

## Impact of Water Project Infrastructure and Operations on Salmon and Salmon Habitats

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| Habitat     | Life Stage and Process | Requirements                                  | Impact of Project Infrastructure                                                                                                                                                                      | Impact of Project Operations                                                                                                                                                                                                                                                                                          | Other Stressors                                                                                                                                                                                           |
|-------------|------------------------|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Headwaters  | Adults--spawning       | Cold water, suitable substrate                | Inaccessible                                                                                                                                                                                          | NA                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                           |
|             | Eggs--incubation       | Cold water, suitable substrate                | Inaccessible                                                                                                                                                                                          | NA                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                           |
|             | Juveniles--rearing     | Cold water, suitable substrate, food, refugia | Inaccessible                                                                                                                                                                                          | NA                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                           |
| Mainstem    | Adults--migration      | Cool water, attraction flows                  | Diversion into managed floodplains without upstream exit                                                                                                                                              | Warm water and low flows delay migration, increases pre-spawn mortality.                                                                                                                                                                                                                                              | River sport fisheries                                                                                                                                                                                     |
|             | Adults--spawning       | Cold water, suitable substrate                | Disrupt sediment supply                                                                                                                                                                               | Warm temperatures delay spawning; increasingly restrict spawning to small area below dam                                                                                                                                                                                                                              |                                                                                                                                                                                                           |
|             | Eggs--incubation       | Cold water, suitable substrate                | Encourage spawning in deep areas                                                                                                                                                                      | <b>Warm water kills eggs</b> (1,2); flow fluctuations strand nests; flow effects on O2 supply (11,12)                                                                                                                                                                                                                 | Thiamine deficiency in parents (10)                                                                                                                                                                       |
|             | Juveniles--rearing     | Cool water, food, refugia                     | Channelization and bank armoring reduces refugia                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                       | Disease (C. shasta) (9). Aggravated by hatchery practices that are intended to mitigate                                                                                                                   |
|             | Smolts--migration      | Cool water, pulse flows, turbidity            | Dams reduce sediment supply, increase water clarity and therefore predation risk                                                                                                                      | Flattening of hydrograph removes migration cues (3); <b>lower velocities increase travel time and predation</b> (4,5); lower velocities and exports increase entrainment into export facilities; lower velocities increase temperatures and reduce survival (13)                                                      | Disease (C. shasta). Aggravated by hatchery practices that are intended to mitigate project effects, and reduced velocities reduce sediment scour which would otherwise disrupt C. shasta life cycle (14) |
| Floodplains | Juveniles--rearing     | Cool water, food                              | Bank armoring and levees limit access to and from floodplain                                                                                                                                          | <b>Reduce frequency and duration of floodplain activation</b>                                                                                                                                                                                                                                                         | Toxics (Hg, pesticides)                                                                                                                                                                                   |
| Estuary     | Adults--migration      | Cool water, attraction flows                  | Looped channels and tidal flows increase travel time through Delta                                                                                                                                    | Warm water delays migration, increases pre-spawn mortality. Low flows delay/prohibit homing                                                                                                                                                                                                                           |                                                                                                                                                                                                           |
|             | Juveniles--rearing     | Cool water, food, refugia                     | Transformed nature of tidal channels from mostly small blind channels to large, deep and looped channels; greatly reduced food production; conditions support non-native salmon predators and SAV (6) |                                                                                                                                                                                                                                                                                                                       | Non-native predators (15), increased water clarity due to invasive clam and SAV (16,17)                                                                                                                   |
|             | Smolts--migration      | Cool water, turbidity                         | Looped channels and tidal flows increase travel time through Delta and exposure to predators; SAV increases water clarity                                                                             | Reduced inflows increase the prevalence (and upstream extent) of tidal flows in channels resulting in longer transit times and higher predation risk (7) and at certain times, increase water temperature in shoulder seasons (8), resulting in higher <b>predation risk</b> (15); entrainment into export facilities | Non-native predators (15), increased water clarity due to invasive clam and SAV (16,17)                                                                                                                   |

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