**NMFS Proposed Edits April 2011**

**Winter-run Chinook Salmon –DRAFT**

**BDCP Logic Chains for Covered Fish Species**

***Note to Reviewer:***

*The following presents a draft set of BDCP biological objectives for winter-run Chinook Salmon. Per the recommendations of the independent science review panel, the objectives have been structured to address specific stressors as identified in existing documents such as existing recovery plans, biological opinions, and/or DRERIP life history conceptual models. A standardized table is used for each objective to provide specificity regarding the objective. Terms used in the table such as “Indicator” and “Attribute” are defined in Attachment 1. Additional components of the logic chain such as expected outcomes, conservation measures, and monitoring metrics are not presented herein. However, portions of the objective table are specifically intended to provide information relevant for these additional components. Efforts to link specific species objectives to broader natural community objectives and ecosystem objectives will be conducted once the species objectives have been reviewed and finalized.*

***Disclaimers:***

1. *The Global Goals and Global Objectives presented below are not BDCP goals and objectives. BDCP will contribute to the achievement of these global goals and objectives.*

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# Global Goal

Removal of the Sacramento River winter-run Chinook salmon ESU from the Federal List of Endangered and Threatened Wildlife (NMFS 2009). According to the NMFS draft recovery plan (2009), recovery and long-term sustainability requires:

1. Adequate protection for replacement of losses due to natural mortality (disease and stochastic events);
2. Sufficient genetic robustness to avoid inbreeding depression and allow for adaptation
3. Sufficient habitat (type, amount, and quality) for long-term population maintenance, and
4. Elimination or control of threats.

**Global Recovery Goals for Winter-Run Chinook Salmon**

Disclaimer: These are preliminary, unofficial goals that have not been reviewed or approved by NMFS.

1. Attainment of the winter-run Chinook salmon global abundance goal will occur by 2060 with achievement of 6-year geometric mean escapement levels of: 20,000 in the mainstem Sacramento River with no year below 5,000; 3,000 in the Battle Creek watershed with no year below 500; and 500 in a third dependent population with no year below 200.

2. Attainment of the winter-run Chinook salmon global spatial distribution goal will occur by 2060 with restoration of two self-sustaining, independent populations in two watersheds of the Sacramento River drainage, and a third dependent population in the Sacramento River drainage.

3. Attainment of the winter-run Chinook salmon global life history diversity goal will occur by 2060 with restoration of two self-sustaining, independent populations in two watersheds of the Sacramento River drainage, and a third dependent population in the Sacramento River drainage. ;

# Global Objectives:

There are two components of Global Objectives that are relevant to the BDCP program. The first pertains to Recovery Plan goals based on Viable Salmonid Population (VSP) criteria, and further refined for the Central Valley in Lindley et al (2007). The second component relates to Critical Habitat (as designated for Winter-run Chinook June 16, 1993, 58 FR 33212)

1. Global VSP Objectives include:

VSP1. Increase abundance;

VSP2. Increase spatial distribution;

a. Secure all extent populations (all populations are important because there are so many “missing” populations in the Central Valley),

1. Recover populations in each diversity group (only one diversity group for Winter-run)
2. VSP3. Protect and increase life history and genetic diversity. VSP4. Increase productivity (population growth rate = births-deaths)

Viable populations should demonstrate a combination of population growth rate and abundance that produces an acceptable probability of population persistence (NMFS Draft Recovery Plan).

1. Global Critical Habitat Objectives (from primary constituent elements)

CH1) Provide access to spawning areas on the Upper Sacramento River, including upstream passage of adults to spawning grounds

CH2) Provide of adequate quality and quantity of spawning gravels

CH3) Provide for adequate river flows for successful spawning, incubations of eggs, fry development and emergence, and downstream transport of juveniles

CH4) Provide water temperatures for successful spawning, egg inclubation, and Fry development

CH5) Provide habitat areas and prey that are not contaminated

CH6) Provide riparian (including floodplain) habitat for successful juvenile development and survival

CH7) Provide adequate downstream migration corridors for successful emigration of juveniles

# BDCP Goals and Objectives for winter-run Chinook

NMFS has attempted to distill the above Global Objectives for VSP and Critical Habitat into four BDCP Global Objectives for Winter-run, by focusing on how these apply to the Delta:

# (WRGO1) Increase the survival and growth of juvenile (both fry and smolt) winter-run Chinook salmon rearing in and migrating through the Delta, from Knights Landing to Chipps Islands, including maintaining and increasing life history diversity (VSP 1 , 2, and 4)

# (WRGO2) Remove/mitigate any upstream migratory obstructions for adult winter-run returning to spawning grounds (CH1).

# (WRGO3) Provide for adequate flows and increase rearing habitat (including floodplain, channel margin and riparian habitats) throughout the Delta for successful juvenile rearing and emigrations (CH3 and CH6) .

1. (WRGO4) Provide for adequate downstream migratory corridors of successful emigration of juveniles (CH7).

Note: I’ve numbered this objectives, so that they could be referred to in the subsequent stressor-based objectives; but have not yet done this.

# 

# Stressors/Limiting Factors

The following stressors/limiting factors were adapted from Williams (2009) and the National Marine Fisheries Service (NMFS) Draft Recovery Plan for Chinook salmon and Steelhead (2009). Not all of the stressors listed below are proposed to be addressed by BDCP.

|  |  |  |
| --- | --- | --- |
| ***ID*** | ***Stressor*** | ***Summary Description*** |
| **Stressors Addressed by BDCP** | | |
| **1** | Habitat loss and modification | Changes in the extent, access to, and or quality of habitat including habitat variability and food. |
| **2** | Predation | Predation losses, including effects of structures and habitat alterations that promote predators. |
| **3** | Altered flows | Modifications to Delta inflow and outflow rates and hydrodynamics resulting in deviations from historic migration pathways, delays, and reduced survival. |
| **4** | Impingement and entrainment | Impingement and entrainment at project and non-project facilities. |
| **5** | Water quality (toxics, DO, temperature) | Water quality conditions affecting migration, growth rate, and reproductive success. |
| **6** | Passage impediments/barriers | Factors within the Planning Area that reduce or eliminate access to key habitats. |
| **7** | Hatchery effects | Interbreeding or hatchery and wild-type species can reduce genetic fitness with long-term effects. |
| **8** | Illegal harvest | Direct mortality due to illegal harvest |
| **Stressors Not Addressed by BDCP** | | |
| **9** | Access to historic spawning habitat. | Barriers to historic spawning habitat are predominately located outside of the BDCP planning area. In-delta migration and barriers addressed in Stressor #3 and 6 above. |
| **10** | Climate change | Effects of climate change are considered, but no specific objectives proposed. |

### Stressor #1: Habitat Loss and Modification

Habitat modification created by levees and other landscape modifications is a major stress on juvenile Chinook by blocking their access to rearing areas and confining them to habitat in the channels (Williams 2009). The loss of floodplain and tidal marsh habitat has greatly reduced the availability and quality of juvenile rearing habitat, including reduced input of organic and inorganic material and food resources.

**BDCP Objective #1**

Increase extent, access to, availability and quality of habitat for juvenile winter-run Chinook salmon, including presence of suitable food resources.

|  |  |
| --- | --- |
| **Relation to Global Objective** | Increasing the extent, access to, availability and quality of rearing habitat will improve juvenile survival in the Delta and growth (~increased survival of smolts in the Bay and nearshore ocean). This objective will also improve life history diversity. |
| **Indicator** | Floodplain, tidal, and channel margin riparian habitat  Fish accessing Yolo bypass |
| **Locations** | * Yolo Bypass, Cache Slough, Suisun Marsh, West Delta, Cosumnes/Mokelumne, South Delta * Sacramento River, Steamboat and Sutter sloughs |
| **Attribute** | * Extent, duration, and frequency, of access to activated floodplain habitat. * Extent, quality, and access to tidal marsh habitat. * Extent and quality of riparian and channel margin habitat * Food quality and quantity |
| **Quantity or State** | AchieveYolo Bypass inundation frequency of 75 to 90% of years for a minimum of \_\_ days that inundate \_\_ acres (specify spatial extent) – see currently proposed action  Increase spatial extent of tidal habitat (up to 65,000 acres).  Create and/or enhance 20 to 40 miles of channel margin habitat.  Increase presence of preferred prey.  Increase growth of juvenile salmonids accessing Bypass  Need to explore spatial extent question  Further calibrate flow rate needed to get a significant fraction of the fish into Yolo bypass (telemetry study) |
| **Time Frame** | Floodplain Habitat:   * within 5-15 years   Tidal Habitat:   * 14,000 acres developed within 10 years * 25,000 acres (cumulative) developed by year 15 * 65,000 acres (cumulative) developed by year 40   Channel Margin Habitat:   * at least 5 miles by year 10 * at least 10 miles by year 20 * at least 15 miles by year 25 * at least 20 miles by year 30 * at least 40 miles as necessary to achieve survival outcome |

### Stressor #2: Predation

Predation is a threat to winter-run Chinook salmon, especially in the Delta where there are high densities of non-native fish that prey on outmigrating salmon (NMFS 2009). Modification of natural channel margins and riparian habitats, colonization of non-native SAV and FAV, as well as artificial instream structures may change the natural predator-prey dynamics favoring predators (NMFS 2009). Habitat for fish predators generally consists of a specific suite of attributes that allow them to forage more efficiently, such as dark locations adjacent to light locations or deep pools that allow the predator to hide and ambush their prey. There are multiple locations in the Delta that contain these physical attributes and attract predatory fish that prey upon covered fish species.

**BDCP Objective #2**

Reduce susceptibility to, and impact of predation by non-native predatory fish on juvenile outmigrants.

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| **Relation to Global Objective** | Reducing predation of Chinook salmon will increase the survival of juveniles through the Delta |
| **Indicator** | Juvenile survival and predator abundance in a given area |
| **Location** | Sacramento to Rio Vista |
| **Attribute** | Increase in survivorship (reduced losses to predation) |
| **Quantity or State** | Difficult to measure  Predator abundance (change in numbers – bioenergetics model to determine change in prey consumption)  Survivorship (tagging studies)  Reduce predation by \_\_% from pre-permit levels. See Effects Analysis – Ongoing additional modeling efforts may improve understanding of issue.  Use telemetry studies to better identify hot spots. Focused experiment.  Maybe focus on specific area (hot spots)  Don’t know current level of predation (baseline)  May have low benefit – remaining predators may just eat more or other predators may move in. |
| **Time Frame** | Within 10 years of permit issuance? |

### Stressor #3: Altered Flows

Delta exports and diversions can affect Delta flow rates and hydrodynamics resulting in migration delays and the diversion of juveniles from the mainstem Sacramento River into the central and southern Delta where environmental conditions are poor (NMFS 1997). The channel complexity and reverse flow conditions in the central Delta likely delay migration to the ocean thereby increasing the length of time that fish may be exposed to adverse conditions where survival is substantially lower than through northern routes (NMFS 2009).

**BDCP Objective #3**

Provide hydrodynamic conditions that facilitate rearing, outmigration and imprinting of juvenile salmonids throughout the entire emigration window.

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| **Relation to Global Objectives** | Improving outmigration success will:   * Increase productivity (more return spawners); * Promote maintenance of life history/genetic diversity (by increasing the window of migration opportunity). |
| **Indicator** | In Delta hydrodynamics and juvenile outmigration |
| **Location** | Upstream areas (to be defined) (?)  Freeport  Knights Landing  Rio Vista |
| **Attribute** | River flows  Net tidal flows (OMR flows)  Gate operations (?)  Outmigration success (eg. JPI) - Survival to Chips Island (using telemetry)  Access to/utilization of rearing habitat (for example, Sutter and Steamboat) |
| **Quantity or State** | TBD |
| **Time Frame** | Within 10 years of permit issuance? |

### Stressor #4: Impingement and Entrainment

According to NMFS (1997), entrainment of juvenile winter-run Chinook salmon is one of the most ubiquitous causes of mortality in the Sacramento River and Delta. Unscreened water diversions and CVP and SWP pumping plants entrain juvenile salmon, leading to fish mortality (NMFS 2009). The cumulative effect of entrainment at these diversions and delays in outmigration of smolts caused by reduced flow may affect winter-run Chinook salmon fitness (NMFS 2009). Additionally, cooling water intakes at power plants in Antioch and Pittsburgh entrain and kill juvenile fish from mechanical and heat stress (CALFED 2000).

**BDCP Objective #4**

Reduce impingement and entrainment of juvenile winter-run Chinook salmon

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| **Relation to Global Objective** | Reducing direct and indirect mortality associated with entrainment and salvage will have positive effects on:   * Productivity * Life history/genetic diversity maintenance (restoration) |
| **Indicator** | Impingement and Entrainment |
| **Location** | Power plants and water diversions within BDCP planning area. |
| **Attribute** | Impingement  Entrainment  Salvage |
| **Quantity or State** | Reduce impingement and entrainment by \_\_% of JPE  Need to look at data by water year type to scale the target reduction |
| **Time Frame** | Within 10 years of permit issuance and maintained annually thereafter. |

### Stressor #5: Water Quality (Toxics, D.O., Temperature)

The main potential toxicity components for salmon are ammonia, pyrethroid pesticides, and copper (Williams 2009). The effects of these contaminants include the suppression of immune competence, reduced growth and damage to the olfactory system (NMFS 1997, Williams 2009). High concentrations of ammonium can inhibit primary and secondary production with cascading trophic effects (NMFS 2009).

Water temperatures in June and July are frequently at the upper limit of acceptability for winter-run Chinook immigration (NMFS 2009, Williams 2009). However, most winter-run Chinook salmon adults are expected to have migrated to cooler areas upstream of the Delta before this time (NMFS 2009). Impediments to passage, including those associated with water quality conditions are discussed under Stressor #6 Passage Impediments/Barriers.

**BDCP Objective #5**

a. Toxics - Reduce levels of ammonia, organophosphate, pyrethroid pesticides and copper in the Delta to levels below chronic and acute effect threshold for salmon and their food.

b. Water Temperature - Maintain water temperatures within the suitable range for juvenile and adult salmon in upstream spawning areas.

|  |  |
| --- | --- |
| **Relation to Global Objective** | Improvements in key water quality parameters will positively effect:   * Spatial extent of key life stages * Productivity * Life history/genetic diversity maintenance (restoration) |
| **Indicator** | Water quality parameters. |
| **Location** | Key migratory corridors, upstream spawning and rearing areas of Sacramento River (for temperature) |
| **Attribute** | * Concentration (µg/L) of;   + ammonia,   + pyrethroids,   + copper,   + organophosphates * Water temperature in the upper Sac river |
| **Quantity or State** | TBD |
| **Time Frame** | TBD |

### Stressor #6: Passage Impediments/Barriers

During high flow or flood events water is diverted into the Sutter and Yolo bypasses (NMFS 2009). Adult winter-run Chinook salmon migrating upstream may enter these bypasses, where their migration may be delayed or blocked by control structures.

Low dissolved oxygen conditions in the area of the Sacramento Deep Water Ship Channel (SDWSC) can also be a threat to adult winter-run migration through the Delta (NMFS 2009). In addition, the Delta Cross Channel (DCC) can delay or block passage to winter-run salmon that migrate through the central Delta (NMFS 2009).

**BDCP Objective #6**

Improve upstream fish passage success

|  |  |
| --- | --- |
| **Relation to Global Objective** | Elimination of passage barriers in the Yolo Bypass will have positive effects on:   * Productivity * Life history/genetic diversity maintenance |
| **Indicator** | Upstream passage |
| **Location** | Yolo Bypass and SDWSC |
| **Attribute** | * Immigration rate * Immigration success |
| **Quantity or State** | Increase immigration success by \_\_%.  Reduce migratory delays by \_\_\_% |
| **Time Frame** | Within 10 years of permit issuance. |

### Stressor #7: Hatchery Effects

Hatchery programs in the Central Valley may pose threats to winter-run Chinook

salmon stock genetic integrity (NMFS 1998). Most of the Central Valley winter-run Chinook salmon production is of hatchery-origin, and naturally spawning populations may be interbreeding with both fall/late fall- and spring-run Chinook salmon hatchery fish (NMFS 2009). Hatchery salmon can have negative effects on naturally reproducing salmon for various reasons, reviewed in Williams (2006). Among the more serious and persistent effects are genetic changes, resulting from selection for a life cycle that involves reproduction in a hatchery, rather than a stream (Myers et al. 2004; Araki et al. 2007; 2008).

**BDCP Objective #7**

Manage hatchery to minimize genetic affects on natural producing winter-run.

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| --- | --- |
| **Relation to Global Objective** | Reduced effects of hatcheries will help maintain life history/genetic diversity. |
| **Indicator** | Winter-run Chinook salmon genetics |
| **Location** | BDCP Planning Area |
| **Attribute** | * Develop and implement a genetic management program to assess winter-run Chinook salmon population genetic variability. * Adjust and maintain management program as needed. |
| **Quantity or State** | TBD |
| **Time Frame** | Within \_\_\_ years of permit issuance. |

### Stressor #8: Illegal Harvest

**BDCP Objective #8**

Reduce illegal harvest of adult winter-run Chinook salmon.

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| **Relation to Global Objective** | Reductions in illegal harvest will reduce adult mortality and increase productivity. |
| **Indicator** | Illegal Harvest |
| **Location** | Upstream spawning areas |
| **Attribute** | Enforcement |
| **Quantity or State** | Increase number of patrol hours by \_\_% |
| **Time Frame** | Within \_\_\_ years of permit issuance. |

# References

Alabaster, JS. 1989. The dissolved oxygen and temperature requirements of king salmon, Oncorhynchus tshawytscha, in the San Joaquin Delta, California. Journal of Fish Biology 34:331-332.

Araki, H, Berejikian, BA, Ford, MJ, Blouin, MS. 2008. Fitness of hatchery-reared salmonids in the wild. Evolutionary Applications 1:342-355.

Araki, H, Cooper, B, Blouin, MS. 2007. Genetic effects of captive breeding cause a rapid, cumulative fitness decline in the wild. Science 318:100-103.

Hallock, RJ, Elwell, RF, Fry, DHJr. 1970. Migrations of adult king salmon (Oncorhynchus tshawytscha) in the San Joaquin Delta as demonstrated by the use of sonic tags. Fish Bulletin 151. California Department of Fish and Game.

Jeffres, CA, Opperma, JJ, Moyle, PB. 2008. Ephemeral floodplain habitats provide best growth conditions for juvenile Chinook salmon in a California River. Environmental Biology of Fishes In press: DOI: 10.1007/s10641-008-9367-1

Lotze, JK, Lenihan, HS, Bourque, BJ, Bradbury, RH, Cooke, RG, Kay, MC, Kidwell, SM, Kirby, MX, Peterson, CH, Jackson, JB. 2006. Depletion, degradation, and recovery potential of estuaries and coastal seas. Science 312:1806-1809.

Myers, RA, Levin, SA, Lande, R, James, FC, Murdock, WW, Paine, RT. 2004. Hatcheries and endangered salmon. Science 303:1980.

National Marine Fisheries Service (NMFS). (2009). Public Draft Recovery Plan for the Evolutionary Significant Units of Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon and the Distinct Population Segment of Central Valley steelhead. Sacramento Protected Resources Division. October 2009.

Nichols, FH, Cloern, JE, Luoma, S, Peterson, DH. 1986. The modification of an estuary. Science 231:567-573.

Williams, JG. 2006. Central Valley salmon: a perspective on Chinook and steelhead in the Central Valley of California. San Francisco Estuary and Watershed Science 4: http://repositories.cdlib.org/jmie/sfews/vol4/iss3/art2

Williams, J.G. (2009). Life-history conceptual model for Chinook salmon and steelhead (*Oncorhynchus tshawytscha* and *O. mykiss*) - Partial Review. 75 pp. Sacramento-San Joaquin Delta Regional Ecosystem Restoration Implementation Plan. December 2009.

# Attachment 1: Objective Worksheet

|  |  |
| --- | --- |
| **Indicator** | What will be measured?  Species, habitat, ecological process, physical condition… |
| **Location** | Where will it be achieved? |
| **Attribute** | What aspect of the indicator will be measured?  Population size, density, cover, presence/absence, reproductive rate… |
| **Quantity or State** | What measurable condition or change is expected?  Increase, decrease, maintain or limit negative impact?  *Quantity*: 500 individuals, 20% cover, 30% increase …  *Quality*: Weed-free, all life stages present, cover class 4… |
| **Time Frame** | When will this be achieved? |