INFORMATION ITEM B12. SUMMARY OF BIOLOGICAL INFORMATION

1. INTRODUCTION

The purpose of this information item (B12) is to summarize existing information that will be useful in developing fish passage alternatives as part of the Study of Fish Passage Feasibility at Watana Dam. While additional resources, such as evaluation matrices and the Biological Performance Tool (B11) will be available to evaluate different alternatives once they are identified, this summary is intended to organize a simple framework for consideration during brainstorming identification of alternatives. This summary is comprised of a conceptual model for Chinook salmon as well as tables summarizing information related to collection, sorting, and design requirements for upstream and downstream passage facilities.

2. CONCEPTUAL MODEL FOR CHINOOK SALMON

The following section provides a conceptual model for the segment of the Susitna River Chinook salmon population that may use fish passage facilities at Watana Dam. Some information is available regarding Chinook salmon in the Upper Susitna River under existing conditions whereas empirical information regarding this population segment under post-impoundment conditions is not available. For this reason, the following conceptual model was developed to provide a framework that can be used in addressing fish passage considerations. Chinook salmon was chosen as the species for this model based on their existing distribution in the Upper Susitna River and their obligate migratory life history.

2.1. Life History Pattern in Existing Environment

Chinook salmon currently are the only Pacific salmon known to inhabit the Upper Susitna River. From mid-July to early-August adults migrate upstream past the project site to the Oshetna and Kosina watersheds.

Although the data are limited they have provided an indication of migration patterns and habitat use. Adults have been documented spawning in both the Oshetna River and Kosina Creek based historic and recent observations and fish capture. In 2013 and 2014, juvenile Chinook salmon were captured in these tributaries during summer months and also in downstream migrant traps located near tributary mouths. The size of the juveniles that were captured in traps (>100mm) is indicative of juveniles rearing in tributaries for more than one year. Furthermore, some unknown fraction of the juvenile population migrates into the mainstem Susitna River to either continue downstream migration or possibly rear for a period of time. Data from July 2014 includes captures of Chinook smolts in the main-stem downstream migrant trap at the dam site as well as in off-channel mainstem habitats upstream.

2.2. Expectations Following Impoundment

The construction of a dam will present migratory and passage challenges to this species. Additionally, the impoundment will dramatically alter habitat characteristics within the Susitna River as well as the lower reaches of the two major tributaries used by Chinook salmon. In terms of migratory impacts both adult and juvenile life stages will be affected. For adults the timing of migration in the vicinity of the dam could be altered, due to changes in the hydrograph (timing and velocity) and/or water temperature in the tailrace and downstream environs. Those same factors can potentially affect juveniles as well. Experience in other systems has revealed that migration timing and speed are sensitive to both water temperature and water velocity. Any shift from baseline conditions is difficult to predict until operations are finalized and effects on water flow/velocity and temperature downstream from the project are analyzed. However, water quality models are being developed that will help us to predict both reservoir and riverine conditions under future operational scenarios (Study Plan Section 5.6 - Water Quality Modeling).

Within the reservoir, if adults are released in the forebay, observations from other impounded river systems suggest that Chinook can successfully navigate reservoirs en route to destination tributaries. Observations from populations inhabiting river systems with lakes in the migratory path exhibit the same behavior. We do not expect the reservoir to impede adult migration.

In contrast, with respect to juveniles the reservoir will likely impede migration downstream. Water velocity will decrease dramatically, diminishing an important migratory cue, thereby slowing the migration seaward and decreasing the probability of survival through the project area.

An additional consideration may be needed regarding tributaries where the water elevation in the reservoir will provide access to new streams suitable for, but not currently inhabited by, Chinook salmon. Successful colonization of virgin streams requires both access (flooded natural barriers) and habitat suitable to promote successful spawning, egg incubation and juvenile rearing.

Our collective experience at numerous other dam sites suggests there are viable options for passing adults with negligible effects on survival. However, dams can have a negative effect on juveniles migrating downstream. Not all fish will be able to locate passage routes, and those that do will incur varying levels of mortality during passage. Providing suitable and effective juvenile passage for anadromous salmonids at dams has proved to be a challenging endeavor at sites throughout the Pacific Northwest. Solutions are usually site-specific and tailored to the unique environmental conditions and operational constraints at the project. The Fish Passage Technical Team (FPTT) is charged with evaluating the feasibility of various passage options to optimize fish passage success at the dam for both juvenile and adult life stages.

2.3. Anticipated Impact on the Chinook Population

Viable self-sustaining salmon populations are dependent on successful passage and suitable migration conditions to access critical habitats. However, the existence of effective passage facilities does not necessarily ensure a positive outcome for the Chinook salmon population in the Upper River. Given the variety of uncertainties regarding the effects of impoundment at this site, it is difficult to predict the net effect at the population level with the data and analyses currently in hand. We have noted that creation of the impoundment may affect habitat-driven life history processes separate from alterations to the migratory corridor. Inundation of currently productive habitat may be offset by providing access to new productive streams or stream segments. Post-impoundment spawning and rearing habitat potential will likely weigh heavily in any final determination of total effects at the population level. Such a population-level evaluation is beyond the scope of the FPTT.

3. COLLECTION, SORTING, AND DESIGN REQUIREMENTS

To provide a concise reference source during the development of fish passage alternatives, this section contains a summary of select information provided in Information Items B1-B11. The information provided focuses on items relevant to collection, sorting, and design requirements for passage facilities. Information is compiled into single references tables; Table 1 covers information related to upstream passage while Table 2 provides information related to downstream passage. These tables are also meant to stimulate discussion regarding management considerations that will influence fish passage facility alternatives, and as such can be considered a work in progress to be completed and refined during the course of alternative development.

The information provided in these tables fall under several headings. *Species Information* summarizes our current understanding of the life history and distribution of each species. The list of species includes those that may be targeted for fish passage as well as species that may need to be considered with regard to predation, handling, or sorting concerns.

Part of the development of fish passage alternatives will involve the identification of appropriate release destinations for collected species. Columns falling under the *Release Destination* heading reflect an initial suite of potential destinations. As an example, potential release destinations would be in the reservoir above the dam for adult Chinook salmon migrating upstream, and below the dam for juvenile Chinook salmon migrating downstream. For discussion purposes, these examples are reflected in Tables 1 and 2. An additional heading for *Collection Location* (Table 2) is also provided; the suite of potential collection locations will be developed as part of the alternative development.

Each table also provides information under the *Design Data* heading that may need to be considered in the development of fish passage concepts. This includes the identification of potential piscivorous predators, the relative swimming ability of each species (based on *Information Item B6: Life Stage Specific Passage Information*), and estimates of the size and number of fish to be handled. Certain criteria (e.g., design length and weight) may need to be needed at later stages of alternative development and have been included as placeholders.

Lastly, each tables summarizes our current understanding of the run timing exhibited by each species/life stage. Run timing is based on *Information Item B3: Periodicity* and may be refined as additional data becomes available.

4. TABLES

Table 1. Upstream Passage Sorting Requirements and Design Data by Fish Species.

Species Information						Release Destination [A]						Design Data							Run Timing [B]											
		Life History																												
Species	Documented Distribution	Anadromous	Freshwater	Unknown	Life Stage [F]	Down-River	Below Dam	Reservoir Above Dam	Upstream Tributaries	Head of Reservoir	Cull	Potential Predator	Relative Swimming Ability	Length Range (mm) [F]	Fish Design Length (mm)	Body Width Range (mm)	Fish Design Weight (lbs)	Design Peak Daily (no.)	J	F	M	A	M	J	J	A	S	O	N	D
Arctic grayling	U, M, L		X		A								Moderate	190-420 [H]				<100 [D]				-	-	-		-	-	-		
Arctic lamprey	M, L	X	X		A								Weak	125-320 [I]				<100 [D]					-	-	-					
Bering cisco	M, L	X			A								Moderate	240-410 [J]				<100 [D]								-	-	-		
Burbot	U, M, L		X		A							✓	Weak	280-740 [K]				<100 [D]	-	-	-					-	-	-	-	-
Chinook salmon	U, M, L	X			A			✓					Strong	550-1250 [L]				290 [C]							X	X				
Chum salmon	M, L	X			A								Strong	550-800 [L]				930 [C]							-	X	-	-		
Coho salmon	M, L	X			A								Strong	450-700 [L]				490 [C]							-	X	-	-		
Dolly Varden	U, M, L		X	X	A								Moderate	83-370 [M]				<100 [D]					-	-	-		-	-	-	
Humpback Whitefish	U, M, L		X	X	A								Moderate	280-350 [N]				<100 [D]							-	X	-	-	-	
Longnose sucker	U, M, L		X		A								Moderate	188-670 [O]				<100 [D]						X	X					
Rainbow trout	M, L		X	X	A								Moderate	200-620 [P]				<100 [D]			-	-	-	-						
Round Whitefish	U, M, L		X		A								Moderate	199-440 [Q]				<100 [D]						-		-	-	-		
Sockeye salmon	M, L	X			A								Strong	450-750 [L]				16,000 [C]							X	X	-	-		
Other (i.e., invasive/non-native spp.)	L [E]		X	X	A, J							✓	NA [G]	NA [G]				<100 [D]	NA [G]											

See key to notes on next page.

Table 1 Notes:

A Potential destinations provided here have been selected for discussion purposes only and are likely to change during TWG sessions and as management objectives develop.

B "X" denotes peak run-timing; "-" denotes the remaining run timing interval. For some species, periods of peak run-timing could not be discerned from available information.

C Calculated as 10% of total Upper River adult production potential reported by Barrick et al. (1983), rounded to two significant digits. For comparison, maximum daily catch by species at Curry fishwheels comprised 10.7% (Chinook), 10.4% (chum), 8.0% (coho), and 7.6% (sockeye) of total catch in 2012 (LGL 2013).

D For species that do not exhibit an obligate anadromous life history, are not abundant, or for which information is lacking to estimate potential numbers that would utilize passage facilities, "<100" was selected as an initial estimate. These values are subject to refinement during TWG sessions.

E Northern pike have been documented in the Lower River and their suspected distribution extends to tributaries up to the Three Rivers (Ivey 2009). The distribution of Alaska blackfish is unknown in the Susitna River basin (AEA 2012, USFWS 2008).

F "A" denotes adult; "J" denotes juvenile. Length distinctions by life stage are based on the classifications provided in Table 4.7-1 of ISR Part A for Study Plan 9.5 *(Study of Fish Distribution and Abundance in the Upper Susitna River).* Length ranges for the "juvenile-or-adult" category were grouped into the "adult" category for the purposes of this summary.

G "NA" indicates no available information or pending review.

H Maximum length (FL) from Arctic grayling age-4+ and older captured upstream of Devils Canyon during 1981-1982 (Delaney et al. 1981, Sautner and Stratton 1983)

I Maximum length from Arctic lamprey captured in the Susitna River during 1981-1982 (Schmidt et al. 1983). Neither life stages nor length-at-age information were provided; thus, this length range likely includes juveniles.

J Length range of age-3+ to age-6+ Bering cisco captured in the Susitna River during 1981-1982 (ADF&G 1981, 1983).

K Maximum length from age-3+ to age-10+ burbot captured upstream of Devils Canyon during 1981-1982 (Delaney et al. 1981, Sautner and Stratton 1982).

L Length range from 2012 Curry fishwheel captures (note, based on 5-cm bin sizes) (LGL 2013)

M Maximum length from sampling by HDR (2012) upstream of Devils Canyon that captured Dolly Varden ranging from 2.6 to 36.6 cm.

N Maximum length from humpback whitefish captured upstream of Devils Canyon by HDR (2013) and Delaney et al. (1981).

O Maximum length from longnose sucker age-4+ and older captured upstream of Devils Canyon during 1981-1982 (Delaney et al. 1981, Sautner and Stratton 1982).

P Maximum length from rainbow trout age-3+ and older captured in the Middle River during 1981-1983 (Delaney et al. 1981, Schmidt et al. 1983, 1984).

Q Maximum length from round whitefish age-6+ and older captured upstream of Devils Canyon during 1981 (Delaney et al. 1981).

Table 2. Downstream Passage Sorting Requirements and Design Data by Fish Species.

Species Information						Collection Location [A]		Release Destination [A]				Design Data						Run Timing [D]											
Species	Documented Distribution	Life History: Anadromous	Life History: Freshwater	Life History: Unknown	Life Stage [F]	Tributary Collector	Reservoir/ Dam Collector	Below Dam	Reservoir	Tributaries	Cull	Potential Predator	Length Range (mm)	Fish Design Length (mm)	Body Width Range (mm)	Fish Design Weight (lbs)	Design Peak Daily (no.)	J	F	M	A	M	J	J	A	S	O	N	D
Arctic grayling	U, M, L		X		A								190-430 [H]				<100 [C]								-	-	-		
					J [L]								55-189 [H]				<100 [C]					-	-	-	-	-	-	-	
Arctic lamprey	M, L	X	X		J [L]								80-124 [I]				<100 [C]					-	-	-	-	-	-	-	
Bering cisco	M, L	X			A [K]								240-410 [J]				<100 [C]					-	-	-			-	-	
					J								NA [G]				<100 [C]					-	-	-					
Burbot	U, M, L		X		A							✓	280-740 [O]				<100 [C]	-	-	-					-	-	-	-	-
					J								90-279 [O]				<100 [C]						X	X	-	-			
Chinook salmon	U, M, L	X			J			✓					40-120 [P]				9,800 [B]		-	-	-	X	X	X	X	-			
Chum salmon	M, L	X			J								30-70 [Q]				93,000 [B]					X	X	-	-				
Coho salmon	M, L	X			J								30-170 [R]				4,900 [B]	-	-	-	-	X	X	X	X	-	-		
Dolly Varden	U, M, L		X	X	A							✓	83-370 [M]				<100 [C]					-	-	-		-	-	-	
					J [L]								26-82 [M]				<100 [C]					-	-	-	-	-	-	-	
Humpback Whitefish	U, M, L		X	X	A [L]								280-350 [T]				<100 [C]					-	-	-	-	-	-	-	
					J								30-279 [T]				<100 [C]						-	X	X	-	-		
Lake trout	U		X		A							✓	≥300 [F]				<100 [C]	NA [G]											
					J								<300 [F]				<100 [C]												
Longnose sucker	U, M, L		X		A								188-670 [V]				<100 [C]						-	-		-	-	-	
					J								<188 [V]				<100 [C]						X	-	X	X			
Rainbow trout	M, L		X	X	A							✓	200-620 [N]				<100 [C]	-	-						-	-	X	-	X
					J [L]								84-199 [N]				<100 [C]					-	-	-	-	-	-	-	
Round Whitefish	U, M, L		X		A [L]								199-440 [U]				<100 [C]					-	-	-	-	-	-		
					J								20-198 [U]				<100 [C]					-	X	X	-	-			
Sockeye salmon	M, L	X			J								30-90 [S]				160,000 [B]				-	X	X	X	-	-			
Other (i.e., invasive/non-native spp.)	L [E]		X	X	A, J							✓	NA [G]				<100 [C]	NA [G]											

See key to notes on next page.

Table 2 Notes:

A Potential collection and release locations provided here have been selected for discussion purposes only and are likely to change during TWG sessions and as management objectives develop.

B Calculated as 10% of total Upper River smolt production potential reported by Barrick et al. (1983), rounded to two significant digits.

C For species that do not exhibit an obligate anadromous life history, are not abundant, or for which information is lacking to estimate potential numbers that would utilize passage facilities, "<100" was selected as an initial estimate. These values are subject to refinement during TWG sessions.

D "X" denotes peak run-timing; "-" denotes the remaining run timing interval. For some species, periods of peak run-timing could not be discerned from available information.

E Northern pike have been documented in the Lower River and their suspected distribution extends to tributaries up to the Three Rivers (Ivey 2009). The distribution of Alaska blackfish is unknown in the Susitna River basin (AEA 2012, USFWS 2008).

F "A" denotes adult; "J" denotes juvenile. Length distinctions by life stage are based on the classifications provided in Table 4.7-1 of ISR Part A for Study Plan 9.5 *(Study of Fish Distribution and Abundance in the Upper Susitna River).* Length ranges for the "juvenile-or-adult" category were grouped into the "adult" category for the purposes of this summary.

G "NA" indicates no available information or pending review.

H Length (FL) range of Arctic grayling age-1+ and older captured upstream of Devils Canyon during 1981-1982 (Delaney et al. 1981, Sautner and Stratton 1983) and the length range tagged in the Upper Susitna River in 2013 (AEA 2014).

I Minimum length from Arctic lamprey captured in the Susitna River during 1981-1982 (Schmidt et al. 1983). Adults die after spawning (Scott and Crossman 1973).

J Length range of age-3+ to age-6+ Bering cisco captured in the Susitna River during 1981-1982 (ADF&G 1981, 1983). No lengths of Bering cisco younger than age-3+ were reported.

K The timing of post-spawn Bering cisco downstream migrations are unknown; in 1982, no adults were captured during winter sampling or sampling methods other than fishwheel traps (Schmidt et al. 1983). As such, post-spawn adults were assumed to move downstream either immediately after spawning or during the spring when juvenile outmigration occurs.

L Life stages for which downstream movement periodicity is unknown tentatively include the entire open water period.

M Upstream of Devils Canyon, HDR (2012) captured Dolly Varden ranging from 2.6 to 36.6 cm FL.

N Length range of rainbow trout age-1+ and older captured in the Middle River during 1981-1983 (Delaney et al. 1981, Schmidt et al. 1983, 1984).

O Length range of age-0+ to age-10+ burbot captured upstream and downstream of Devils Canyon during 1981-1982 (ADF&G 1981, Delaney et al. 1981, Sautner and Stratton 1982) and the length range tagged in the Upper Susitna River in 2013 (AEA 2014).

P Combined length range of age-0+ (3.6-9.5 cm) and age-1+ (6.1-11.7 cm) Chinook salmon captured at the Talkeetna Station outmigrant trap in 1984 (Roth and Stratton 1985).

Q Length range of age-0+ chum salmon captured in the Talkeetna Station outmigrant trap in 1984 (Roth and Stratton 1985).

R Combined length range of age-0+ (2.8-8.7 cm) and age-1+ (5.1-15.0 cm) coho salmon captured at the Talkeetna Station outmigrant trap and age-2+ (10.9-17.4 cm) captured throughout the Susitna River in 1985 (Roth et al. 1986).

S Combined length range of age-0+ (2.5-9.1 cm) and age-1+ (5.6-10.2 cm) sockeye salmon captured at the Talkeetna Station outmigrant trap in 1984 (Roth and Stratton 1985).

T Minimum length reflects the smallest humpback whitefish captured in juvenile outmigrant traps in 1983 (Sundet and Wenger 1984), while maximum length reflects the largest adult captured upstream of Devils Canyon in 1981 (Delaney et al. 1981).

U Minimum length reflects the smallest round whitefish captured in juvenile outmigrant traps in 1983 (Sundet and Wenger 1984), while maximum length reflects the largest adult captured upstream of Devils Canyon in 1981 (Delaney et al. 1981).

V Minimum length reflects the smallest longnose sucker captured in juvenile outmigrant traps in 1983 (Sundet and Wenger 1984), while maximum length reflects the largest adult captured upstream of Devils Canyon during 1981-1982 (Delaney et al. 1981, Sautner and Stratton 1982).