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 95404-4731

September 23, 2020 **Refer to NMFS No:** WCRO-2020-01200

Jim Mazza
Chief, Regulatory Division
U.S Department of Army
San Francisco District, Corps of Engineers
450 Golden Gate Avenue, 4th Floor, Suite 0134
San Francisco, California 94102-3406

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response and Fish and Wildlife Coordination Act Recommendations for the Mad River Gravel Operations for the Years 2020-2029

Dear Mr. Mazza:

Thank you for your letter of April 21, 2020, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for issuance of individual Clean Water Act Section 404 permits for gravel mining activities on the Mad River for the years 2020-2029. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR Part 402, as amended; 84 Fed. Reg. 44976, 45016 (August 27, 2019)).

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)) for this action. NMFS has concluded that the action would adversely affect the EFH of Pacific Salmon. Therefore, we have included the results of that review in Section 3 of this document.

NMFS has determined that the proposed action will adversely affect listed species and their critical habitats and has provided an incidental take statement that must be followed.

Please contact Dan Free, Arcata Office at (707) 825-5164 or Dan.Free@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Enclosure

cc: Michael Van Hattem, CDFW, Eureka
Randy Klein, CHERT
Kasey Sirkin, Corps, Eureka
Jake Shannon, NCRWQCB, Santa Rosa
Mike Atkins, Trinity Valley Associates
Bob Brown, Stillwater Sciences
Travis Schneider, Pacific Affiliates
Copy to ARN File 151422WCR2020AR00108

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, and Fish and Wildlife Coordination Act Recommendations

Gravel Mining on the Mad River for the Years 2020-2029

NMFS Consultation Number: WCRO-2020-01200
Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Southern Oregon/Northern California Coast Coho Salmon (*O. kisutch*)	Threatened	Yes	No	Yes	No
California coastal Chinook (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
Northern California Steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	Yes	No

Essential Fish Habitat and NMFS' Determinations:

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	No

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Date: September 23, 2020

Table of Contents

1. INTRODUCTION 1
1.1 Background 1
1.2 Consultation History 1
1.3 Proposed Federal Action 2
1.3.1 General Description of Proposed Action 3
1.3.2 Detailed Project Description 4
2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT 14
2.1 Analytical Approach 15
2.2 Rangewide Status of the Species and Critical Habitat 16
2.2.1 Life History and Range 16
2.2.2 Status of the Species 18
2.2.3 Factors for Decline (ESU or DPS Scale) 20
2.2.4 Critical Habitat 25
2.3 Action Area 29
2.4 Environmental Baseline 30
2.4.1 Status of Listed Species in the Action Area 30
2.4.2 Status of Critical Habitat in the Action Area 32
2.4.3 Factors affecting species environment within the action area 33
2.5 Effects of the Action 39
2.5.1 Potential Effects from Gravel Mining 39
2.5.2 Exposure 40
2.5.3 Minimal Effects 42
2.5.4 Adverse Effects to Individuals 44
2.5.5 Effects to Critical Habitat 54
2.6 Cumulative Effects 54
2.7 Integration and Synthesis 55
2.7.1 Effects on SONCC Coho Salmon 55
2.7.2 Effects on CC Chinook Salmon 57
2.7.3 Effects on NC Steelhead 59
2.7.4 Effects on Critical Habitat 61
2.8 Conclusion 62

2.9 Incidental Take Statement 62
2.9.1 Amount or Extent of Take 62
2.9.2 Effect of the Take 63
2.9.3 Reasonable and Prudent Measures 63
2.9.4 Terms and Conditions 64
2.10 Conservation Recommendations 64
2.11 Reinitiation of Consultation 65
3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE 65
3.1 Essential Fish Habitat Affected by the Project 66
3.2 Adverse Effects on Essential Fish Habitat 66
3.3 Essential Fish Habitat Conservation Recommendations 66
3.4 Supplemental Consultation 66
4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW 66
4.1 Utility 66
4.2 Integrity 66
4.3 Objectivity 67
5. REFERENCES 68
Appendix A 82

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

NOAA's National Marine Fisheries Service (NMFS) prepared the biological opinion (Opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR Part 402, as amended.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at NMFS Arcata Office.

1.2 Consultation History

This Opinion considers five individual permit applications for gravel mining in the Mad River received by the United States Army Corps of Engineers (Corps). The five permit applicants: (1) Eureka Ready Mix Concrete Company, Inc. (ERM), (2) GLJ Construction, (3) Mad River Sand and Gravel (MRSG), (4) Mercer Fraser Company (MF), and (5) GR Sundberg, Inc. (Sundberg), share similar proposed actions that are described and analyzed in one biological assessment (Stillwater Sciences 2020). This Opinion considers all five individual permit applications in one document and as such is a "batched" consultation [50 CFR 402.14 (c)]. By considering the effects of two or more similar actions within a given geographical area, NMFS is able to analyze the individual and aggregated impacts in a single, comprehensive Opinion. The description of the proposed action describes the overall, shared proposed action, and details any individual differences between applicants.

NMFS has consulted on Corps permitted gravel extraction in the Mad River since 1999. The most recent consultation covered the years 2010-2019. Minor modifications and clarifications regarding the proposed action for this ten-year permit period (2020-2029) are included here and reflect changes that were incorporated based on monitoring of the previous proposed actions, the long-term observations of NMFS scientists, and making the implementation more consistent and repeatable.

NMFS met a number of times with the applicants, California Department of Fish and Wildlife (CDFW), County of Humboldt Extraction Review Team (CHERT), and the Corps beginning in 2019 to discuss the proposed action. This culminated with a Biological Assessment from

Stillwater Sciences (Stillwater Sciences 2020). NMFS received a request for consultation from the Corps on April 21, 2020, and responded on May 20, 2020, to the Corps that the consultation package was complete.

This Opinion analyzes the effects of the proposed action on the following listed species and their designated critical habitats:

- Threatened Southern Oregon/Northern California Coast coho salmon ESU (*Oncorhynchus kisutch*)
  Listing determination (70 FR 37160, June 28, 2005)
  Critical habitat designation (64 FR 24049, May 5, 1999);

- Threatened California Coastal (CC) Chinook salmon Evolutionarily Significant Unit (ESU) (*Oncorhynchus tshawytscha*)
  Listing determination (70 FR 37160, June 28, 2005)
  Critical habitat designation (70 FR 52488, September 2, 2005);

- Threatened Northern California (NC) steelhead Distinct Population Segment (DPS) (*Oncorhynchus mykiss*)
  Listing determination (71 FR 834, January 5, 2006)
  Critical habitat designation (70 FR 52488, September 2, 2005).

We also completed a Pacific salmon essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

1.3 Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). The Corps proposes to issue Clean Water Act (CWA) section 404 permits to individual gravel miners for operations for the years 2020-2029.

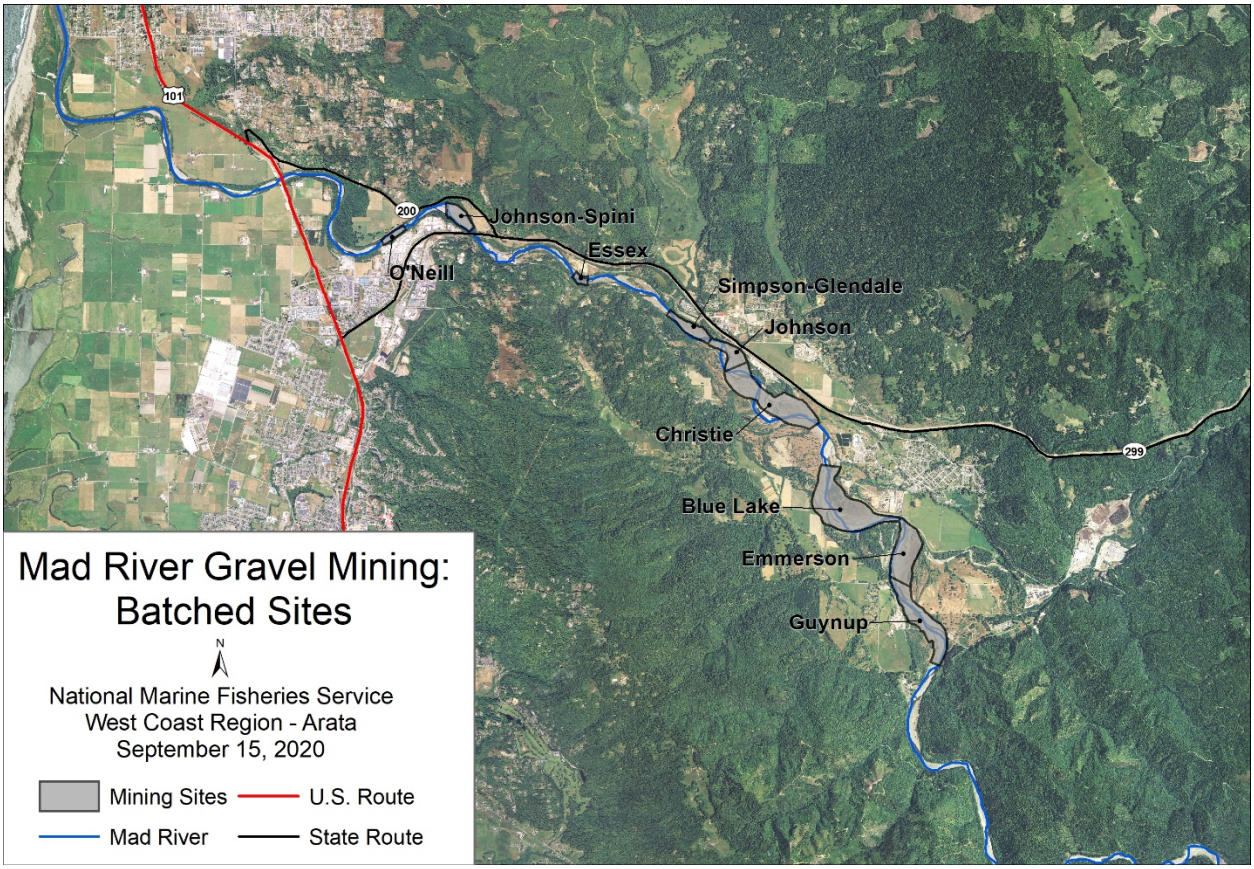


Figure 1. Gravel mining locations on the Mad River.

1.3.1 General Description of Proposed Action

The proposed action is the Corps' renewal of previously authorized individual CWA Section 404 permits (MRSG, GLJ, ERM, MF, and Sundberg; Figure 1). The proposed permit period will run from September 2020 through December 31, 2029. The proposed project involves annual gravel extraction, monitoring, and temporary crossing construction activity on Mad River gravel bars at:

- MRSG's Guynup Bar (river mile [RM] 10.5);
- ERM's Emmerson, Christie, Johnson, Johnson-Spini, Miller-Almquist, and O'Neill bars (RM 9.5, RM 7.5, RM 6.8, RM 4.2, RM 4.0, and RM 3.5, respectively);
- GLJ's Blue Lake Bar (RM 9);
- MF's Essex Bar (RM 5.3); and
- Sundberg's Simpson-Glendale Bar (RM 6.5).

All extraction and reclamation activities are restricted to occur between June 1 and October 15 of each year, although work extensions may be granted by the Corps on a case-by-case basis until October 31. Additional monitoring will be necessary to receive an extension. All temporary crossing activities are restricted to occur between June 30 and September 15 of each year, although extensions may be granted by the Corps, NMFS, and CDFW on a case-by-case basis until October 31. These operating season dates and conditions are modified from Stillwater

(2020) and are the result of a request for clarification/modification via a September 14, 2020, email from Kasey Sirkin of the Corps to Dan Free of NMFS (Sirkin 2020).

Certain habitat enhancement activities, such as riparian-planting projects, may be conducted outside of the normal extraction operating season. For example, riparian-planting efforts tend to have a higher rate of success when cuttings are collected and installed during the plant's dormant season. In addition, in an effort to keep large woody debris that deposits on gravel bars from being cut for firewood, shake bolts, fence posts, etc., the applicants may enter the action area with heavy equipment to pile gravel on individual pieces to deter use of chainsaws (preferred) and/or move logs to a secure stockpile area for future redistribution or use for habitat improvement structures. Any habitat improvement structures would need to go through a separate permitting process.

The activities authorized by individual permits are expected to include certain activities within permitted gravel extraction sites during extraction seasons to enhance habitat for salmonids and other riverine species. The specific details of such habitat enhancement activities will be determined during, and will follow, the same multi-agency pre-extraction design review process used for gravel extraction operations. Many of the habitat enhancement activities (including extraction with a habitat improvement component) will be consistent in scope, size, and cost as similar activities that have occurred during the previous CWA 404 permit period. These activities included, but were not limited to, alcove construction, placement of edgewater large woody debris, and construction of floodplain excavations to improve aquatic and riparian habitat. Some proposed habitat enhancement activities include, but not limited to, riparian planting and strategic placement of wood within alcoves or other extraction areas. Habitat enhancement activities completed outside of the boundary areas of the applicant's ownerships or requiring engineering design or additional external funding are outside the purview of this consultation.

The proposed total annual gravel extraction volume will follow the variable extraction strategy (FEV) implemented in the 2010 Biological Opinion (NMFS 2010). The FEV was developed as a way to vary the annual extraction volume based on the intensity of the water year and corresponding sediment recruitment volumes. The FEV generally allows an annual extraction volume up to 59% of the estimated annual bed-material recruitment while establishing the upper and lower annual limits of 72,000–175,000 cubic yards (cy), respectively. A gravel "banking" option (described below) is also proposed that could result in an annual extraction volume below 72,000 cy when banking and over 175,000 cy when using the banked credits.

1.3.2 Detailed Project Description

The five applicants all propose to operate under a common project description as described below. Any site-specific deviations from the common project description are identified below as necessary.

1.3.2.1 Annual Extraction Volume Allocation

The proposed annual extraction volume for each of the five applicants is based on the original Humboldt County allocations prior to 2010. There are nine extraction sites included in the

project area under the five applicants. Six of the sites are in the "upper reach" above the Annie and Mary Bridge while the other three are in the lower reach. Table 1 shows a summary of the ownerships and site level volume distribution. Following the FEV extraction strategy, the volumes are subdivided by the relative area of each of the six sites in the upper reach wherever possible while still meeting the original pre-2010 allocation percentages for the applicant. For Eureka Ready Mix (ERM), which mines both the upper and lower reaches, the proposed extraction volume will be maximized first on the downstream sites before extracting from the upper reach at Christie Bar. Table 2 shows some example water years and potential FEV total annual volume for each site. Each operator's annual approved extraction volume will fluctuate in response to annual bed material recruitment into the reach and the replenishment on each site. Each individual extraction site will be limited to the corresponding percent of the total FEV.

Table 1. Annual extraction volume distribution following the FEV strategy.

Applicant	Site Name	Volume Fraction %	Site Volume Strategy	Volume Calculation	Maximum Annual Site Volume (CY) (FEVx175k)
MRSG	Guynup	19.2%	FEV%	0.192 x FEV	33,600
GLJ	Blue Lake	16.4%	FEV%	0.164 x FEV	28,700
Sundberg	Simpson-Glendale	3.6%	FEV%	0.036 x FEV	6,300
MF	Essex	1.9%	County Allotment 3,300 CY	0.019 x 175k	3,300
ERM	Emmerson	9.7%	FEV%	0.097 x FEV	17,000
	Johnson	4.1%	FEV%	0.041 x FEV	7,200
	Christie	34%	Maximize Johnson-Spini and O'Neill first	0.34 x FEV	78,900
	Johnson-Spini	45.1%	County Allotment 78,900 CY	0.451 x 175k	
	O'Neill				

Table 2. Example volume distribution for different water year types.

		Water Year Type	**Very Low**	**low**	**moderate**	**high water**	**very high**
		Recruitment (cy)	**<122,000**	**150,000**	**200,000**	**275,000**	**>296,600**
		Calculated FEV (cy)	**72,000**	**88,500**	**118,000**	**162,250**	**175,000**
Applicant	**Site**						
MRSG	Guynup		13,800	17,000	22,700	31,200	33,600
GLJ	Blue Lake		11,800	19,400	19,400	26,600	28,700
Sundberg	Simpson-Glendale		2,600	3,200	4,200	5,800	6,300
MF	Essex		3,300	3,300	3,300	3,300	3,300
ERM	Emmerson		7,000	8,600	11,400	15,700	17,000
	Johnson		3,000	3,600	4,800	6,700	7,200
	Christie		24,480	28,500	13,900	18,900	0
	Johnson-Spini and O'Neill		20,000	50,000	65,000	60,000	78,900

The annual application of the FEV strategy and site level volume estimates require bed material estimates and application of the percent used for each site. NMFS (2010) describes the bedload equations used to estimate the annual recruitment. The equations are included in the FEV annual calculator sheet (NMFS 2020). The annual recruitment calculations require daily average flow values for the Mad River and the North Fork of the Mad. Since the North Fork does not have a USGS stream gage, the flow data from the nearest comparable stream gage (i.e., Little River near Trinidad, CA, USGS 11481200) is used to estimate the North Fork daily average flow. Each late spring after flows have receded with no significant bed material movement, the daily average discharge from October 1 to the most recent date for the USGS 11481000 Mad River near Arcata gage and the USGS 11481200 Little River gage will be input to the FEV spreadsheet to calculate the annual FEV volume. With the flow data, the North Fork flow and the sediment recruitment is automatically calculated using the embedded equations developed for each flow range. The sheet will automatically calculate the annual FEV volume (59% of the total recruitment estimate within the FEV limits) and the maximum volume potential for each site.

Extraction volumes are influenced by the previous winter's stream flows and the amount of gravel replenishment to extraction bars. The amount of bedload transport and associated replenishment is dependent on the intensity and duration of high-flow events. Years that experience low-intensity and short-duration peak flows experience less bedload transport than those years with larger and longer duration peak flows. These processes are reflected in the amount of gravel available for harvest. In general, actual approved and extracted volumes are less than the maximum permitted amounts. The County-approved and actual extractable volumes for any given year are based on a number of factors including, but not limited to FEV volume, replenishment on the bars, access to sediment deposits, presence of salmonid habitat, and market conditions. We expect the extraction volume for the 2020-2029 to fluctuate relative to the water year intensities.

There is the opportunity to "bank" 50–100 percent of the potential allowable extractable volume when the minimum (72,000 yd^3) is all that is available based on the FEV. This would be allowed one time during the 10-year permit period and the banked volume would only be taken when the maximum (175,000 yd^3) is allocated. Operators would notify NMFS and other regulatory agencies of the banking proposal prior to initiating extraction operations.

In any given year, individual extraction volumes, locations, and methods have been and will continue to be submitted by the applicant for approval or comment by local, state, and federal agencies, including CHERT, CDFW, Corps, and NMFS. This planning process is more specifically described below.

1.3.2.2 Conservation Measures

The instream mining activities proposed for the Mad River will include a host of conservation measures beginning with the FEV calculations described above, planning and approval process, operating season, minimum head-of-bar buffers, minimum skim floor elevation, storage and stockpile use and maintenance, maintenance of riparian vegetation and wetlands, large woody debris retention, structure setbacks, and post-extraction bar grooming. The minimum head-of-bar buffer is defined as that portion of the bar that extends from at least the upper third of the bar to the upstream end of the bar that is exposed at summer low flow. The intent of the buffer is to provide protection of the natural stream flow steering effect provided by an undisturbed bar. An increased or decreased buffer that maintains the steering effect may be further delineated based on the river morphology as observed during the field visit. This process results in extraction plans that are protective of the physical and biological processes within the extraction reach. However, additional annual field reviews are necessary to take into consideration the annual replenishment of previously mined areas, adjustments to extraction designs to avoid or protect sensitive habitat areas, adaptive management, and the siting of bridges.

All equipment used to conduct extractions (e.g., scrapers, excavators, bull dozers, front-end loaders, dump trucks, or any other heavy equipment used for extraction will be monitored for fuel, oil, or hydraulic fluid leaks. Fueling will not occur within the 100-year floodplain. All equipment will carry a spill prevention and clean-up kit with them when operating within the 100-year floodplain.

1.3.2.3 Annual Extraction Development Process

The proposed action is intended to reduce environmental impacts by site-specific planning of extraction activities on the proposed bars that considers river morphology, vegetation patterns, salmonid spawning and rearing habitat, tributary stream locations, bedload transport, and other factors. In addition to providing for the applicants' aggregate needs, the proposed activities will preserve riparian vegetation at strategic locations, increase riparian vegetation cover and successional development by using specific extraction techniques, and augment winter rearing habitat at low to high flows.

A comprehensive extraction planning process is key to developing annual mining plans that are protective of riverine function and listed salmonid species and their habitat. This involves annual review of aerial photographs coupled with comparison of recent and historical full-channel cross-sections, which are used by CHERT and regulatory agencies during the annual pre-harvest reviews to identify hydrological and morphological alterations. Gravel and sand extraction methods are developed in consideration of local and reach-wide geomorphic processes, and protection of bedforms important for sediment transport continuity, changes in local reach hydraulics, sediment transport characteristics, and fish habitat.

Pre-extraction cross-section surveys are typically conducted during May and June or earlier depending on spring flow characteristics. The applicants delineate the 35% exceedance flow line on their gravel bars by conducting site visits as the river approaches 900 cfs at the USGS 11481000 Mad River near Arcata stream gage. At that time, the applicant will mark the water's edge on the substrate. The applicant will calculate 35% exceedance flow water surface elevation at the time of the pre-extraction site visits based on the surveyed marks and adjustments necessary to represent 900 cfs and include flow corrections made by USGS. The applicants and will also use the cross-sections to help identify potential extraction areas containing commercial quantities of aggregate within the project boundaries. Applicants will provide the monitoring data and pre-extraction plans following a reporting format consistent between all applicants and consistent with previous data collection. Several other factors are considered during extraction planning, including:

- site-specific determinations of replenishment since the previous season;
- locations of gravel deposits;
- morphological changes caused by high flows and changes in sediment deposition patterns from the previous season or longer term;
- how the extraction can be tailored to and blend with surrounding natural contours to minimize extraction-induced depressions and initiation of nick-point erosion;
- avoidance of riparian vegetation; and
- the potential use of alternative extraction methods to improve some instream or floodplain habitat features.

The operator will delineate the proposed extraction plan on aerial photographs, describe in detail the various operational and protective aspects of the extraction, calculate potential harvestable volume that aligns with the FEV, and identify roads and temporary crossing locations, if any. The plan would also include an assessment of how the extraction of selected bar features could potentially affect surrounding morphology when flows increase. Once the proposed extraction plan is developed, it is submitted to the Corps, CHERT, CDFW, NMFS, North Coast Regional Water Quality Control Board (NCRWQCB), and Humboldt County. A field review is conducted, at the request of the operators, to describe the proposed plan, solicit comments or recommendations, and make any final modifications. The plan is then resubmitted to CHERT and NMFS for their final review and recommendation. The Corps makes the final determination to approve the extraction plan.

Extraction designs are implemented by marking mining areas, which may include grade staking or laser levelling, similar to the process used in road construction. The heavy equipment operator

is provided with temporary grade stakes that delineate the extraction boundaries and grades determined during the extraction plan review process. Typically, final surfaces are designed to be: (1) free-draining toward the river channel; (2) sloped downstream, parallel to the river; (3) not compacted; and (4) complementary to surrounding natural contours. This extraction planning and implementation strategy is intended to promote low-flow channel confinement and riparian development while reducing the potential for channel shifting, ponding, fish stranding, riffle instability, and nick-point erosion caused by moderate to high-flow inundation.

Following extraction, CHERT and regulatory agencies also conduct post-extraction field visits, analyze pre- and post-extraction physical monitoring data and aerial photographs to determine compliance with approved extraction plans, and assess effects of gravel operations on the form and function of the river.

1.3.2.4 Extraction Season

The operating season for extraction operations extends from June 1 through October 15, with potential for a Corps-approved extension until October 31 (Sirkin 2020). Bridge construction and use is limited to June 30 through September 15. Bridge-use extensions can be granted until October 31 with Corps, NMFS, and CDFW approval.

The intent of the established operating season is to limit the potential for direct impacts and other interactions between extraction activities and various salmonid life-history stages that occupy (seasonally or year-round) the extraction reaches. The bulk of the adult runs are expected to be absent from the mining reach during the operating season. In addition, as reported by Sparkman (2002), most of the downstream smolt migration would be complete by the end of June, with only a few stragglers remaining by the June 30 bridge installation date. Most steelhead fry that occupy edgewater habitats during the first weeks of their lives would be expected to have grown to a larger size, more likely to flee rather than burrow into substrate, and moved into deeper and faster water by June 30.

1.3.2.5 Extraction Descriptions

The primary objective of standard extraction methods is to extract commercial quantities of aggregate. These methods include narrow and wide shoreline skims, offset skims, secondary channel skims, floodplain excavations, trenches and other options developed by the applicants, CHERT, NMFS, and other pre-extraction review team members that will allow for both economical operations and aquatic resource protection. Identification of specific extraction methods will occur during the pre-extraction planning process and will depend on site conditions at that time. The standard impact minimization measures associated with these methods include, but are not limited to, the 35-percent exceedance flow elevation buffer from the low-flow channel, head-of-bar buffer, retaining the natural high points of the bar, avoiding riparian vegetation, avoiding skimming or trenching adjacent to riffles, large woody debris retention, and post-extraction bar surface grooming.

Narrow shoreline skim
Narrow shoreline skims are no more than one-third of the exposed gravel bar width, follow the shape of the bar feature, maintain the point of maximum height of the bar along the length of the skim, and trend in the general direction of stream flow. These skims maintain a vertical offset corresponding to the flow at the calculated 35-percent exceedance level. Finished skims are free-draining and slope either toward the low-flow channel or in a downstream direction. Furthermore, these skims avoid the head of the bar, defined as the upstream one-third of the exposed bar surface. This buffer may be decreased on a case-by-case basis provided that the extraction area narrows, tapering smoothly to a point, and remains below the upstream cross-over riffle. The location of the skim with respect to its orientation to the channel may vary depending on bar morphology.

Wide shoreline skim
A wide skim has one edge close to the low flow channel at or above the calculated 35% flow elevation with a width that varies depending on bar morphology. The location may also vary depending on the bar morphology. This method is only intended for use at in the lower reach below the Annie and Mary Railroad Bridge.

Secondary channel skims
These extractions are long, linear shallow skims located in dry, overflow channels. These extractions are designed to be free-draining and open at the lower end to prevent any potential fish stranding and maintain existing flow inundation level by preserving the highest portion along the secondary channel. The extraction plan will be designed to be protective of the upstream riffle crest and maintain the existing inundation level and maximum height of the secondary channel. The skim floor of these excavations is set at the 35-percent exceedance flow elevation.

Trench
A trench is generally a long, narrow excavation parallel and adjacent to, but outside of, the wetted perimeter of the channel. This type of extraction may be used to help promote active channel narrowing by concentrating mining adjacent to the channel, thereby allowing for adjacent bar height to continue building. Using a trench along the low flow channel would minimize the area of disturbance and potentially allow the interior to be recolonized with vegetation and build in elevation. Trenches will be typically located adjacent to runs and glides. Standards for trench placement include:

- Not adjacent to eroding banks;
- Upstream end of trench at least 150 ft downstream from riffles;
- 1/3 low flow channel width or less, between 4–15 ft deep;
- Separation by at least 250 feet or the length of the largest trench being planned; and
- Connection to the wetted channel at the upstream and downstream end to prevent fish entrapment.

Floodplain extractions
Opportunities for extracting gravel from floodplain locations have been identified upstream of the Annie and Mary Railroad Bridge. Preferred locations are on floodplains that have limited

potential for riparian development. Design parameters include excavation down to the dry season capillary fringe to promote riparian vegetation development and, therefore, may also be referred to as "moist pits." Additional design parameters include development of a single connection to secondary or main channels to minimize the potential for fish stranding and avoiding areas where high flow channels exist. The bottom of the excavation shall be ripped to reduce heavy equipment compaction and facilitate seed germination and rooting.

As described above, preferred locations are on floodplain areas vegetated with shrubs or invasive grasses, such as pampas grass and coyote brush. Locations that present a risk of capturing the main flow should be avoided. Further, areas should be avoided where excavations might interfere with adjacent beneficial habitat or alter the river geomorphology such that habitat is adversely affected or increased instability occurs.

On floodplains with multiple excavations, the total excavation area over the permit period for each site will be limited to minimize the risk of channel avulsion and/or excessive increase in channel braiding. The area of the floodplain excavation will be limited during the permit period at each site based on the following:

1) No more than 10% on a frequent floodplain (inundation by 2–5-year flood) unit, accumulated over the 10-year permit period, because of the higher potential for channel avulsion; or
2) No more than 20% on a relatively infrequent floodplain (inundation by 5–10-year flood) unit, accumulated over the 10-year permit period, due to lower chance of channel avulsion.
3) These area restrictions will reset once the areas replenish or are otherwise not relevant if the channel migrates (naturally) into these areas.

Locally-sourced small to large woody debris can be added into floodplain excavations to improve moisture conditions for natural vegetation recruitment. Additionally, excavations can be planted to enhance vegetation colonization. The type and placement of woody debris will be determined during pre-extraction field reviews.

Floodplain excavations may have a narrow connection to the mainstem river or secondary channels at the downstream end at excavation floor elevation, but this connection should not result in an additional flow velocity or flow paths when inundated. The connection will allow for fish that use the excavations as high flow refugia to reenter channels as flows and water surface elevations subside. The excavation will be monitored for fish entrapment once precipitation for the season has ended (typically April or May), instream flows are receding, and the outlet is expected to be dry. NMFS shall be contacted if stranding is observed.

Fish access channel
Fish access channels are generally narrow trenches excavated within the Mad River active channel, in areas where the mouths of tributary creeks or rivers go dry, thereby inhibiting fish migration. The channel excavation may extend below the groundwater table or simply remove excess material, which would allow for surface water connection between the tributary and Mad

River with relatively small increases in flow. Suitable locations for this type of excavation include the mouths of Quarry Creek, Hall Creek, Powers Creek, and the North Fork Mad River.

Alcoves
Alcoves occur naturally in alluvial rivers and provide important rearing and holding habitat for salmonids. Alcoves typically form at the downstream end of point bars, downstream end of transverse riffles, against bedrock or large wood obstructions where a bar diverts upstream flow, and at complex meander bends or channel expansions where flow bifurcates around medial or transverse bars or islands become disconnected from upstream surface flow during low flow periods. Alcoves are water filled and maintain a downstream connection, but don't have an upstream connection to the main channel during summer low flow period. They are characterized by having deeper, cooler water than some main channel pools and more cover in the form of woody debris and overhanging trees.

During thermal stress conditions in late summer/early fall, alcoves provide thermal and predation refugia. Cooler subsurface (hyporheic) water filtrates from the upstream gravel bar into the alcove (Ock and Kondolf 2012). This, along with typically better shading than in the main channel, sustains cooler water throughout the warmer months. During high flow conditions in the winter, alcoves can provide refugia from high flow velocities in the main channel.
Several guidelines for properly locating and designing artificial alcoves will assist gravel operators and their consultants in developing proposals that will meet with approval by regulators.

Alcove widths should not exceed approximately one-third of the low flow main channel width. The upstream end of the alcove should be below the upper 1/3 of bar or below the highest point of the bar, whichever is less. Excavated alcoves should include a small channel at the downstream end to ensure low water connection and prevent stranding. Excavation of this connecting channel should be delayed until after extraction of the alcove is complete and after enough time has passed (several days to a week) for suspended sediment to settle out to avoid turbidity impacts to the main channel. The connection should extend no more than a foot below the low flow channel. In addition, alcoves should not present a risk of capturing the main flow through headcutting. As such, they should primarily be located at the downstream end of point bars. There are some locations where alcoves have been constructed a number of times during the 2010-2019 extraction period that were not located at the downstream end of a point bar (e.g., an alcove has been constructed at the downstream end of the Johnson-Spini Bar with no adverse effects) which may be suitable during implementation of this proposed action. As with other extraction types, alcoves would be subject to field review by regulatory agencies and CHERT.

Adaptive Management
Extractions that deviate from that described above may be considered on a case-by-case basis and may require additional monitoring and assessment to ensure the effects do not exceed that considered in this Opinion. Deviations shall thoroughly describe the expected geomorphic response of the river to the extraction and how habitat and listed species will be protected. Additional hydraulic modeling and/or monitoring (e.g., HecRas) may be required of the potential effects of an adaptive management proposal to determine if they are within the expected range

considered in this Opinion. Requirements for additional monitoring or modeling is dependent on the proposal being considered.

1.3.2.6 Stream Crossings

Channel alignment and sediment depositional areas may change from year to year throughout Mad River. Changes in morphology may necessitate the installation of temporary crossings to access extraction areas where none were needed previously. Summer crossings typically consist of rail flat car bridges placed across a shallow and narrow portion of channel. Bridges are not installed over pools because of the depth and potential impacts from abutments, nor riffles and others areas where spawning might occur. Installation requires one loader to cross through the active channel to construct the far-side gravel abutment and secure the bridge. K-Rail or large concrete blocks will be placed beneath the ends and sides of the gravel abutment of the bridge to provide an elevated abutment to support the ends of the bridge, provide adequate clearance above the low-flow channel, and contain abutment fill.

Encroachment of bridge abutments into the channel will occur on the sides only and not enter the channel thalweg. Only washed material will be used within the wetted area and extend above the low-flow water surface elevation of the near side approach. Native river bar material will also be used outside of the wetted channel. Heavy equipment will not be used in the wetted channel except for crossing installation and removal activities, each of which require one to two crossings.

Secondary channels with very low flow may be present in some extraction areas. In many cases, these channels may only be a few feet wide and installation of a bridge structure may be an unreasonable or a more impactive option. In these cases, suitably sized culverts may be used to construct the crossing. The number and size of culverts used will be scaled to fully pass potential increases in flow that may occur with summer and early fall freshets. All crossings will be meet NMFS Fish Passage Guidelines.

All crossing activities are restricted to occur between June 30 and September 15 of each year, although work extensions may be granted by the Corps, in consultation with NMFS and CDFW, on a case-by-case basis until October 31. Monitoring of weather, river flow, and adult Chinook salmon presence in the Mad River will be necessary for granting bridge extensions under this permit. The location, construction, and removal of all temporary channel crossings will be included in the annual pre-extraction plan. The location for channel crossings will be determined during the pre-extraction site review.

1.3.2.7 Monitoring

Monitoring of extraction activities and river morphological changes will be primarily through the annual surveys of long-established cross sections and spring aerial photos at each mining site. Additionally, pre- and post-extraction cross sections and gravel volume calculations are required for each extraction location. Paper copies of the he monitoring cross sections and aerial photos are required to be provided on the day of the pre-extraction site visit. Final electronic post-

extraction cross section information will be delivered to NMFS by December 31 of each year of extraction.

Physical monitoring will include:

- identification of the elevation and location of the 35-percent exceedance flow water surface,
- pre-extraction cross sections,
- post-extraction cross sections,
- full-channel monitoring cross sections,
- high-water elevation and location from the previous winter, and
- monitoring of floodplain extractions for salmonid stranding and riparian vegetation development.

Alternative physical monitoring methods may be developed by the operators in consultation with NMFS and the Corps. These alternatives may include marking the 35-percent exceedance flow elevation and cross-section monitoring. Any modifications to, or replacement, of the existing 35-percent exceedance flow marking or cross-section monitoring will provide an equal or greater amount of information and protection.

Riparian vegetation monitoring would be conducted toward the end of the 2020–2029 permit period in preparation for the next (2029) permit renewal period. Riparian vegetation monitoring will also be conducted if a 25-year recurrence interval flood occurs. The riparian assessment method will be compatible with those used in the BA (Stillwater Sciences 2020). Other monitoring may be developed as the project proceeds.

We considered whether the proposed action would cause any other activities that would have consequences on listed fish species and their critical habitat and determined that it would not. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an Opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This Opinion includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of" a listed species, which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This Opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ''destruction or adverse modification'' analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this Opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44976, 44977), that definition does not change the scope of our analysis and in this Opinion, we use the terms "effects" and "consequences" interchangeably.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the range-wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

We have relied on the applicant's biological assessment (Stillwater 2020), peer-reviewed literature regarding the effects of sediment removal on stream geomorphology and how these

changes may affect salmonids and their habitat as referenced in this Opinion, CHERT reports and other documents regarding sediment extraction in Humboldt County, monitoring information for this ongoing proposed action, past Opinions on similar proposed actions in Humboldt County, status reviews and recovery plans for the potentially affected listed species, and the decades of experience of NMFS staff who help to monitor and implement the Opinions in the NMFS Arcata, California office.

2.2 Rangewide Status of the Species and Critical Habitat

This Opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The Opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species.

2.2.1 Life History and Range

2.2.1.1 Coho Salmon

Coho salmon adults migrate to and spawn in small streams that flow directly into the ocean, or tributaries and headwater creeks of larger rivers (Sandercock 1991, Moyle 2002). Adults migrate upstream to spawning grounds from September through late December, peaking in October and November. Spawning occurs mainly November through December, with fry emerging from the gravel in the spring, approximately three to four months after spawning. Juvenile rearing usually occurs in tributary streams with a gradient of 3 percent or less, although they may move up to streams of 4 percent or 5 percent gradient. Juveniles have been found in streams as small as 1 to 2 meters wide. They may spend one to two years rearing in freshwater (Bell and Duffy 2007), or emigrate to an estuary shortly after emerging from spawning gravels (Tschaplinski 1988). With the onset of fall rains, coho salmon juveniles are also known to redistribute into non-natal rearing streams, lakes, or ponds, where they overwinter (Peterson 1982). At a length of 38–45 mm, fry may migrate upstream a considerable distance to reach lakes or other rearing areas (Sandercock 1991, Nickelson *et al.* 1992). Emigration from streams to the estuary and ocean generally takes place from March through June.

The SONCC Coho Salmon ESU includes all naturally spawned populations of coho salmon in coastal streams from the Elk River, Oregon, through the Mattole River, California. It also includes three artificial propagation programs: Cole Rivers Hatchery in the Rogue River Basin, and the Trinity and Iron Gate hatcheries in the Klamath-Trinity River Basin.

2.2.1.2 Chinook Salmon

Chinook salmon follow the typical life cycle of Pacific salmon in that they hatch in freshwater, migrate to the ocean, and return to freshwater to spawn. Diversity within this life cycle exists, however, in the time spent at each stage. Juvenile Chinook salmon are classified into two groups, ocean-type and stream-type, based on the period of freshwater residence (Healey 1991). Ocean-type Chinook salmon spend a short period of time in freshwater after emergence, typically migrating to the ocean within their first year of life. Stream-type Chinook salmon reside in freshwater for a longer period, typically a year or more, before migrating to the ocean. After emigration, Chinook salmon remain in the ocean for two to five years (Healey 1991) tending to stay in the coastal waters of California and Oregon. Chinook salmon are also characterized by the timing of adult returns to freshwater for spawning, with the most common types referred to as fall-run and spring-run fish. Typically, spring-run fish have a protracted adult freshwater residency, sometimes spawning several months after entering freshwater, and produce stream-type progeny. Fall-run fish spawn shortly after entering freshwater and generally produce ocean-type progeny. Historically, both spring-run and fall-run fish existed in the CC Chinook Salmon ESU. At present, only fall-run fish appear to be extant in the ESU.

Fall-run Chinook salmon are decidedly ocean-type (Moyle 2002), specifically adapted for spawning in lowland reaches of big rivers and their tributaries (Moyle 2002, Quinn 2005). Adults move into rivers and streams from the ocean in the fall or early winter in a sexually mature state and spawn within a few weeks or days upon arrival on the spawning grounds (Moyle 2002). Juveniles emerge from the gravel in late winter or early spring and within a matter of months, migrate downstream to the estuary and the ocean (Moyle 2002, Quinn 2005). This life history strategy allows fall-run Chinook salmon to utilize quality spawning and rearing areas in the valley reaches of rivers, which are often too warm to support juvenile salmonid rearing in the summer (Moyle 2002).

The CC Chinook Salmon ESU includes all naturally spawned populations of Chinook salmon from rivers and streams south of the Klamath River (exclusive) to the Russian River (inclusive). Seven artificial propagation programs are considered part of the ESU: the Humboldt Fish Action Council (Freshwater Creek), Yager Creek, Redwood Creek, Hollow Tree, Van Arsdale Fish Station, Mattole Salmon Group, and Mad River Hatchery fall-run Chinook hatchery programs, but these programs were discontinued over a decade ago.

2.2.1.3 Steelhead

Steelhead probably have the most diverse life history of any of any salmonid (Quinn 2005). There are two basic steelhead life history patterns: winter-run and summer-run (Quinn 2005, Moyle 2002). Winter-run steelhead enter rivers and streams from December to March in a sexually mature state and spawn in tributaries of mainstem rivers, often ascending long distances (Moyle 2002). Summer steelhead (also known as spring-run steelhead) enter rivers in a sexually immature state during receding flows in spring, and migrate to headwater reaches of tributary streams where they hold in deep pools until spawning the following winter or spring (Moyle 2002). Spawning for all runs generally takes place in the late winter or early spring. Eggs hatch in 3 to 4 weeks and fry emerge from the gravel 2 to 3 weeks later (Moyle 2002). Juveniles spend

1 to 4 years in freshwater before migrating to estuaries and the ocean where they spend 1 to 3 years before returning to freshwater to spawn.

Another expression of the life history diversity of steelhead is the “half pounder” - sexually immature steelhead that spend about 3 months in estuaries or the ocean before returning to lower river reaches on a feeding run (Moyle 2002). Half pounders then return to the ocean where they spend 1 to 3 years before returning to freshwater to spawn. This steelhead life history form has only been observed in the Rogue and Klamath Rivers (of the Klamath Mountain Province Steelhead DPS) and the Mad and Eel Rivers (of the NC Steelhead DPS, Busby *et al.* 1996). Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al.* 1996). Some steelhead "residualize," becoming resident trout and never adopting the anadromous life history.

The NC Steelhead DPS includes all naturally spawned populations of steelhead in California coastal river basins from Redwood Creek (inclusive) southward to the Russian River (exclusive). Two artificial propagation programs are considered part of the DPS: the Yager Creek Hatchery and the North Fork Gualala River Hatchery (Gualala River Steelhead Project), but these programs were discontinued over a decade ago.

2.2.2 Status of the Species

2.2.2.1 SONCC Coho salmon

The following summary is from Williams *et al.* 2016, the most recent biological viability report for SONCC coho salmon:

> Although long-term data on coho abundance in the SONCC Coho Salmon ESU are scarce, all available evidence from more recent trends since the 2011 assessment (Williams *et al.* 2011) indicate little change since the 2011 assessment. The two population-unit scale time series for the ESU both have a trend slope not different from zero. The composite estimate for the Rogue Basin populations was not significantly different from zero ($p > 0.05$) over the past 12 years and significantly positive over the 35 years of the data set ($p = 0.01$). The continued lack of appropriate data remains a concern, although the implementation of the Coastal Monitoring Program (CMP) for California populations is an extremely positive step in the correct direction in terms of providing the types of information to assess and evaluate population and ESU viability. The lack of population spatial scale monitoring sites in Oregon is of great concern and increases the uncertainty when assessing viability. Additionally, it is evident that many independent populations are well below low-risk abundance targets, and several are likely below the high-risk depensation thresholds specified by the TRT and the Recovery Plan (NMFS 2014). Though population-level estimates of abundance for most independent populations are lacking, it does not appear that any of the seven diversity strata currently supports a single viable population as defined by the TRT’s viability criteria, although all occupied. The SONCC Coho Salmon ESU is currently considered likely to become endangered. Of particular concern is the low number of adults counted entering the Shasta River in 2014-

> 15. The lack of increasing abundance trends across the ESU for the populations with adequate data are of concern. Moreover, the loss of population spatial scale estimates from coastal Oregon populations is of great concern. The new information available since the 2011, while cause for concern, does not appear to suggest a change in extinction risk at this time.

2.2.2.2 CC Chinook Salmon

The following summary is from Williams *et al.* 2016, the most recent biological viability report for CC Chinook salmon.

> The lack of long-term population-level estimates of abundance for Chinook salmon populations continues to hinder assessment of status, though the situation has improved with implementation of the CMP in the Mendocino Coast Region and portions of Humboldt County. The available data, a mixture of short-term (6-year or less) population estimates or expanded redd estimates and longer-term partial population estimates and spawner/redd indexes, provide no indication that any of the independent populations (likely to persist in isolation) are approaching viability targets. In addition, there remains high uncertainty regarding key populations, including the Upper and Lower Eel River populations and the Mad River population, due to incomplete monitoring across the spawning habitat of Chinook salmon in these basins (O'Farrell *et al*. 2012). Because of the short duration of most time series for independent populations, little can be concluded from trend information. The longest time series, video counts in the Russian River, indicates the population has remained steady during the 14-year period of record. The longer time series associated with index reaches or partial populations suggest mixed patterns, with some showing significant negative trends (Prairie Creek, Freshwater Creek, Tomki Creek), one showing a significant positive trend (Van Arsdale Station), and the remainder no significant trends.
>
> At the ESU level, the loss of the spring-run life history type represents a significant loss of diversity within the ESU, as has been noted in previous status reviews (Good *et al*. 2005, Williams *et al*. 2011). Concern remains about the extremely low numbers of Chinook salmon in most populations of the North-Central Coast and Central Coast strata, which diminishes connectivity across the ESU. However, the fact that Chinook salmon have regularly been reported in the Ten Mile, Noyo, Big, Navarro, and Garcia rivers represents a significant improvement in our understanding of the status of these populations in watersheds where they were thought to have been extirpated. These observations suggest that spatial gaps between extant populations are not as extensive as previously believed.

In summary, Williams *et al.* (2016) concludes "there is a lack of compelling evidence to suggest that the status of these populations has improved or deteriorated appreciably since the previous status review" and that "the new available information does not appear to suggest there has been a change in the extinction risk of this ESU."

2.2.2.3 NC Steelhead

The following summary is from Williams *et al.* 2016, the most recent biological viability report for NC steelhead.

> The availability of information on steelhead populations in the NC Steelhead DPS has improved considerably in the past 5 years, due to implementation of the CMP across a significant portion of the DPS. Nevertheless, significant information gaps remain, particularly in the Lower Interior and North Mountain Interior diversity strata, where there is very little information from which to assess status. Overall, the available data for winter-run populations—predominately in the North Coastal, North-Central Coastal, and Central Coastal strata— indicate that all populations are well below viability targets, most being between 5% and 13% of these goals…for the two Mendocino Coast populations with the longest time series, Pudding Creek and Noyo River, the 13-year trends have been negative and neutral, respectively (Williams *et al.* 2016). However, the short-term (6-year) trend has been generally positive for all independent populations in the North-Central Coastal and Central Coastal strata, including the Noyo River and Pudding Creek (Williams *et al.* 2016). Data from Van Arsdale Station likewise suggests that, although the long-term trend has been negative, run sizes of natural-origin steelhead have stabilized or are increasing (Williams *et al.* 2016). Thus, we have no strong evidence to indicate conditions for winter-run have worsened appreciably since the last status review.
>
> Summer-run populations continue to be of significant concern because of how few populations currently exist. The Middle Fork Eel River population has remained remarkably stable for nearly five decades and is closer to its viability target than any other population in the DPS (Williams *et al.* 2016). Although the time series is short, the Van Duzen River appears to be supporting a population numbering in the low hundreds. However, the Redwood Creek and Mattole River populations appear small, and little is known about other populations including the Mad River and other tributaries of the Eel River (*i.e.*, Larabee Creek, North Fork Eel, and South Fork Eel).
>
> In summary, the available information for winter-run and summer-run populations of NC steelhead do not suggest an appreciable increase or decrease in extinction risk since publication of the last status reviews…most populations for which there are population estimates available remain well below viability targets; however, the short-term increases observed for many populations, despite the occurrence of a prolonged drought in northern California, suggests this DPS is not at immediate risk of extinction.

2.2.3 Factors for Decline (ESU or DPS Scale)

2.2.3.1 Timber Harvest

Timber harvest and associated activities occur over a large portion of the range of the affected species. Timber harvest has caused widespread increases in sediment delivery to channels through both increased landsliding and surface erosion from harvest units and log decks. Much of the largest riparian vegetation has been removed, reducing future sources of large woody

debris (LWD) needed to form and maintain stream habitat that salmonids depend on during various life stages. In the smaller streams, recruited wood does not usually wash away, so logs remain in place and act as check-dams that store sediment eroded from hillsides (Reid 1998). Sediment storage in smaller streams can persist for decades (Nakamura and Swanson 1993). In fish-bearing streams, LWD originating from mature coniferous forests is important for storing sediment, halting debris flows, and decreasing downstream flood peaks, and its role as a habitat element becomes directly relevant for Pacific salmon species (Reid 1998). LWD alters the longitudinal profile and reduces the local gradient of the channel, especially when log dams create slack pools above or plunge pools below them, or when they are sites of sediment accumulation (Swanston 1991).

Cumulatively, the increased sediment delivery and reduced LWD supply have led to widespread impacts on stream habitats and salmonids. These impacts include reduced spawning habitat quality, loss of pool habitat for adult holding and juvenile rearing, loss of velocity refugia, and increases in the levels and duration of turbidity that reduce the ability of juvenile fish to feed. These changes in habitat have led to widespread decreases in the carrying capacity of streams that support salmonids.

2.2.3.2 Road Construction

Road construction, whether associated with timber harvest or other activities, has caused widespread impacts on salmonids (Furniss *et al.* 1991). Where roads cross salmonid-bearing streams, improperly placed culverts have blocked access to many stream reaches. Land sliding and chronic surface erosion from road surfaces are large sources of sediment across the affected species' ranges. Roads also have the potential to increase peak flows and reduce summer base flows with consequent effects on the stability of stream substrates and banks. Roads have led to widespread impacts on salmonids by increasing the sediment loads. The consequent impacts on habitat include reductions in spawning, rearing, and holding habitat, and increases in turbidity. The delivery of sediment to streams can be generally considered as either chronic, or episodic. Chronic delivery refers to surface erosion that occurs from rain splash and overland flow. More episodic delivery, on the order of every few years, occurs in the form of mass wasting events, or landslides, that deliver large volumes of sediment during large storm events.

Construction of road networks can also greatly accelerate erosion rates within a watershed (Haupt 1959; Swanson and Dyrness 1975; Swanston and Swanson 1976; Reid and Dunne 1984; Hagans and Weaver 1987). Once constructed, existing road networks are a chronic source of sediment to streams (Swanston 1991) and are generally considered the main cause of accelerated surface erosion in forests across the western United States (Harr and Nichols 1993). Processes initiated or affected by roads include landslides, surface erosion, secondary surface erosion (landslide scars exposed to rain splash), and gullying. Roads and related ditch networks are often connected to streams via surface flow paths, providing a direct conduit for sediment. Where roads and ditches are maintained periodically by blading, the amount of sediment delivered continuously to streams may temporarily increase as bare soil is exposed and ditch roughness features, which store and route sediment and armor the ditch, are removed. Hagans and Weaver (1987) found that fluvial hillslope erosion associated with roads in the lower portions of the Redwood Creek watershed produced about as much sediment as landslide erosion between 1954 and 1980. In the Mattole River watershed, the Mattole Salmon Group (1997) found that roads,

including logging haul roads and skid trails, were the source of 76 percent of all erosion problems mapped in the watershed. This does suggest that, overall, roads are a primary source of sediment in managed watersheds.

Road surface erosion is particularly affected by traffic, which increases sediment yields substantially (Reid and Dunne 1984). Other important factors that affect road surface erosion include condition of the road surface, timing of when the roads are used in relation to rainfall, road prism moisture content, location of the road relative to watercourses, methods used to construct the road, and steepness on which the road is located.

2.2.3.3 Hatcheries

Releasing large numbers of hatchery fish can pose a threat to wild salmon and steelhead stocks through genetic impacts, competition for food and other resources, predation of hatchery fish and wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991). The genetic impacts of artificial propagation programs are primarily caused by the straying of hatchery fish and the subsequent hybridization of hatchery and wild fish. Artificial propagation threatens the genetic integrity and diversity that protects overall productivity against changes in environment (61 FR 56138, October 31, 1996). The potential adverse impacts of artificial propagation programs are well-documented (Waples 1991; Waples 1999; National Research Council 1995).

2.2.3.4 Water Diversions and Habitat Blockages

Stream-flow diversions are common throughout the species' ranges. Unscreened diversions for agricultural, domestic, and industrial uses are a significant factor for salmonid declines in many basins. Reduced stream-flows due to diversions reduce the amount of habitat available to salmonids and can degrade water quality, such as causing elevated water temperatures. Reductions in water quantity can reduce the carrying capacity of the affected stream reach by reducing the amount of available habitat, including by causing discontinuous flow and subsequent disconnected pools. Where warm return flows enter the stream, fish may seek reaches with cooler water, thus increasing competitive pressures in these areas.
Habitat blockages have occurred in relation to road construction as discussed previously. In addition, hydropower, flood control, and water supply dams of different municipal and private entities, have permanently blocked or hindered salmonid access to historical spawning and rearing grounds. The percentage of habitat blocked by dams is likely greatest for steelhead because steelhead were more extensively distributed upstream than Chinook or coho salmon. Because of migrational barriers, salmon and steelhead populations have been confined to lower elevation mainstems that historically only were used for migration and rearing. Population abundances have declined in many streams due to decreased quantity, quality, and spatial distribution of spawning and rearing habitat (Lindley *et al*. 2007).

2.2.3.5 Predation

Predation likely did not play a major role in the decline of salmon populations; however, it may have substantial impacts at local levels. For example, Higgins *et al.* (1992) and CDFG (1994)

reported that Sacramento River pikeminnow (*Ptychocheilus grandis*) accidentally introduced to the Eel River basin are a major competitor and predator of the native salmonids found there.

2.2.3.6 Disease

Disease has not been identified as a major factor in the decline of ESA-listed salmonids. However, disease may have substantial impacts in some areas and may limit recovery of local salmon populations. Although naturally occurring, many of the disease issues salmon and steelhead currently face have been exacerbated by human-induced environmental factors such as water regulation (damming and diverting) and habitat alteration. Natural populations of salmonids have co-evolved with pathogens that are endemic to the areas salmonids inhabit and have developed levels of resistance to them. In general, diseases do not cause significant mortality in native salmonid stocks in natural habitats (Bryant 1994, Shapovalov and Taft 1954). However, when this natural habitat is altered or degraded, outbreaks can occur. For example, ceratomyxosis, which is caused by *Ceratonova shasta*, has been identified as one of the most significant diseases for juvenile salmon in the Klamath Basin due to its prevalence and impacts there (Nichols *et al.* 2007) that are related to reduced flows and increased water temperatures.

2.2.3.7 Commercial and Recreational Fisheries

Salmon and steelhead once supported extensive tribal, commercial, and recreational fisheries. NMFS has identified over-utilization as a significant factor in their decline. This harvest strongly affected salmonid populations because, each year, it removed adult fish from the ESU before they spawned, reducing the numbers of offspring in the next generation. In modern times, steelhead are rarely caught in ocean salmon fisheries. Directed ocean Chinook salmon fisheries are currently managed by NMFS to achieve Federal conservation goals for west coast salmon in the Pacific Coast Salmon Fishery Management Plan (FMP). The goals specify the numbers of adults that must be allowed to spawn annually, or maximum allowable adult harvest rates. In addition to the FMP goals, salmon fisheries must meet requirements developed through NMFS' intra-agency section 7 consultations, including limiting the incidental mortality rate of ESA-listed salmonids.

2.2.3.8 Climate Change

Global climate change presents a potential threat to salmonids and their critical habitats. Impacts from global climate change are already occurring in California. For example, average annual air temperatures, heat extremes, and sea level have all increased in California over the last century (Kadir *et al.* 2013). Snowmelt from the Sierra Nevada Mountains has declined (Kadir *et al.* 2013). However, total annual precipitation amounts have shown no discernible change (Kadir *et al.* 2013). Listed salmonids may have already experienced some detrimental impacts from climate change. NMFS believes the impacts on listed salmonids to date are likely fairly minor because natural, and local, climate factors likely still drive most of the climatic conditions steelhead experience, and many of these factors have much less influence on steelhead abundance and distribution than human disturbance across the landscape.

The threat to listed salmonids from global climate change will increase in the future. Modeling of climate change impacts in California suggests that average summer air temperatures are expected

to continue to increase (Lindley *et al.* 2007, Moser *et al.* 2012). Heat waves are expected to occur more often, and heat wave temperatures are likely to be higher (Hayhoe *et al.* 2004, Moser *et al.* 2012. Kadir *et al.* 2013). Total precipitation in California may decline; critically dry years may increase (Lindley *et al.* 2007, Schneider 2007, and Moser *et al.* 2012). Wildfires are expected to increase in frequency and magnitude (Westerling *et al.* 2011, Moser *et al.* 2012).

For Northern California, most models project heavier and warmer precipitation. Extreme wet and dry periods are projected, increasing the risk of both flooding and droughts (DWR 2013). Estimates show that snowmelt contribution to runoff in the Sacramento/San Joaquin Delta may decrease by about 20 percent per decade over the next century (Cloern *et al.* 2011). Many of these changes are likely to further degrade listed salmonid habitat by, for example, reducing stream flow during the summer and raising summer water temperatures. Estuaries may also experience changes detrimental to salmonids. Estuarine productivity is likely to change based on changes in freshwater flows, nutrient cycling, and sediment amounts (Scavia *et al.* 2002, Ruggiero *et al.* 2010). In marine environments, ecosystems and habitats important to juvenile and adult salmonids are likely to experience changes in temperatures, circulation, water chemistry, and food supplies (Doney *et al*. 2012). The projections described above are for the mid to late 21st Century. In shorter time frames, climate conditions not caused by the human addition of carbon dioxide to the atmosphere are more likely to predominate (Cox and Stephenson 2007, Santer *et al.* 2011).

2.2.3.9 Ocean Conditions

Variability in ocean productivity affects fisheries production both positively and negatively (Chavez *et al.* 2003). Beamish and Bouillion (1993) showed a strong correlation between North Pacific salmon production and marine environmental factors from 1925 to 1989. Beamish *et al.* (1997a) noted decadal-scale changes in the production of Fraser River sockeye salmon that they attributed to changes in the productivity of the marine environment. Warm ocean regimes are characterized by lower ocean productivity (Behrenfeld *et al.* 2006, Wells *et al.* 2006), which may affect salmon by limiting the availability of nutrients regulating the food supply, thereby increasing competition for food (Beamish and Mahnken 2001). Data from across the range of coho salmon on the coast of California and Oregon reveal there was a 72 percent decline in returning adults in 2007/08 compared to the same cohort in 2004/05 (MacFarlane *et al.* 2008). The Wells Ocean Productivity Index, an accurate measure of Central California ocean productivity, revealed poor conditions during the spring and summer of 2006, when juvenile coho salmon and Chinook salmon from the 2004/05 spawn entered the ocean (McFarlane *et al.* 2008). Data gathered by NMFS suggests that strong upwelling in the spring of 2007 may have resulted in better ocean conditions for the 2007 coho salmon cohort (MacFarlane *et al.* 2008). The quick response of salmonid populations to changes in ocean conditions (MacFarlane *et al.* 2008) strongly suggests that density dependent mortality of salmonids is a mechanism at work in the ocean (Beamish *et al.* 1997b, Levin *et al.* 2001, Greene and Beechie 2004).

The poor conditions reflect warmer than average sea surface and deep-sea temperatures associated with a relative lack of lipid-rich species of zooplankton, and krill biomass that was the lowest in the last 20 years (Peterson *et al.* 2015). These warm ocean conditions are attributed to a strengthening El Niños in addition to anomalously warm conditions (the “warm blob”) that began in 2013 (Peterson *et al.* 2015) and continued through 2019.

The smolt to adult return rate for coho salmon at Freshwater Creek, a tributary of Humboldt Bay in Northern California, was less than 3 percent from 2011 to 2013 (Anderson *et al.* 2015). Bradford et al. (2000) found that the average coastal coho salmon population would be unable to sustain itself when marine survival rates fall below about 3 percent. Ocean conditions are not necessarily the only influence of marine survival; however, if marine survival is below 3 percent, the SONCC coho salmon ESU will have difficulty sustaining itself. Therefore, poor ocean conditions and low marine survival poses a key threat to the SONCC Coho Salmon ESU. This is likely the case for other ESUs and DPSs that use the California Current.

2.2.3.10 Drought

The following language is taken from Williams *et al*. 2016, which provides the most recent description of the effects of recent drought conditions on listed salmonids in California. California has experienced well below average precipitation over the last decade (2010-2020). Some paleoclimate reconstructions suggest that the current drought is the most extreme in the past 500 or perhaps more than 1000 years. Anomalously high surface temperatures have amplified the effects of drought on water availability. This period 2010-2020 of drought and high air, stream, and upper-ocean temperatures have together likely had negative impacts on the freshwater, estuary, and marine phases for many populations of Chinook salmon, coho salmon, and steelhead.

2.2.3.11 Marine-Derived Nutrients

Marine-derived nutrients (MDN) are nutrients that are accumulated in the biomass of salmonids while they are in the ocean and are then transferred to their freshwater spawning sites where the salmon die. The return of salmonids to rivers makes a significant contribution to the flora and fauna of both terrestrial and riverine ecosystems (Gresh *et al.* 2000), and has been shown to be vital for the growth of juvenile salmonids (Bilby *et al.* 1996, 1998). Evidence of the role of MDN and energy in ecosystems suggests a deficit of MDN may result in an ecosystem failure contributing to the downward spiral of salmonid abundance (Bilby *et al.* 1996). Reduction of MDN to watersheds is a consequence of the past century of decline in salmon abundance (Gresh *et al.* 2000).

2.2.4 Critical Habitat

NMFS is responsible for designating critical habitat for species listed under its jurisdiction. In designating critical habitat, NMFS considers the following requirements of the species: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring; and, generally; and (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species (see 50 CFR 424.12(b)). In addition to these factors, NMFS focuses on the known physical and biological features (PBFs) within the designated area that are essential to the conservation of the species and that may require special management considerations or protection. Designated critical habitat for all the species listed below overlaps with the action area.

This Opinion analyzes the effects of the proposed gravel mining operations on the Mad River for the years 2020-2029 on critical habitat for SONCC coho salmon, CC Chinook salmon, and NC steelhead. The ESA defines conservation as "to use all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to the ESA are no longer necessary." As a result, NMFS approaches its "destruction and adverse modification" determinations by examining the effects of actions on the conservation value of the designated critical habitat—that is, the value of the critical habitat for the conservation of threatened or endangered species.

2.2.4.1 SONCC Coho Salmon Critical Habitat

Description

Designated critical habitat for SONCC coho salmon encompasses accessible reaches of all rivers (including estuarine areas and tributaries) between the Mattole River in California and the Elk River in Oregon, inclusive (May 5, 1999, 64 FR 24049). Excluded are: (1) areas above specific dams identified in the Federal Register notice; (2) areas above longstanding natural impassible barriers (i.e., natural waterfalls); and (3) tribal lands. The area described in the final rule represented the current freshwater and estuarine range of coho salmon. Land ownership patterns within the coho salmon ESU analyzed in this document and spanning southern Oregon and northern California are 53% private lands, 36% Federal lands, 10% State and local lands, and 1% tribal lands.

The designated critical habitat for SONCC coho salmon is separated into the five PBFs of the species' life cycle. The five PBFs (essential habitat types) include: (1) juvenile summer and winter rearing areas; (2) juvenile migration corridors; (3) areas for growth and development to adulthood; (4) adult migration corridors; and (5) spawning areas. Within these areas, PBFs (essential features) of SONCC coho salmon critical habitat include adequate: (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) safe passage conditions (64 FR 24049; May 5, 1999).

Current Condition

The condition of SONCC coho salmon critical habitat at the ESU scale, specifically its ability to provide for the species' conservation, has been degraded from conditions known to support viable salmonid populations that contribute to survival and recovery of the species. NMFS determined that present depressed population conditions are, in part, the result of human-induced factors affecting critical habitat, including: intensive timber harvesting, agricultural and mining activities, urbanization, stream channelization, dams, wetland loss, and water withdrawals for irrigation. All of these factors were identified when SONCC coho salmon were listed as threatened under the ESA, and they continue to affect this ESU (NMFS 2014). However, efforts to improve coho salmon critical habitat have been widespread and are expected to benefit the ESU over time (NMFS 2014).

Within the SONCC recovery domain, a large number of habitat restoration actions have been implemented including reducing sediment, creating backwater channels and ponds for juvenile

rearing, increasing flows and screening diversions, adding LWD, and fixing fish passage impediments. Therefore, the condition of SONCC coho salmon critical habitat is likely improved or trending toward improvement compared to when it was designated in 1999.

SONCC coho salmon are dependent upon complex, low gradient habitats for winter rearing, and will express diversity by overwintering in low-gradient, off-channel and estuarine habitats when they are available. The lack of complex aquatic habitat, and much decreased access to floodplains and low gradient tributaries are common features of current critical habitat conditions within the SONCC Coho Salmon ESU (NMFS 2014). The Recovery Plan also describes that land use activities (e.g., timber harvest, road building, etc.) that occur upstream of low gradient streams, still affect the habitat within low gradient streams by reducing the amount of large wood and shade available and by increasing the amount of sediment that routes through the valley bottom habitats.

2.2.4.2 CC Chinook Salmon Critical Habitat

Description

Designated critical habitat for CC Chinook salmon includes the stream channels up to the ordinary high-water line (50 CFR Part 226.211). In areas where the ordinary high-water line has not been defined pursuant to 50 CFR Part 226.211, the lateral extent is defined by the bankfull elevation. Critical habitat in estuaries is defined by the perimeter of the water body as displayed on standard 1:24,000 scale topographic maps or the elevation of extreme high water, whichever is greater.

Critical habitat for CC Chinook salmon was designated as occupied watersheds from the Redwood Creek watershed, south to and including the Russian River watershed (70 FR 52488, September 2, 2005). Humboldt Bay and the Eel River estuary are designated as critical habitat for the CC Chinook Salmon ESU. Some areas within the geographic range were excluded due to economic considerations. Critical habitat was not designated on Indian lands. Designated critical habitat for CC Chinook salmon overlaps the action area. In designating critical habitat for CC Chinook salmon, NMFS focused on areas that are important for the species' overall conservation by protecting quality growth, reproduction, and feeding. The critical habitat designation for these species identifies the known PBFs that are necessary to support one or more Chinook salmon life stages, including: (1) freshwater spawning, (2) freshwater rearing, (3) freshwater migration, (4) estuarine areas, (5) nearshore marine areas, and (6) offshore marine areas. Within the PBFs, essential elements of CC Chinook salmon critical habitats include adequate (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, (10) safe passage conditions, and (11) salinity conditions (70 FR 52488, September 2, 2005).

Current Condition

The condition of CC Chinook salmon critical habitat, specifically its ability to provide for their conservation, is degraded from conditions known to support viable salmonid populations. NMFS has determined that present depressed population conditions are, in part, the result of the following human-induced factors affecting critical habitat: logging, agricultural and mining activities, urbanization, stream channelization, dams, freshwater and estuarine wetland loss, and

water withdrawals for irrigation. All of these factors were identified when CC Chinook salmon were listed as threatened under the ESA, and they all continue to affect this ESU. However, efforts to improve CC Chinook salmon critical habitat have been widespread and are expected to benefit the ESU.

2.2.4.3 NC Steelhead Critical Habitat

Description

NMFS designated critical habitat for seven of the ESUs/DPSs of Pacific salmon and steelhead, including NC steelhead in September 2005 (70 FR 52488, September 2, 2005). Specific PBFs, that are essential for the conservation of each species, were identified as: freshwater spawning sites; freshwater rearing sites; freshwater migration corridors; estuarine areas; nearshore marine areas; and offshore marine areas. Within the PBFs, essential elements of NC steelhead critical habitats include adequate (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, (10) safe passage conditions, and (11) salinity conditions (70 FR 52488, September 2, 2005). Habitat areas within the geographic range of the ESU/DPSs having these attributes and occupied by the species were considered for designation. Steelhead critical habitat was designated throughout the watersheds occupied by the ESU/DPSs. In general, the extent of critical habitat conforms to the known distribution of NC steelhead in streams, rivers, lagoons and estuaries (NMFS 2005). In some cases, streams containing NC steelhead were not designated because the economic benefit of exclusion outweighed the benefits of designation, as in the North Fork Eel River. Native American tribal lands and U.S. Department of Defense lands were also excluded.

Designated critical habitat for NC steelhead includes the stream channels up to the ordinary high-water line (50 CFR 226.211). In areas where the ordinary high-water line has not been defined pursuant to 50 CFR 226.211, the lateral extent is defined by the bankfull elevation. Critical habitat in estuaries is defined by the perimeter of the water body as displayed on standard 1:24,000 scale topographic maps or the elevation of extreme high water, whichever is greater. Critical habitat for NC steelhead was designated as occupied watersheds from the Redwood Creek watershed, south to and including the Gualala River watershed. Humboldt Bay and the Eel River estuary are designated as critical habitat for the NC Steelhead DPS. Some areas within the geographic range were excluded due to economic considerations. Critical habitat was not designated on Indian lands. Designated critical habitat for NC steelhead overlaps the action area. In designating critical habitat for NC steelhead, NMFS focused on areas that are important for the species' overall conservation by protecting quality growth, reproduction, and feeding.

Current Condition

Similar to the current condition of SONCC coho salmon critical habitat, the current condition of NC steelhead critical habitat is degraded throughout most of the range of this species. Estuaries and lower river habitats are greatly reduced, in both area and condition, as the valley bottoms near the mouths of rivers are where most of the agricultural and urban development is concentrated. Levees constrain most estuaries and lower rivers in this DPS and prevent access to important off-channel rearing habitat. Upstream land uses increase the amount of sediment and warm water that enters low gradient streams and decreases the availability of large wood in these habitats.

The condition of NC steelhead critical habitat, specifically its ability to provide for their conservation, is degraded from conditions known to support viable salmonid populations. NMFS determined that present depressed population conditions are, in part, the result of the following human-induced factors affecting critical habitat: logging, agricultural and mining activities, urbanization, stream channelization, dams, freshwater and estuarine wetland loss, and water withdrawals for irrigation. All of these factors were identified when NC steelhead were listed as threatened under the ESA, and they all continue to affect this DPS. However, efforts to improve NC steelhead critical habitat have been widespread and are expected to benefit the DPS.

2.2.4.4 Conservation Value of Critical Habitat

The PBFs of designated critical habitat for SONCC and CCC coho salmon, NC, CCC, and S-CCC steelhead, and CC Chinook salmon are those accessible freshwater habitat areas that support spawning, incubation and rearing, migratory corridors free of obstruction or excessive predation, and estuarine areas with good water quality and that are free of excessive predation. Timber harvest and associated activities, road construction, urbanization and increased impervious surfaces, migration barriers, water diversions, and large dams throughout a large portion of the freshwater range of the ESUs and DPSs continue to result in habitat degradation, reduction of spawning and rearing habitats, and reduction of stream flows. The result of these continuing land management practices in many locations has limited reproductive success, reduced rearing habitat quality and quantity, and caused migration barriers to both juveniles and adults. These factors likely limit the conservation value (*i.e.*, limiting the numbers of salmonids that can be supported) of designated critical habitat within freshwater habitats at the ESU/DPS scale.

Although watershed restoration activities have improved freshwater critical habitat conditions in isolated areas, reduced habitat complexity, poor water quality, and reduced habitat availability because the same land management practices persist in many locations.

2.2.4.5 Summary

Although watershed restoration activities have improved freshwater and estuarine critical habitat conditions in isolated areas, reduced habitat complexity, poor water quality, and reduced habitat availability that resulted from historical and ongoing land management practices persist in many locations, and are limiting the conservation value of designated critical habitat within these freshwater and estuarine habitats at the ESU and DPS scales.

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

The action area for this consultation includes the Mad River from the Mad River Hatchery near the City of Blue Lake, Humboldt County, California, downstream 12.5 miles to the mouth of the Mad River at the Pacific Ocean (Figure 1).

This section of the Mad River is in a partially unconfined, alluvial reach that allows for gravel deposition. The lateral extent of the action area for the Mad River batched proposed action includes the river channel, the floodplain (100-year), and the associated roads and gravel processing facilities that are outside the 100-year floodplain. The action area includes tributary mouths that enter the river in this section and downstream habitat that may be affected by gravel mining and associated activities.

2.4 Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

2.4.1 Status of Listed Species in the Action Area

The Mad River is part of the Central Coast diversity stratum for SONCC coho salmon, and the North Coastal diversity stratum for CC Chinook salmon and NC winter steelhead (Spence *et al.* 2008, Williams *et al.* 2008). In addition, the Mad River is part of the Northern Coastal/North Mountain Interior diversity stratum for NC summer steelhead. For coho salmon, CC Chinook salmon, and NC steelhead, the Mad River is identified as an area that should ultimately support a viable population (one at low risk of extinction) because these populations are expected to play a key role in recovery of the ESU or DPS. In order for an ESU or DPS to be viable and eligible for delisting, all diversity strata that make up that ESU or DPS must be viable (Spence *et al.* 2008, Williams *et al.* 2008). Given the current expected roles of each population in recovery, the Mad River must support a viable population in order for the Central Coastal and Northern Coastal diversity strata of coho salmon and Chinook salmon and NC steelhead, respectively, to be viable. Table 3 provides a summary of the status of coho salmon, Chinook salmon, and steelhead in the action area.

Actual population estimates for coho salmon, summer-and winter- steelhead, and Chinook salmon are limited to what has been collected in recent years. CDFW has been operating sonar and apportioning results to species in the Lower Mad River since 2013 using an ARIS (Adaptive Resolution Imaging Sonar) system. From August 28, 2017 to January 2, 2018, the abundance estimate for adult coho salmon was 1,575 (95% CI = 1,482 – 1,668; CV = 3.0%) (Sparkman and Holt 2020). The Mad River estimate of adult CC Chinook salmon populations using sonar for the years 2014-2018 ranged from 4,100 to 9,606 (Sparkman and Holt 2020). The number of adult winter steelhead (natural and hatchery-origin) detected per year ranged from 712 to 7,761 between fall 2014 and winter of 2018. The number of adult summer steelhead from 2014-2018 ranged between 191 and 558 (Sparkman and Holt 2020). It should be noted that CDFW also differentiated fall steelhead

from either summer steelhead or winter steelhead which reduces the summer-and winter-run estimates.

Table 3. Status of the three ESA-listed salmonid species' populations found within the action area as outlined in each species recovery plans.

	SONCC Coho Salmon	**CC Chinook Salmon Fall-Run**	**NC Steelhead (Winter-Run)**	**NC Steelhead (Summer-run)**
Population within the Action Area	Mad River	Mad River	Mad River	Mad River
Diversity Stratum	Central Coastal	North Coastal	North Coastal/North Mountain Interior	North Coastal/North Mountain Interior
Role within ESU/DPS	Functionally Independent	Functionally Independent	Functionally Independent	Functionally Independent
Extinction Risk	High	Low*	Low*	High*
Depensation Threshold	Likely below	Above*	Above*	Below*
Spawner Abundance Target	9,300 adults	3,000 adults	Lower Mad River=3,200 adults Upper Mad River=6,100 adults	Effective populations size N_e>=500
Watershed Size/Potential Habitat	494 square miles 135 IP-km	494 Square miles 94 IP-km	494 Square miles Lower Mad River= 146 IP-km; Upper Mad River= 304 IP-km	494 Square miles Lower Mad River= 146 IP-km; Upper Mad River= 304 IP-km
Limiting Stresses	Altered Sediment Supply; Lack of Floodplain and Channel Structure	Estuary: Quality and Extent; Water Quality: Turbidity; Habitat Complexity: Large Wood, Shelter and Pools	Water Quality: Temperature and turbidity; Riparian Vegetation: Canopy Cover and Tree Diameter; Habitat Complexity: Large Wood	Water Quality: Temperature and turbidity; Riparian Vegetation: Canopy Cover and Tree Diameter; Habitat Complexity: Large Wood
Limiting Threats	Roads, Mining/gravel extraction	Channel Modification; roads	Channel Modification; Logging and Wood harvesting; Roads	Channel Modification; Logging and Wood harvesting; Roads

*The Multispecies Recovery Plan did not assign extinction risk categories or address depensation levels, so professional judgement was used to assign these categories to be consistent with the SONCC Coho Salmon Recovery Plan.

2.4.2 Status of Critical Habitat in the Action Area

The Mad River is designated critical habitat for SONCC coho salmon, CC Chinook salmon, and NC steelhead. The key limiting stresses for each species are identified above in Table 3. Timber harvest, road building, gravel mining, grazing and water diversion/impoundment are the land and water uses that have had the most pronounced effect on salmon and steelhead habitat in the Mad River basin. Much of the North Fork watershed and the lower and middle portions of the Mad River basin are owned by Green Diamond Resource Company (GDRC) and are used for timber production. Grazing occurs on large ranches throughout the Mad River basin, as well as more concentrated grazing along the reaches of the lower river and its tributaries. Most of the upper basin is part of the Six Rivers National Forest and is managed using an ecosystem-based approach that provides for resource protection under the Northwest Forest Plan (Forest Ecosystem Management Assessment Team 1993).

The Humboldt Bay Municipal Water District (HBMWD) constructed Matthews Dam in 1961 at river mile (RM) 84 in the upper basin which created Ruth Reservoir, well upstream of historic coho salmon and Chinook salmon habitat, but it did block some steelhead habitat. The reservoir is used by HBMWD to store storm flows for release down the river and withdrawal near the Essex facility in Arcata, California for municipal and industrial use. The withdrawals are accomplished using Ranney wells approximately 50 feet below the river bottom and from a screened surface water diversion. The release of water from Ruth Reservoir provides a higher summer low flow than what occurred prior to dam construction because HBMWD needs to deliver adequate water downstream for diversion at the Essex facility. The HBMWD operations primarily impact flows during the fall and early winter when they begin capturing flows from the first storm events in the watershed above Ruth Reservoir. These lower flows may have some influence on Chinook salmon migration timing during some years when this decreased flow would result in impaired adult migration cures or reduce the depth of water for migration in the action area. Additionally, during some years, the flow hydrograph recession in the spring may result in lower flows during a short period of time when mandated river flows are less than what the natural flows would be which may influence Chinook salmon smolt outmigration timing.

Extensive instream gravel mining occurs throughout the lower Mad River; mining practices have greatly improved since the 1970s. The majority of large gravel bars on the lower mainstem Mad River between Blue Lake and Highway 299 are mined each year, and annual mining typically removes the estimated mean annual recruitment of gravel coming into the mining reach. Since gravel extraction is the focus of this Opinion, more information will be provided below.
The communities of Arcata, Blue Lake, and McKinleyville are located along the lowermost reach of the Mad River, near the mouth. Many of the impacts of urbanization are in the form of development and associated road construction and land clearing, resulting in increased run-off, increased fine sediment, increased chemical contamination from run-off of roads and other surfaces, intrusion into the Mad River floodplain with development (*e.g.*, roads, bridges, houses, and other infrastructure) that reduces the floodplain, water diversions from tributaries for agriculture and domestic uses, and establishment of homeless encampments.

The land uses described above have reduced available salmon and steelhead habitat throughout the basin. Increased sediment production from logged hill slopes and roads, especially as

occurred during the 1955 and 1964 flood events, have filled the Mad River with sediment, creating chronically high turbidity levels. Although the Mad River basin has naturally high rates of sediment delivery due to unstable hill slopes prone to landslides and high rates of surface erosion, the U.S. Environmental Protection Agency (USEPA) estimated that 64 percent of total sediment delivered to streams was attributed to human and land management related activities, with roads being the dominant sediment source (USEPA 2007). In the lower Mad River and North Fork areas, total sediment loading is currently five times greater than natural sediment loading (USEPA 2007).

Compounding the increase in sediment delivery, loss of riparian vegetation has reduced shading and created a lack of instream large wood. These land uses have resulted in warm, shallow and wide instream habitat conditions that have severely impacted salmonids. Most of the basin is now comprises forest stands of smaller diameter trees, with a greater percentage of hardwoods that provide different ecological functions than those found historically (GDRC 2006). Improved salmonid access to lower river tributaries such as Mill, Hall, and Quarry creeks is occurring through culvert upgrades and barrier removal, but some of the lower river tributaries still have habitat blocked by road-stream crossings. Water impoundment and release for municipal diversion and hydroelectric operations has resulted in greater than naturally occurring summer flows in the middle and lower sections of the river, potentially increasing habitat availability during summer and early fall months. Screened water diversions at Essex in the lower river create minor fluctuations in the rate of flows in the summer and early fall. The impacts of this diversion are negligible in most instances. However, peak flows in the fall are dampened and this may make adult migration more difficult or may dampen the flow cues salmonids use for upstream migration.

The Mad River is listed as “Impaired” for sediment and temperature under section 303(d) of the Clean Water Act (USEPA 2007). NMFS (2014) describes stresses to the Mad River salmonid populations as: lack of floodplain and channel structure, impaired water quality, altered sediment supply, degraded riparian conditions, and altered hydrologic function. Salmonid habitat in the Mad River is generally degraded. There is excessive sediment supply coming from roads and other land disturbances, which fills pools and interferes with spawning success. Suitable instream structure, as well as off-channel habitat, is extremely limited. These habitat features are essential to rearing juveniles. Insufficient riparian cover means there is not enough large wood falling into the stream to create this structure. Degraded riparian condition also leads to impaired water temperatures due to a lack of shade. Water temperatures in the lethal to stressful range have been observed Mad River (NMFS 2014). Tributary stream flows have been adversely affected by diversion of streams and springs for rural domestic and marijuana farming (NMFS 2014).

2.4.3 Factors affecting species environment within the action area

The key limiting threats, those that most affect the viability of the population by influencing stresses, are roads and mining/gravel extraction, and timber harvest. Several other threats with somewhat lower potential to affect survival and recovery are also present in the action area, as summarized below.

Roads
Road density is very high throughout the basin, ranging from 4.4 to 6.3 miles of road per square mile in the lower Mad River and North Fork areas (USEPA 2007). Roads are a substantial source of both chronic and catastrophic sediment input to streams in the basin, affecting the quality and quantity of available salmon and steelhead habitat in the Mad River and its tributaries. In 2007, the USEPA developed the TMDL for sediment and turbidity for the Mad River (USEPA 2007). An estimated 64 percent of the total sediment delivered to streams was attributed to human and land management-related activities, and road-related sediment contributes approximately 62 to 73 percent of the anthropogenic sediment in the basin (USEPA 2007). Additionally, roads and associated infrastructure can impinge on the floodplains reducing availability for salmonids and riparian development.

Mining/Gravel Extraction
Historic gravel extraction was very damaging to the habitat in the lower Mad River. In response to habitat concerns, Humboldt County initiated the extraction review team (CHERT) in 1994. Current instream mining practices are much improved over past practices and extraction volumes have been significantly reduced. However, even with minimization measures, gravel extraction may reduce overall habitat complexity, but the magnitude of this effect is highly variable depending on the location, type, and volume of the extraction. Additionally, some appropriately placed and sized extractions (e.g., alcoves) can provide short-term enhancement of habitat complexity and value. Previously, channel enlargement has occurred in the upper reach of the action area (CHERT 2005, NMFS 2004, CHERT 2009, NMFS 2010) with the most pronounced and persistent enlargement at the Guynup, Emmerson, Christie and the Johnson gravel mining sites (Figure 2). This is most likely a result of extraction exceeding replenishment rates. However, in 2010, NMFS instituted a strategy to manage extraction volumes based on the area of the extraction and a percentage of the recruitment that varies from year to year depending on the flow levels and duration (i.e., higher flow levels and higher duration of high flow events increases recruitment) (NMFS 2010).

An assessment of the channel enlargement through cross section analysis for the recent 2010-2018 extraction period suggests channel enlargement has been reduced in some locations and reversed on Christie Bar during this period (NMFS 2020). Guynup Bar, Blue Lake Bar, and Johnson Bar showed continued enlargement, though the amount of enlargement at Blue Lake Bar decreased in the last five years of the permit period. The enlargement at Guynup Bar continued at the same or slightly higher rate than before the 2010-2018 period. This recent enlargement seems mostly related to the bank caving on the right bank that occurred in 2017, possibly in response to the removal of a low-head dam at the Mad River Hatchery. Bank caving has also been observed at Johnson Bar. The Guynup Bar extraction intensity occurs at a relatively higher extraction rate than the other bars in the upper reach, except the Blue Lake Rancheria's (BLR) Bar, which is not included in this consultation. Christie Bar has aggraded where the extraction intensity is the lowest in the upper reach and significantly less than the previous permit period. Cross section enlargement has been observed at the BLR bar on the Mad River where extraction was not based on variability in estimated annual recruitment (NMFS 2020).

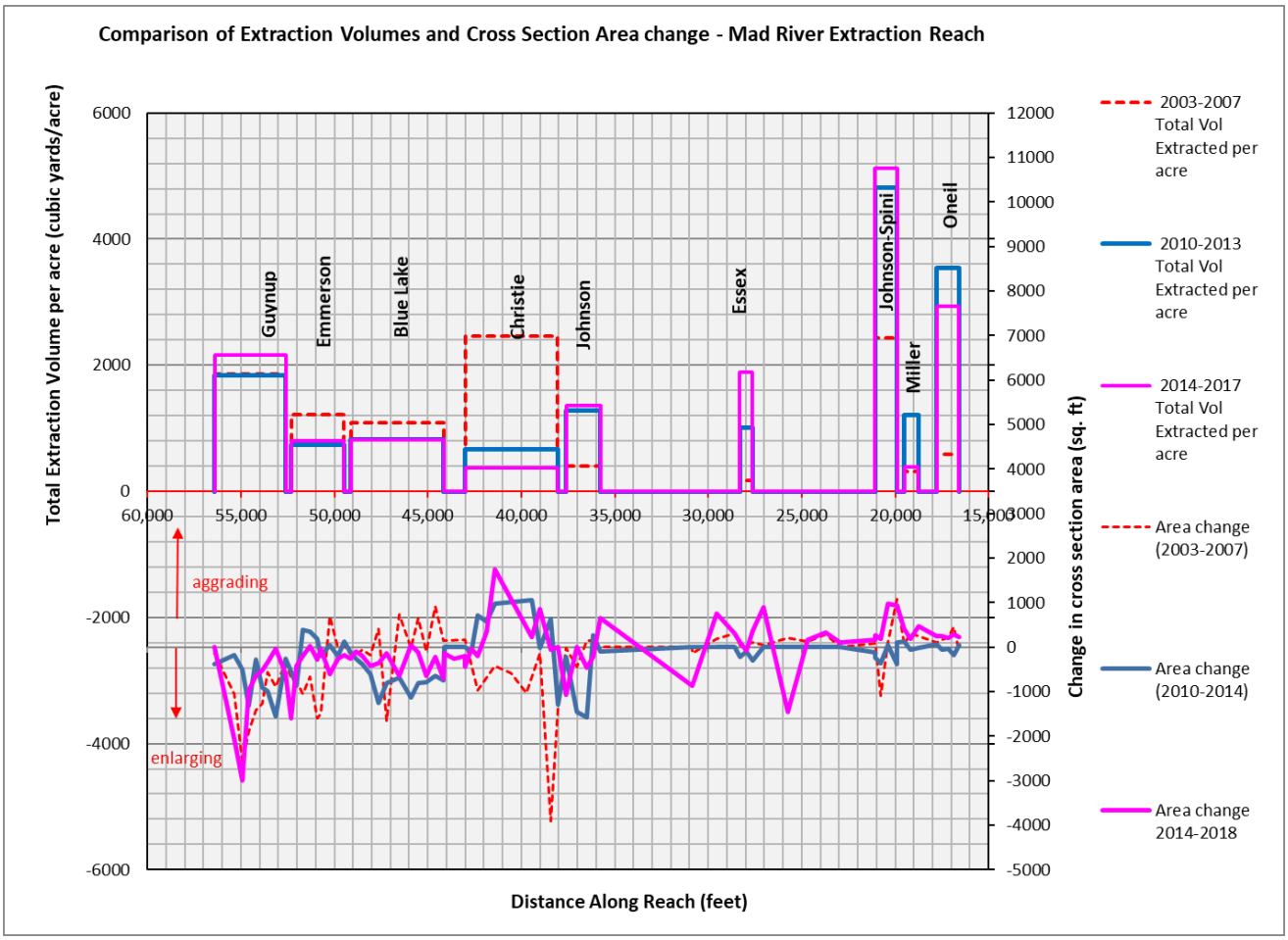


Figure 2. Comparisons of cross-section area change in the Mad River mining reach.

The channel enlargement observed in the past resulted in reduced channel confinement over a range of flows with less stream power to create and maintain pools and riffles, decrease in secondary, lateral flows required for efficient bar building, increased lateral channel instability (NMFS 2010), and increased riffle instability (NMFS 2004, 2010), which reduced the quality and quantity of juvenile salmonid rearing habitat and adult holding and Chinook salmon spawning habitat. The implementation of the FEV strategy for managing gravel volumes and changes in extraction techniques (e.g., narrower and fewer skims) during 2010-2019 has reduced the channel instability and resulted in a more stable dynamic equilibrium in the channel. There is still some potential for enlargement at sites that may be over-extracted, or where extractions lead to channel capture or with extractions when multiple low flow years occur in succession. However, the amount of enlargement and the time for recovery is reduced under the FEV strategy.

The implementation of the FEV for the ERM bars (Christie, Johnson-Spini, and O'Neill bars promoted maximizing gravel volumes at the bars below the A&M Bridge (Johnson-Spini and O'Neill bars) to reduce mining intensity and allow recovery of Christie Bar where significant channel widening occurred in the past (NMFS 2010, NMFS 2020). In practice, ERM maximized gravel extraction (given the limits on extraction e.g., the skim floor elevation of the 35% flow

and head-of-bar buffers) from the Johnson-Spini and O'Neill bars while not taking the maximum allowable on the Christie Bar complex.

Given the sensitivity of the channel to disturbance caused by extractions, and the use of the gravel extraction reach by salmon and steelhead, gravel extraction is a high threat to salmon and steelhead in the Mad River as described in the recovery plans for Chinook salmon, steelhead, and coho salmon (NMFS 2014, 2016). However, there is a recent trend in the recovery of habitat in the mining reach that may be attributed to some extraction techniques (Stillwater 2020) as a result of increased riparian growth that has resulted from implementation of floodplain extractions, reducing skimming and skim widths, short-term improvements from alcove extractions, varying the annual extraction volume based on estimated gravel recruitment in the extraction volume, and a reduction in the annual volume extracted. Stillwater (2020) compared riparian and habitat classifications from 1994, 2007, and 2018 and observed a 1.5x decrease in open bar area and a concomitant 2.3x increase in palustrine woodland acreage. Notably, most of the decrease in open bar area and increase in palustrine woodland acreage occurred between 2007 and 2018 (Stillwater 2020), which coincided with a greater focus on riparian restoration through gravel extraction, a narrowing of skim widths, and better managing gravel extraction volumes scaled to annual recruitment estimates.

Channelization/Diking

Channelization and diking presents a high threat to the Mad River population. Levees confine some of the lower mainstem river and the lower North Fork and disconnect the lower river channel from its floodplain and wetlands, reducing the availability of off-channel winter rearing habitat in the lower basin and reducing the ability of the channel to meander and create new habitats.

Timber Harvest

Timber harvest is a medium to high threat to the salmon and steelhead populations in the Mad River. Many of the changes that have occurred to instream and riparian conditions in the basin reflect legacy effects of more intensive harvest from previous decades. Although current timber harvest practices are more protective of salmonid habitat than before, timber harvest likely threatens the persistence of the salmonid populations by increasing sediment yield and reducing streamside shading and potential large wood recruitment. The majority of the private timberland in the Mad River basin is owned by Green Diamond and will continue to be harvested for timber. Within Green Diamond property, harvest occurs at a moderate level and under the direction of the company's Aquatic Habitat Conservation Plan (AHCP; GDRC 2006). This plan lays out goals and objectives to minimize and mitigate effects from timber harvest through measures related to road and riparian management, slope stability, and harvesting activities. Although the private timberland is managed under an AHCP that reduces the effects of timber harvest, increased sediment yield, decreased sources of instream wood, and decreased stream shading are still expected to occur.

Dams/Diversions

Dams and diversions pose a substantial threat to the Mad River salmonid populations. Diversions and groundwater pumping at the HBMWD Essex facility (RM 9 to 10) cause daily flow fluctuations during summer and fall months; however, observations by NMFS staff and analysis

of gage data (NMFS 2005) show negligible impacts on juvenile salmonids, with water level generally dropping no more than 0.2 feet. Due to riffle grade control, it is unlikely that the amount of available habitat is decreased for rearing coho salmon and stranding has never been documented (HBMWD and Trinity Associates 2004). Changes in flows, however, may affect migration of adults during the fall. The impoundment of the Mad River at Matthews Dam has also increased summer and fall flows throughout most of the mainstem Mad River and increased habitat availability from RM 84 to RM 10.

Cannabis cultivation has increased in many areas of the SONCC coho, CC Chinook salmon, and NC steelhead salmon range in recent years. Although the number of plants grown each year is unknown, the water diversion required to support these plants is placing a high demand on a limited supply of water (Bauer 2013). Most diversions for marijuana cultivation occur at headwater springs and streams, thereby removing the coldest, cleanest water in the summer and early fall which is the most stressful time of the year for juvenile salmonids (Bauer 2013). Based on an estimate from the medical marijuana industry, each marijuana plant can consume 900 gallons of water per growing season (HGA 2010). A recent systematic survey of 60 out of 112 watersheds that were either in or bordered Humboldt County determined that up to 700,000 cubic meters of water would be consumed for marijuana cultivation (Butsic and Brenner 2016). At this time, the magnitude of these diversions in the Mad River watershed is unknown as the number of plants grown is increased or decreased and previously unpermitted diversions are permitted and winter storage of water is encouraged.

Agricultural Practices

Agricultural practices pose an overall medium threat to salmonids. Grazing occurs throughout the basin and may contribute to increased sediment generation and delivery and to decreased riparian vegetation. Other agriculture, such as the cultivation of hay and irrigation of pastures and dairy operations also occurs in the lower basin. Marijuana cultivation has become abundant in many areas of the Mad River. Although the number of plants grown each year is unknown, the herbicides, pesticides, and fertilizers and ground clearing activities used to support these plants are likely impairing water quality in salmonid habitat. Specific information on the magnitude of these activities is limited.

High Severity Fire

Altered vegetation characteristics throughout the basin pose a moderate threat to salmonids from high severity fires. Most of the basin contains forests of small diameter trees that are close together. These types of previously logged forests burn with greater intensity than late seral forest stands, and high severity forest fires create an erosion hazard. The increased sediment yield from high severity fires would likely deliver sediment to salmonid habitat in the basin, filling pools and reducing habitat complexity. Riparian vegetation would also be reduced or eliminated, and issues associated with inadequate riparian cover, including increased water temperatures and decreased macroinvertebrate abundance would be aggravated.

Climate Change

Climate change poses a threat to salmonid populations in northern California. Although the current climate is generally cool, modeled regional average temperature shows a relatively large increase over the next 50 years (the period to which the model applies) (PRBO 2011). Average

air temperature could increase by up to 2°C in the summer and by 1°C in winter. Annual precipitation in this area is predicted to change little over the next century. The vulnerability of the estuary and coast to sea level rise is moderate in this population. Juvenile and smolt rearing are most at risk due to increasing temperatures and changes in the amount and timing of precipitation, which will affect water quality and hydrologic function in the summer. However, some degree of protection for mainstem flows is provided by the flow augmentation from Ruth Dam. The range and degree of temperature and precipitation is likely to increase in all populations in the Mad River, and adult salmonids will be negatively affected by ocean acidification and changes in ocean conditions and prey availability (Feely *et al.* 2008).

Urban/Residential/Industrial Development
Population growth and development, especially in the Arcata and McKinleyville area, will continue to present a medium threat to salmonids in the Mad River because it results in removal of vegetation, increased sediment delivery, introduction of exotic species, and increased landscape coverage with impervious surfaces that alters water transport on land and subsequently affects instream flows. Most of the growth within Humboldt County is in the Arcata and McKinleyville area (projected at 0.6 percent annually), resulting in more water diverted from the lower Mad River. All of these activities are expected to result in a degradation of habitat for salmonids in the action area.

Fishing and Collecting
Based on estimates of the fishing exploitation rate, as well as the status of the population relative to depensation and the status of NMFS approval for any monitoring-related scientific collection, these activities pose a medium threat to adult salmonids which means that the populations will be reduced. A significant recreational fishery occurs in the lower Mad River primarily because the presence of the Mad River Hatchery, which produces winter steelhead for angler harvest. Additionally, the Mad River is very accessible by bank fishers. Chinook salmon, coho salmon, and winter and summer steelhead are all vulnerable to impacts from recreational fishing during seasons that overlap with adult presence in the Mad River. The actual impacts to these populations is currently not known because no monitoring of harvest currently occurs.

Road-Stream Crossing Barriers
Road-stream crossing barriers impede juvenile and adult salmonid migration and are considered a low threat to the population. Many of the road-stream crossing barriers in the lower Mad River and its tributaries have been addressed through culvert upgrades or other improvements (e.g., Powers Creek and Quarry Creek.

Summary
The current status of habitat in the action area is improving relative to past conditions that lead to the listing of coho salmon, steelhead, and Chinook salmon in the Mad River. Timber harvest practices and road building have changed to reduce sediment inputs and increase future LWD recruitment to the stream channel. Some road systems on private timber land have been upgraded to reduce sediment. Gravel extraction practices have been changed to better control the volume of gravel extracted based on annual sediment recruitment estimates and protect the natural morphology of the stream. The lower Mad River is still influenced by levees and some sections of the river are restricted from occupying floodplains. However, localized restoration efforts

including culvert replacement and other barrier removal activities, LWD enhancement, and creation of off-channel habitats will further improve conditions for listed salmon and steelhead in the Mad River.

Population monitoring of salmon and steelhead in the Mad River has been limited until recently. However, this limited monitoring suggests Chinook salmon and steelhead populations are likely increasing over previous estimates with the Chinook salmon being at or above the recovery goal of 3,000 adults and the natural steelhead population near the 9,300 escapement goal. The steelhead population has measurably improved since 2001. The abundance of the coho salmon population is still relatively unknown, but considered at high risk of extinction. However, the single population estimate in 2017 was 1,575 adult coho salmon which is significantly higher than previous estimates (Sparkman and Holt 2020).

2.5 Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

2.5.1 Potential Effects from Gravel Mining

Potential impacts from various types of gravel mining on fish habitat are well documented (*e.g.,* Pauley *et al.*1989, Brown *et al.* 1998). Gravel mining modifies the geomorphic features and flow hydraulics at a bar-unit scale, and impacts cascade to a larger reach scale. This changes local salmonid habitat quality and quantity, potentially affecting individual NC steelhead, CC Chinook salmon, and SONCC coho salmon. For example, Brown *et al.* (1998) compared mined sites to reference reaches in gravel bed streams and found that total fish densities in pools were higher in reference reaches than in mined sites and reaches farther downstream. They also found bankfull channel widths were significantly increased at mined sites, and distance between riffles increased, resulting in fewer pools in reaches downstream of mined sites. Biomass and densities of invertebrates were higher in reference reaches. In addition, Pauley *et al.* (1989) observed changes in channel form and resultant impacts to habitat function from skimming, including: (1) decreased channel confinement, with widening and shallowing of the low flow channel and decreased water depths over riffles, which created migration barriers; (2) obliteration of side channels, resulting in reduced habitat for salmonids; and (3) channel instability at the top of skimmed bars, with an increase in the probability of redd scour.

However, the mining examined in the above studies (Pauley *et al.*1989, Brown *et al.* 1998) did not include all of the elements of the Mad River batched proposed action that are intended to reduce effects. In addition to information from literature, NMFS also uses studies of gravel mining in the Mad River, such as CHERT reports, and sediment recruitment estimates (*e.g.,* Knuuti 2003), and our own analysis of gravel mining in the Mad River. NMFS (2002, 2004, 2010, 2020) analyzed the Mad River gravel mining effects through: (1) cross-section area change, (2) longitudinal profile change, (3) habitat trends, 4) channel stability, (5) gravel bar

disturbance and replenishment, (6) instream hydraulics, (7) water year intensity, (8) sediment recruitment, and (9) mining intensity. From these analyses, we determine the likely effects to channel morphology, salmonid habitat and salmonid individuals from the proposed action. The likely impacts of the proposed action are discussed in detail in the sections below.

2.5.2 Exposure

The Mad River proposed gravel extraction activities within the Mad River expose the Mad River SONCC coho salmon population, CC Chinook salmon population, summer-run NC steelhead population, and winter-run NC steelhead population to direct and indirect effects. Figure 3 depicts major exposure-response pathways from gravel extraction that affect listed salmonids. In aggregation (collectively), conclusions regarding likely impacts consider multiple influences from alteration of key biological functions on each freshwater life stage of listed salmonids.

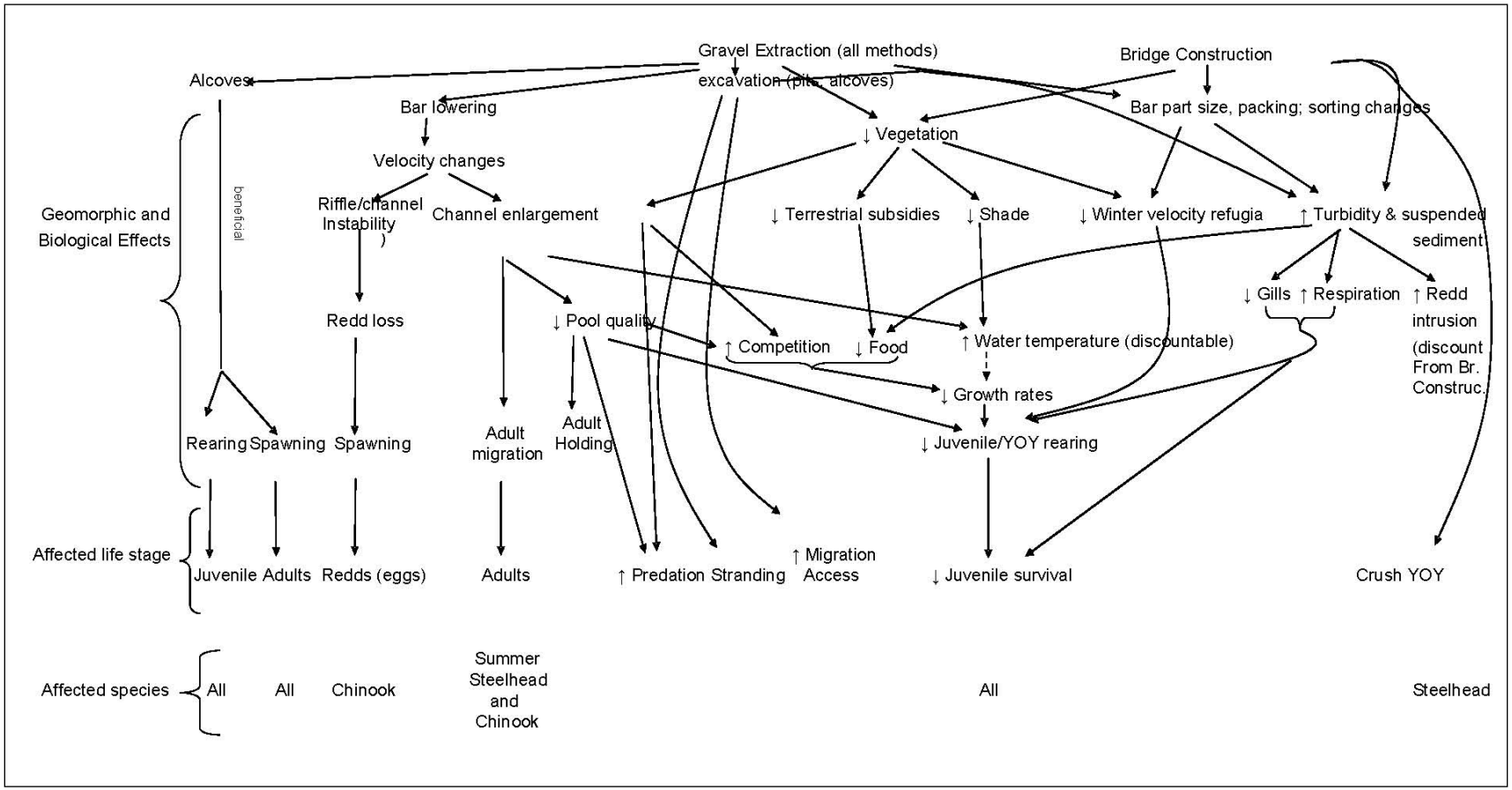


Figure 3. Major exposure-response pathways that may originate from gravel extraction and road and bridge construction related to the Mad River batched gravel mining proposal for 2020 through 2029. Large arrows indicate a primary pathway(s). Small arrows indicate an increase (pointing up) or decrease (pointing down) related to each geomorphic or biologic effect.

2.5.3 Minimal Effects

The proposed in-channel gravel extraction operations and habitat improvement activities result in the following effects to listed salmonids and their habitats that do not result in injury or death of listed salmonids or their critical habitats. These effects include:

(1) Noise, motion, and vibration disturbance from equipment operation;
(2) Chemical contamination from equipment fluids;
(3) Water heating due to less streamside vegetation and shade;
(4) Spawning attraction to temporary channel crossings;
(5) Reduced passage of adults and juveniles through temporary culverts and reduced passage from riffle instability; and
(6) Turbidity and sediment from connection of trenches and alcoves.

2.5.3.1 Noise, Motion, and Vibration Disturbance from Heavy Equipment Operation

Noise, motion, and vibration produced by heavy equipment operation within the vicinity of the wetted channel may disrupt migrating, spawning, or rearing salmonids at all gravel mining sites. Reports from Halligan (1997, 1998, 1999) and Jensen (2000) indicate that gravel mining operations did not result in avoidance behaviors during extraction operations which occurred as close as 45 feet to the stream and on temporary bridges. However, CDFW recently observed a negative behavioral response of holding, adult Chinook salmon to adjacent extraction operations at the Essex Bar (Sparkman 2019). CDFW observed movement of holding adult Chinook salmon out of a holding pool seemingly as a result of nearby excavation activities. This disturbance could force adult Chinook salmon to crowd into other pools that may be less suitable or expose fish to increased predation risk. Therefore, we will also discuss this effect below as an adverse effect to adults. Any exposed listed juvenile salmonids are likely able to hold and migrate near active gravel extraction operations, despite noise, motion, and vibration, without a negative response, thus any effects from noise, motion or vibration are expected to be negligible.

2.5.3.2 Chemical Contamination from Equipment Fluids

All operations use equipment powered by diesel fuel and lubricated by other petroleum products that are hazardous to listed salmonids. The potential for hazardous fluid spills or leaks exists, both within and outside of the wetted channel. However, given the provisions for spill response kits to be included with equipment, only small amounts of hazardous fluids are likely to leak, or be delivered to the wetted channel. Due to the small amount, coupled with dilution factors, any effects from chemical leaks are expected to be negligible.

2.5.3.3 Water Heating Due to Less Streamside Vegetation and Shade

Shade-providing vegetation is not expected to be removed due to proposed woody riparian vegetation protection measures. Some vegetation suppression may occur where roads and extractions occur, but the amount of shade that this future vegetation would provide is limited due to the location of most extraction activities within the annually inundated channel where annual scour and deposition already affect the ability of woody vegetation to grow to sufficient size to provide shade to the low flow stream channel. Increases in riparian vegetation due to extractions intended to promote vegetation are not expected to provide shade such that river temperatures are significantly decreased. However, localized shading of alcoves and wetted overflow channel areas may provide localized reductions in solar radiation and temperature

which could extend the function of these areas for salmonid rearing. Therefore, we expect that increases in water temperature due to streamside vegetation suppression will be negligible.

2.5.3.4 Spawning Attraction to Temporary Channel Crossings

Temporary channel crossings will be removed prior to September 15 each year, but may be extended to October 31 with appropriate monitoring of weather, stream flow, and adult Chinook salmon presence. Chinook salmon typically enter the Mad River at about October 15 each year. Based on Chinook salmon run timing and known spawning locations (Halligan 2003), the project timing restriction of September 15th will avoid the attraction to redd building at or near temporary bridge sites. Therefore, the risk of adverse effects to redds or adults from temporary channel crossings is negligible.

2.5.3.5 Reduced Passage of Adults and Juveniles through Temporary Culverts

Use of temporary culverts rather than temporary bridges may reduce the quality of migratory habitat by hampering or eliminating fish passage through a culvert. The Corps seldom approved culverts associated with gravel mining during the period from 1996 to 2019. The proposed action includes the requirement that when used, culverts allow upstream and downstream fish passage for all life history stages. Based on previous monitoring results and discussions with the Corps and applicants, NMFS anticipates that during the life of the proposed action, few, if any, culverts will be needed as temporary channel crossings, and that they would be used in secondary channels, and not in the main river channel. Additionally, all culverts would be sized for fish passage of all life history stages of listed salmonids present during the time the culvert is in place. Thus, impacts caused by temporary channel crossings to migratory habitat under the proposed action will be negligible.

We expect the minimum skim floor elevation corresponding to the 35 percent exceedance flow to provide for adequate migration depth adjacent to skim extractions. Additionally, we expect that other extraction designs will have sufficient vertical and horizontal offset from the low flow water surface elevation to provide for adequate migration depth. NMFS does not expect that the proposed action will result in migration blockages due to riffle instability.

2.5.3.6 Sediment and Turbidity from the Connection of Alcoves and Trenches

Increased turbidity would also result from the connection of a dry trench or alcove to the wetted channel. Berms are used to separate the trench or alcove from the low flow channel, and suspended sediment is allowed to settle prior to connection to the wetted channel. However, during connection of the dry trench or alcove, a small pulse of turbidity is released to the otherwise clear, low-flow river. Based on observation of the magnitude and duration of the pulse of turbidity associated with dry trenches and alcoves, NMFS anticipates that the turbidity will not result in temporary displacement of individual salmonids and will not result in a decrease in food for salmonids or feeding of individuals salmonids.

2.5.4 Adverse Effects to Individuals

Proposed in-channel gravel extraction operations result in the following adverse effects to listed salmonids or their critical habitats. These impacts include:

(1) Crushing during temporary channel crossing installation and removal activities;
(2) Increased stranding due to extraction;
(3) Elevated turbidity and suspended sediment from temporary and permanent road use and construction, gravel extraction, and channel crossing construction and removal:
(3) Channel enlargement, channel instability, riffle instability; and
(4) Reduced refuge from high water velocity.

2.5.4.1 Crushing During Instream Temporary Crossing Installation and Removal

Temporary channel crossings and limited in-stream equipment operation are proposed between July 1 and September 15 each year, at up to eight locations per year between 2020 and 2029. All young-of-year (YOY) Chinook salmon will avoid exposure because equipment will only operate near the end of their outmigration period. In addition, YOY Chinook salmon and YOY coho salmon typically reside in pools or deeper habitat where bridges are not constructed. Also, juvenile coho salmon and Chinook salmon and adult listed salmonids will be of sufficient size and maturity to successfully flee and avoid death or injury. Therefore, no juvenile coho salmon or Chinook salmon, or adult listed salmonids are expected to be crushed, buried, or otherwise injured by equipment. However, a small number (e.g., less than 10) YOY steelhead, based on the size of the footprint of the bridge abutments, the habitat where bridges are constructed (not in riffles or pools where most steelhead are found) would likely be injured or killed at up to eight temporary channel crossing locations and two habitat improvement locations, per year for the next 10 years because they may occupy shallow areas where bridges are constructed. Redds will not be affected because redds will not be present when heavy equipment will enter the low flow wetted channel.

2.5.4.2 Increased Stranding

Gravel extraction surfaces (*i.e.*, skimmed bars, alcoves, floodplain extractions) all have an increased potential for juvenile salmonid stranding after inundation and subsequent receding flows where extracted gravel bars are left with closed undulations or depressions. The risk of stranding on extracted bars is low due to post-extraction free draining grade; any type of skimmed gravel bar must be final graded to provide a free draining surface as a way to avoid or minimize stranding.

The risk of stranding in floodplain extractions is dependent on the location and whether outlets or connections to the channel, if constructed, remain open. All floodplain excavations will have a connection to the main channel or an overflow channel, but sometimes sediment replenishment and channel morphology changes can reduce the effectiveness of drainage features of these extractions which may result in juvenile salmonid stranding. Once trapped, the fate of juvenile salmonids likely ends in death unless adequate hyporheic flow exists to support survival. Numbers of individual juvenile Chinook salmon, coho salmon or steelhead that become trapped in floodplain excavations will depend on the percent of area disturbed by these extractions, the maintenance of the connections to watered channels, and the frequency of inundation. Because

the proposed action will not disturb more than about 10 percent of the surface area at or above the 2-5 year and 20% of the 5-10 year floodplain at any given time, we expect that low numbers of coho salmon, Chinook salmon and steelhead juveniles will be stranded and die in any given extraction at or above the 2-year floodplain. We cannot estimate the number of juveniles that may be stranded in any given year because this number depends on the frequency of inundation of these extractions, the ability of fish to leave these extractions will vary, and the number of juveniles exposed will vary depending on the adult spawning population and reproductive success. However, the area restriction for these extractions will limit the number of areas that would potentially strand juveniles.

Given the reduced floodplain access in the action area because of infrastructure, levees, and other human encroachment into the floodplain, we expect that the stranding potential would be similar to stranding that would naturally occur in an unmodified river floodplain, which would contain stranding areas that are created by high flows scouring around LWD and multiple high- to moderate-flow channel development across the floodplain. There may be multiple extractions in any given year that are located at or above the 2-year floodplain, but opportunities for their construction will be limited by the areal disturbance, and by the presence of mature, woody vegetation that will be protected from extractions on floodplain surfaces. Adult salmonids are not expected to be stranded in floodplain excavations, as adult salmonids of all three species are more likely to stay within the annually inundated channel and are expected to be able to flee these areas upon detection of receding flows.

2.5.4.3 Elevated Turbidity and Sediment from Gravel Extraction Related Activities

Gravel extraction, and temporary channel crossing construction and removal loosens surface material, reduces surface particle size, and changes channel form, which will likely result in increased erosion of bars and banks and elevated turbidity and sedimentation when disturbed areas become inundated and loosened sediment is available for transport by river flow.

2.5.4.3.1 In-stream Equipment Use

In-stream equipment operations located within the wetted channel are likely to cause short-term increases in turbidity during periods of low flow in otherwise clear water. NMFS expects a maximum of eight temporary channel crossings will be constructed and removed per year, for the next 10 years. Increased turbidity and sedimentation from heavy equipment entry to the wetted channel will likely interfere with respiration, reduce feeding success, and displace any listed juvenile salmonids present during the pulse of turbid water. Increased sedimentation also reduces the interstitial spaces of substrate, and decreases the habitable area for aquatic invertebrates, an important food source for juvenile salmonids (Bjornn *et al.* 1977). In addition, increased turbidity makes salmonid prey and predator detection difficult.

Temporary channel crossing construction and removal methods and instream equipment use associated with habitat improvement activities employ measures aimed to minimize the amount of fine sediment delivery and associated turbidity. Even with minimization measures, in-stream equipment use will result in short-term increases (up to 8 hours at a time) in turbidity and suspended sediment up to 500 meters downstream of the location of the activity, based on our observations of these activities in the past. This will result in short-term behavioral changes of

primarily juvenile coho salmon and steelhead, but also including the small numbers of juvenile Chinook salmon that have not yet out-migrated or that may over-summer.

Behavioral changes include changes in feeding, predator detection, and avoidance of sediment plumes up to 100 meters downstream of the disturbance, such that the juvenile salmonids will be displaced into different habitat. Juvenile salmonids will experience these short-term behavioral changes at approximately 8 locations per year, for the next 10 years. However the timing of each sediment plume will vary throughout the mining season, so that increases in turbidity and sedimentation from in-stream equipment use will be temporally and spatially staggered throughout the mining season and mining reach. The small area of disturbance and the measures for limiting fine sediment delivery will also limit exposure to individuals, and we expect that many individuals will be able to relocate to nearby areas for feeding. However, this relocation of individuals may slightly increase competition among individuals.

In addition to the behavioral changes to individuals discussed above, there will be decreases in the salmonid prey base up to 500 meters downstream of the equipment disturbance due to settling of fine sediment on substrates. Settling of fine sediment on substrates reduces benthic macro-invertebrate (food) by reducing primary productivity, thereby hindering feeding opportunity for exposed juvenile listed salmonids.

2.5.4.3.2 Gravel Extraction and Road Use

Chinook salmon typically spawn in the Mad River from October through January. The first winter storm events that wash over mined bars are likely to occur at the peak of the Chinook salmon spawning. Increases in turbidity and suspended sediment can also result in deposition of suspended sediment on redds, suffocating incubating eggs or embryos. Wickett (1954) showed that sediment intrusion is most damaging to young embryos in the first 30 days of incubation because this stage is less efficient at oxygen uptake. Besides inhibiting the emergence of alevins, one of the principal means by which fine sediment reduces survival of salmonid embryos is by reducing intra-gravel water flow, thereby reducing the amount of dissolved oxygen available for respiration (Bjornn and Reiser 1991).

A minimum skim floor elevation at the 35 percent exceedance flow will provide confinement of the low flow channel until the stream is transporting high levels of suspended sediment such that additional sediment coming off extraction or road surfaces is relatively minor in comparison (NMFS 2002). Therefore, listed salmonids are already responding to high suspended sediment and turbidity levels when the extraction and road surfaces are overtopped by river flow. The relatively small contribution of sediment coming off of extraction and road surfaces during the initial inundation is unlikely to result in an additional response. Therefore, exposure to increased turbidity and sedimentation as a result of extraction activities and road use above the water surface elevation of the 35 percent flow will have only minor effects to respiration and feeding success of juvenile salmonids, will not result in displacement of listed salmonids in the action area, and will not suffocate incubating eggs.

The number of juvenile salmonids that experience reduced growth and survival or otherwise injured or killed (e.g., from increased predation from displacement) is expected to be highly variable because of changes in volumes and extraction techniques, the number of bridges

constructed, and the variability in precipitation, ocean conditions, and the size and timing of increased sediment and turbidity. Therefore, we are using the area disturbed, the number of bridges, and the extraction techniques as a surrogate for the number of salmonids affected by increased sediment and turbidity.

2.5.4.4 Channel enlargement, channel instability, riffle instability

As previously described, a channel enlarged by sediment removal that has outpaced sediment deposition results in decreased channel stability, with subsequent deceases in salmonid habitat quality and quantity (*e.g.,* Newport and Moyer 1974, Behnke 1990, Kanehl and Lyons 1992, Hartfield 1993, Brown *et al.* 1998, NMFS 2010), and the associated riparian habitat can deteriorate (Rivier and Seguier 1985, Sandecki 1989). Potential effects on salmonid habitat include reduced pool depth and complexity and decreased riffle quality. Localized impacts to pool and riffle habitat will likely result in decreased growth of salmonid juveniles by decreases in feeding opportunities, and increased competition between individuals of different species (Harvey and Navasota 1996), which can both affect size of smolts and subsequent smolt-to-adult survival (Ward and Slaney 1988, Holtby *et al.* 1990).

2.5.4.4.1 Channel Enlargement and Increased Channel Instability

As described in detail in the *Environmental Baseline* section, channel enlargement has occurred in the upper reach (above the A&M Bridge) of the action area, and there is still some potential for enlargement from gravel extraction, particularly if multiple low flow years occurs. However, the amount of enlargement and the time for channel recovery will be reduced under the FEV strategy. Several other protective measures will further reduce the potential effects to habitat and individual salmonids from channel enlargement and increased channel instability. These measures include: (1) head-of-bar buffer, (2) maximum width of skims, (3) preservation of the bar shape by avoidance of the highest portions of the gravel bar (both longitudinally and across the bar), (4) avoidance of mining adjacent to spawning riffles, and (5) limited extraction in areas above the 2-year flow level for riparian enhancement purposes.

A head-of-bar buffer will reduce the potential for geomorphic changes to the river from sediment extraction, as the head-of-bar buffer will remain undisturbed. With a head-of-bar buffer, we expect that channel shifting and potential widening will be reduced, but not completely eliminated. For example, in the absence of a buffer, the channel would be free to shift position across a completely mined bar feature and possibly assume a braided or very wide and shallow configuration. However, even with the undisturbed head-of-bar buffer, the channel may shift downstream of the head-of-bar into the skimmed surface or into deeper extractions like alcoves. We expect that this response will decrease with the FEV strategy and implementation of the head-of-bar buffer. In addition, avoiding the higher portions of the bar will retain the larger scale topographic features that provide hydraulic control during larger storm flows, providing additional assurance that the channel will not be subject to increased lateral instability and channel widening.

Limiting the extent of the skim width in the upper reach is expected to serve two purposes. First, it reduces the area over which extraction may occur and therefore lessens the immediate changes in channel width. Second, the proposed narrow skims in the upper reach will better conform to

the overall river planform and more readily replenish during high river flows, reducing the size and duration of immediate channel enlargement caused by gravel removal. Avoiding mining adjacent to spawning riffles will also reduce the area over which extraction may occur and reduce overall disturbance in the upper reach.

In addition, although we expect short-duration, localized, low-flow channel enlargement to occur when low flow years occur back to back or more often, we also expect that a limited amount of extractions in the areas above the 2-year flow elevation and judicious implementation of alcove extractions and other alternative extraction techniques will help the lower active bar areas to replenish and recover function. This will decrease the negative effects of temporary, low-flow channel enlargement on habitat in the upper reach. For example, NMFS has found increased juvenile salmonid utilization in the large tributary excavation at the mouth of the North Fork Mad River (Free 2009) due to the thermal refuge created by the excavation and large wood habitat structure. Additionally, increased riparian vegetation that has established as a result of extractions intended to promote vegetation establishment has reduced the overall effects of channel enlargement because this vegetation provides food, cover, and velocity refuge as the channel meanders across the floodplain and intercepts these areas.

As discussed in the *Environmental Baseline*, the 2010-2019 implementation of the FEV is similar, but not exactly like what we expect for the 2020-2029, period. Therefore, the channel cross section analysis (NMFS 2020) that showed a significant reduction on the Christie Bar (Figure 2, NMFS 2020) may not reflect the implementation of this proposed action. However, we assume that managing the extraction of the Christie Bar based on the FEV as described in the proposed action, which will limit the intensity of extraction by area and recruitment, will reduce the potential for degradation and channel widening on the Christie Bar, although continued aggradation may be reduced or ended.

Since the proposed action is designed to protect existing morphology, we do not expect that the proposed action will measurably increase channel enlargement in the action area. However, limited adverse impacts to pools and riffles from channel enlargement and an associated increase in channel instability may still occur at the site level. Only localized and short-duration channel enlargement is expected to occur; habitat will not significantly deteriorate at the reach scale due to channel enlargement. Localized impacts to pool and riffle habitat will likely result in decreased growth of salmonid juveniles by decreases in feeding opportunities, and increased competition between individuals of different species (Harvey and Nakamoto 1996), which can both affect size of smolts and subsequent smolt-to-adult survival (Ward and Slaney 1988, Holtby *et al.* 1990). We cannot accurately estimate the number of juveniles that would be injured or killed from habitat changes that result from localized channel widening because of the highly variable physical environment and highly variable fish populations. Overall, we expect that the proposed action will promote the existing channel morphology and channel stability and promote the maintenance of functioning salmonid habitat in the action area.

2.5.4.4.2 Increased Riffle Instability

Riffle instability from gravel mining affects spawning, migrating, and rearing habitat for listed salmonids.

Impacts to Spawning Habitat

Sediment removal can initiate channel instability that has consequence on the stability and quality of riffle habitats. There is greatest potential for riffle instability to occur if sediment removal causes channel enlargement that reduces channel confinement, or with bar skimming or instream trenching as the extraction technique. Sediment removal, particularly instream trenching, can cause bed lowering to propagate both upstream and downstream, thereby scouring spawning substrate or redds. Decreased channel stability, either through degradation or lateral migration, increases the probability of salmonid redd scour or de-watering, or decreases fry emergence by altering the channel hydraulics at redds. Bar skimming reduces bar heights, reducing channel confinement and increasing shear stress over riffles that can scour redds (NMFS 2004), until the skimmed surface is replenished.

At a stable riffle, where flow diverges, the water depth and velocity become more uniform, providing conditions conducive to the formation of well sorted patches of gravel. It is these gravel patches, combined with the gradient of the hyporheic flow field (subsurface water) that provides optimal substrates for spawning salmonids (Groot and Margolis 1991). In a disturbed river channel, where habitat is simplified and the pool-riffle sequence is less pronounced, as noted by Collins and Dunne (1990), spawning habitat quantity and quality will be reduced. Also, sediment extraction has been demonstrated to reduce the overall substrate size by removal of the armor layer. Therefore, where larger particles are in short supply, gravel extraction would likely reduce the quality of spawning habitat by reducing the size of spawning substrate needed for Chinook salmon. Also, decreased particle size due to sediment removal activities would lead to increased bed mobility and a higher likelihood of redd scour.

The upper reach of the action area provides spawning habitat for Chinook salmon. A number of protective measures have been included in the proposed action to reduce the effects of gravel extraction on spawning habitat: (1) the FEV strategy will maximize extraction downstream of spawning habitat and will minimize channel enlargement and channel instability in the upper reach, (2) extraction will be avoided adjacent to spawning riffles in the upper reach, (3) alcoves and riparian enhancement excavations will occur, and (4) traditional, wide skimming will not be used in the upper reach. The combination of these protective measures will likely reduce impacts to spawning habitat to instances of where localized channel enlargement decreases channel confinement and alters channel hydraulics, causing a decrease in channel stability.

Based on habitat data collected during previous implementation of proposed actions (Stillwater Sciences 2020), the quantity of spawning habitat is not limited in the upper reach. However, the quality of spawning habitat will be affected in localized instances. We expect that localized instances of channel enlargement will be most likely to occur when narrow skimming is used at sites in the upper reach, or if more than two low flow years occur in a row and sediment volumes in excess of replenishment are removed under the FEV strategy. The banking provision may reduce the likelihood of low volume extractions at specific bars in some years, but it isn't guaranteed that the operators will want to use the banking strategy. Additionally, the river may

move into some extractions thereby increasing channel instability on a short-term, localized scale. In these instances, gravel extraction will increase the frequency at which channel migration occurs in the upper reach, thereby reducing the quality of spawning habitat. Bar skimming, in particular, promotes lateral instability and increased scour as the flow path is shortened over the skimmed bar. When bar skimming is used as the extraction technique, we expect a general decrease in substrate size over time in areas with high mining intensity. However, the removal of gravel from bars in the upper reach will not likely influence the availability of suitable substrate for spawning because the supply from upstream should be adequate to maintain spawning sites.

Narrow skimming is expected to be used at bars in the upper reach during times of high sediment recruitment when there is more available sediment for extraction than can be mined with alcoves or riparian enhancement extractions, especially on sites with the largest available areas for extraction, *i.e.,* the Guynup, Christie, Emmerson and Blue Lake Bars. Based on the previous hydrologic record, we expect that some skimming will occur in the upper reach each year, but not necessarily at each location.

In years when substantial bar skimming is used in the upper reach or extraction designs are increasing channel instability, we anticipate a portion of Chinook salmon redds will be scoured or experience reduced fry emergence as a result of adjacent extraction and consequent changes in the scour and depositional environment due to changes in channel location. The extent or probability of redds being destroyed by scour depends on the timing of hydrologic events relative to spawning and incubation timing. It also depends on the presence of redds which varies depending on flow conditions during adult migration. However, given the past timing of storms that affect the hydrology of the Mad River, there is a high likelihood that a hydrologic event with the potential to result in scour will occur during the incubation period.

Also, given the past hydrologic record, we anticipate a multiple-year low flow cycle to occur during the 10-year permit period. We also think that the proposed limits on extraction volumes will reduce the probability of channel enlargement due to repeated over-extraction during low flows, but that localized channel enlargement due to sediment withdrawals from when replenishment is low may occur about once during the permit period. During a low flow cycle of more than two consecutive years, we expect that localized channel enlargement at the Guynup, Christie, Emmerson and Blue Lake Bars will decrease riffle stability at some redds, decreasing Chinook salmon fry emergence during two years of the 10-year period. We estimate a maximum of one skim per year at the 4 upper bars will result in a loss of one redd per bar.

Impacts to Rearing Habitat

The shallow, swift flows over riffles are important habitats for numerous species of invertebrates, many of which are food sources for salmonids. Reductions in the quality of riffles occur by a decrease in substrate size by chronic sediment removal (especially in locations with a high density of mining and where mining out-paces sediment deposition), resulting in changes and overall reductions in macro-invertebrates, thereby decreasing food availability for rearing juvenile salmonids. Decreased food availability will result in smaller juveniles. Decreased smolt

size at the time of ocean entry has been shown to decrease ocean survival, and thus reduce the abundance of returning adults (Ward and Slaney 1988, Holtby *et al.* 1990).

NMFS expects that the following measures will reduce the likelihood of riffle instability and the associated fining of riffle particle size, thus reducing impacts to rearing habitat and individual juveniles of all species: (1) the FEV strategy will reduce channel enlargement and over-extraction in the upper reach, thereby allowing particle size at riffles to coarsen; (2) the head-of-bar buffer will preserve channel confinement at riffles adjacent to the upstream end of bars, which will promote riffle stability; (3) the avoidance of mining adjacent to riffles in the upper reach will also promote channel confinement; (4) the minimum skim floor elevation will confine the low flow channel and promote riffle stability; and (5) extraction techniques with a habitat improvement component, such as alcoves and off-channel riparian enhancement extractions, will provide additional habitat value, such as thermal and velocity refuge, for rearing juveniles in the upper reach.

Some of the above protection measures apply only to the upper reach. In the lower reach where extraction will be maximized and not subject to the FEV variation of extraction volume, or additional riffle protection, we expect that approximately 3 riffles in the lower reach and 4 riffles in the upper reach used for rearing will experience moderate instability, fining of particle size and decrease in riffle area. combination of short-term impacts to riffle stability in the upper reach (described above in *Impacts to Spawning Habitat*) with impacts to riffles in the lower reach will lead to decreased invertebrate abundance and diversity, and result in reduced fitness of a portion of juvenile salmonids of all species within the entire action area, especially in the lower reach. This will result in decreased smolt size at the time of ocean entry of a portion of the juvenile salmonids rearing in the action area.

Impacts to Migration Habitat

Calculations of water surface elevation using cross sections in mined areas indicate that the 35 percent exceedance flow provides for a water depth sufficient to allow for adult salmonid migration (Mosley 1982). In an undisturbed river, 10 inches of water over the riffle crest should be sufficient to provide unimpeded fish passage because fish are observed migrating over shallower riffles with their backs above the water and few, if any Chinook salmon in the Mad River will be dorso-laterally greater in body size. However, in disturbed channels with increased riffle instability, fish expend additional energy to migrate through simplified and reduced pool-riffle structures. Frequently disturbed rivers are often missing some of the important attributes of a natural river that allow unimpeded migration or spawning. Those attributes include channel margin complexity, bed roughness, and vegetative cover. Additional flow depth beyond the cited minimums can help offset the lack of habitat complexity.

Adult migration may be impeded through longer-term increases in channel width due to repeated sediment removal and incomplete replenishment at a site. This occurs as bars are lowered or portions of bars are removed, and stream habitat becomes less complex. The habitat simplification that occurs as a result of sediment removal out-pacing sediment deposition increases flat water habitat. Adult migration may be impeded if long stretches of flat water habitat occur without holding cover (Thompson 1972). As discussed previously, channel enlargement, including increases in channel width, and associated increases in flat water habitat

are expected to be minimized by the FEV strategy and other protective measures. However, some localized increases in flat water are expected when skimmed bars do not replenish and when winter flows are inadequate to scour sediment that is deposited into pools during moderate flows.

2.5.4.5 Reduced Refuge from High Water Velocity

Gravel extraction can alter the distribution of velocity refugia in extraction reaches. These impacts can occur through: (1) pool and channel complexity reduction, (2) decreased channel bed roughness, and (3) increased velocity at high flow.

In addition to reducing stream depths over riffles (as a result of increasing channel width), gravel removal operations increases water velocities and reduces hydraulic complexity, thereby forcing migrating salmonids to expend additional energy from their finite energy reserves used for migration and spawning. Reduced flow-field complexity and increased migratory velocities, particularly reduced edge-water eddies and low velocity zones, result from reduced sinuosity, increased channel width at bars, and reduced topographic complexity of geomorphic features, which all affect adult salmonids during their upstream migrations across riffles by increasing their energy expenditure. Juvenile salmonids, especially newly emergent fry, will face challenges finding and using velocity refuges during high flows in simplified, hydraulically smoother channels. NMFS expects that suitable low velocity areas will be available in nearby areas such that a portion of the juvenile populations will be able to relocate to these areas. However, some individuals in the reach, particularly Chinook salmon fry and juveniles, may perish because they are unable to locate suitable velocity refugia.

Pool and Channel Complexity Loss

Pools should provide a complex of deep, low water velocity areas, backwater eddies, and submerged structural elements that provide cover, winter holding, and flood refuge for fish (Brown and Moyle 1991). During their upstream migration, adult salmonids typically move quickly through rapids and pause for varying duration in deep holding pools (Briggs 1953, Ellis 1962, Hinch *et al.* 1996, Hinch and Bratty 2000). Holding pools provide listed salmonids with safe areas in which to rest when low flows or fatigue suppress migration. Pools are also preferred by juvenile coho salmon (Hartman 1965, McMahon 1983, Fausch 1986), the subset of Chinook salmon that over-summer, and steelhead. Steelhead also utilize riffle habitat for rearing if it is complex with velocity refuge behind cobble and small boulders (Hartman 1965, Raleigh *et al.* 1984, Hearn and Kynard 1986, Shirvell 1994). Pools with sufficient depth and size can also moderate elevated water temperatures stressful to salmonids (Matthews *et al.* 1994). Deep, thermally stratified pools with low water velocities, or connection to cool groundwater, provide important cold water refugia for cold water fish such as salmonids (Shirvell 1994.).

Given the current habitat conditions in the action area (see *Environmental Baseline* section), existing velocity refugia in the form of complex pools, off-channel habitat, and topographic complexity is limited compared to the availability of velocity refugia in an undisturbed channel. We expect that the FEV strategy will continue to reduce the potential for over-extraction and consequent channel enlargement and the trend toward flatwater habitat. As gravel bars maintain height and area during most years, a more confined channel will provide the hydraulics

necessary to form and maintain pools and riffles. However, we still expect skimming, especially when the morphological changes persist with drought years and a lack of recruitment, will reduce the scour to maintain pool depths and simplify habitat and potentially crowd juveniles and adults into smaller areas, which will increase competition and reduce growth of individual salmon and steelhead.

Changes in Channel Bed Roughness and Increased Velocities at High flows
Reductions in exposed particle size result from the removal of overlying coarse sediments and abrasion and particle breakage caused by the passage of heavy equipment. Coastal watersheds in the action area are composed of sedimentary and low-grade metamorphic rocks. Particles that easily break into smaller particles when moving downstream and when heavy equipment crushes them dominate the coarse sediment load in these coastal streams, such as the Mad River. As a result of disrupting the natural armoring process and mechanical crushing, disturbed bar surfaces are typically finer-grained than undisturbed bar surfaces.

Areas of heavy bed armor can provide valuable fish habitat during high flows (Church *et al.* 2001) because of low near-bed velocity and productive benthic habitat whenever inundated (Bjornn *et al.* 1977). Also, riffles with coarse substrate such as cobbles provide velocity refuges for juvenile salmonids (Hartman 1965, Raleigh *et al.* 1984, Hearn and Kynard 1986, Shirvel 1994). As described previously, sediment removal, especially when large areas of gravel bars are disturbed by repeated skimming without full replenishment, results in finer substrate sizes. Finer substrate sizes results in increased bed mobility, which will result in less stable velocity refugia provided by the channel bed. The characteristic particle size distribution in the action area is largely dominated by gravel and cobble. Gravel extraction, particularly bar skimming, reduces the presence of coarse armor layer, translating to localized reductions in high-flow velocity refugia.

Gravel bars are typically inundated during most storm flows in the late fall, winter, and early spring. If a skimmed surface does not completely replenish quickly during the first storm flows above the 35% exceedance flow, then more uniform water velocity occurs over the lower, skimmed surfaces, reducing the transverse flow responsible for building the bar shape and sediment sorting. These skimmed areas would otherwise provide particle roughness and areas of low edge water velocity which are beneficial to newly emergent juvenile salmonids. Although velocity refuge is important for juveniles of all species in the action area, it is especially important near redds as newly emergent fry must find suitable rearing habitat or else they are likely to be swept downstream with consequent increases in injury and mortality. We expect a slight decrease in survival of a small number of salmonid fry all species from narrow skimming use adjacent to spawning sites near the four bars that are mined in the upper reach. We also expect that traditional skimming will be used in the lower reach, and that water velocities will increase as a result. We expect a small reduction in fry and juvenile survival of all species due to higher edge water velocities, but especially of Chinook salmon fry at each of the bars or 8 bars total.

Given the overall degraded condition of juvenile rearing habitat in the lower Mad River, we expect this reduction in velocity refuge to result in reduced survival for a small number of juveniles of all species, but especially of Chinook salmon fry, due to their small size during high

flows and their reliance on the action area for rearing. We expect that at least 1 skim per bar will be completed in the upper reach annually. Additionally, we expect that traditional bar skimming will be used primarily in the lower reach, maintaining smaller particle size and a channel bed with decreased roughness value and less available refuge from high velocity flows. Therefore, we expect that a total of 8 skims will affect juvenile survival because of a reduction in particle size in the channel bed.

2.5.5 Effects to Critical Habitat

As previously described in detail in this *Effects of the Action* section, the majority of effects from the proposed action will be in the form of effects to PBFs, such that the effects to critical habitat will occur from: (1) localized instances of channel enlargement that results in reduced channel confinement and increased channel instability in the upper reach affecting hydraulic conditions at Chinook salmon spawning sites and reproductive success; (2) decreased particle size and increased high water velocities from bar skimming resulting in reductions in sheltering habitat; (3) localized instances of channel enlargement that results in fining of riffle particle size affecting food sources and feeding; (4) increases in turbidity affecting water quality, feeding and sheltering; and (5) localized decreases in pool quality affecting feeding and sheltering.

For CC Chinook salmon and NC steelhead, and SONCC coho salmon critical habitat, the PBFs: (1) substrate, (2) water quality, (3) water velocity, (4) cover/shelter, (5) food, (6) riparian vegetation, and (7) space (in the form of pool availability) will experience localized decreases in conservation value during the 10 year proposed action. However, the decrease in conservation value of the 7 PBFs is expected to be localized to the individual site scale, not expected to propagate to the reach scale, and not expected to occur every year of the 10 year period. We expect that there will be PBFs, such as water quantity, water temperature, safe passage conditions and salinity, within the action area that will not experience decreases in conservation value.

In summary, the proposed action is not expected to decrease the condition of critical habitat in the action area to a level where conservation of the Mad River populations of SONCC coho salmon, CC Chinook salmon, NC steelhead and is unachievable.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02 and 402.17(a)). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

We anticipate that ongoing activities related to urbanization, agriculture, forestry, and recreation (e.g., fishing) will continue to affect habitat and listed Chinook salmon, coho salmon, and steelhead survival, as described in the environmental baseline.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of

the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5), including the minimal effects identified under section 2.5.3, to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminishes the value of designated or proposed critical habitat for the conservation of the species.

The preceding analyses focused on the effects from the proposed gravel mining operations on listed salmonids and their habitat in the action area. This section considers the effects to individual salmonids, including the addition of the minimal effects described in section 2.5.3, and determines how effects to individuals would affect the VSP parameters of their four constituent populations. The effects to individuals as described below incorporates the effects from the existing and future Environmental Baseline conditions, including climate change, and cumulative effects to habitat, as described in those sections. In addition, the resulting effects to the VSP parameters of the four constituent populations considers the known "take" of individuals expected from other actions that are taking place concurrently with the proposed action including the take of individuals authorized under section 10 scientific collecting permits, take authorized under 4d limits for steelhead, Chinook salmon, and coho salmon, including CDFW's Mad River Hatchery HGMP. After determining the effects of the action on the VSP parameters, NMFS then analyzes whether the effects to the populations would jeopardize the continued existence of the ESU/DPS. In addition, this section assesses the effects of the proposed action on the primary constituent elements of critical habitat to determine whether there is an appreciable reduction in the conservation value of the critical habitat.

2.7.1 Effects on SONCC Coho Salmon

2.7.1.1 Population Size

Tributaries outside of the action area are utilized for coho salmon spawning, but the action area provides rearing and migratory habitat for both fry and juvenile coho salmon, primarily in the winter and spring when temperatures in the action area are suitable for coho salmon. Juvenile rearing capacity is limited in tributaries, especially in years with below average precipitation when many of the tributaries have extensive reaches that lack surface flow. None of the minimal effects as described in section 2.5.3 are expected to add additional stress or cumulatively injure or kill coho salmon in the action area. The proposed action will result in the death or injury of a small number of fry that do not access suitable winter sheltering habitat. However, sheltering areas (*e.g.*, alcoves) will also be created under the proposed action, so any decreases in survival from the proposed action will be offset by improvements in survival for other individuals.

We also expect a small number of smolts may be smaller at ocean entry because of reduced feeding and sheltering opportunities as a result of the proposed action. The effects of climate change, including increases in temperature, changes in precipitation patterns and amounts, and ocean conditions that result in poor survival may enhance the adverse effects of the proposed action and result in increased mortality of coho salmon. For example, reductions in growth may be more impactful to survival in the ocean when ocean conditions are poor. Additionally, the effects of turbidity and sediment from the proposed action on juvenile coho salmon survival is likely increased because of high turbidity and suspended sediment conditions as discussed in the environmental baseline. However, given that the smolt to adult survival rate entering the ocean is less than 10 percent during the best of conditions, the small number of smolts that would have reduced survival because of reduced fitness at ocean entry will result in a negligible reduction in the number of adults that will return when factoring in all the effects of the proposed action. Therefore, the reduction in the size of the Mad River coho salmon population will be negligible.

2.7.1.2 Population Productivity

As discussed above, the small reduction in abundance of coho salmon in the Mad River is expected to be negligible under the proposed action. The effects to habitat from the proposed action that reduce rearing success of non-natal coho salmon fry and juveniles will not result in a decrease in the number of coho salmon that return to spawn. In addition, although we expect decreases in juvenile rearing success, we expect that these reductions will be localized and will not occur every year during the 10-year permit, such that returning adults will be able to successfully reproduce and replace themselves during the 10-year permit. Therefore, the reduction in productivity of the Mad River coho salmon population is expected to be negligible.

2.7.1.3 Spatial Structure

The spatial structure of the Mad River coho salmon population will slightly improve under the proposed action if access to tributaries is improved through extraction at tributary mouths, which is very likely under the proposed action. The small reduction of the number of smolts that survive to enter the ocean is not expected to appreciably reduce the size of the Mad River coho salmon population. Under a similar proposed action over the previous ten years, adult coho salmon numbers have increased in some years. In addition, the proposed action will not impede the ability of coho salmon to access habitat within or outside of, the action area. Therefore, the spatial structure of the Mad River coho salmon population is not expected to be reduced.

2.7.1.4 Diversity

The diversity of coho salmon within the Mad River is expected to be slightly reduced by reductions in juvenile feeding and sheltering opportunities. However, since phenotypic or genotypic changes are not expected, we do not expect the small reduction in diversity to appreciably reduce the diversity of the Mad River Chinook salmon population.

2.7.1.5 Summary

The numbers, distribution, and reproduction of the Mad River coho salmon population is not

expected to decrease during the 10 year period. Overall, the numbers of spawners are not expected to be appreciably reduced to the extent that reductions in the Mad River population's likelihood of survival and recovery would be expected to reduce the likelihood of survival and recovery of the species at the ESU level. The viability of the Mad River population of SONCC coho salmon will not be affected to the extent that the ESU's ability to survive and recover will be appreciably reduced.

2.7.2 Effects on CC Chinook Salmon

2.7.2.1 Population Size

Our analysis of the effects indicates that the proposed action will result in a decrease in the number and quality of pools and riffles, velocity refugia, and food production in the action area over the 10-year period. None of the minimal effects as described in section 2.5.3 are expected to add additional stress or cumulatively injure or kill Chinook salmon in the action area. The effects to winter rearing habitat and velocity refugia near spawning areas will result in a slight decrease in survival of fry from 4 redds in the action area, from redds upstream of the action area and from redds in tributaries.

NMFS expects that there will be reduction in egg-to-fry success for CC Chinook salmon during some years primarily because of hydraulic changes near redds, redd scour, changes in the lateral course of the river, and sedimentation is expected to occur in the 4 mile upper reach that is also used for spawning by Chinook salmon. We expect that the reduction in the number of juvenile Chinook salmon that eventually migrate to the ocean will be negligible as the reduction in egg-to-fry success will be small, localized to the site level and will not occur every year of the 10-year period. We also expect a small number of smolts may be smaller at ocean entry because of reduced juvenile feeding and sheltering opportunities as a result of the proposed action.

The effects of climate change, including increases in temperature, changes in precipitation patterns and amounts, and ocean conditions that result in poor survival may enhance the adverse effects of the proposed action and result in increased mortality of Chinook salmon. For example, reductions in growth may be more impactful to survival in the ocean when ocean conditions are poor. Additionally, the effects of turbidity and sediment from the proposed action on juvenile Chinook salmon survival is likely increased because of high turbidity and suspended sediment conditions as discussed in the environmental baseline. However, given that the smolt to adult survival rate entering the ocean is less than 10 percent during the best of conditions, the small number of smolts that would have reduced survival because of reduced fitness at ocean entry will result in a negligible reduction in the number of adults that will return. For example, if 90 smolts enter the ocean under the proposed action with high fitness, but 100 smolts would have entered absent the proposed action, at a 10% return rate that would equate to the loss of 1 adult return. This example assumes a 10% reduction in the fitness of the Chinook salmon population which is much higher than what we would expect from the proposed action where the fitness likely affects less than 1% of the population. Therefore, although we expect a slight reduction in the number of fry and juveniles that will survive as a result of the action, we do not expect an appreciable reduction in the number of returning adults in the CC Chinook salmon population.

2.7.2.2 Population Productivity

As discussed above, the proposed action is expected to primarily reduce the survival of eggs and fry and affect juvenile feeding, sheltering and ocean survival. However, the reduction in the number of smolts that survive and enter the ocean is expected to be small and not appreciably reduce the number of returning adults. In addition, although we expect a small reduction in the survival of eggs and fry and decreases in juvenile feeding and sheltering opportunities, we expect that these reductions will be localized and will not occur every year during the 10-year permit, such that returning adults will be able to successfully reproduce and replace themselves during the 10-year permit. Under the previous ten-year mining period and a similar proposed action, the Mad River Chinook salmon population was able to respond to improved ocean, river, and tributary habitat conditions such that the population exceeded recovery targets. We believe this shows that Chinook salmon productivity is not affected by the proposed action such that the Mad River population and ESU cannot survive and recover if the baseline continues to improve as a result of regulation of other activities and implementation of habitat restoration actions. Climate change and ocean productivity declines will continue to affect the productivity of Chinook salmon in the Mad River and the ESU regardless of implementation of the proposed action. Therefore, we do not expect the slight reduction in productivity from the proposed action will measurably affect the productivity of the Mad River Chinook salmon population.

2.7.2.3 Spatial Structure

The small reduction in the number of smolts that survive to enter the ocean is not expected to appreciably reduce the size of the Mad River Chinook salmon population. In addition, the proposed action may increase, but will not reduce, access to habitats currently available to the Mad River Chinook salmon population. Therefore, the spatial structure of the Chinook salmon population is not expected to be reduced.

2.7.2.4 Diversity

The diversity of Chinook salmon within the Mad River is expected to be slightly reduced by the reduction in egg and fry survival and reductions in juvenile feeding and sheltering opportunities. However, since phenotypic or genotypic changes are not expected, we do not expect the small reduction in diversity to appreciably reduce the diversity of the Mad River Chinook salmon population.

2.7.2.5 Summary

The Mad River CC Chinook salmon population is an independent population in the CC Chinook salmon ESU. Although we expect a decrease in the survival of eggs and fry, and reduced juvenile feeding and sheltering, we do not expect that these reductions will result in an appreciable reduction to the survival and recovery of the Mad River CC Chinook salmon population. Under a similar proposed action over the previous ten years, adult Chinook salmon numbers have increased in some years such that recovery targets have been exceeded. We believe this shows that Chinook salmon productivity is not affected by the proposed action such that the Mad River population and ESU cannot survive and recover if the baseline continues to improve as a result of regulation of other activities and implementation of habitat restoration

actions. Climate change and ocean productivity declines will continue to affect the productivity of Chinook salmon in the Mad River and the ESU regardless of implementation of the proposed action. Therefore, the viability of the Mad River population of CC Chinook salmon will not be affected to the extent that the ESU's ability to survive and recover will be appreciably reduced.

2.7.3 Effects on NC Steelhead

The Mad River includes two populations of NC steelhead that will be affected by the proposed action; summer-run and winter-run steelhead. However, NMFS assumes that individuals from each population will have the same response to the proposed action. Therefore, the assessment below is for each population.

2.7.3.1 Population Size

The proposed action will primarily affect juveniles of all age classes (age 0+, 1+, and 2+) by reducing the quality of rearing habitat which reduces the number of individuals that the habitat can support (*e.g.*, feeding, sheltering) and also reduces the function of the habitat which will reduce the fitness and consequent survival of individuals. In addition, the proposed bridge construction is expected to result in the death or injury of a small number of age 0+ steelhead each year. This small loss of age 0+ steelhead translates into a small loss of smolts that enter the ocean, and a negligible reduction in returning spawning adults. None of the minimal effects as described in section 2.5.3 are expected to add additional stress or cumulatively injure or kill steelhead in the action area. The effects of climate change, including increases in temperature, changes in precipitation patterns and amounts, and ocean conditions that result in poor survival may enhance the adverse effects of the proposed action and result in increased mortality of juvenile steelhead. For example, reductions in growth may be more impactful to survival in the ocean when ocean conditions are poor. Additionally, the effects of turbidity and sediment from the proposed action on juvenile steelhead survival is likely increased because of high turbidity and suspended sediment conditions as discussed in the environmental baseline.

However, given the availability of adequate rearing habitat in other portions of the Mad River watershed and the juvenile steelhead production that occurs in the watershed, it is unlikely that the small reduction in the numbers of juvenile steelhead as a result of implementing the proposed action would appreciably reduce the size of the Mad River steelhead population. In addition, the size of the adult steelhead population seems to be able to respond to improved ocean and freshwater conditions under a similar proposed action that occurred the last ten years (2009-2019). Therefore, NMFS expects that proposed action will not appreciably reduce the NC steelhead population size in the Mad River, diversity stratum, or DPS.

2.7.3.2 Population Productivity

The productivity of the populations is not expected to be reduced because the number of adults steelhead returning is not expected to be appreciably reduced. The negligible reduction in population productivity is expected to be spread among both of the affected steelhead populations in the Mad River. Under the previous ten-year mining period and a similar proposed action, the Mad River winyter steelhead population was able to respond to improved ocean, river, and tributary habitat conditions such that the population approached recovery targets. We believe this shows that steelhead productivity is not affected by the proposed action such that the

Mad River population cannot survive and recover if the baseline continues to improve as a result of regulation of other activities and implementation of habitat restoration actions. Climate change and ocean productivity declines will continue to affect the productivity of steelhead in the Mad River regardless of implementation of the proposed action. Therefore, the productivity of the DPS is not expected to be reduced to the extent that the DPS's ability to survive and recover will be appreciably reduced.

2.7.3.3 Spatial Structure

Although two NC steelhead populations are affected, it is unlikely that both populations will be affected to the extent that adult escapement is reduced during every year of the 10-year permit. In addition, the proposed action may increase, but will not reduce access to habitats currently available to the Mad River steelhead populations. Therefore, the spatial structure of the steelhead populations is not expected to be reduced.

2.7.3.4 Diversity

Recent genetic analysis of summer steelhead suggests that the genes for expression of this phenotype exist in all steelhead, but its expression is dependent on other unknown factors that may have changed such that expression of the winter-run type dominates. We do not think that the effects of gravel mining will affect expression of the summer-run phenotype. Since phenotypic or genotypic changes are not expected, the diversity of affected steelhead populations is not expected to be reduced by the loss of a negligible number of adult steelhead during the 10-year permit.

2.7.3.5 Summary

The viability of the 2 populations of steelhead that use the action area will not be diminished because we only expect a negligible decrease in adult potential as a result of gravel mining. However, we expect this decrease will be ameliorated by the increased productivity of the winter-run steelhead population because of continual improvements to the baseline from changes in forestry practices, increased regulation of stream diversions and cannabis production, improvements in fish passage, habitat restoration actions, and consistent and higher mainstem flows from operations of Mathews Dam in coordination with the HBMWD, which results in increases in summer flows upstream of the HBMWD diversion point in Arcata, California. Under a similar proposed action over the previous ten years, adult winter-run steelhead numbers have increased significantly in some years. We believe this shows that steelhead productivity is not affected by the proposed action such that the Mad River population and ESU cannot survive and recover if the baseline continues to improve as a result of regulation of other activities and implementation of habitat restoration actions. Climate change and ocean productivity declines will continue to affect the productivity of steelhead, especially summer steelhead, in the Mad River and the ESU. However, climate change and ocean productivity will continue to influence the productivity of Mad River steelhead populations regardless of the implementation of the proposed action. Therefore, a decrease in the viability of the NC steelhead DPS is not expected. Overall, the numbers of spawners are not expected to be appreciably reduced to the extent that reductions in the populations' likelihood of survival and recovery would be expected to reduce the likelihood of survival and recovery of the species at the DPS level.

2.7.4 Effects on Critical Habitat

NMFS approaches its "destruction and adverse modification determinations" by examining the effects of actions on the *conservation value* of the designated critical habitat; that is, the value of the critical habitat for the conservation of threatened or endangered species.

2.7.4.1 SONCC Coho Salmon Critical Habitat

The action area is critical for the conservation of the Mad River population of SONCC coho salmon because all juveniles must use the action area during a portion of their freshwater life stage. Included as a life history diversity strategy for Mad River coho salmon in the action area is the existence of a “nomad” life history type (Koski 2009). Nomad coho salmon move downstream from natal areas into the action area for rearing. This strategy should increase the resilience and productivity of the population, especially since natal areas are located in small tributaries to the Mad River which have their own suite of poor habitat conditions and even some that dry or have intermittent flows during the summer. Therefore, NMFS believes that the action area is critical for the conservation of coho salmon in the Mad River; however, the effects to critical habitat from the proposed action will not appreciably reduce this conservation value.

2.7.4.2 CC Chinook Salmon Critical Habitat

The action area includes approximately 4 miles of spawning habitat for CC Chinook salmon. This area is important for the early spawning component of the Mad River Chinook salmon population because spawning typically commences prior to the onset of fall rains, but is especially important during years when fall and early winter rainfall is low, which impedes access to spawning habitat in tributaries and farther upstream on the Mad River. In addition, all juvenile and adult Chinook salmon must migrate and rear within the action area during significant portions of their freshwater life histories. Therefore, the Mad River action area is essential for the conservation of the Mad River population of CC Chinook salmon. NMFS expects that implementation of the proposed action will result in a decrease in Chinook salmon spawning habitat quality and quantity. However, this decrease is not expected to result in a significant decrease in the conservation value of the action area. Low velocity refugia during critical winter and spring rearing periods are expected to be reduced, but this habitat is not currently limiting in the action area, so this reduction is not expected to significantly decrease the conservation value of the action area. Additionally, construction of alcoves and increases in riparian habitat will increase low velocity habitat. Therefore, NMFS believes that the proposed action will not appreciably reduce the conservation value of CC Chinook salmon critical habitat in the action area.

2.7.4.3 NC Steelhead Critical Habitat

Almost all of the gravel bars within the 8-mile mining reach will be subject to gravel extraction, resulting in a decrease in the conservation value of many of the PBFs in a critical portion of the river that all individuals of the Mad River steelhead populations must pass and spend time feeding and sheltering prior to ocean entry. Therefore, the action area is critical to the conservation of the Mad River steelhead populations. However, the decrease in conservation value is expected to be localized to the individual site scale, not expected to propagate to the

reach scale, and not expected to occur every year of the 10-year proposed action. We expect that there will be critical habitat within the action area that will not experience decreases in conservation value and may increase with increases in riparian vegetation and the creation of alcoves.

In addition, the localized decreases in conservation value of PBFs within the action area will not limit the ability of the Mad River NC steelhead populations to respond to favorable ocean conditions and/or improved PBFs outside of the action area. NMFS believes that the proposed action will result in habitat conditions in the action area that will support an increase in the populations of NC steelhead because populations have positively responded to improvements in the habitat baseline and other regulatory actions. Additionally, habitat in the action area improved under implementation of a similar proposed action from 2010-2019. Therefore, NMFS believes that the proposed action will not appreciably reduce the conservation value of NC steelhead critical habitat in the action area.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of SONCC coho salmon, CC Chinook salmon, or NC Steelhead and is not likely to destroy or adversely modify their designated critical habitats.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur from crushing during temporary channel crossing construction, channel enlargement and instability, increased stranding in extraction areas, elevated turbidity, and reduced refugia. NMFS expects that up to 10 NC steelhead juveniles per crossing at up to 8 temporary channel crossings each year may be killed during heavy equipment use while constructing and removing crossings. All eggs and/or fry in up to 4 Chinook salmon redds near extraction sites in the upper reach may be killed by scour from increased channel instability.

It is not possible to quantify the amount of individual juvenile coho salmon, Chinook salmon, and steelhead injured or killed as a result of stranding in extraction areas, elevated turbidity, channel enlargement and instability, and reduced refugia because it is not possible to meaningfully measure the number of juvenile coho salmon, Chinook salmon, and steelhead that use the action area during the winter when effects would occur and locating small, dead fish is practically impossible due to predation, decomposition, and poor water visibility. In addition, juvenile distribution is not even across the action area, making it difficult to estimate the number of fish. When NMFS cannot quantify the amount or extent of incidental take in terms of the numbers of individuals, NMFS uses surrogates to estimate the amount or extent of incidental take.

Therefore, we use the FEV allocation for each site for a particular year (plus application of banking where applicable) as an overall surrogate for take from increased stranding in extraction areas, elevated turbidity, channel enlargement and instability, and reduced refugia (Table 1 in section 1.3.2.1 of the *Proposed Action*). Additional surrogates are used as well. The take surrogate for turbidity will be based a maximum of 8 bridge construction per year. The take surrogates for stranding will be limited to the floodplain extraction locations and total areal percent of extractions in the floodplain. Specifically, the take surrogates for stranding of coho salmon, Chinook salmon, and steelhead juveniles are that floodplain extractions will only be at the Guynup, Emmerson, Blue Lake, Christie, and Simpson-Glendale bars and that only up to 10% of the 2 to 5 year floodplain and up to 20% of the 5 to 10 year floodplain may be extracted in the mining reach until the applicable floodplain area replenish or if the channel migrates into the applicable 2 to 5 year and/or 5 to 10 year floodplain area. The take surrogate for the reduced refugia will be an annual maximum of 8 skims in the mining reach. If at any time the level or method of taking as described in this Opinion is exceeded, reinitiation of consultation will be required.

2.9.2 Effect of the Take

In the biological Opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02). NMFS considers that the following reasonable and prudent measures are necessary and appropriate to minimize take of SONCC coho salmon, CC Chinook salmon and NC steelhead. The Corps shall:

1. Ensure that the monitoring necessary to track the response of the Mad River to gravel extraction is completed in a timely manner.
2. Ensure that extractions minimize the stranding of fish.
3. Ensure that the FEV strategy is implemented correctly.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the Corps or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The Corps or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:
   - The Corps shall ensure that the applicant(s) categorize the appropriate floodplain zone of any proposed floodplain extractions (e.g., using either hydraulic modeling or direct observation and marking of each flow level representing the 2-5 year and 5-10 year flood zones) prior to approving those floodplain extractions.
   - The Corps shall ensure that all required monitoring is completed annually. All monitoring cross section data for the previous year must be provided to NMFS prior to the Corps approving the annual extraction.
   - The Corps shall ensure that spring aerial photos and monitoring cross sections that include the previous year's extractions and the 35% exceedance flow elevation are provided at least one day prior to the pre-extraction field review. Monitoring cross sections for the field review shall span the 100-year flow channel and include the wetted channel unless the river is too high for safe surveying.
   - Ensure that annual extraction monitoring reports follow data format and standards in the Gravel Extraction Monitoring Guidelines and are provided to NMFS each year by December 31. Reports shall be submitted to:

     North Coast Branch Supervisor
     National Marine Fisheries Service
     1655 Heindon Road
     Arcata, California 95521

2. The following terms and conditions implement reasonable and prudent measure 2:
   The Corps shall require applicants or their consultants to assess extractions that may strand fish (e.g., alcoves and floodplain extractions) for stranding in the spring of each year following extraction. NMFS shall be contacted if stranded fish are observed.

3. The following terms and conditions implement reasonable and prudent measure 3:
   The Corps shall require the applicants (or CHERT) to annually update the FEV volume calculator with the current water year daily flow information, with input from NMFS, by May 15 of each year and provide the resultant gravel volume allocations to NMFS and the operators. Adjustments to the FEV sediment volumes can be made if high flows occur after May 15. The results of the FEV update will be provided to NMFS by May 31 of each year.

2.10 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the

purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

1) The Corps should work with CHERT, state and federal resource agencies, and the operators to develop a rapid method for documenting changes in habitat in the action area.
2) The Corps should work with CHERT and the state and federal resource agencies to develop new sediment recruitment estimates for the Mad River.
3) The Corps should work with CHERT to provide NMFS and the resource agencies a running list of extractions for the sites with annual notes on the river changes at the site until full replenishment.
4) The Corps should encourage alcove extractions be located mostly at the downstream end of point bars.
5) The Corps should monitor effectiveness of riparian enhancement extractions for development of riparian habitat.
6) The Corps should work with CHERT to analyze cross sections every year to assess the change in area comparable to the previous cross-section analysis (NMFS 2020).

2.11 Reinitiation of Consultation

This concludes formal consultation for the Mad River Batched Gravel Mining Permits. As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

HAPCs for salmon affected by the Project are: complex channel and floodplain habitat, as described in the Pacific Salmon FMP.

3.2 Adverse Effects on Essential Fish Habitat

The adverse effects to EFH from the proposed action are included in the effects of the action section of this Opinion. These include localized decreases in substrate size, changes in the geomorphology of the river from gravel extraction, and localized increases in fine sediment and turbidity.

3.3 Essential Fish Habitat Conservation Recommendations

NMFS has no additional conservation recommendations for EFH over what is described in the Opinion and Incidental Take Statement (ITS). NMFS believes that the proposed action and the terms and conditions in the ITS would minimize the adverse effects to Pacific Coast salmon EFH.

3.4 Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that effects the basis for NMFS' EFH Conservation Recommendations (50 CFR600.920(1)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Opinion addresses these DQA components, documents compliance with the DQA, and certifies that this Opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this Opinion are the Corps. Other interested users could include the County of Humboldt and the applicants. Individual copies of this Opinion were provided to the Corps. The format and naming the document adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security

of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this Opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

5. REFERENCES

Anderson, C.W., G. Scheer, D. Ward. 2015. Results of Freshwater Creek Salmonid Life Cycle Monitoring Station 2014-15. California Department of Fish and Game Anadromous Fisheries Resource Assessment and Monitoring Program. 64 p.

Bauer, S., J. Olson, A. Cockrill, M. van Hattem, L. Miller, M. Tauzer, and G. Leppig. 2013. Impacts of surface water diversions for marijuana cultivation on aquatic habitat in four Northwestern California watersheds. PLoS ONE 10(3): e0120016. Doi:10.1371/journal.pone.0120016.

Beamish, R. J., C. Mahnken, and C. M. Neville. 1997a. Hatchery and wild production of Pacific salmon in relation to large-scale, natural shifts in the productivity of the marine environment. ICES Journal of Marine Science. 54: 1200-1215.

Beamish, R. J., C. M. Neville, and A. J. Cass. 1997b. Production of Fraser River sockeye salmon (*Oncorhynchus nerka*) in relation to decadal-scale changes in the climate and the ocean. Canadian Journal of Fisheries and Aquatic Sciences 54:435-554.

Beamish, R. J. and D. R. Bouillion. 1993. Pacific salmon production trends in relation to climate. Canadian Journal of Fisheries and Aquatic Sciences 50:1002-1016.

Beamish R. J., and C. Mahnken. 2001. A critical size and period hypothesis to explain natural regulation of salmon abundance and the linkage to climate and climate change. Progress in Oceanography 49:423–437.

Behnke, A.C. 1990. A perspective on America's vanishing streams. Journal of the North American Benthological Society 9:77-88.

Behrenfeld, M. J., R. T. O'Malley, D. A. Siegel, C. R. McClain, J. L. Sarmiento, G. C. Feldman, A. J. Milligan, P. G. Falkowski, R. M. Letelier, and E. S. Boss. 2006. Climate-driven trends in contemporary ocean productivity. Nature 444: 752–755.

Bell, E. and W.G. Duffy. 2007. Previously undocumented two-year freshwater residency of juvenile coho salmon in Prairie Creek, California. Transactions of the American Fisheries Society 136: 966-970.

Beschta, R.L. 1991. Stream habitat management for fish in the Northwestern United States: the role of riparian vegetation. American Fisheries Society Symposium 10:53-58.

Beschta, R.L., and W.S. Platts. 1986. Morphological features of small streams: significance and function. Water Resources Bulletin 22:369-379.

Bilby, R. E., B. R. Fransen, and P. A. Bisson. 1996. Incorporation of nitrogen and carbon from spawning coho salmon into the trophic system of small streams: evidence from stable isotopes. Canadian Journal of Fisheries and Aquatic Sciences 53:164-173.

Bilby, R. E., B. R. Fransen, P. A. Bisson, and J. K. Walter. 1998. Response of juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead (*Oncorhynchus mykiss*) to the addition of salmon carcasses to two streams in southwestern Washington, USA. Canadian Journal of Fisheries and Aquatic Sciences 55:1909-1918.

Bjornn, T.C., M.A. Brusven, M.P. Molnau, J.H. Milligan, R.A. Klamt, E. Chaco, and C. Schaye. 1977. Transport of granitic sediment in streams and its effects on insects and fish. U.S. DOI, Office of Water Research Technology. Research Technical Completion Report Project B-036-IDA

Bjornn, T.C. and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Pp. 83-138 In: W.R. Meehan (*ed.*). Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19. Bethesda, MD. 751 pp.

Boling, R., Jr., E. Goodman, J. Van Sickle, J. Zimmer, K. Cummins, R. Peterson. 1975. Toward a model of detritus processing in a woodland stream. Ecology 56:141-151.

Bradford, M. J., R. A. Myers, and J. R. Irvine. 2000. Reference points for coho salmon harvest rates and escapement goals based on freshwater production. *Canadian Journal of Fisheries and Aquatic Sciences* 57: 677– 686.

Bretscko, G. and H. Moser. 1993. Transport and retention of matter in riparian ecotones. Hydrobiologia 251:95-101.

Briggs, J.C. 1953. The behavior and reproduction of salmonid fishes in a small coastal stream. Fish Bulletin, No. 94, California Department of Fish and Game, Marine Fisheries Branch: 62.

Brown, A.V., M.M. Lyttle, and K.B. Brown. 1998. Impacts of gravel mining on gravel bed streams. Transactions of the American Fisheries Society 127:979-994.

Brown, L.R, and P.B. Moyle. 1991. Status of coho salmon in California. Report to the National Marine Fisheries Service, 114 pp. Available from National Marine Fisheries Service, Environmental and Technical Services Division, 525 N.E. Oregon Street, Portland, OR 97232.

Bryant, G. J. 1994. Status review of coho salmon in Scott Creek and Waddell Creek, Santa Cruz County, California. Natl. Mar. Fish. Serv., SW Region, Protected Species Management Division, 102 p.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon and California. U.S. DOC, NOAA Technical Memo NMFS-NWFSC-27, Seattle, Washington.

Butsic, V. and J.C. Brenner. 2016. Cannabis (*Cannabis sativa or C. Indica*) agriculture and the environment: a systematic, spatially-explicit survey and potential impacts. Environmental Research Letters 11:044203.

California Department of Fish and Game (CDFG). 1994. Petition to the California Board of Forestry to list coho salmon (*Oncorhynchus kisutch*) as a sensitive species. California Department of Fish and Game Report. 35 pp. plus appendices. (Available from California Board of Forestry, 1416 Ninth, Sacramento, California 95814). *In:* Weitkamp *et al*. (1995).

Chavez, F. P., J. Ryan, S. E. Lluch-Cota, and M. Ñiquen C. 2003. From Anchovies to Sardines and Back: Multidecadal Change in the Pacific Ocean. Science 299 (5604), 217.

Church, M., D. Ham, and H. Weatherly, 2001. Gravel management in lower Fraser River. Report to The City of Chilliwack, British Columbia; 110p.

Cloern, J.E., N. Knowles, L.R. Brown, D. Cayan, M.D. Dettinger, T.L.Morgan, D.H.Schoellhamer, M.T. Stacey, M. van der Wegen, R.W. Wagner, and A.D. Jassby. 2011.Projected evolution of California's San Francisco Bay-Delta-River system in a century of climate change. PLoS ONE 6(9):13.

Collins, B. and T. Dunne. 1990. Fluvial geomorphology and river-sediment mining: a guide for planners, case studies included. Calif. Depart. Conserv., Div. Mines Geol., Spec. Pub. 98. 29 pp.

County of Humboldt Extraction Review Team (CHERT). 2005. Historical Analyses of the Mad River: 1993-2003 Formatting and Figure Numbers Corrected 2009. 128p.

County of Humboldt Extraction Review Team (CHERT). 2009. Historical Analyses of the Mad River: 2004-2007 Update. 44p.

County of Humboldt Extraction Review Team (CHERT). 2010. Annual report of Mad River Gravel extraction.

County of Humboldt Extraction Review Team (CHERT). 2011. Annual report of Mad River Gravel extraction.

County of Humboldt Extraction Review Team (CHERT). 2012. Annual report of Mad River Gravel extraction.

County of Humboldt Extraction Review Team (CHERT). 2013. Annual report of Mad River Gravel extraction.

County of Humboldt Extraction Review Team (CHERT). 2014. Annual report of Mad River Gravel extraction.

County of Humboldt Extraction Review Team (CHERT). 2015. Annual report of Mad River Gravel extraction.

County of Humboldt Extraction Review Team (CHERT). 2016. Annual report of Mad River Gravel extraction.

County of Humboldt Extraction Review Team (CHERT). 2017. Annual report of Mad River Gravel extraction.

County of Humboldt Extraction Review Team (CHERT). 2018. Annual report of Mad River Gravel extraction.

County of Humboldt Extraction Review Team (CHERT). 2019. Annual report of Mad River Gravel extraction.

Cox, P., and D. Stephenson, 2007: A changing climate for prediction. Science, 317, 207-208, doi: 10.1126/science.1145956.

Cummins K.W., R. Petersen, F. Howard, J. Wuycheck, and V. Holt. 1973. The utilization of leaf litter by stream detritivores. Ecology 54(2): 336-345.

Doney, S. C,M. Ruckelshaus, J.E. Duffy, J.P. Barry, F. Chan, C.A. English, H.M. Galindo, J.M. Grebmeier, A.B. Hollowed, N. Knowlton, J. Polovina, N.N. Rabalais, W.J. Sydeman, L.D. Talley. 2012. Climate change impacts on marine ecosystems. Annual Review of Marine Science 4:11-37.

Ellis, D.V. 1962. Preliminary studies on the visible migrations of adult salmon. Journal of the Fisheries Research Board of Canada 19:137-148.

Environmental Protection Agency Region (EPA). IX. 2007. Mad River Total Maximum Daily Loads for Sediment and Turbidity.

Fausch, K.D. 1984. Profitable stream positions for salmonids: relating specific growth rate to net energy gain. Canadian Journal of Zoology 62: 441-451.

Fausch, K.D. 1986. Competition among juveniles of coho salmon, brook trout, and brown trout in a laboratory stream, and implications for Great Lakes Tributaries. Transactions of the American Fisheries Society 115:363-381.

Feely RA, Orr J, Fabry VJ, Kleypas JA, Sabine CL, Landgon C. 2008. Present and future changes in seawater chemistry due to ocean acidification. In AGU Monograph on the Science and Technology of Carbon Sequestration. ed. B.J. McPherson, E.T. Sundquist. Am. Geophys. Union.

Free, Dan. 2009. National Marine Fisheries Service, Arcata, California. Personal communication.

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction and maintenance. Pp. 297-323. *In:* W.R. Meehan (1991).

Good, T. P., R. S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-NWFSC-66. 597 p.

Green Diamond Resource Company (GDRC). 2006. Aquatic habitat conservation plan and candidate conservation agreement with assurances. Volume 1–2, Final report. Prepared by Green Diamond Resource Company for National Marine Fisheries Service and U.S. Fish and Wildlife Service.

Greene, C. M. and T. J. Beechie. 2004. Consequences of potential density-dependent mechanisms on recovery of ocean-type Chinook salmon (Oncorhynchus tshawytscha). Can. J. Fish. Aquat. Sci. 61(4): 590–602.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. BioScience 41(8): 540-551.

Gresh, T., J. Lichatowich, and P. Schoonmaker. 2000. An estimation of historic and current levels of salmon production in the northeast Pacific ecosystem. Fisheries 15(1):15-21.

Groot, C. and L. Margolis. 1991. Pacific Salmon Life Histories. UBC Press. Vancouver, British Columbia, Canada.

Hagans, D.K., and W.E. Weaver. 1987. Magnitude, cause and basin response to fluvial erosion, Redwood Creek basin, northern California. In *Erosion and Sedimentation in the Pacific Rim*. Beschta, R.L., Blinn, T., Grant, G.E., Ice, G.G., and F.J. Swanson [Eds.]. IAHS Publication No. 165. International Assoc. of Scientific Hydrology: Wallingford, Oxfordshire. p. 419-428.

Halligan, D. 1997. Review of potential impacts to fisheries resources from gravel extraction in Humboldt County, California. Biological assessment submitted to the USACE. 35 pp.

Halligan, D. 1998. Final Report, 1997 Fisheries monitoring program for gravel extraction operations on the Mad, Van Duzen, and Trinity rivers. Natural Resources Management Corporation, 1434 Third Street, Eureka, California 95501. January 5. 24 pp. plus appendices.

Halligan, D. 1999. Final Report, 1998 Fisheries monitoring program for gravel extraction operations on the Mad, Van Duzen, and Trinity rivers. Natural Resources Management Corporation, 1434 Third Street, Eureka, California 95501. January 6. 20 pp. plus appendices.

Halligan, D. 2003. Humboldt County Gravel Monitoring Report, 2002. Natural Resources Management Corporation, 1434 Third Street, Eureka, California 95501. January 17.

Harr, R.D and R.A. Nichols. 1993. Stabilizing forest roads to help restore fish habitats: A northwest Washington example. Fisheries 18(4):18-22

Hartfield, P. 1993. Headcuts and effect on freshwater mussels. Pp. 131-141 *In:* K.S. Cummings, A.C. Buchanan, and L.M. Loch, (*eds*.). Conservation and management of freshwater mussels. Proceedings of the Upper Mississippi River Conservation Committee, Rock Island, Illinois.

Hartman, G.F. 1965. The role of behavior in the ecology and interaction of underyearling coho salmon and steelhead trout. Journal of the Fisheries Research Board of Canada 22: 1035-1081.

Harvey, B.C. and R.J. Nakamoto. 1996. Effects of steelhead density on growth of coho salmon in a small California coastal stream. Transactions of the American Fisheries Society 125:237-243.

Haupt, H.F. 1959. Road and slope characteristics affecting sediment movement from logging roads. J. Forestry 57(5): 329-339.

Hawkins, C.P., M.L. Murphy, and N.H. Anderson. 1982. Effects of canopy, substrate composition, and gradient on the structure of macroinvertebrate communities in Cascade Range streams of Oregon. Ecology 63(6):1840-1855.

Hayhoe, K., D. Cayan, C. B. Field, P. C. Frumhoff, E. P. Maurer, N. L. Miller, S. C. Moser, S. H. Schneider, K. N. Cahill, E. E. Cleland, L. Dale, R. Drapek, R. M. Hanemann, L. S. Kalkstein, J. Lenihan, C. K. Lunch, R. P. Neilson, S. C. Sheridan, and J. H. Verville. 2004. Emissions pathways, climate change, and impacts on California. Proceedings of the National Academy of Sciences of the United States of America, volume 101: 12422-12427.

Healey, M.C. 1991. The life history of chinook salmon (*Oncorhynchus tshawytscha*). Pp. 213-393 *In:* Groot and Margolis (*1991*).

Hearn, W.E. and B.E. Kynard. 1986. Behavioral interactions and habitat utilization of juvenile rainbow trout and Atlantic salmon in tributaries of the White River of Vermont. Canadian Journal of Fisheries and Aquatic Sciences 43: 1988-1998.

Higgins, P., S. Dobush, and D. Fuller. 1992. Factors in northern California threatening stocks with extinction. Unpublished manuscript, Humboldt Chapter American Fisheries Society. 24 pp. Available from Humboldt Chapter of the American Fisheries Society, P.O. Box 210, Arcata, CA 95521.

Hinch, S.G., R.E. Diewert, T.J. Lissimore, A.M.J. Prince, M.C. Healey, and M.A, Henderson. 1996. Use of electromyogram telemetry to assess difficult passage areas for river migrating adult sockeye salmon. Transactions of the American Fisheries Society 125:253-260.

Hinch, S.G. and J. Bratty. 2000. Effects of swim speed and activity pattern on success of adult sockeye salmon migration through an area of difficult passage. Transactions of the American Fisheries Society 129: 598-606.

Humboldt Growers Association (HGA). 2010 Humboldt County 314–55.1 Medical Marijuana Land Uses Draft Proposal.

Holtby, L.B., B.C. Anderson, and R.K. Kadowaki. 1990. Importance of smolt size and early ocean growth to interannual variability in marine survival of coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences 47:2181-2194.

Humboldt Bay Municipal Water District and Trinity Associates. 2004. Habitat conservation plan for Mad River Operations. Humboldt Bay Municipal Water District, Eureka, California and Trinity Associates.

Jensen, A. 2000. Final Report, 1999 Fisheries monitoring program for gravel extraction operations on the Mad, Van Duzen, and Trinity rivers. Natural Resources Management Corporation, 1434 Third Street, Eureka, California 95501. January 13. 42 pp. plus appendices.

Kadir, T., L. Mazur, C. Milanes, and K. Randles. 2013. Indicators of Climate Change in California. California Environmental Protection Agency, Office of Environmental Health Hazard Assessment. Sacramento, CA.

Kanehl, P. and J. Lyons. 1992. Impacts of in-stream sand and gravel mining on stream habitat and fish communities, including a survey of the Big Rib River, Marathon County, Wisconsin. Wisconsin Department of Natural Resources, Research Report 155, Madison, Wisconsin.

Knuuti, K. 2003. Assessment of Changes in Channel Morphology and Bed Elevation in the Mad River, California, 1971-2000. Final Report. U.S. Army Corps of Engineers. Engineer Research and Development Center.

Koski, K.V. 2009. The fate of coho salmon nomads: The story of an estuarine rearing strategy in promoting resilience. Ecology and Society 14 (1): 4.

Levin, P. S., R. W. Zabel and J. G. Williams. 2001. The road to extinction is paved with good intentions: negative association of fish hatcheries with threatened salmon. Proc. R. Soc. Lond. B. 268: 1153–1158.

Lindley, S. T., R. S. Schick, E. Mora, P. B. Adams, J. J. Anderson, S. Greene, C. Hanson, B. May, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2007. Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary and Watershed Science 5: Article 4.

Lisle, T.E. 1986. Stabilization of a gravel channel by large streamside obstructions and bedrock bends, Jacoby Creek, northwestern California. Geological Society of America Bulletin 97: 999-1011.

MacFarlane, R. B., S. Hayes, and B. Wells. 2008. Coho and Chinook Salmon Decline in California during the Spawning Seasons of 2007/08. National Marine Fisheries Service. Southwest Region. Santa Cruz, California.

Matthews, K.R., N.H. Berg, D.L. Azuma, and T.R. Lambert. 1994. Cool water formation and trout habitat use in a deep pool in the Sierra Nevada, California. Transactions of the American Fisheries Society 123:549-564.

Mattole Salmon Group. 1997. Mattole Salmon Recovery Progress. Mattole Watershed Document #8. Mattole Salmon Group, Petrolia, California.

McMahon, T.E. 1983. Habitat suitability index models: coho salmon. United States Fish and Wildlife Service, USFWS/OBS-82/10.49.

Meehan, W. (*ed*.) 1991. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. Bethesda MD. 751 pp.

Moser, S., J. Ekstrom, and G. Franco. 2012. Our Changing Climate 2012: Vulnerability and Adaptation to the Increasing Risks from Climate Change in California. A Summary Report on the Third Assessment from the California Climate Change Center. July. CEC-500-20102-007S.

Mosley, P.M. 1982. Critical depths for passage in braided rivers in Canterbury, New Zealand. New Zealand Journal of Marine and Freshwater Research. 16: 3-4.

Moyle, P. B. 2002. *Inland Fishes of California*. Second Edition. University of California Press. Berkeley, California.

Nakamura, F. and F. K. Swanson. 1993. Effects of Coarse Woody Debris on Morphology and Sediment Storage of a Mountain Stream System in Western Oregon. Earth Surface Processes and Landforms 18:43-61.

National Marine Fisheries Service (NMFS). 2002. Analysis of a flow-based minimum skim floor elevation for in-channel gravel mining in Humboldt County. National Marine Fisheries Service, Arcata Field Office, California. 18 pp.

National Marine Fisheries Service (NMFS). 2005. Final Assessment of the National Marine Fisheries Service's Critical Habitat Analytical Review Teams (CHARTs) for Seven Salmon and Steelhead Evolutionarily Significant Units (ESUs) in California. Protected Resources Division, Long Beach, CA.

National Marine Fisheries Service (NMFS). 2004. Review of the effects of Gravel Mining on the Mad River. Draft. Arcata Field Office, Arcata, California.

National Marine Fisheries Service (NMFS) 2010. Analysis of Gravel Extraction on the Mad River. Northern California Office, Arcata, California.

National Marine Fisheries Service (NMFS). 2014. Final recovery plan for the Southern Oregon/Northern California Coast evolutionarily significant unit of coho salmon. September 2014. Arcata, California.

National Marine Fisheries Service (NMFS). 2016. Final Coastal Multispecies Recovery Plan for California Coastal Chinook Salmon, Northern California Steelhead and Central California Coast Steelhead. October. West Coast Region.

NRC (National Research Council). 1995. Science and the Endangered Species Act. National Academy Press, Washington, D.C. 271 p

Newport, B.D. and J.E. Moyer. 1974. State-of-the-art: sand and gravel industry. U.S. Environmental Protection Agency, EPA-660/2-74-066. Washington, D.C.

Nichols, K., K. True, E. Wiseman, and J.S. Foot. 2007. FY 2005 Investigational Report: Incidense of *Ceratomyxa Shasta* and *Parvicapsula minibicornis* infections by QPCR and historilogy in juvenile Klamath River Chinook salmon. U.S. Fish and Wildlife Service, CANV Fish Health Center. Anderson, California.

Nickelson, T.E., J.W. Nicholas, A.M. McGie, R.B. Lindsay, D.L. Bottom, R.J. Kaiser, and S.E. Jacobs. 1992. Status of anadromous salmonids in Oregon coastal basins. Unpublished manuscript. Oregon Department of Fish and Wildlife, Research and Development Section, Corvallis, and Ocean Salmon Management, Newport. 83 pp.

Ock, G. and G. M. Kondolf. 2012. Assessment of Ecological Roles of Gravel Bar Features Restored by Gravel Augmentation and Channel Rehabilitation Activities below Lewiston Dam in the Trinity River, California. U.S. Bureau of Reclamation, Science and Technology Program Scoping Report. University of California, Berkeley, California.

O'Farrell, M. R., W. H. Satterthwaite, and B. C. Spence. 2012. California Coastal Chinook salmon: status, data, and feasibility of alternative fishery management strategies. NOAA Technical Memorandum NMFS-SWFSC-494.

Peterson, W.T., J.L. Fisher, C.A. Morgan, J.O. Peterson, B.J. Burke, and K. Fresh. 2015. Ocean ecosystem indicators of salmon marine survival in the Northern California current. National Marine Fisheries Service Northwest Fisheries Science Center. December. 94 p

PFMC. 2014. Appendix A to the Pacific Coast Salmon Fishery Management Plan, as modified by Amendment 18. Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon.

Pauley, G.B., G.L. Thomas, D.A. Marino, and D.C. Weigand. 1989. Evaluation of the effects of sediment bar scalping on juvenile salmonids in the Puyallup River drainage. Final Report to the Washington Department of Fisheries, Service Contract No. 1620. Cooperative Fisheries Research Unit, University of Washington. Seattle, Washington. 150 pp.

Peterson, N. P. 1982. Population characteristics of juvenile coho salmon (*Oncorhynchus kisutch*) overwintering in riverine ponds. Canadian Journal of Fisheries and Aquatic Sciences 39: 1303- 1307.

Quinn, T. P. 2005. The Behavior and Ecology of Pacific Salmon and Trout. University of Washington Press, Seattle, Washington.

Raleigh, R.F., T. Hickman, R.C. Solomon, and P.C. Nelson. 1984. Habitat suitability information: rainbow trout. U.S. Fish Wildl. Serv. FWS/OBS-82/10.60.

Reid, G.K. 1961. Ecology of inland waters and estuaries. Van Nostrand Reinhold Co. New York, New York. 375 pp.

Reid, L.M. 1998. Review of the: Sustained yield plan/habitat conservation plan for the properties of the Pacific Lumber Company, Scotia Pacific Holding Company, and Salmon Creek Corporation. Unpublished report. USDA Forest Service. Pacific Southwest Research Station. Redwood Sciences Laboratory. Arcata, California. 63 pp.

Reid, L.M. and Dunne, T. 1984. Sediment production from forest road surfaces. Water Resources Research 20(11): 1753-1761.

Rivier, B. and J. Seguier. 1985. Physical and biological effects of sediment removal in river beds. Pp. 131-146 *In:* Alabaster, J.S. (*ed*.). Habitat modification and freshwater fisheries. Butterworths, London.

Sandecki, M. 1989. Aggregate mining in river systems. California Geology42(4):88–94.

Sandercock, F.K. 1991. Life history of coho salmon. Pp. 397-445 *In:* Groot, C. and L. Morgolis. 1991. Pacific Salmon Life Histories. UBC Press. Vancouver, British Columbia, Canada.

Santer, B.D., and Coauthors. 2011. Separating signal and noise in atmospheric temperaturechanges: The importance of timescale. *J. Geophys. Res.*, **116,** D22105, doi:10.1029/2011 JD016263.

Saulitis, E., C. Matkin, L. Barrett-Lennard, K. Heise, and G. Ellis. 2000. Foraging strategies of sympatric killer whale (*Orcinus orca*) populations in Prince William Sound, Alaska. Mar. Mamm. Sci. 16(1): 94-109.

Scavia, D., J.C. Field, D.F. Boesch, R.W. Buddemeier, V. Burkett, D.R. Cayan, M. Fogarty, M.A. Harwell, R.W. Howarth, C. Mason, D.J. Reed, T.C. Royer, A.H. Sallenger, and J.G.

Titus. 2002. Climate change impacts on U.S. coastal and marine ecosystems. Estuaries 25(2):149-164.

Scheffer, V.B. and J.W. Slipp. 1948. The whales and dolphins of Washington State. Am. Midl. Nat. 39: 257-289.

Schneider, S.H. 2007. The unique risks to California from human-induced climate change. California State Motor Vehicle Pollution Control Standards; Request for Waiver of Federal Preemption, presentation May 22, 2007.

Shapovalov, L., and A.C. Taft. 1954. The Life Histories of the Steelhead Rainbow Trout *Salmogairdneri gairdneri*) and Silver Salmon (*Oncorhynchus kisutch*) with Special Reference toWaddell Creek, California, and Recommendations Regarding Their Management. California Department of Fish and Game, Fish Bulletin No. 98. 375 pp.

Shirvell, C. S. 1994. Effect of changes in streamflow on the microhabitat use and movements of sympatric juvenile coho salmon (*Oncorhynchus kisutch*) and chinook salmon (*O.tshawytscha*) in a natural stream. Canadian Journal of Fisheries and Aquatic Sciences 51:1644-1652.

Sirkin, K. 2020. Email to Dan Free of NMFS on September 14, 2020, clarifying the proposed gravel season.

Sparkman, M.D. 2002. Juvenile Steelhead Downstream Migration Study in the Mad River, Humboldt County, California – Spring 2001. Project 2a3. 2000-2001 Annual Report. California Department of Fish and Game. Steelhead Research and Monitoring Program. 52pp.

Sparkman, M.D. 2019. California Department of Fish and Game. Personal Communication regarding gravel operations effects on adult Chinook salmon holding.

Sparkman, M. D., and S. C. Holt. 2020 ARIS sonar estimates of abundance and migration patterns of Chinook salmon, late summer/fall-run Steelhead Trout, Coho Salmon, and Pink Salmon in the Mad River, Humboldt County, California August 2017 – January 2018. California Department of Fish and Wildlife, Anadromous Fisheries Resource Assessment and Monitoring Program, 19 p.

Spence, B.C., E.P. Bjorkstedt, J.C. Garza, J. J. Smith, D.G. Hankin, D. Full-er, W.E. Jones, R. Macedo, T.H. Williams, and E. Mora. 2008. A framework for assessing the viability of threatened and endangered salmon and steelhead in the north-central California coast recovery domain. NOAA-TM-NMFS-SWFSC-423. 194 p.

Stillwater Sciences. 2009. Batched biological assessment for aggregate extraction operations in the lower Mad River, Humboldt County, California. Final Report. Prepared by Stillwater Sciences, Arcata, California for Mad River Sand and Gravel, Granite Construction, Eureka Ready Mix, Mercer-Fraser Company, and D&R Miller.

Stillwater Sciences 2020. Biological Assessment for aggregate extraction operations in the lower Mad River, Humboldt County, California. Final Report. Prepared by Stillwater Sciences, Arcata, California for Mad River Sand and Gravel, GLS Construction, Eureka Ready Mix, Mercer-Fraser Company, and Sundberg, Inc.

Swanson, F.J. and Dryness C.T. 1975. Impact of clearcutting and road construction on soil erosion and landsliding in the Western Cascade Range, Oregon. Geology 3(7): 393-396.

Swanston, D.N. and F.J. Swanson. 1976. Timber harvesting, mass erosion, and steepland forest geomorphology in the Pacific Northwest. In Coates, D.R. ed., Geomorphology and Engineering. Dowden, Hutchison, and Ross, Inc., Pages 199-221. Stroudsburg, PA.

Swanston, D. N. 1991. Natural processes. pp. 139-179. In W. R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. Amer. Fish. Soc. Spec. Publ. 19. 751 p.

Thompson, K. E. Determining streamflows for fish life. 1972. Proceedings of the instream flow requirements workshop. pp.31–50. Portland, Oregon: Pacific Northwest River Basins Commission.

Trush, B. 2008. Lower Mad River woody riparian vegetation trend between WY 1994 and WY 2007. Appendix A—Mad River supplemental programmatic environmental impact report. County of Humboldt, Eureka, California.

Tschaplinski, P. J. 1988. The use of estuaries as rearing habitats by juvenile coho salmon. In Proceedings of a Workshop: Applying 15 Years of Carnation Creek Results. Edited by T.W. Chamberlin. Carnation Creek Steering Committee, Nanaimo, B.C. pp. 123–142.

USEPA (U.S. Environmental Protection Agency). 2007. Mad River Total Maximum Daily Loads for Sediment and Turbidity.

Vannote, R.L., G.W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Science 37:130-137.

Waples, R.S. 1991. Definition of "species" under the Endangered Species Act: Application to Pacific salmon. U.S. Department of Commerce. Technical Memorandum NMFS F/NWC-194. 29 p.

Waples, R.S. 1999. Dispelling some myths about hatcheries. Fisheries 23(2):12-21.

Ward, B.R. and P.A. Slaney. 1988. Life history and smolt-to-adult survival of Keogh River steelhead trout (*Salmo gairdneri*) and the relationship to smolt size. Canadian Journal of Fisheries and Aquatic Sciences 45:1110-1122.

Ward, E.J., E.E. Holmes and K.C. Balcomb. 2009. Quantifying the effects of prey abundance on killer whale reproduction. J. App. Ecol. 46(3): 632-640.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-24, Northwest Fisheries Science Center, Seattle, Washington. 258 pp.

Wells, B. K., C. B. Grimes, J. C. Field and C. S. Reiss. 2006. Covariation between the average lengths of mature coho (Oncorhynchus kisutch) and Chinook salmon (O. tshawytscha) and the ocean environment. Fish. Oceanogr. 15:1, 67–79.

Westerling, A.L., B.P. Bryant, H.K. Preisler, T.P. Holmes, H.G. Hidalgo, T.Das, and S.R. Shrestha. 2011. Climate change and growth scenarios for California wildfire. Climate Change 109(1):445-463.

Wickett, W. P. 1954. The oxygen supply to salmon eggs in spawning beds. Journal of the Fisheries Research Board of Canada 11:933–953.

Williams, T. H., E. P. Borkstedt, W. G. Duffy, D. Hillemeier, G. Kautsky, T. E. Lisle, M. McCain, M. Rode, R. G. Szerlong, R. S. Schick, M. N. Goslin, and A. Agrawal. 2006. Historical population structure of coho salmon in the Southern Oregon/Northern California Coasts Evolutionarily Significant Unit. U.S. Dept. Commer. NOAA Tech. memo. NMFS-NWFSC-390. June. 71 p.

Williams, T. H., B. C. Spence, W. Duffy, D. Hillemeier, G. Kautsky, T. Lisle, M. McCain, T. Nickelson, E. Mora, and T. Pearson. 2008. Framework for assessing viability of threatened coho salmon in the Southern Oregon/Northern California Coast Evolutionarily Significant Unit. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-432. December. 113 p.

Williams, T. H., S. T. Lindley, B. C. Spence, and D. A. Boughton. 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, California.

Williams, T.H., B.C. Spence, D.A. Boughton, R.C. Johnson, L. Crozier, N. Mantua, M. O'Farrell, and S.T. Lindley. 2016. Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. 2 February 2016 Report to National Marine Fisheries Service – West Coast Region from Southwest Fisheries Science Center, Fisheries Ecology Division 110 Shaffer Road, Santa Cruz, California 95060. 182 p.

Federal Register Notices Cited

64 FR 24049. National Marine Fisheries Service. Final Rule and Correction. Designated Critical Habitat; Central California Coast and Southern Oregon/Northern California Coasts Coho Salmon. May 5, 1999.

70 FR 37160. National Marine Fisheries Service. Final Rule. Endangered and Threatened Species: Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs. June 28, 2005.

70 FR 52488. National Marine Fisheries Service. Final Rule. Endangered and Threatened Species: Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California. September 2, 2005.

71 FR 834. National Marine Fisheries Service. Final Rule. Endangered and Threatened Species: Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead. January 5, 2006.

Appendix A

MONITORING AND SUBMITTAL PREPARATION GUIDELINES

Ground surveys and aerial photography provide the primary basis for physical monitoring of extraction areas. They are also essential for project planning, proposal preparation, field reviews, project modification, and compliance verification. Although technological advancements in recent years have lowered the costs and increased the accuracy of digital terrain modeling (DTM), the more conventional cross section surveys are still in common use by Humboldt County's mining industry. Consequently, the guidelines below focus on conventional cross section surveys. However, use of DTM-based monitoring information is encouraged and should provide much of the same information (e.g., elevations of the water surface, top of silt band, etc.) discussed below.

The physical monitoring program relies on two types of cross sectional measurements: Monitoring Cross Sections and Extraction Zone Cross Sections. *Monitoring cross-sections* are permanent, monumented cross sections that span the 100-year flood level, whose purpose is to document yearly and long-term changes in river channel elevation and morphology at extraction sites and adjacent reaches. They also aid in extraction planning, field reviews, and, in some cases, estimation of volumes extracted. *Extraction zone cross-sections* (both pre- and post-extraction) are temporary, seasonal cross-sections used for the planning of an extraction, for estimation of the actual volume extracted, and for evaluating compliance with approved gravel extraction plans.

Monitoring Cross-Sections

Monitoring cross-sections shall be measured each spring and after any extraction to include the extracted areas. Most monitoring cross-sections have already been established in previous years. Requirements for establishment of monitoring cross-sections are discussed in the *Establishing Monitoring Cross Sections* section below.

Requirements for Monitoring Cross-Sections

- All survey data must be referenced to State Plane (FIPS 0401) coordinate system, and the 1983 North American Datum (NAD) and 1988 North American Vertical Datum (NAVD88). Cross-sections must be resurveyed from the same endpoints each year. The endpoints should be located at or above the 100-year flood water surface elevation unless another flood level is agreed upon by agencies and CHERT and far enough from the river's edge to remain consistent from year to year.
- Previous years topography that clearly has not changed over the year may be used in the upper elevations of the cross section but the current year's survey must include those portions of each cross-section inundated or affected by the previous winter's highest flow. Plots must include accurate representations of all ground topography between endpoints and clearly label where older (previous survey) data are used. This is included as a cost saving measure for areas where it is clear that no scour or deposition has occurred since the previous survey.

- If flow conditions make below-water portions of the cross section unsafe to survey prior to the site visit, those sections may be completed as soon as flow conditions allow and must be included in the final monitoring submittal for the year.
- Maximum distance between any two elevation points along a cross-section shall be 50 feet, including the wetted channel portion. Exception: if ground outside wetted channel is essentially smooth and rises less than 0.5 feet for a distance of 100-feet, distance between points can be increased to 100 feet. All obvious breaks in slope must still be included in order to collect accurate topography that is representative of site conditions.
- At the time of extraction survey, stake or spray paint (using non-toxic paint) the following points on the ground in each cross-section:
    a. Water's edge on at least one side of the river; or both sides of the river if it is feasible. If this is not practicable, stake at 10 feet offset from water's edge. Position the stake to be included in the survey.
    b. The water surface near the 35% exceedence level along the main channel and along overflow channels containing the 35% flow. The actual 35% flow elevation, with USGS gage adjustments, should be calculated using the data sheets provided, at the time of extraction design.
    c. Top of the silt band if visible.
- Where discernible, the elevation and position of high-water marks for previous winter's flow (floodmarks, debris lines, swept or racked vegetation, etc) should be identified on the cross-sections.
- Water discharge at time of survey from USGS 11481000 Mad River near Arcata gage to be shown in legend.
- Re-survey all monitoring cross-sections which overlap an extraction area immediately following extraction, before flows or rain affect the zone. Only resurvey through those portions of the cross-section altered by extraction, temporary stockpiles, road construction, or other types of ground disturbance. See Figure 1.
- Cross-section plots and worksheets should denote the position and elevation (to the nearest 0.1 foot) of the following points:
    a. End points.
    b. The top of the silt band adjacent to the low flow channel, if visible.
    c. The corrected 35% flow exceedence water surface elevation (during years planned for extraction).
    d. Existing Water surface elevation at time of survey.
    e. Edge of woody or riparian vegetation stands.
    f. Any other features useful for field orientation and review.
- Cross-sections at all sites shall be plotted at the same vertical and horizontal scales (Horizontal 1-inch = 100-feet; Vertical 1-inch = 10-feet).
- Cross-section plots shall be cut and stacked so that whole cross-sections can be placed on one page and be consistently presented each year.
- Cross-sections shall be surveyed and drafted consistently so that the right bank (RB) of the river as you face downstream is at the right side of the drafted cross-section. Zero (0) distance in cross-sections shall be at the left (LB) endpoint as you face downstream.
- Cross sections shall be plotted on gridded paper, where the grid logically corresponds to the scale at which the cross-section is plotted. We suggest a grid of 10 squares to the inch. Grid shall be visible in the reproduced paper copies provided to the agencies.

- Cross sections shall have clearly labeled vertical and horizontal axes. Each cross section should have its own horizontal axis to facilitate measurement of distances (rather than a single set of axis labels at bottom of page). Each cross-section should have its origin on a heavy grid line.
- Any endpoints lost due to changes to the bank shall be clearly noted along with the length and direction of change(s) on the cross section plots. New endpoints should be established if washed out.

Establishing Monitoring Cross-Sections

1. Cross Section endpoints and benchmarks shall be established in accordance with the following specifications:
   a. The endpoints should be located at or above the 100-year flood water surface elevation unless another flood level is agreed upon by agencies and CHERT.
   b. Clearly monumented and labeled in the field and accurately located on current air photos and maps. A common color of flagging, or environmentally benign painting shall be used to mark cross-sections at all sites.
2. Cross-sections shall be oriented perpendicular to a hypothetical center line for the 'frequently scoured' river channel, and delineating the zone of frequent bedload movement (annual scour and deposition). This zone is typically devoid of large trees and excludes floodplains and terraces.
3. If the radius of curvature is less than ten times larger than the average frequently scoured channel width of the project reach, the reach is considered a bend. If the radius of curvature is more than ten times larger than the average actively scoured channel width of the project reach, the reach is considered straight.
4. Cross-sections shall be no more than 400 feet apart on bends and 500 feet apart in straight reaches. If the length of the project reach is not evenly divisible by 400 or 500 feet, the number of cross-sections should be rounded to the next larger number. Longer distances between cross sections or abandonment and replacement of cross sections may be allowed on a case-by-case basis.
5. The first cross-section shall extend across the channel at the upstream limit of the project reach (entire project site); the last cross-section shall extend across the channel at the downstream limit of the project reach.

Extraction Zone Cross-Sections

The extraction zone is the total area that will be extracted and/or graded as a result of gravel extraction activities. Extraction zone cross-sections (pre- and post-extraction) are required the year of any proposed mining activity.

Number and Layout of Extraction Zone Cross-Sections

- Extraction zone cross-sections shall be surveyed prior to extraction and resurveyed once extraction is complete using State Plane (FIPS 0401) coordinate system, and the 1983 North American Datum (NAD) and 1988 North American Vertical Datum (NAVD88).
- A minimum of 5 equally-spaced extraction cross-sections shall be surveyed in each

extraction zone or area along with endpoints and end sections to enable a georeferenced extraction perimeter to be shown on the plan view photo submitted pre-extraction, and the actual extraction perimeter submitted annually in spreadsheet form.

-Cross-sections shall be oriented perpendicular to the long-axis of the extraction area.

-Extraction zone cross-sections should be marked with temporary (seasonal) monuments at each end, such as stakes or rebar, which can be removed after extraction is complete.

Extraction Zone Cross-Sections (Before Mining – Pre-Extraction)

1. Pre-extraction zone cross-sections in the specified coordinate system are required before agency approval of the mining plan or Letter of Modification from the Corps.
2. Pre-extraction cross-section plots shall include the pre-mining cross-section data overlain onto the proposed mining configuration.
3. The proposed area of extraction should be lightly shaded or hatched. Should changes be required for project approval, pre-extraction cross sections shall be re-submitted with the approved mining configuration.
4. If the cross-section becomes inundated by late-spring high flows after the pre-extraction survey is completed, the inundated cross-section points must be resurveyed.
5. Survey at least several weeks prior to the desired beginning date of operations to allow sufficient time for the review and approval process.

Extraction Zone Cross-Sections (After Mining – Post-Extraction)

1. Post-extraction cross-sections are to be surveyed using the specified coordinate system immediately following mining, before flows or rain affect the zone. Operators relying on extensions need to ensure that the monitoring is completed prior to river rise.
2. Post-extraction zone cross-section plots shall include the post-mining cross-section data [solid line] overlain on the approved mining configuration [dashed line]. The actual area of extraction should be lightly shaded or hatched.
3. Total volume extracted should be computed, using double end area or computer generated digital terrain models. All measurements and calculations should be included in tabular form and verified by a California Licensed Land Surveyor or appropriately authorized engineer.
4. The perimeter of each extraction zone shall be geo-referenced and accurately depicted on the post-extraction aerial photo plan views and submitted digitally in spreadsheet form.
5. All information in this section shall be included in the Annual Data Submittal.

Site Visit Requirements

1. On the day of the site visit, a hard copy of the current year's monitoring cross sections is required (including the calculated 35% flow elevation). Portions of monitoring cross sections which were too deep to be surveyed may be skipped and be surveyed at a later date that same season.
2. On the day of the site visit, current year's aerial photos of the site are required unless flows remain higher than the 35% exceedence flow throughout June, in which case photos from the previous year may be used for preliminary planning.
3. The current year's monitoring cross-section overlain on the previous years (if any) monitoring cross-section. The area of the previous year's actual extraction (if any) should be lightly shaded or hatched (Figure 1).

(Pre) Extraction Plan Submittal Requirements

1. All pre-extraction site maps submitted for approval are to be prepared on a color, georeferenced (or ortho-rectified) aerial photo of good quality from current year. Site maps should show the entire project area, the proposed extraction area, and other pertinent features at a scale of approximately 1:6000 (1 in = 500 ft). This may require reduction or enlargement of original air photos. See Figure 2.
2. Calculated 35% flow exceedance marked on monitoring cross section plots. Electronic plots should depict the 35% line in red.
3. When submitting a final extraction plan to the agencies for their approval, ensure that there is a brief narrative detailing the mining being proposed, including: vegetation to be disturbed; location and description of temporary crossings and the desired flow each temporary crossing will be designed to pass; habitat improvement activities; justification and rationale for any deviation; and locations of stockpiles and haul roads.

Annual Data Submittal Requirements (Post-Extraction)

1. Cross-sections, maps, and associated calculations (such as extraction volumes and surface areas) must be prepared by or under the direction of a State of California Licensed Land Surveyor or an authorized Professional Engineer and certified as to content and accuracy.
2. All plan view monitoring and extraction cross sections will be shown on the georeferenced spring aerial photos. If a site is adjacent to another actively mined site, the two sites must be georeferenced and join seamlessly within the channel and floodplain. This may require coordination between applicants (or their consultants) with adjacent sites to ensure that the georeferenced photos line up correctly. See the guidance on aerial photos in the Requirements for Aerial Photos section. If photos are received that are not georeferenced accurately enough to line up adjacent sites, corrections will be required.
3. All monitoring cross sections will be accurately located and labeled on the plan view site map placed over the georeferenced spring aerial photo along with cross section view in the specified scale and coordinate system. These plan view maps will be available for the pre-extraction site visit.
4. The horizontal limits (perimeter) of the actual extraction areas shall be georeferenced and included with the post-extraction submittal in electronic form, along with cross section as

described above. Only the current year air photos shall be used for post-extraction submittals.

5. By December 31 of each year, all hard copies of post-extraction plots, volume calculations, aerial photos, brief narratives, and all other requirements (except for the electronic formats from Item 2 above) shall be provided to the CHERT, NMFS, CDFW, and the Corps. The brief narrative should be 1-2 pages and contain the following: (1) dates of any pre-extraction surveys and results (snowy plover, etc); (2) the beginning and end dates of gravel extraction; (3) the dates of bridge installation and removal; (4) detail on how the gravel extraction deviated in any way from the pre-extraction plan, including volumetric differences; (5) reasoning or explanation of sites that were over or under extracted; and (6) details of any biological enhancement activities.
6. By December 31 of each year, the previous years' electronic files with the Monitoring Cross-Sections shall be provided to the CHERT, NMFS, CDFW, and the Corps in the standardized reporting MS Excel spreadsheet. The data (PNEZD and Date of Capture) should be grouped by cross-section and organized from L bank to R bank. Header information shall be included with each cross section file that indicates the date of survey, cross section number, mining site, and river. The 35% water surface elevation calculations will be included on the excel sheets with each cross section data. Other relevant information (e.g., lost/re-established endpoints, etc.) shall also be included. Files shall be submitted in CD-ROM or other common media. A 'Read Me' text file may also be included if explanation of other issues is necessary (See Figures 3 to 5).

Requirements for Aerial Photos

1. Aerial photos should be taken when flows are below 35% exceedance.
2. Aerial photos should extend one-half a meander upstream and downstream from each mined site.
3. Only the current year photo shall be used for the post extraction submittal.
4. Airphotos shall be georeferenced to the State Plane (FIPS 0401) coordinate system, and the 1983 North American Datum (NAD).
5. All adjacent sites must be georeferenced in such a way that the two sites line up correctly. Misaligned airphotos will be returned to the applicants for corrections.

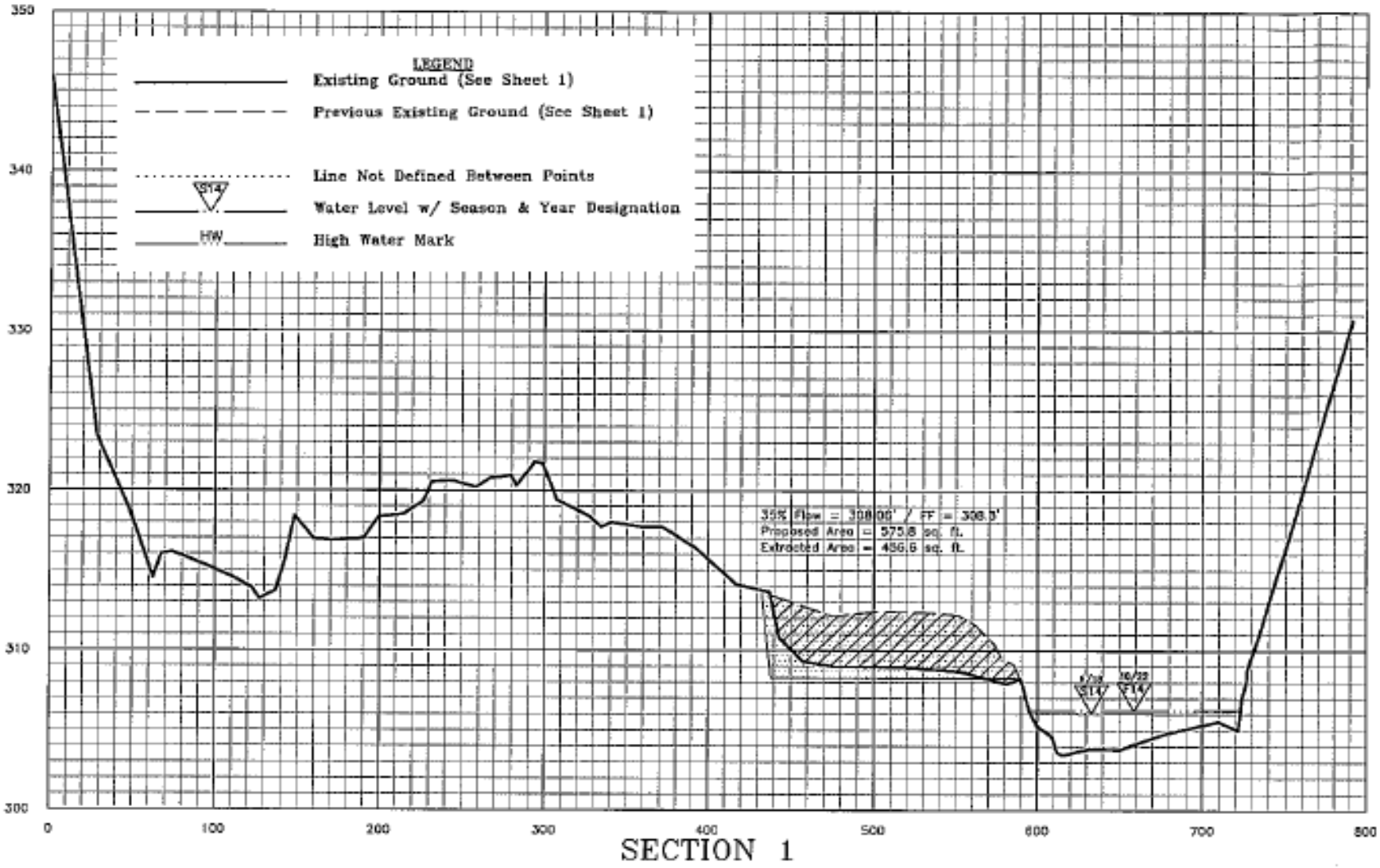


FIGURE 1: Example monitoring cross-section with an extraction area resurveyed post-extraction and WSE s marked (showing approved vs actual extraction).

0 250 500 1000
N
HANSEN
HAUCK
PROCESSING SITE
ALTON INTERCHANGE
MERTZ
106-221-015
25p00
21p00
MONITORING SECTIONS
17p00
106-221-002
CHRISTIANSEN
13p00
106-221-003
HANSEN
9p00
HAUL ROAD
HAUCK
106-221-004
VOORHEES
5p00
1p00
xs-5/1p00
xs-4
xs-3
AREA #2 ALCOVE
xs-2/3p00
xs-1
HAUL ROAD
-3p00
GRIZZLEY BLUFF ROAD
PAINE
106-221-05D
7p00
-11p00
ALXS-7
ALXS-6
ALXS-5
ALXS-4
ALXS-3
ALXS-2
ALXS-1
2011 TRENCH BY L. ROCK
AREA #1 INBOARD SKIN
VAN DUZEN
EEL RIVER
SCALE-H: 1" = 500'
SCALE-V:
DRAWN BY: P.K.
REVISED:
FLOW EEL = 1030 CFS
VAN DUZEN = 155 CFS
HAUCK BAR, EEL RIVER
2011 SITE PLAN
GRAVEL EXTRACTION
PHOTO DATE: JULY 07, 2011

FIGURE 2: Example pre-extraction aerial photo w/ extraction zone cross sections delineated.

Figure 3 is

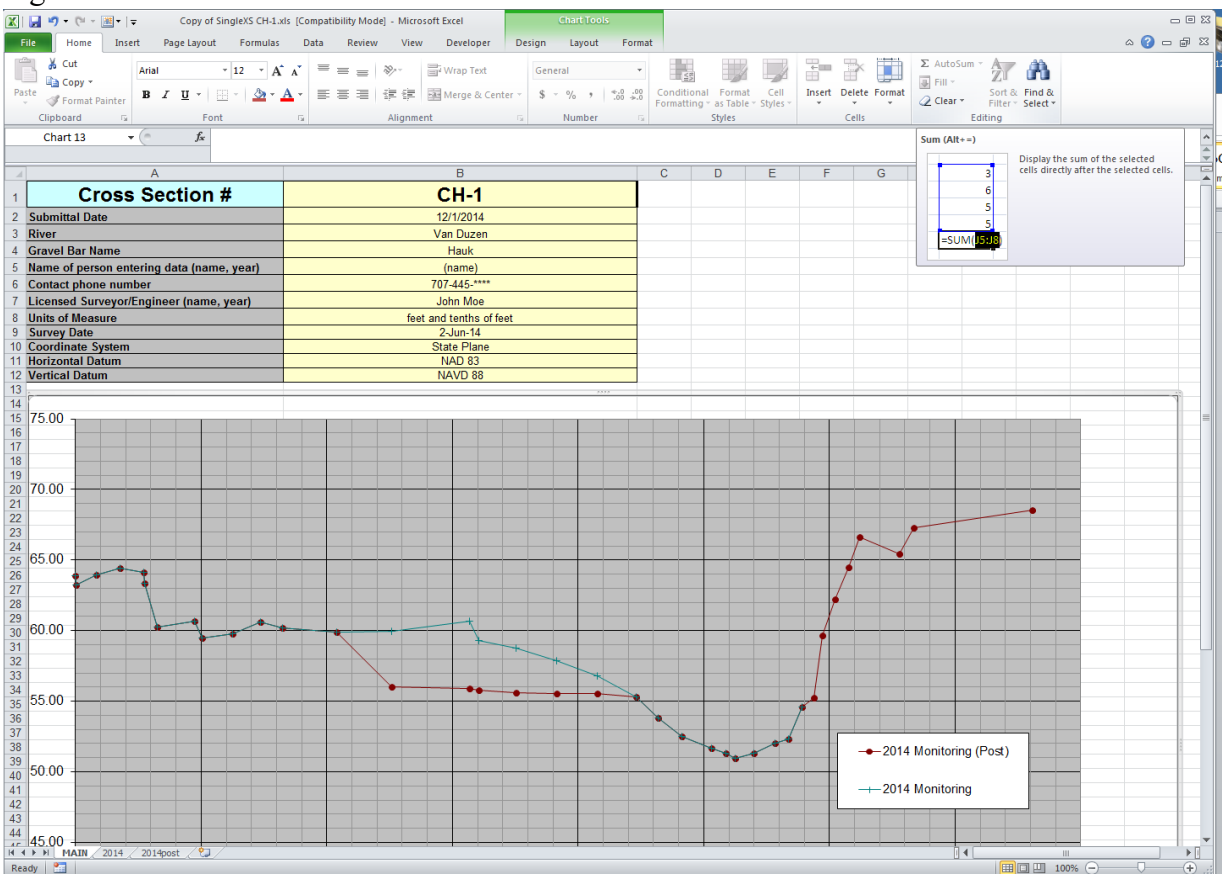
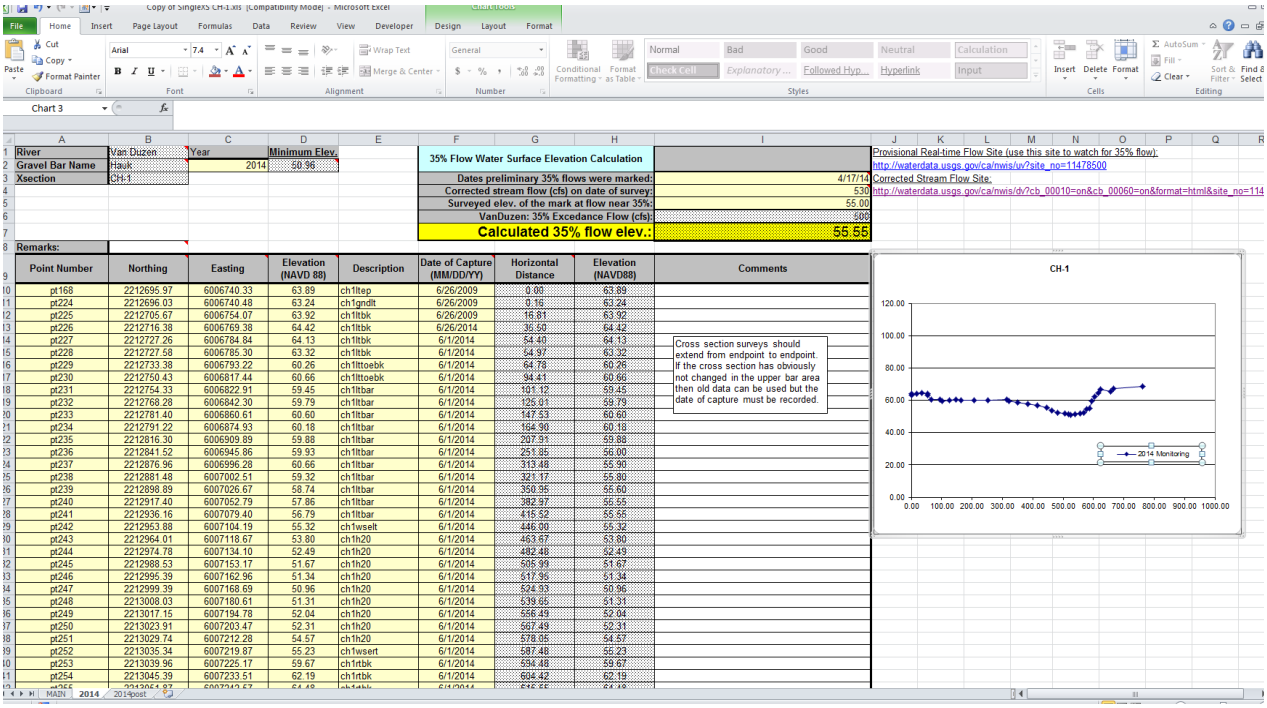


Figure 3. Front Page of each cross section Excel workbook: general cross section information with automatic plotted cross sections.



River	Van Duzen	Year	Minimum Elev.
Gravel Bar Name	Hauk	2014	50.96
Xsection	CH-1		

35% Flow Water Surface Elevation Calculation	
Dates preliminary 35% flows were marked:	4/17/14
Corrected stream flow (cfs) on date of survey:	530
Surveyed elev. of the mark at flow near 35%:	55.00
VanDuzen: 35% Excedance Flow (cfs):	300
Calculated 35% flow elev.:	**55.55**

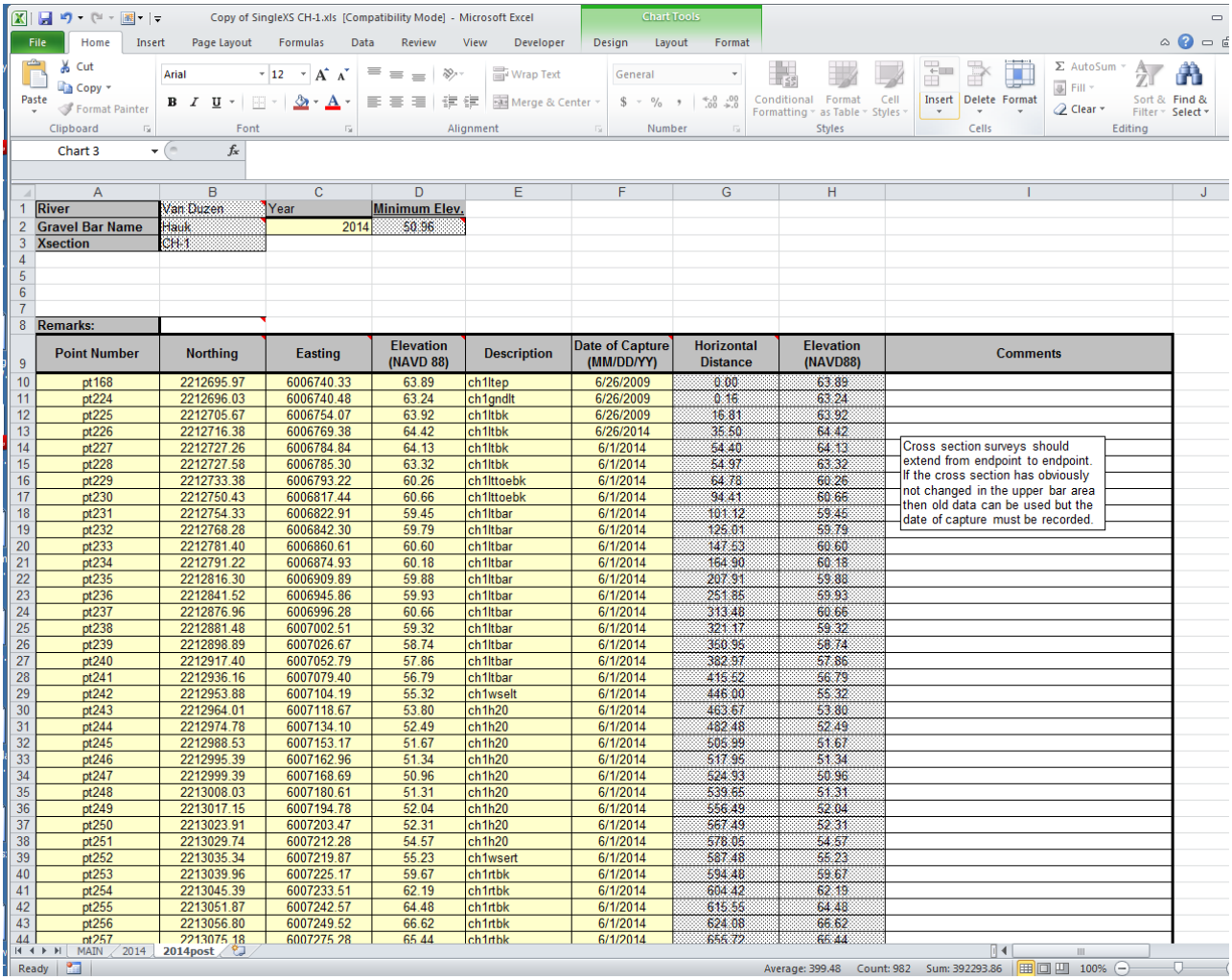
Provisional Real-time Flow Site (use this site to watch for 35% flow):
http://waterdata.usgs.gov/ca/nwis/uv?site_no=11478500
Corrected Stream Flow Site:
http://waterdata.usgs.gov/ca/nwis/dv?cb_00010=on&cb_00060=on&format=html&site_no=114

Remarks:

Point Number	Northing	Easting	Elevation (NAVD 88)	Description	Date of Capture (MM/DD/YY)	Horizontal Distance	Elevation (NAVD88)	Comments
pt168	2212695.97	6006740.33	63.89	ch1ltep	6/26/2009	0.00	63.89	
pt224	2212696.03	6006740.48	63.24	ch1gndlt	6/26/2009	0.16	63.24	
pt225	2212705.67	6006754.07	63.92	ch1ltbk	6/26/2009	16.81	63.92	
pt226	2212716.38	6006769.38	64.42	ch1ltbk	6/26/2014	36.50	64.42	
pt227	2212727.26	6006784.84	64.13	ch1ltbk	6/1/2014	54.40	64.13	
pt228	2212727.58	6006785.30	63.32	ch1ltbk	6/1/2014	54.97	63.32	
pt229	2212733.38	6006793.22	60.26	ch1lttoebk	6/1/2014	64.78	60.26	
pt230	2212750.43	6006817.44	60.66	ch1lttoebk	6/1/2014	94.41	60.66	
pt231	2212754.33	6006822.91	59.45	ch1ltbar	6/1/2014	101.12	59.45	
pt232	2212768.28	6006842.30	59.79	ch1ltbar	6/1/2014	125.01	59.79	
pt233	2212781.40	6006860.61	60.60	ch1ltbar	6/1/2014	147.53	60.60	
pt234	2212791.22	6006874.93	60.18	ch1ltbar	6/1/2014	164.96	60.18	
pt235	2212816.30	6006909.89	59.88	ch1ltbar	6/1/2014	207.31	59.88	
pt236	2212841.52	6006945.86	59.93	ch1ltbar	6/1/2014	251.85	56.00	
pt237	2212876.96	6006996.28	60.66	ch1ltbar	6/1/2014	313.48	55.90	
pt238	2212881.48	6007002.51	59.32	ch1ltbar	6/1/2014	321.17	55.80	
pt239	2212898.89	6007026.67	58.74	ch1ltbar	6/1/2014	350.56	55.60	
pt240	2212917.40	6007052.79	57.86	ch1ltbar	6/1/2014	382.97	55.55	
pt241	2212936.16	6007079.40	56.79	ch1ltbar	6/1/2014	415.52	55.55	
pt242	2212953.88	6007104.19	55.32	ch1wselt	6/1/2014	446.00	55.32	
pt243	2212964.01	6007118.67	53.80	ch1h20	6/1/2014	463.67	53.80	
pt244	2212974.78	6007134.10	52.49	ch1h20	6/1/2014	482.48	52.49	
pt245	2212988.53	6007153.17	51.67	ch1h20	6/1/2014	505.99	51.67	
pt246	2212995.39	6007162.96	51.34	ch1h20	6/1/2014	517.95	51.34	
pt247	2212999.39	6007168.69	50.96	ch1h20	6/1/2014	524.93	50.96	
pt248	2213008.03	6007180.61	51.31	ch1h20	6/1/2014	539.65	51.31	
pt249	2213017.15	6007194.78	52.04	ch1h20	6/1/2014	556.49	52.04	
pt250	2213023.91	6007203.47	52.31	ch1h20	6/1/2014	567.49	52.31	
pt251	2213029.74	6007212.28	54.57	ch1h20	6/1/2014	578.05	54.57	
pt252	2213035.34	6007219.87	55.23	ch1wsert	6/1/2014	587.48	55.23	
pt253	2213039.96	6007225.17	59.67	ch1rtbk	6/1/2014	594.48	59.67	
pt254	2213045.39	6007233.51	62.19	ch1rtbk	6/1/2014	604.42	62.19	

Cross section surveys should extend from endpoint to endpoint. If the cross section has obviously not changed in the upper bar area then old data can be used but the date of capture must be recorded.

Figure 4 Second page of workbook: Monitoring Cross Section data include 35%.



River	Van Duzen	Year	Minimum Elev.
Gravel Bar Name	Hauk	2014	50.96
Xsection	CH-1		

Remarks:

Point Number	Northing	Easting	Elevation (NAVD 88)	Description	Date of Capture (MM/DD/YY)	Horizontal Distance	Elevation (NAVD88)	Comments
pt168	2212695.97	6006740.33	63.89	ch1ltep	6/26/2009	0.00	63.89	
pt224	2212696.03	6006740.48	63.24	ch1gndlt	6/26/2009	0.16	63.24	
pt225	2212705.67	6006754.07	63.92	ch1ltbk	6/26/2009	16.81	63.92	
pt226	2212716.38	6006769.38	64.42	ch1ltbk	6/26/2014	35.50	64.42	
pt227	2212727.26	6006784.84	64.13	ch1ltbk	6/1/2014	54.40	64.13	
pt228	2212727.58	6006785.30	63.32	ch1ltbk	6/1/2014	54.97	63.32	
pt229	2212733.38	6006793.22	60.26	ch1lttoebk	6/1/2014	64.78	60.26	
pt230	2212750.43	6006817.44	60.66	ch1lttoebk	6/1/2014	94.41	60.66	
pt231	2212754.33	6006822.91	59.45	ch1ltbar	6/1/2014	101.12	59.45	
pt232	2212768.28	6006842.30	59.79	ch1ltbar	6/1/2014	125.01	59.79	
pt233	2212781.40	6006860.61	60.60	ch1ltbar	6/1/2014	147.53	60.60	
pt234	2212791.22	6006874.93	60.18	ch1ltbar	6/1/2014	164.90	60.18	
pt235	2212816.30	6006909.89	59.88	ch1ltbar	6/1/2014	207.91	59.88	
pt236	2212841.52	6006945.86	59.93	ch1ltbar	6/1/2014	251.85	59.93	
pt237	2212876.96	6006996.28	60.66	ch1ltbar	6/1/2014	313.48	60.66	
pt238	2212881.48	6007002.51	59.32	ch1ltbar	6/1/2014	321.17	59.32	
pt239	2212898.89	6007026.67	58.74	ch1ltbar	6/1/2014	350.95	58.74	
pt240	2212917.40	6007052.79	57.86	ch1ltbar	6/1/2014	382.97	57.86	
pt241	2212936.16	6007079.40	56.79	ch1ltbar	6/1/2014	415.52	56.79	
pt242	2212953.88	6007104.19	55.32	ch1wselt	6/1/2014	446.00	55.32	
pt243	2212964.01	6007118.67	53.80	ch1h20	6/1/2014	463.67	53.80	
pt244	2212974.78	6007134.10	52.49	ch1h20	6/1/2014	482.48	52.49	
pt245	2212988.53	6007153.17	51.67	ch1h20	6/1/2014	505.99	51.67	
pt246	2212995.39	6007162.96	51.34	ch1h20	6/1/2014	517.95	51.34	
pt247	2212999.39	6007168.69	50.96	ch1h20	6/1/2014	524.93	50.96	
pt248	2213008.03	6007180.61	51.31	ch1h20	6/1/2014	539.65	51.31	
pt249	2213017.15	6007194.78	52.04	ch1h20	6/1/2014	556.49	52.04	
pt250	2213023.91	6007203.47	52.31	ch1h20	6/1/2014	567.49	52.31	
pt251	2213029.74	6007212.28	54.57	ch1h20	6/1/2014	578.05	54.57	
pt252	2213035.34	6007219.87	55.23	ch1wsert	6/1/2014	587.48	55.23	
pt253	2213039.96	6007225.17	59.67	ch1rtbk	6/1/2014	594.48	59.67	
pt254	2213045.39	6007233.51	62.19	ch1rtbk	6/1/2014	604.42	62.19	
pt255	2213051.87	6007242.57	64.48	ch1rtbk	6/1/2014	615.55	64.48	
pt256	2213056.80	6007249.52	66.62	ch1rtbk	6/1/2014	624.08	66.62	
pt257	2213075.18	6007275.28	65.44	ch1rtbk	6/1/2014	656.72	65.44	

Cross section surveys should extend from endpoint to endpoint. If the cross section has obviously not changed in the upper bar area then old data can be used but the date of capture must be recorded.

Figure 5 Third page of cross section workbook: Post Extraction Monitoring survey.