Creek flows emerge through the rock berm to enter the Klamath. None of the flow exiting from the pond flowed out over the surface where fish could pass.

References Cited

Bradford, M.J., and J.S. Heinonen. 2008. Low flows, instream flow needs and fish ecology in small streams. Canadian Water Resources Journal 33: 164-180.

Corum, R.A.. 2010. Middle Klamath Tributary Coho Spawning Survey Report. Project report, Karuk Tribe, Department of Natural Resources.

Hillemeier, D., T. Soto, S. Silloway, A. Corum, M. Kleeman, and L. Lestelle. 2009. The role of the Klamath River mainstem corridor in the life history and performance of juvenile coho salmon (Oncorhynchus kisutch). Report submitted to the United States Bureau of Reclamation. Klamath Falls, OR 97603.

Knechtle, M. 2012. Population estimates of adult and juvenile Coho salmon in the Scott River, Shasta River and Bogus Creek. California Department of Fish and Wildlife, power point presentation.

Krall, M.R. 2016. The influence of habitat characteristics on abundance and growth of juvenile Coho salmon *Oncorhynchus kisutch* in constructed habitats in the middle Klamath River Basin. Masters Thesis, Humboldt State University.

Maria, D. 2010. Coho Presence in Stanshaw Creek, Near Somes Bar, California. Memo to the file. Siskiyou Fisheries Unit.

Moore, K.M.S ; K.K. Jones, and J.M. Dambacher. 1997. Methods for stream habitat surveys. Oregon Department of Fish and Wildlife, Portland.

Montgomery, D. R., E. M. Beamer, G. R. Pess, T. P. Quinn. 1999. Channel type and salmonid spawning distribution and abundance. Canadian Journal of Fisheries and Aquatic Sciences, Vol. 56, Page(s): 377-387.

Nickelson, T. E. 1998. A habitat-based assessment of coho salmon production potential and spawner escapement needs for Oregon coastal streams. Oreg. Dept. Fish Wildl. Fish. Div. Info. Rep. 98-4.

Nickelson, T.E. 2001. Population Assessment: Oregon Coast Coho Salmon ESU. Northwest Region Research and Monitoring Program, Oregon Department of Fish and Wildlife. Portland, OR.

NMFS. 2014. Final SONCC Coho recovery plan.

NMFS. 2016. Letter of August 3, 2016 from Alecia Van Atta (NMFS) to Barbara Envoy (State Water Resources Control Board).

Soto, T., A. Corum, H. Voight, D. Hillemeier, and L. Lestelle. 2008. The Role Of The Klamath River Mainstem Corridor In The Life History And Performance Of Juvenile Coho Salmon (*Oncorhynchus kisutch*) Phase 1 Report 2006-07 Winter. Karuk Tribe Department of Natural Resources, submitted to U.S. Bureau of Reclamation, Klamath Falls, Oregon.

Taylor, R. 2015. Findings report for Stanshaw Creek Habitat and Instream Flow Assessment. Ross Taylor and Associates, contract report to Karuk Tribe. 10 pages.

Witmore, S.K. 2014. Seasonal growth, retention, and movement of juvenile Coho salmon in natural and constructed habitats of the mid-Klamath River. Master's Thesis, Humboldt State University.