

APPENDIX C

WRIA 8 Pressures Assessment

During the Plan update process, the WRIA 8 Technical Committee (TC) estimated the intensity of the most important known sources of human-caused stress to Chinook salmon and salmon habitat in the WRIA 8 watershed. This “pressures assessment” was based on current scientific research and local knowledge of conditions in each habitat used by Chinook salmon. The pressures assessment rated the scope, severity and irreversibility of each important stressor to Chinook salmon at each life stage and habitat component for both WRIA 8 Chinook populations. These ratings were entered into a regional conservation planning tool (Miradi) to create a summary that constitutes the judgement of the TC on the relative impacts of each stressor to Chinook salmon in the watershed.

The WRIA 8 pressures assessment began with the list of 47 stressors developed by the Puget Sound Partnership as part of the effort to create a common regional ‘language’ for Chinook and Puget Sound Recovery (PSP, 2014). As part of what was known as “Phase 1” of a PSP-led Monitoring & Adaptive Management process, the TC first classified each stressor on a scale of 1-5 (5 denoting the highest negative impact). With a few exceptions, stressors that were classified below 2.5 in the 2014 assessment were not carried forward for further prioritization. A few others, noted below, were combined to simplify the assessment. This initial filtering and combining process reduced the total number of stressors subsequently assessed to 35.

The TC concurrently developed a life-cycle based conceptual model, and incorporated that knowledge into the pressures assessment by considering each stressor in relation to each life stage of both populations. This approach is somewhat aligned with WDFW’s approach to managing species based on life stages and life-cycle modeling in the Columbia Basin and elsewhere. With this approach, estimates of impacts were focused on the specific locations used by Chinook salmon in WRIA 8 during the specific times and life stages Chinook occupy them.

Next, the TC reviewed the links between stressors and components (Chinook habitats and life stages for each population), and rated the impact of each stressor on each component. The pressures assessment rated each stressor/component pair low, medium, high, or very high in terms of scope, severity and irreversibility according to regional definitions (see below). (If a stressor was hypothesized to have no impact on a particular life stage, the component pair was not rated.) Note that a score of low or medium is not meant to convey that the pressure is unimportant, but rather that relative to other pressures, it is not the most widespread or severe for that life stage.

Life Stage Components Used for Rankings

The following life stages match those identified in the conceptual model, which represents the basis of TC assumptions and working knowledge of Chinook in WRIA 8. The two WRIA 8 Chinook populations were rated separately due to their different experiences in the watershed.

Migration - Cedar population (returning adults)

Migration - Sammamish population (returning adults)

Spawning - Cedar population

Spawning - Sammamish population

Incubation and emergence - Cedar population

Incubation and emergence - Sammamish population

Stream rearing - Sammamish population

Downstream migration – Sammamish population

Lake rearing – Sammamish population

Stream rearing – Cedar population

Downstream migration – Cedar population

Lake rearing - Cedar population

Migration to Puget Sound- Sammamish and Cedar populations

Nearshore foraging - Sammamish and Cedar populations

Maturation (Marine Waters) - Sammamish and Cedar populations

Pressure Rating Definitions

SCOPE: Most commonly defined spatially as the proportion of the habitat component (life stage + geography) that can reasonably be expected to be affected by the pressure within ten years given the continuation of current circumstances and trends. For ecosystem and ecological communities, measured as the proportion of the component's occurrence.

Low: The pressure is likely to be very narrow in its scope, affecting the component across a small (1-10%) proportion of the area/population.

Medium: The pressure is likely to be restricted in its scope, affecting the component across some (~11-30%) of the area/population.

High: The pressure is likely to be widespread in its scope, affecting the component across much (~31-70%) of the area/population.

Very High: The pressure is likely to be pervasive in its scope, affecting the component across all or most (~71-100%) of the area/population.

SEVERITY: Within the scope, the level of damage to the component from the pressure that can reasonably be expected given the continuation of current circumstances and trends.

Low: Within the scope, the pressure is likely to slightly degree/reduce the component or reduce its population by ~1-10% within ten years or three generations.

Medium: Within the scope, the pressure is likely to moderately degrade/reduce the component or reduce its population by ~11-30% within ten years or three generations.

High: Within the scope, the pressure is likely to seriously degrade/reduce the component or reduce its population by ~31-70% within ten years or three generations.

Very High: Within the scope, the pressure is likely to destroy or eliminate the component or reduce its population by ~71-100% within ten years or three generations.

IRREVERSIBILITY (PERMANENCE): The degree to which the effects of a pressure can be reversed and the component affected by the pressure restored

Low: The effects of the pressure are easily reversible and the component can be easily restored at a relatively low cost and/or within 0-5 years.

Medium: The effects of the pressure can be reversed and the component can be restored with a reasonable commitment of resources and/or within 6-20 years.

High: The effects of the pressure can technically be reversed and the component restored, but it is not practically affordable and/or within 21-100 years.

Very High: The effects of the pressure cannot be reversed and it is very unlikely the component can be restored, and/or it would take more than 100 years to achieve this.

Results:

The summary results are shown in Table 1. The rating for each pressure to component pair is performed in Miradi using an algorithm to weigh scope, severity and irreversibility. A rating of Low, Medium, High or Very High is assigned to all relevant relationships (a blank cell indicates no significant relationship is hypothesized between the pressure and life stage). The TC highlighted high or very high pressures for the most important life stages to address first.

Climate impacts are reflected in the results. By considering altered peak flows, temperatures and predation, which are predicted to be exacerbated in WRIA 8 by continued climate change, the ratings reflect current and predicted worsening through the severity and irreversibility ratings.

The life stages identified for the WRIA 8 Chinook Recovery Plan update process as the highest priority are lake rearing, stream rearing, and migration (both downstream migrants and returning adults). The high and very high pressures for each priority life stage were summarized and were presented to a workshop of WRIA 8 TC and Implementation Committee (IC) members in August of 2016. The joint workshop analyzed the current recovery strategies in relation to the pressures and developed new strategies where needed. Some pressures were only relevant or highly rated for one of the populations; therefore, strategies have a geographic specificity reflected in the recovery strategies and associated actions.

At a high level, the pressures assessment process and workshops confirmed the following pressures as most important to address in WRIA 8 for Chinook salmon recovery:

- Land conversion
- Levees
- Shoreline armoring
- Altered peak flows
- Increased water temperatures
- Predation (native and non-native species)
- Ballard Locks (fish passage)

References

Puget Sound Partnership (PSP). 2014. Puget Sound pressure assessment – stressor definitions. <https://docs.google.com/>. Accessed July 18, 2017.

WRIA 8 Pressures Assessment by life stage Version: 2017-06-29

Pressure Ratings – Summary Table

NOTES: C = Cedar Population; S = Sammamish Population. Life stages as in WRIA 8 Conceptual Model

Pressures \ Components	C - Adult Migration	S - Adult Migration	C - Spawning	S - Spawning	C - Inc & Emerge	S - Inc & Emerge	S - Stream Rearing	C - Stream Rearing	S - Dnstrm Migration	C - Dnstrm Migration	S - Lake Rearing	C - Lake Rearing	S&C - Migration to PS	S&C - Nearshore Foraging	S & C - Maturation
01.1 Conversion of land cover for residential, commercial, and industrial use	Low	Low	Low	Low			Medium	Medium	Medium	Medium	High	High	Very High	High	
01.3 Conversion of land cover for transportation & utilities							High	Medium			Medium	Medium		High	
02 Terrestrial habitat fragmentation							Medium	Medium							
03 Shoreline hardening	Low	Low	Medium	High	High	High	Very High	High	High	High	High	High		High	
04 Shading of shallow water habitat											Medium	Medium			
05.1 Ballard Locks	Very High	Very High											Very High		
05.2 Culverts and other fish passage barriers		Low					High	Low							
07.1 Terrestrial and freshwater species disturbance in human dominated areas	Low	Medium	Medium	High			High	Medium	High	High	High	High			
10.1 Altered peak flows from land cover change	Low	Medium	Low	High	Low	High	High	Medium	Low	Low					
11.1 Altered low flows from land cover change	Low	Medium	Low	Medium	Low	Medium	Low	Low	Low	Low					
11.3 Altered low flows from withdrawals	Low	Medium	Low	Medium	Low	Low	Low	Low	Low	Low					
13.1 In channel structural barriers to water, sediment, debris flows	Low	Low	Low	Low	High	High	High	Low	High	High	High	High			
13.2 Levees and Revetments			Medium	Medium	High	High	Very High	High	High	High					
14 Animal harvest	Low	Low													Medium
17.1 Predation from increased native species	Low	Low	Medium	Medium	Medium	Medium	High	High	High	High	High	High	High		

Table C-1. WRIA 8 Pressures Assessment by Life Stage - Version: 2017-06-29

Pressure Rating Details

S - Spawning

Pressure	Scope	Severity	Irreversibility	Summary Pressure Rating	Comments
11.3. 11.3 Altered low flows from withdrawals	Medium	Medium	High	Medium	Low flows during adult spawning period (from wells) are possible, potentially delaying or preventing migration to spawning streams. See Tributary Streamflow document (Tributary Streamflow Technical Committee 2006). Highest need/ importance/benefits to be seen in Bear, EF Issaquah, Issaquah and Rock Creek. also augmenting cold water inflows to Sammamish.
13.1. 13.1 In channel structural barriers to water, sediment, debris flows	Low	Low	Medium	Low	
13.2. 13.2 Levees and Revetments	Medium	Medium	High	Medium	This pressure includes levees and revetments. Effect on spawning habitat to the extent it restricts creation of side channels (used by Chinook for spawning) or affects the natural delivery and deposition of spawning gravel.
01.2. 01.2 Conversion of land cover for natural resources production	Low	Low	Low	Low	Current natural resource production limited to small timber harvest areas on DNR land in upper reaches of Issaquah Creek and its tributaries.
10.2. 10.2 Altered peak flows from climate change	Medium	High	Very High	High	Climate scenarios do not indicate higher flows earlier in season. (CHECK) Potential for higher fall flows, increased occurrence of atmospheric rivers.
03. 03 Shoreline hardening	High	High	High	High	Hardened shorelines affect spawning habitat quantity and quality. Armoring also limits instream wood and overhanging vegetation for cover. Likely more pronounced inside UGA.
17.1. 17.1 Predation from increased native species	Medium	Medium	Medium	Medium	Predation on eggs by cutthroat, sculpin etc -- no evidence of increased numbers (?)
17.2. 17.2 Displacement by increased native species	Low	Low	High	Low	
7.2. 7.2 Terrestrial and freshwater species disturbances in natural landscapes	Low	Low	Low	Low	Few natural landscapes in Sammamish system (upper reaches of Issaquah Creek) likely to see very little species disturbance. Most species disturbance will occur in developed landscapes.

C - Inc & Emerge

Pressure	Scope	Severity	Irreversibility	Summary Pressure Rating	Comments
11.3. 11.3 Altered low flows from withdrawals	Low	Low	Low	Low	Withdrawals for municipal water supply are mitigated by flow rules under the CR HCP. Low flows are monitored and managed to prevent dewatering of redds.
13.1. 13.1 In channel structural barriers to water, sediment, debris flows	High	High	Medium	High	
13.2. 13.2 Levees and Revetments	High	High	High	High	This pressure includes levees and revetments. Effect on incubation to the extent it affects hydraulics and scour.
10.2. 10.2 Altered peak flows from climate change	Medium	High	High	Medium	If changing climate brings more atmospheric river/other high flow events, could result in increasing redd scour and diminished survival. Management response should be to increase resilience of stream ecosystems (reconnect flood plains, increase wood in streams, increase riparian cover). NOTE: Cedar HCP flow control, where possible, could buffer impacts from some events. Water management is not designed for flood control however.
03. 03 Shoreline hardening	Medium	High	Very High	High	Effect on incubation to the extent it affects hydraulics and scour. Shoreline hardening scores higher in irreversibility than "other structural barriers" pressure though lower in scope (defining this threat to include infrastructure in urban areas where removal is unlikely in next 100y).
17.1. 17.1 Predation from increased native species	Medium	Medium	Medium	Medium	predation of emerging fry by sculpin -- no evidence of increased native spp (?)
17.2. 17.2 Displacement by increased native species	Low	Low	High	Low	
21.2. 21.2 Non-point source, persistent toxic chemicals in aquatic systems	Medium	Medium	High	Medium	
11.2. 11.2 Altered low flows from climate change	Low	Low	Low	Low	NOTE: Cedar Instream Flow Agreement maintains minimum flows to prevent dewatering of redds.
22.2. 22.2 Non-point source, non-persistent toxic chemicals in aquatic systems	Medium	Medium	High	Medium	See non-point source persistent chemicals
24.2. 24.2 Non-point source conventional water pollutants	Low	Low	Low	Low	Not as much of an issue in the Cedar.
10.1. 10.1 Altered peak flows from land cover change	Low	Low	Low	Low	Not likely to be a strong pressure on this life stage in Cedar basin.

24.3. 24.3 Changes in water temperature from local causes	High	Low	High	Low	Incubation time shortens as water temp increases. Severity is low for this life stage;
12. 12 Flow regulation -- prevention of flood flows	Medium	Low	Very High	Medium	Flow regulation on the Cedar River does attenuate flood flows. This has negative consequences for habitat-forming processes that provide spawning gravels and habitat. On the other hand, prevention of flood flows during incubation and emergence increases fry survival. Greater issue is disconnection of floodplain from river channel.
26.1. 26.1 Changing air temperature	High	Low	High	Low	See changing water temperature notes for this life stage. Effects of changing air temperature on fish felt through changing water temperature.
11.1. 11.1 Altered low flows from land cover change	Low	Low	High	Low	Altered low flows from LC change not likely to have much of an impact on this life stage.

C - Adult Migration

Pressure	Scope	Severity	Irreversibility	Summary Pressure Rating	Comments
11.3. 11.3 Altered low flows from withdrawals	Low	Medium	High	Low	Cedar R instream flows managed through Cedar River Habitat Conservation Plan to provide spawning flows. The group is not saying that this is a huge impact to fish but the irreversibility is high because it is part of the HCP and wouldn't be changed.
13.1. 13.1 In channel structural barriers to water, sediment, debris flows	Low	Low	Medium	Low	
14. 14 Animal harvest	Low	Low	High	Low	Harvest is governed by international treaty and Puget Sound Harvest Management Plan. Only looking at fw component... also, harvest is a goal... (harvest we are leaving to co managers, and noaa – ranking low based on poaching and incidental fisheries... approved by NOAA). Total annual harvest rates for all areas approx 20%-54% over last 10 years.
15. 15 Bycatch	Low	Low	Medium	Low	Some bycatch occurs during coho or sockeye fishery, when those fisheries occur. Closely monitored.
10.2. 10.2 Altered peak flows from climate change	Low	Low	Very High	Medium	Climate scenarios do not indicate altered peak flows earlier in season – therefore not likely to affect this life stage.
03. 03 Shoreline hardening	Medium	Low	High	Low	Most severe at Ballard Locks/Ship Canal area. Some areas along migration corridor are more severely affected than others. Adult life stage not as affected as others.
17.1. 17.1 Predation from increased native species	Low	Low	Low	Low	potential increased native predators in Salmon Bay, though no data to substantiate
05.1. 05.1 Ballard Locks	Very High	High	Very High	Very High	This pressure is the proxy for the Chittenden Locks. Could delay migration; salinity, temp, physical barrier... BIOP says it is a barrier. Consider severity in terms of structure itself but also salinity and temp exchange barrier.
7.2. 7.2 Terrestrial and freshwater species disturbances in natural landscapes	Low	Low	Low	Low	Existing riparian areas in natural landscapes are likely to remain protected. Some minimal rafting and "salmon watching" occurs on Cedar River during fall migration and spawning season, though effect on migration and spawning is not likely to be extreme.

21.1. 21.1 Point source, persistent toxic chemicals in aquatic systems	Low	High	Low	High	Low	Not likely an extreme threat to this life stage. Prespawn mortality not known to be severe for Chinook salmon, though coho salmon affected strongly.
21.2. 21.2 Non-point source, persistent toxic chemicals in aquatic systems	Low	High	Low	High	Low	not likely an extreme threat to this life stage
22.1. 22.1 Point source, non-persistent toxic chemicals in aquatic systems	Low	High	Low	High	Low	Not likely an extreme threat to this life stage. Prespawn mortality not known to be severe for Chinook salmon, though coho salmon affected strongly.
11.2. 11.2 Altered low flows from climate change	Low	Medium	Medium	Medium	Low	NOTE: Cedar Instream Flow Agreement maintains minimum flows during spawning season. In years of extreme drought, when Lake levels are managed to conserve water, there may be some small effect on passage through Locks facility.
22.2. 22.2 Non-point source, non-persistent toxic chemicals in aquatic systems	Low	High	Low	High	Low	SS not likely an extreme threat to this life stage
01.1. 01.1 Conversion of land cover for residential, commercial, and industrial use	High	High	Low	High	Low	Migratory pathways considered intact (assuming Lake Washington basin hydrology post construction of Ship Canal is new 'normal'). Conversion of Chinook habitat reflected more strongly in other components/geographies.
07.1. 07.1 Terrestrial and freshwater species disturbance in human dominated areas	Low	Medium	Low	Medium	Low	Some disturbance by people, their pets, artificial light, Salmon watchers during migration.... Size of Cedar likely limits interactions somewhat. Timing of spawning (peaking in October) is usually after most recreation on the river has ended.
24.2. 24.2 Non-point source conventional water pollutants	Low	High	Low	High	Low	Not likely an extreme threat to this life stage
24.3. 24.3 Changes in water temperature from local causes	High	High	Medium	High	Medium	Assuming any and all water temp (not just local causes) - Focus on Locks and Ship Canal; Medium severity here for chinook; higher for Sammamish pop. Ways to manage it in local areas to maintain pops in foreseeable future. but not reversible
23. 23 Large Spills	Low	Medium	High	Medium	Low	Low probability event
10.1. 10.1 Altered peak flows from land cover change	Low	High	Low	High	Low	Not an issue for Cedar population. Included here for contrast with Sammamish.

10.1. 10.1 Altered peak flows from land cover change	Low	Low	High	Low	Not an issue for Cedar population. Included here for contrast with Sammamish.
26.1. 26.1 Changing air temperature	High	Medium	High	Medium	See changing water temperature notes for this life stage. Effects of changing air temperature on fish felt through changing water temperature.
11.1. 11.1 Altered low flows from land cover change	Low	Low	High	Low	Altered low flows from LC change not likely to have much of an impact on this life stage.

S - Inc & Emerge

Pressure	Scope	Severity	Irreversibility	Summary Pressure Rating	Comments
11.3. 11.3 Altered low flows from withdrawals	Low	Low	High	Low	Low flows during incubation period (from wells) are possible, potentially delaying or preventing migration to spawning streams. However, incubation period is less likely to see LOW flows -- more likely to see high flows. See Tributary Streamflow document (Tributary Streamflow Technical Committee 2006). Highest need/importance/benefits to be seen in Bear, EF Issaquah, Issaquah and Rock Creek. also augmenting cold water inflows to Sammamish.
13.1. 13.1 In channel structural barriers to water, sediment, debris flows	High	High	Medium	High	
13.2. 13.2 Levees and Revetments	High	High	High	High	This pressure includes levees and revetments. Effect on incubation to the extent it affects hydraulics and scour.
01.2. 01.2 Conversion of land cover for natural resources production	Low	Low	Low	Low	Current natural resource production limited to small timber harvest areas on DNR land in upper reaches of Issaquah Creek and its tributaries.
10.2. 10.2 Altered peak flows from climate change	Medium	High	High	Medium	If changing climate brings more atmospheric river/other high flow events, could result in increasing redd scour and diminished survival. Management response should be to increase resilience of stream ecosystems (reconnect flood plains, increase wood in streams, increase riparian cover).
03. 03 Shoreline hardening	Medium	High	Very High	High	Effect on incubation to the extent it affects hydraulics and scour. Shoreline hardening scores higher in irreversibility than "other structural barriers" pressure though lower in scope (defining this threat to include infrastructure in urban areas where removal is unlikely in next 100y).
17.1. 17.1 Predation from increased native species	Medium	Medium	Medium	Medium	predation of emerging fry by sculpin -- no evidence of increased native spp (?)
17.2. 17.2 Displacement by increased native species	Low	Low	High	Low	

21.2. 21.2 Non-point source, persistent toxic chemicals in aquatic systems	High	Medium	High	Medium	Medium	Low flows during winter months are possible (dewatering redds) but climate models do not project this element to increase. See non-point source persistent chemicals
11.2. 11.2 Altered low flows from climate change	Medium	Medium	High	Medium	Medium	
22.2. 22.2 Non-point source, non-persistent toxic chemicals in aquatic systems	High	Medium	High	Medium	Medium	
24.2. 24.2 Non-point source conventional water pollutants	High	High	Medium	High	High	Focused on sediment (ditches; erosion of streambanks). Pervasive but reversible. Group on the fence for irreversibility - medium or high. SS highest generally in urban areas
10.1. 10.1 Altered peak flows from land cover change	High	High	High	High	High	Increased flashiness from increased urbanization likely, though stormwater regs are intended to minimize or prevent such impacts.
24.3. 24.3 Changes in water temperature from local causes	High	Low	High	Low	Low	
26.1. 26.1 Changing air temperature	High	Low	High	Low	Low	See changing water temperature notes for this life stage. Effects of changing air temperature on fish felt through changing water temperature.
11.1. 11.1 Altered low flows from land cover change	Medium	Medium	High	Medium	Medium	Altered low flows from land cover change may affect this life stage, if flows are insufficient to allow sufficient habitat.

S - Stream Rearing

Pressure	Scope	Severity	Irreversibility	Summary Pressure Rating	Comments
11.3. 11.3 Altered low flows from withdrawals	Low	Low	Medium	Low	See comments for Altered low flows from land cover change
13.1. 13.1 In channel structural barriers to water, sediment, debris flows	High	High	Medium	High	
13.2. 13.2 Levees and Revetments	High	High	Very High	Very High	Irreversibility - Sammamish has been changed due to Locks and dredging that makes reconnection nearly impossible. Make 13.2 the same as 03.
02. 02 Terrestrial habitat fragmentation	High	Medium	High	Medium	Terr. habitat fragmentation often affects runoff patterns, hydrology. If riparian areas included, then severity is high or very high. Irreversibility ranked high (not very high) because while fragmentation is irreversible, LID and stormwater techniques could hypothetically restore hydrology to natural or nearly natural state.
01.2. 01.2 Conversion of land cover for natural resources production	Low	Low	Low	Low	Current natural resource production limited to small timber harvest areas on DNR land in upper reaches of Issaquah Creek and its tributaries.
10.2. 10.2 Altered peak flows from climate change	High	High	Very High	Very High	Potential high flows during early rearing season could displace rearing juveniles, especially in simplified channels. Highest likelihood of effect in urban areas. Improved stormwater management could mitigate somewhat (therefore irreversibility set at high rather than very high).
03. 03 Shoreline hardening	Very High	High	Very High	Very High	8/10 changed to very high Irreversibility: Possible over time but it would take more than 20 years and political will. Note the length of time in the stream rearing - is the short timing a result of lack of habitat or would the population migrate quickly anyway. We don't have an answer, so it is important to express this for diversity. Need to distinguish when we are thinking about tribes (this is high) versus sammamish (medium - but Sammamish ranks higher for 13.2 structural barriers)

17.1. 17.1 Predation from increased native species	High	Medium	Very High	High	Interspecific dynamics (cutthroat vs coho, sculpin etc.) complex and not well understood
17.2. 17.2 Displacement by increased native species	High	Medium	High	Medium	Interspecific dynamics complex and not well understood. Uncertainty of effect is high. 8/10 irreversibility changed to high. This may be a bigger issue for small streams so increased scope from medium to high.
18.1. 18.1 Predation from non-native species	High	Medium	Very High	High	predation by bass and other non-native species documented. Likely to affect this life stage, especially in lower reaches of streams. 8/10 changed to match Cedar stream rearing.
21.2. 21.2 Non-point source, persistent toxic chemicals in aquatic systems	High	Medium	High	Medium	
05.2. 05.2 Culverts and other fish passage barriers	High	High	Medium	High	Use ratings for 13.2. The group is "combining" culverts and other in-stream structural barriers. This includes Tier 1 and Tier 2. Same as 13.1. Group only using one pressure due to redundancies.
11.2. 11.2 Altered low flows from climate change	Low	Medium	Very High	Medium	SS Effects of altered low flows on this life stage are not clear. Late winter/spring months, when this life stage inhabits streams, not generally considered to be time of year with low flow problems. 2015 was an extreme outlier and effects were seen on Bear Cr (check with K Kiyohara) -- however, forecasts for conditions under most climate scenarios do not indicate less winter/spring precipitation (CHECK). 8/10 Increased irreversibility to very high.
22.2. 22.2 Non-point source, non-persistent toxic chemicals in aquatic systems	High	High	High	High	See non-point source persistent chemicals. May be more of an issue for Sammimish population. Changed scope and severity to high and the overall summary rating to high.
01.1. 01.1 Conversion of land cover for residential, commercial, and industrial use	High	Medium	High	Medium	Effect of this pressure most likely felt inside UGA, though some areas of Bear/Cottage Creek (T1) and Little Bear Creek (T2) could be affected.

07.1. 07.1 Terrestrial and freshwater species disturbance in human dominated areas	High	Medium	Very High	High	Species disturbance by people, their pets, artificial light....
24.2. 24.2 Non-point source conventional water pollutants	High	High	Medium	High	Sedimentation results in decline in inverts
01.3. 01.3 Conversion of land cover for transportation & utilities	High	High	High	High	Transportation and utility projects in stream corridors often result in confined channels without ability to meander. For example, wastewater lines exist along both banks of Sammamish River; also wastewater lines along shoreline of Lake Washington. NOTE: did not include Ballard Locks in this component (covered elsewhere). Keeping severity at high - more of an issue in Sammamish pop than Cedar.
10.1. 10.1 Altered peak flows from land cover change	High	High	High	High	Stream flashiness is detrimental to stream rearing and exacerbated by shoreline hardening, stream channel simplification, lack of wood and riparian vegetation. Most severe inside UGA. There is data to back
24.3. 24.3 Changes in water temperature from local causes	Medium	Medium	Very High	High	Increased temperatures during stream rearing stage may have positive effect on growth, but negative consequences possible but unclear. Later in stream-rearing season, temperatures could affect migration/survival (saw effects in 2015 -- though considered extreme outlier. Potential increase in activity from warm-water predators (e.g. bass in some lower reaches) could have negative consequences. Assuming local causes include "heat island" effects, warming wetlands, and local air temperature changes. Including increases from climate change in this pressure, which is why irreversibility is very high. Groundwater connections, riparian shading are good efforts to sustain/improve conditions.
26.1. 26.1 Changing air temperature	Medium	Low	Very High	Medium	See changing water temperature notes for this life stage. Effects of changing air temperature on fish felt through changing water temperature.
11.1. 11.1 Altered low flows from land cover change	Low	Low	Medium	Low	Effects of altered low flows on this life stage are not clear. Late winter/spring months, when this life stage inhabits streams, not generally considered to be time of year with low flow problems.

C - Dnstrm Migration

Pressure	Scope	Severity	Irreversibility	Summary Pressure Rating	Comments
11.3. 11.3 Altered low flows from withdrawals	Low	Low	High	Low	SS Effects of altered low flows on this life stage are not clear. Late winter/spring months, when juveniles are migrating to the lake, not generally considered to be time of year with low flow problems. 2015 was an extreme outlier and effects were seen (check with K. Kiyohara) -- however, projections for conditions under most climate scenarios do not indicate less winter/spring precipitation (CHECK). NOTE: Cedar Instream Flow Agreement maintains minimum flows for rearing and migration.
13.1. 13.1 In channel structural barriers to water, sediment, debris flows	High	High	Medium	High	
13.2. 13.2 Levees and Revetments	High	Medium	Very High	High	
10.2. 10.2 Altered peak flows from climate change	Medium	Medium	Medium	Medium	SS Downstream migration is often triggered by freshets. Change in timing of freshets could affect timing of migration.
03. 03 Shoreline hardening	Medium	Medium	Very High	High	SS Hardened shorelines affect edge habitat quantity and quality. Armoring also limits instream wood and overhanging vegetation for hydraulic relief and cover. Therefore, when juveniles are shoreline-oriented, could be serious issue. (confirm extent that juveniles are shoreline-oriented during active migration)
17.1. 17.1 Predation from increased native species	High	High	High	High	Tabor work
17.2. 17.2 Displacement by increased native species	Medium	Medium	Medium	Medium	
18.1. 18.1 Predation from non-native species	High	Medium	Very High	High	
21.2. 21.2 Non-point source, persistent toxic chemicals in aquatic systems	Medium	Medium	High	Medium	

11.2. 11.2 Altered low flows from climate change	Low	Low	High	Low	SS Effects of altered low flows on this life stage are not clear. Late winter/spring months, when juveniles are migrating to the lake, not generally considered to be time of year with low flow problems. 2015 was an extreme outlier and effects were seen (check with K. Kiyohara) -- however, projections for conditions under most climate scenarios do not indicate less winter/spring precipitation (CHECK). NOTE: Cedar Instream Flow Agreement maintains minimum flows for rearing and migration.
22.2. 22.2 Non-point source, non-persistent toxic chemicals in aquatic systems	Medium	Medium	High	Medium	
01.1. 01.1 Conversion of land cover for residential, commercial, and industrial use	Medium	Medium	Medium	Medium	SS During migration, to the extent that juveniles are shoreline oriented -- strongest effects in lower reaches (i.e. inside UGA).
07.1. 07.1 Terrestrial and freshwater species disturbance in human dominated areas	High	High	High	High	SS effects of artificial light during downstream migration affects behavior, susceptibility to predation. Most other human disturbance likely low during this life stage. True strength of effect not known but assumed to be high. Effect strongest in urban areas, e.g. Renton.
24.2. 24.2 Non-point source conventional water pollutants	Medium	Medium	Medium	Medium	SS hypothetical effect on ability to detect predators, prey? (turbidity)
10.1. 10.1 Altered peak flows from land cover change	Low	Low	Low	Low	
24.3. 24.3 Changes in water temperature from local causes	Medium	Low	Very High	Medium	SS Hypothetically could shift migration dates earlier -- some possible evidence of this from 2016? (check with K Kiyohara). Likelihood of strong effect on Cedar population is small.
26.1. 26.1 Changing air temperature	Medium	Low	Very High	Medium	SS See changing water temperature notes for this life stage. Effects of changing air temperature on fish felt through changing water temperature.
11.1. 11.1 Altered low flows from land cover change	Low	Low	Low	Low	SS Altered low flows from land cover change not likely to have much impact.

S - Lake Rearing

Pressure	Scope	Severity	Irreversibility	Summary Pressure Rating	Comments
13.1. 13.1 In channel structural barriers to water, sediment, debris flows	High	High	Medium	High	Discussion in Technical Committee about importance of small streams and stream mouths for juvenile salmon -- therefore this pressure was included in Lake Rearing.
24. 24.1 Point source conventional water pollutants	Low	Medium	Medium	Low	Point source -- wastewater outfalls, CSO outfalls. Nutrients, sediment, turbidity. Not an extensive or frequent problem in watershed. Active CSO reduction management ongoing.
03. 03 Shoreline hardening	High	High	High	High	Issaquah Creek juveniles likely use southern Lake Sammamish shoreline.
17.1. 17.1 Predation from increased native species	High	High	High	High	Cutthroat trout, northern pikeminnow, sculpin... Current research (2016) by Beauchamp et al.
17.2. 17.2 Displacement by increased native species	Low	Low	Low	Low	No data indicating displacement by increased native species.
04. 04 Shading of shallow water habitat	High	Medium	Medium	Medium	Difficult to change; may be able to shift new dock types. Connected tightly to predation pressure.
18.1. 18.1 Predation from non-native species	High	Medium	High	Medium	Large and small mouth bass, rock bass, walleye. Assessment slightly different due to orientation to shoreline. Need more data on non-native predators.
21.1. 21.1 Point source, persistent toxic chemicals in aquatic systems	High	Medium	High	Medium	
21.2. 21.2 Non-point source, persistent toxic chemicals in aquatic systems	Medium	Medium	High	Medium	
22.1. 22.1 Point source, non-persistent toxic chemicals in aquatic systems	Medium	Medium	High	Medium	
22.2. 22.2 Non-point source, non-persistent toxic chemicals in aquatic systems	Medium	Medium	High	Medium	
01.1. 01.1 Conversion of land cover for residential, commercial, and industrial use	High	High	High	High	Conversion of lake shoreline habitat in addition to shoreline hardening. Especially affecting early season juveniles that are shoreline-oriented.
01.1. 01.1 Conversion of land cover					

<p>07.1. 07.1 Terrestrial and freshwater species disturbance in human dominated areas</p>	<p>High</p>	<p>High</p>	<p>High</p>	<p>High</p>	<p>Effects of artificial light on behavior, susceptibility to predation during lake rearing likely strong. Dock maintenance often occurs during March before the lake level is raised. Boat prep/washing also occurs during this time. Power washing and some soap/chemical use. Possibly also wastewater pump station intakes: There are documented entrainment of fish/other organisms in these pump/flush stations (KP), many with shallow water intake within 10 ft of shore— often with damaged or even without screens.</p>
<p>24.2. 24.2 Non-point source conventional water pollutants</p>	<p>Medium</p>	<p>Medium</p>	<p>Medium</p>	<p>Medium</p>	<p>Hypothetical effect on ability to detect predators, prey? (turbidity) Also exposure to other conventional pollutants during rearing could pose risks</p>
<p>01.3. 01.3 Conversion of land cover for transportation & utilities</p>	<p>Medium</p>	<p>Medium</p>	<p>High</p>	<p>Medium</p>	<p>Wastewater infrastructure along Lake Washington and Lake Sammamish shorelines.</p>
<p>23. 23 Large Spills 24.3. 24.3 Changes in water temperature from local causes</p>	<p>Low Medium</p>	<p>High Medium</p>	<p>Medium Very High</p>	<p>Low High</p>	<p>Low probability event Climate change effects included here. Temperature effects on lake rearing stage, if present, likely relate to 1) potential food web shifts as daphnia populations fluctuate (potential mismatch with phytoplankton blooms) and 2) earlier spring warming could increase activity of warm-water predators. Increasing temperatures could also affect growth rates, metabolic demand, shift migration timing to earlier periods.</p>
<p>26.1. 26.1 Changing air temperature</p>	<p>Medium</p>	<p>Medium</p>	<p>Very High</p>	<p>High</p>	<p>See changing water temperature notes for this life stage. Effects of changing air temperature on fish felt through changing water temperature.</p>

S - Dnstrm Migration

Pressure	Scope	Severity	Irreversibility	Summary Pressure Rating	Comments
11.3. 11.3 Altered low flows from withdrawals	Low	Low	High	Low	SS Low flows during downstream migration period are possible, potentially delaying or preventing migration. However, migration period is much less likely to see LOW flows -- more likely to see high flows. Potential for lower flows increases after May -- could influence later migrants.
13.1. 13.1 In channel structural barriers to water, sediment, debris flows	High	High	Medium	High	
13.2. 13.2 Levees and Revetments	High	Medium	Very High	High	Downstream migration impacted; Chinook looking for velocity refugia as they make their way out.
01.2. 01.2 Conversion of land cover for natural resources production	Low	Low	Low	Low	SS Current natural resource production limited to small timber harvest areas on DNR land in upper reaches of Issaquah Creek and its tributaries.
10.2. 10.2 Altered peak flows from climate change	Medium	Medium	Medium	Medium	SS Downstream migration is often triggered by freshets. Change in timing of freshets could affect timing of migration.
03. 03 Shoreline hardening	Medium	Medium	Very High	High	SS Hardened shorelines affect edge habitat quantity and quality. Armoring also limits instream wood and overhanging vegetation for hydraulic relief and cover. Therefore, when juveniles are shoreline-oriented, could be serious issue. (confirm extent that juveniles are shoreline-oriented during active migration)
17.1. 17.1 Predation from increased native species	High	Medium	Very High	High	SS Interspecific dynamics (cutthroat vs coho, sculpin etc.) complex and not well understood
17.2. 17.2 Displacement by increased native species	Medium	Medium	Medium	Medium	
18.1. 18.1 Predation from non-native species	High	Medium	Very High	High	SS predation by bass and other non-native species documented. Likely to affect this life stage, especially in lower reaches of streams.
21.2. 21.2 Non-point source, persistent toxic chemicals in aquatic systems	High	Medium	High	Medium	

11.2. 11.2 Altered low flows from climate change	Low	Medium	High	Low	SS Effects of altered low flows on this life stage are not clear. Late winter/spring months, when juveniles are migrating to the lake, not generally considered to be time of year with low flow problems. 2015 was an extreme outlier and effects were seen (check with K. Kiyohara) -- however, projections for conditions under most climate scenarios do not indicate less winter/spring precipitation (CHECK).
22.2. 22.2 Non-point source, non-persistent toxic chemicals in aquatic systems	High	Medium	High	Medium	SS See non-point source persistent chemicals
01.1. 01.1 Conversion of land cover for residential, commercial, and industrial use	Medium	Medium	Medium	Medium	SS During migration, to the extent that juveniles are shoreline oriented -- strongest effects in lower reaches (i.e. inside UGA).
07.1. 07.1 Terrestrial and freshwater species disturbance in human dominated areas	High	High	High	High	SS effects of artificial light during downstream migration affects behavior, susceptibility to predation. Most other human disturbance likely low during this life stage. True strength of effect not known but assumed to be high. Effect strongest in urban areas.
24.2. 24.2 Non-point source conventional water pollutants	Medium	Medium	Medium	Medium	SS hypothetical effect on ability to detect predators, prey? (turbidity)
10.1. 10.1 Altered peak flows from land cover change	Low	Low	Low	Low	
24.3. 24.3 Changes in water temperature from local causes	High	Medium	High	Medium	Can push them out earlier or trap them in the small, cooler systems (e.g. Bear and North Creek)
26.1. 26.1 Changing air temperature	High	Medium	High	Medium	SS See changing water temperature notes for this life stage. Effects of changing air temperature on fish felt through changing water temperature.
11.1. 11.1 Altered low flows from land cover change	Low	Medium	High	Low	SS Effects of altered low flows on this life stage are not clear. Late winter/spring months, when juveniles are migrating to the lake, not generally considered to be time of year with low flow problems. 2015 was an extreme outlier and effects were seen (check with K. Kiyohara) -- however, projections for conditions under most climate scenarios do not indicate less winter/spring precipitation (CHECK).

C - Lake Rearing

Pressure	Scope	Severity	Irreversibility	Summary Pressure Rating	Comments
13.1. 13.1 In channel structural barriers to water, sediment, debris flows	High	High	Medium	High	Discussion in Technical Committee about importance of small streams and stream mouths for juvenile salmon -- therefore this pressure was included in Lake Rearing.
24. 24.1 Point source conventional water pollutants	Low	Medium	Medium	Low	Point source -- wastewater outfalls, CSO outfalls. Nutrients, sediment, turbidity. Not an extensive or frequent problem in watershed. Active CSO reduction management ongoing.
03. 03 Shoreline hardening	High	High	High	High	Assumption: juvenile Chinook use the southern portion of the Lk WA shoreline during this life stage. Mouth of Cedar to I-90. Scope is focused on southern Lk. WA.
17.1. 17.1 Predation from increased native species	High	High	High	High	Cutthroat trout, northern pikeminnow, sculpin... Current research (2016) by Beauchamp et al.
17.2. 17.2 Displacement by increased native species	Low	Low	Low	Low	No data indicating displacement by increased native species.
04. 04 Shading of shallow water habitat	High	Medium	Medium	Medium	Difficult to change; may be able to shift new dock types. Connected tightly to predation pressure.
18.1. 18.1 Predation from non-native species	Medium	Medium	High	Medium	Large and small mouth bass, rock bass, walleye. Expensive and difficult to reverse. NOTE: could be much more serious threat than estimated here. Ship Canal not included in this life stage. See Migration to Puget Sound stage for Ship Canal Assessment.
21.1. 21.1 Point source, persistent toxic chemicals in aquatic systems	Medium	Medium	High	Medium	
21.2. 21.2 Non-point source, persistent toxic chemicals in aquatic systems	Medium	Medium	High	Medium	
22.1. 22.1 Point source, non-persistent toxic chemicals in aquatic systems	Medium	Medium	High	Medium	
22.2. 22.2 Non-point source, non-persistent toxic chemicals in aquatic systems	Medium	Medium	High	Medium	
01.1. 01.1 Conversion of land cover for residential, commercial, and industrial use	High	High	High	High	Conversion of lake shoreline habitat in addition to shoreline hardening. Especially affecting early season juveniles that are shoreline-oriented.

<p>07.1. 07.1 Terrestrial and freshwater species disturbance in human dominated areas</p>	<p>High</p>	<p>High</p>	<p>High</p>	<p>High</p>	<p>Effects of artificial light on behavior, susceptibility to predation during lake rearing likely strong. Dock maintenance often occurs during March before the lake level is raised. Boat prep/washing also occurs during this time. Power washing and some soap/chemical use. Possibly also wastewater pump station intakes: There are documented entrainment of fish/other organisms in these pump/flush stations (KP), many with shallow water intake within 10 ft of shore— often with damaged or even without screens.</p>
<p>24.2. 24.2 Non-point source conventional water pollutants</p>	<p>Medium</p>	<p>Medium</p>	<p>Medium</p>	<p>Medium</p>	<p>Hypothetical effect on ability to detect predators, prey? (turbidity) Also exposure to other conventional pollutants during rearing could pose risks</p>
<p>01.3. 01.3 Conversion of land cover for transportation & utilities</p>	<p>Medium</p>	<p>Medium</p>	<p>High</p>	<p>Medium</p>	<p>Wastewater infrastructure along Lake Washington shoreline.</p>
<p>24.3. 24.3 Changes in water temperature from local causes</p>	<p>Medium</p>	<p>Medium</p>	<p>Very High</p>	<p>High</p>	<p>Climate change effects included here. Temperature effects on lake rearing stage, if present, likely relate to 1) potential food web shifts as daphnia populations fluctuate (potential mismatch with phytoplankton blooms) and 2) earlier spring warming could increase activity of warm-water predators. Increasing temperatures could also affect growth rates, metabolic demand, shift migration timing to earlier periods.</p>
<p>23. 23 Large Spills</p>	<p>Low</p>	<p>High</p>	<p>Medium</p>	<p>Low</p>	<p>Low probability event</p>
<p>26.1. 26.1 Changing air temperature</p>	<p>Medium</p>	<p>Medium</p>	<p>Very High</p>	<p>High</p>	<p>See changing water temperature notes for this life stage. Effects of changing air temperature on fish felt through changing water temperature.</p>

S&C – Migration to PS

Pressure	Scope	Severity	Irreversibility	Summary Pressure Rating	Comments
05.1. 05.1 Ballard Locks	Very High	High	Very High	Very High	If this is just considered as a fish passage the severity might be lower than if you connect all of the other issues associated with the structure. Current conditions may be improved through stony gate valves. Kept the severity score high until this is dealt with.
21.1. 21.1 Point source, persistent toxic chemicals in aquatic systems	High	Medium	High	Medium	
21.2. 21.2 Non-point source, persistent toxic chemicals in aquatic systems	Medium	Medium	High	Medium	
22.1. 22.1 Point source, non-persistent toxic chemicals in aquatic systems	High	Medium	High	Medium	
24. 24.1 Point source conventional water pollutants	Low	Medium	Medium	Low	SS Point source -- wastewater outfalls, CSO outfalls. Nutrients, sediment, turbidity. Not an extensive or frequent problem in watershed. Some CSO outfalls in Ship Canal. Active CSO reduction management ongoing.
22.2. 22.2 Non-point source, non-persistent toxic chemicals in aquatic systems	Medium	Medium	High	Medium	
01.1. 01.1 Conversion of land cover for residential, commercial, and industrial use	High	High	Very High	Very High	SS Shoreline along migratory route from Lake Washington to Puget Sound (i.e., Ship Canal) is highly modified.
17.1. 17.1 Predation from increased native species	High	High	High	High	Need more data
24.2. 24.2 Non-point source conventional water pollutants	Medium	Medium	Medium	Medium	SS Some exposure hypothesized (especially in Lake Union) but transit time is fairly short.
24.3. 24.3 Changes in water temperature from local causes	High	High	High	High	Temperature bottleneck as fish outmigrate at the Locks. Severity between high and medium.
18.1. 18.1 Predation from non-native species	High	High	High	High	
26.1. 26.1 Changing air temperature	High	High	High	High	SS See changing water temperature notes for this life stage. Effects of changing air temperature on fish felt through changing water temperature.

S&C - Nearshore Foraging

Pressure	Scope	Severity	Irreversibility	Summary Pressure Rating	Comments
01.1. 01.1 Conversion of land cover for residential, commercial, and industrial use	Medium	High	Very High	High	SS Seawalls, bulkheads related to residential/commercial/industrial-- not a large issue in WRIA 8 because most of shoreline is impacted by BNSF. However, marinas are considered in this pressure. Certainty of effect on WRIA 8 chinook is low -- likely greater effect on other populations (circumstantial evidence suggests WRIA 8 chinook do not use nearshore to great extent).
03. 03 Shoreline hardening	High	High	High	High	BNSF SS This seems to duplicate 'conversion of land cover for transportation and utilities.' Actual effect is from shoreline hardening as opposed to clearing land. As stated elsewhere, use of nearshore by WRIA 8 juveniles thought to be minimal. However, armoring of shoreline highly likely to affect other chinook populations.
08. 08 Species disturbances - marine	Low	Low	Low	Low	SS No data
23. 23 Large Spills	Low	High	Medium	Low	SS Irreversibility (restoration in 6-20y) may be optimistic. Low probability, high impact event.
01.3. 01.3 Conversion of land cover for transportation & utilities	High	High	High	High	BNSF As stated elsewhere, use of nearshore by WRIA 8 juveniles thought to be minimal. However, armoring of shoreline highly likely to affect other chinook populations. Actual effect is from shoreline hardening as opposed to clearing land.
26.4. 26.4 Changing ocean condition	High	Medium	Very High	High	SS Top-down or bottom-up effects on chinook uncertain but potential is thought to be severe. For this geography, it is also uncertain how extensively chinook from WRIA 8 use the nearshore -- some evidence indicates that WRIA 8 chinook are larger than most smolts leaving their natal estuary and may not be nearshore oriented.
26.3. 26.3 Sea level rise	High	High	Very High	Very High	SS Loss of nearshore habitat, pocket estuaries likely to affect habitat and prey resources. As stated elsewhere, use of nearshore by WRIA 8 juveniles thought to be minimal.

C - Stream Rearing

Pressure	Scope	Severity	Irreversibility	Summary Pressure Rating	Comments
11.3. 11.3 Altered low flows from withdrawals	Low	Low	Low	Low	Withdrawals for municipal water supply are mitigated by flow rules under the CR HCP. Not likely an issue for this life stage.
13.1. 13.1 In channel structural barriers to water, sediment, debris flows	Low	Low	Low	Low	
02. 02 Terrestrial habitat fragmentation	High	Medium	High	Medium	Terr. habitat fragmentation often affects runoff patterns, hydrology. If riparian areas included, then severity is high or very high. Irreversibility ranked high (not very high) because while fragmentation is irreversible, LID and stormwater techniques could hypothetically restore hydrology to natural or nearly natural state.
13.2. 13.2 Levees and Revetments	High	High	High	High	8/10 The group discussed this as a part migrant concern. Changed the scope from very high to high. This pressure is being ranked the same as shoreline hardening (3.0) since one includes levees and hte other revetments (with similar effect).
01.2. 01.2 Conversion of land cover for natural resources production	Low	Low	Low	Low	Not an issue in Cedar watershed
10.2. 10.2 Altered peak flows from climate change	Medium	High	Very High	High	Potential increased high flows during rearing season could displace rearing juveniles, especially in simplified channels. CR managed to moderate high flows when possible, but water supply system is not designed for flood control. Increasing rain events in upper watershed could constrain options of watershed managers. Irreversibility set at very high because options for further reservoir capacity likely limited.
03. 03 Shoreline hardening	High	High	High	High	8/10 group following logic and scores for 13.2 which they are now combining to simplify (levees and revetments are interchangeable in the way they are addressed in this system).
17.1. 17.1 Predation from increased native species	High	High	High	High	See Tabor et al. 2014. Cutthroat trout predation likely significant. Concerns over the reliability of the data on cutthroat predation. 8/10 Group is keeping as high despite some concern over cutthroat predation numbers (see JB notes for concern over this being highly severe over long periods of time).

17.2. 17.2 Displacement by increased native species	Medium	Medium	High	Medium	Interspecific dynamics complex and not well understood. Uncertainty of effect is high. If there is more habitat to displace them to, it shouldn't be a big concern for Chinook in the Cedar. 8/10 Group changed the irreversibility from medium to high
18.1. 18.1 Predation from non-native species	High	Medium	Very High	High	predation by bass and other non-native species documented. Likely to affect this life stage, especially in lower reaches of CR. Scope is high because all juveniles pass through lower reaches. Likelihood or utility of predation management probably not favorable.
21.2. 21.2 Non-point source, persistent toxic chemicals in aquatic systems	Medium	Medium	High	Medium	
05.2. 05.2 Culverts and other fish passage barriers	Low	Low	Low	Low	This is more of a Sammamish population issue. Not aware of anything in Cedar tribbs or mainstem where Chinook are present.
11.2. 11.2 Altered low flows from climate change	Low	Low	Very High	Medium	SS Effects of altered low flows on this life stage are not clear. Late winter/spring months, when this life stage inhabits streams, not generally considered to be time of year with low flow problems. 2015 was an extreme outlier and effects were seen (check with K. Kiyohara) -- however, forecasts for conditions under most climate scenarios do not indicate less winter/spring precipitation (CHECK). NOTE: Cedar Instream Flow Agreement maintains minimum flows for rearing and migration.
22.2. 22.2 Non-point source, non-persistent toxic chemicals in aquatic systems	Medium	Medium	High	Medium	8/10 Group changed irreversibility to very high elevating the overall pressure to medium from low.
01.1. 01.1 Conversion of land cover for residential, commercial, and industrial use	Medium	Medium	High	Medium	
07.1. 07.1 Terrestrial and freshwater species disturbance in human dominated areas	Medium	Medium	High	Medium	Species disturbance by people, their pets, artificial light.... Timing of this life stage may intersect with recreation in CR during late spring/early summer, though water temps are likely too cold for much in-water recreation.

24.2. 24.2 Non-point source conventional water pollutants	Low	Low	Medium	Low	not likely a serious threat to the CR instream rearing
01.3. 01.3 Conversion of land cover for transportation & utilities	High	Medium	High	Medium	Fiber optic cable beneath CR trail; SR 169 -- shoreline hardening and floodplain disconnection also associated with conversion. 8/10 Changed severity to medium.
10.1. 10.1 Altered peak flows from land cover change	Medium	Medium	High	Medium	Stream flashiness is detrimental to stream rearing and exacerbated by shoreline hardening, stream channel simplification, lack of wood and riparian vegetation. Most severe inside UGA. Since most of CR is outside UGA, pressure is less than elsewhere in watershed for this life stage. Also, flow regulation in CR watershed diminishes this pressure.
24.3. 24.3 Changes in water temperature from local causes	Low	Medium	Very High	Medium	Increased temperatures in CR coupled with low flows affected juvenile outmigration in CR in 2015. Could pose a threat to stream rearing life stage, though 2015 is (for now) considered an extreme outlier event. Including temperature changes from climate change in this pressure, which is why irreversibility is very high. 8/10: This might alter behavior - outmigration timing. Questions about whether this is really limiting. The summary rating of high doesn't have consensus. Changing the scope to low because this doesn't impact a large majority of the population in this life stage in this location.
12. 12 Flow regulation -- prevention of flood flows	Medium	Low	Very High	Medium	Flow regulation on the Cedar River does attenuate flood flows. This has negative consequences for habitat-forming processes that provide spawning gravels and habitat. On the other hand, prevention of flood flows during incubation and emergence increases fry survival. Greater issue is disconnection of floodplain from river channel.
26.1. 26.1 Changing air temperature	Medium	Low	Very High	Medium	See changing water temperature notes for this life stage. Effects of changing air temperature most directly felt through changing water temperature.
11.1. 11.1 Altered low flows from land cover change	Low	Low	Medium	Low	Low flows from land cover change generally not an issue for juvenile life stage.

S & C - Maturation

Pressure	Scope	Severity	Irreversibility	Summary Pressure Rating	Comments
14. 14 Animal harvest	Medium	Medium	High	Medium	SS Harvest is governed by international treaty and Puget Sound Harvest Management Plan. Total annual harvest rates for all areas approx 20%-54% over last 10 years.
15. 15 Bycatch	Medium	Low	High	Low	SS Bycatch is regulated under ESA take rules. I don't have any data on bycatch outside (coho/sockeye) terminal area, or in some seasons in Lake Washington?
08. 08 Species disturbances - marine	Medium	Medium	Medium	Medium	SS No data
23. 23 Large Spills	Low	High	Medium	Low	SS Low probability, high impact event. Puget Sound.
26.4. 26.4 Changing ocean condition	High	High	High	High	SS Food web issues related to a warming ocean, or interdecadal climate patterns, have been reported.

S - Adult Migration

Pressure	Scope	Severity	Irreversibility	Summary Pressure Rating	Comments
11.3. 11.3 Altered low flows from withdrawals	Medium	Medium	High	Medium	Low flows during adult migration period (from wells) are possible, potentially delaying or preventing migration to spawning streams. See Tributary streamflow document (Tributary Streamflow Technical Committee 2006). Highest need/importance/benefits to be seen in Bear, EF Issaquah, Issaquah and Rock Creek. also augmenting cold water inflows to Sammamish.
13.1. 13.1 In channel structural barriers to water, sediment, debris flows	Low	Low	Medium	Low	
14. 14 Animal harvest	Low	Low	High	Low	Harvest is governed by international treaty and Puget Sound Harvest Management Plan. Total annual harvest rates for all areas approx. 20%-54% over last 10 years.
10.2. 10.2 Altered peak flows from climate change	Low	Low	Very High	Medium	Climate scenarios do not indicate higher flows earlier in season. (CHECK)
15. 15 Bycatch	Low	Low	Medium	Low	Some bycatch occurs during coho or sockeye fishery, when those fisheries occur. Closely monitored.
03. 03 Shoreline hardening	High	Low	High	Low	Most severe at Ballard Locks/Ship Canal area. Some areas along migration corridor are more severely affected than others. Adult life stage not as affected as others.
17.1. 17.1 Predation from increased native species	Low	Low	Low	Low	Potential increased native predators in Salmon Bay, though no data to substantiate
05.1. 05.1 Ballard Locks	Very High	High	Very High	Very High	This is the proxy for locks. Could delay migration; salinity, temp, physical barrier... BiOp says it is a barrier. Consider severity in terms of structure itself but also salinity and temp exchange barrier.
7.2. 7.2 Terrestrial and freshwater species disturbances in natural landscapes	Low	Low	Low	Low	Few natural landscapes in Sammamish system (upper reaches of Issaquah Creek) likely to see very little species disturbance.
21.1. 21.1 Point source, persistent toxic chemicals in aquatic systems	Low	Low	High	Low	Not likely an extreme threat to this life stage. Prespawn mortality not known to be severe for Chinook salmon, though some PSM (likely due to elevated temperatures in Sammamish R has been noted).
21.2. 21.2 Non-point source, persistent toxic chemicals in aquatic systems	Low	Low	High	Low	Not likely an extreme threat to this life stage

05.2. 05.2 Culverts and other fish passage barriers	Low	Low	Low	Low	Most existing barriers aren't for Chinook or are only partial
22.1. 22.1 Point source, non-persistent toxic chemicals in aquatic systems	Low	Low	High	Low	Not likely an extreme threat to this life stage
11.2. 11.2 Altered low flows from climate change	High	Medium	Very High	High	Low flows during adult migration period (from climate change) are possible, potentially delaying or preventing migration to spawning streams. Not as likely in larger tributaries where chinook normally spawn (North, Bear, Issaquah), but potentially serious in other smaller streams with episodic chinook use or tributaries where other issues (e.g. milfoil) compound effects of lower flows (e.g. Kelsey Creek). Would be exacerbated by water withdrawals in basin.
22.2. 22.2 Non-point source, non-persistent toxic chemicals in aquatic systems	Low	Low	High	Low	Not likely an extreme threat to this life stage
01.1. 01.1 Conversion of land cover for residential, commercial, and industrial use	High	Low	High	Low	Migratory pathways considered intact (assuming Lake Washington basin hydrology post construction of Ship Canal is new 'normal'). Sammamish Valley conversion for various purposes decreased habitat substantially; however, extensive historic wetland system likely not as productive for chinook salmon. Conversion of Chinook habitat reflected more strongly in other components/geographies.
07.1. 07.1 Terrestrial and freshwater species disturbance in human dominated areas	High	Medium	Medium	Medium	Some disturbance by people, their pets, artificial light, Salmon SEEson volunteers during migration.... Size of most streams in Sammamish pop make closer approaches (thus greater harassment) possible. Also T2 areas likely have much greater human disturbance opportunities.
24.2. 24.2 Non-point source conventional water pollutants	Low	Low	High	Low	Not likely an extreme threat to this life stage
24.3. 24.3 Changes in water temperature from local causes	High	High	High	High	Includes Locks and River; higher severity in Sammamish River population.
23. 23 Large Spills	Low	High	Medium	Low	Low probability event
10.1. 10.1 Altered peak flows from land cover change	Medium	Medium	High	Medium	Possibility of increased flashy flows during migration having impact, though not likely to be severe for this life stage.

26.1. 26.1 Changing air temperature	High	High	High	High	See changing water temperature notes for this life stage. Effects of changing air temperature on fish felt through changing water temperature.
11.1. 11.1 Altered low flows from land cover change	Medium	Medium	High	Medium	Low flows during adult migration period (from wells) are possible, potentially delaying or preventing migration to spawning streams. See Tributary streamflow document (Tributary Streamflow Technical Committee 2006). Highest need/ importance/benefits to be seen in Bear, EF Issaquah, Issaquah and Rock Creek, also augmenting cold water inflows to Sammamish.

C - Spawning

Pressure	Scope	Severity	Irreversibility	Summary Pressure Rating	Comments
11.3. 11.3 Altered low flows from withdrawals	Low	Low	Medium	Low	Cedar R instream flows managed through CR HCP to provide spawning flows.
13.1. 13.1 In channel structural barriers to water, sediment, debris flows	Low	Low	Medium	Low	
13.2. 13.2 Levees and Revetments	Medium	Medium	High	Medium	This pressure includes levees and revetments. Effect on spawning habitat to the extent it restricts creation of side channels (used by Chinook for spawning) or affects the natural delivery and deposition of spawning gravel.
10.2. 10.2 Altered peak flows from climate change	Medium	Medium	Very High	High	Climate scenarios do not indicate higher flows earlier in season. Potential for higher fall flows, increased occurrence of atmospheric rivers; moderated to the extent possible by flow control on Cedar River (not designed for flood control).
03. 03 Shoreline hardening	Medium	Medium	High	Medium	Hardened shorelines affect spawning habitat quantity and quality. Armoring also limits instream wood and overhanging vegetation for cover.
17.1. 17.1 Predation from increased native species	Medium	Medium	Medium	Medium	Predation on eggs by cutthroat, sculpin etc -- no evidence of increased numbers
17.2. 17.2 Displacement by increased native species	Low	Low	High	Low	Interspecific dynamics complex and not well understood. Uncertainty of effect is high. Sockeye redd superposition is documented, but generally not severe (Burton annual reports).
7.2. 7.2 Terrestrial and freshwater species disturbances in natural landscapes	Low	Low	Low	Low	Existing riparian areas in natural landscapes are likely to remain protected. Some minimal rafting and "salmon watching" occurs on Cedar River during fall migration and spawning season, though effect on migration and spawning is not likely to be extreme.
21.2. 21.2 Non-point source, persistent toxic chemicals in aquatic systems	Low	Low	High	Low	Not likely an extreme threat to this life stage
11.2. 11.2 Altered low flows from climate change	Low	Low	Medium	Low	NOTE: Cedar Instream Flow Agreement maintains minimum flows during spawning season.
22.2. 22.2 Non-point source, non-persistent toxic chemicals in aquatic systems	Low	Low	High	Low	Not likely an extreme threat to this life stage

01.1. 01.1 Conversion of land cover for residential, commercial, and industrial use	High	Low	High	Low
07.1. 07.1 Terrestrial and freshwater species disturbance in human dominated areas	Medium	Medium	Medium	Medium
24.2. 24.2 Non-point source conventional water pollutants	Low	Low	High	Low
10.1. 10.1 Altered peak flows from land cover change	Low	Low	High	Low
24.3. 24.3 Changes in water temperature from local causes	Medium	Low	High	Low
26.1. 26.1 Changing air temperature	Medium	Low	High	Low
11.1. 11.1 Altered low flows from land cover change	Low	Low	High	Low

Species disturbance by people, their pets, artificial light, Salmon SEEson volunteers....
 Not likely an extreme threat to this life stage

Not likely to be a strong pressure on this life stage in Cedar basin, though effects in (urban) lower Cedar are possible.

Could change spawn timing and add to pre-spawn mortality; susceptibility to disease.
 Temperature effects on spawning (as opposed to migration) not likely to be severe, especially for Cedar population.

See changing water temperature notes for this life stage. Effects of changing air temperature on fish felt through changing water temperature.

Altered low flows from LC change not likely to have much of an impact on this life stage.