between the refuge and the YN that 30 cfs is the minimum post-irrigation flow in Toppenish Creek[1].

Table 1. The U.S. Fish and Wildlife Service state water rights and period of use for the Headquarters Unit of the Toppenish National Wildlife Refuge (WDOE 2018).

Habitat	Period of Use	Quantity
Toppenish Creek		
Use: Screened diversion at Gamble Ditch	Continuous	15 cfs: 350 acre feet/year April 1–Sept 30 non-consumptive; 175 acre feet/year Oct 1–March 31
Use: Various wetlands	Oct 1–April 1	205 acre feet/year
Snake Creek		
Use: Wetlands 2 & 3	Oct 1–April 1	650 acre feet/year

The TNWR has summer water rights of 15 cfs from Toppenish Creek for wetland units 6a, 6b, and 6c, and WIP summer water rights, which encompass wetland units 8a, 9a, 9b, 9c, 9d, 10a, 10b, 10c, and 10d. In these units, the refuge has rights to hold water, as well as add water within the constraints of minimum Toppenish Creek flows, after April 1.

Additionally, the water rights of interest in the main unit from both Snake and Toppenish creeks are federal reserved water rights. Under these rights, diverting water after April 1 is not allowed, however retaining water that was screened and stored prior to April 1 is not disallowed. Waters that are screened and have no potential to have entrained steelhead (3a, 3c, 4a, 4b, 5a, 5b, 5c, 6a, 6b, 6c, 7a, 7b, 8a, 8b, 9c, 9d) can be held to achieve the purpose of the right, which is wildlife habitat.

Wetlands on TNWR include both natural floodplain wetlands along Toppenish Creek and Snake Creek and man-made impoundments designed to mimic natural floodplain features. Snake Creek, which is a lateral branch of Toppenish Creek, provides water to wetlands south of Toppenish Creek, and wetlands north of Toppenish Creek receive WIP and Toppenish Creek water. From 1995 to 1998, the refuge completed improvement projects to restore wetland habitat conditions and eliminate monotypic stands of invasive reed canary grass. Habitat improvements boosted fall/winter use from 2,000 to 50,000 waterfowl, and increased overall use by many species of water birds, shorebirds, and other migratory birds. Records indicate increased use by bald eagles, peregrine falcons, and willow flycatchers. However, management to provide these benefits for waterfowl can increase the risk of predation and entrain juvenile steelhead into the wetland system, potentially delaying or killing them.

Natural flooding events in winter and spring often inundate the wetlands, and water overtops the levees. As floodwaters recede in spring, water control structures with flashboard risers allow the managers to retain water in selected units. Water is held in the wetlands at 6- to 18-inch depths to prevent the growth of invasive reed canary grass. Prior to this consultation, wetlands using Snake Creek water were "drawn down" or dewatered slowly, throughout the months of May and June. As described below, beginning in 2019, wetlands using Snake Creek water will now begin "drawn down" or dewatering starting April 1. During the dewatering process, while first

[1] Personal communication with David Lind, YN Biologist and Lisa Wilson, USFWS' TNWR Manager.

channel and inundate the floodplain at flows above approximately 500 cfs.[2] The flood plain is flooded annually to varying extents, but flooding over levees into wetlands is less common and requires a higher flow. All of the wetlands are managed as flow-through systems with flashboard risers, so, once full, the same amount of water that enters the wetland must leave over the boards at the outflow. Wetland units are flooded by the time the majority of smolts arrive, so smolts are not moving into units without an outflow.

As floodwaters recede in spring, water control structures with flashboard risers allow the managers to retain water in selected units until April 1, when refuge mangers remove flashboards in potential fish-bearing wetlands to provide free-flowing passage. When water is held in wetlands, it is kept at 6- to 18-inch depths to prevent the growth of invasive reed canary grass. Prior to this consultation, wetlands were “drawn down” or dewatered, sometime between April 1 and June 15. Past water management at TNWR has focused on filling wetlands in the fall to hold water from October through May for migratory, breeding, and brooding water birds, which is the refuge purpose. Future water management will require that flashboards in potential fish-bearing wetlands are removed by April 1 to improve conditions for outmigrating smolts while still providing waterfowl habitat.

The screened pumping station at Toppenish Creek provides water to Gamble Ditch along the north boundary of the refuge. This water is the primary source for wetland units 5–8 and 9c and 9d. Lateral C is a side channel to Toppenish Creek that moves water when Toppenish Creek is above 40 cfs, depending on other conditions. Lateral C supplies unscreened water to 9a, 9b, and the 10 wetlands. Snake Creek provides water to the unit 2, 3, and 4 wetlands. The unit 2 wetlands are fed through an unscreened culvert. Wetlands 3a and 4 are supplied with Snake Creek water through a paddlewheel driven fish screen. Snake Creek then runs unscreened through wetlands 2a, 2b, and 3b where flashboards retain the flow before it returns to Toppenish Creek. During high flow events in the winter and spring, fish may enter various wetlands when flows exceed the channel capacity of Toppenish Creek, over spillways, levees and roads. It is estimated that this “overtopping” begins at 500 cfs[3] . In any wetland units that might possibly have fish, whether due to a flood event or an unscreened intake, boards are pulled, as flow into the unit decreases in spring/summer to encourage fish to move out of the unit[4].

Refuge wetlands are usually filled as much as possible using WIP system water, beginning in late September. After October 1, water is also pumped from Toppenish Creek, when flows are greater than 30 cfs, to fill wetlands north of Toppenish Creek (see Figure 1 above). Toppenish Creek then flows through the refuge between wetland units; it does not flow directly through any wetlands as Snake Creek does. Managers fill the units south of Toppenish Creek with flows from Snake Creek as flows increase in the late winter and spring; upstream withdrawals for irrigation and private waterfowl ponds within Toppenish Creek affect how much water reaches Snake Creek, and withdrawals in Snake Creek control when and how much Snake Creek water reaches the refuge. There is no minimum instream flow agreement on Snake Creek.

[2] Personal communication with Dr. J. Romine, USFWS research fish biologist at TNWR, September 2018.
[3] Personal communication with D. Lind, Yakama Nation Fisheries Biologist, September 2018
[4] Electronic communication with L. Wilson, TNWR Manager, September 2018.

This opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features (PBFs) essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214).

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) replace this term with PBFs. The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

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

1) Identify the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
2) Describe the environmental baseline in the action area.
3) Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
4) Describe any cumulative effects in the action area.
5) Integrate and synthesize the above factors by: (1) reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
6) Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.
7) If necessary, suggest a reasonable and prudent alternative (RPA) to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

The status of MCR steelhead is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The condition of critical habitat throughout the designated area is determined by the current function of the essential PBFs that help to form that conservation value.

The MCR steelhead Distinct Population Segment (DPS) is comprised of 20 independent populations (17 extant) within four major population groups (MPGs) in Washington and Oregon. Having multiple viable populations makes a DPS less likely to become extinct from a single catastrophic event (ICTRT 2007; Spence, B.C. et al. 1996). NMFS expresses the status of a DPS in terms of the status and extinction risk of its individual populations, relying on McElhaney et al.'s (2000) description of a viable salmonid population. The four parameters used to evaluate the viability of a salmonid population are abundance, productivity, spatial structure, and diversity. The recovery plan for MCR steelhead (NMFS 2009; SRSRB (Snake River Salmon Recovery Board) 2011) describes these four parameters in detail, and the parameter values needed for persistence of individual populations and for recovery of the DPS. Only one MPG, the Yakima River MPG, is exposed to the effects of the proposed action.

Tables 2 and 3 summarize the status and available information for the MCR steelhead DPS and the Yakima River MPG, based on detailed information on the status of individual populations, and the species as a whole, provided by the ESA Recovery Plan for MCR steelhead DPS (NMFS 2009), 2016 5-Year Review: Summary & Evaluation of MCR steelhead (NMFS 2016), and Status Review Update for Pacific Salmon and steelhead Listed under the Endangered Species Act: Pacific Northwest (NWFSC 2015). These three documents are incorporated in the following tables by reference.

Table 2. Listing classification and date, status summary (from recovery plan, update and status review) and limiting factors for Middle Columbia River (MCR) steelhead.

Species	Listing & Classification Date	Status Summary	Limiting Factors
MCR steelhead	Threatened 3/25/1999; Reaffirmed 8/15/2011	Distinct Population Segment is composed of 20 populations classified into four major population groups with one functionally extirpated[5] population, the White Salmon River, and two extinct[6] populations, the Crooked River and the Willow Creek populations. According to the 2015 Northwest Fisheries Science Center status review and the Interior Columbia Basin Technical Recovery Team viability criteria, four populations are considered at high risk of extinction, one population is at moderate risk, five are rated as viable, one is highly viable and six are maintained. The majority of natural MCR steelhead populations are rated at moderate risk for abundance and productivity, and low to moderate risk for spatial structure and diversity.	Limiting factors identified for MCR steelhead include (1) hydropower system mortality at mainstem Columbia River dams, (2) reduced streamflow in tributaries, (3) impaired passage in tributaries, (4) excessive fine sediment in stream substrates, (5) degraded water quality, and (6) altered channel morphology (NMFS 2005a).

[5] Extirpated: Locally extinct. Other populations of this species exist elsewhere. Functionally extirpated populations are those of which there are so few remaining numbers that there are not enough fish or habitat in suitable condition to support a fully functional population.
[6] Extinct: No longer in existence. No individuals of this species can be found.

Table 3. Summary of the Middle Columbia River steelhead population status (ICTRT 2007) Abundance/Productivity and Spatial Structure/Diversity metrics for recovery of the Yakima River Major Population Group [adapted from (NWFSC 2015, Table 37)]. Toppenish Creek is shown in **bold**.

Population	ICTRT Minimum Abundance Threshold	Natural Spawning Abundance	Productivity (returns-per-spawner) 2000–2009[c]	Integrated Abundance/ Productivity Risk[c]	Integrated Spatial Structure/Diversity Risk	Overall Viability Rating
Satus Creek	1,000 (500)	1127	1.93	Low	Moderate	Viable
Toppenish Creek	**500**	**516**	**2.52**	**Low**	**Moderate**	**Viable**
Naches River	1,500	1,244	1.83	Moderate	Moderate	Moderate
Yakima R. Upper Mainstem	1,500	246	1.87	Moderate	High	High Risk

The proposed action occurs in the Toppenish Creek watershed, which supports the Toppenish Creek MCR steelhead population. Taken as a whole, the available data indicate that although short-term increases in abundance have been observed in some MPGs of the DPS, long-term productivity problems related to the failure of natural MCR steelhead stocks in a few populations to replace themselves continue. Known reduction in spatial structure, and likely loss of genetic diversity, are all contributing to hamper the attainment of viability for the entire DPS in the immediate future. The Yakima River MPG does not meet viability criteria because the integrated spatial structure and genetic diversity risk of the Satus Creek, Toppenish Creek and Naches River populations are considered moderate, respectively, while the overall risk to the Upper Yakima River population is high (NWFSC 2015). Two of the four populations' abundance and productivity risk are low (including Toppenish Creek), and two are moderate. At the current time, Satus and Toppenish creeks have a 5 percent risk of extinction over the next 100 years, the Naches River population extinction risk is up to 25 percent, and the Upper Yakima River population extinction risk is greater than 25 percent.

2.2.1 Range-wide Status of Critical Habitat

Table 4 summarizes the critical habitat for MCR steelhead using information on the status of critical habitat for MCR steelhead described in the recovery plan for the species (NMFS 2009), incorporated by reference here. NMFS designated those habitats presently occupied by a particular species and containing PBFs that are essential to support one or more of the life stages of steelhead. The PBFs of freshwater migration, spawning and rearing sites include migratory access for adults and juveniles, water flow, water quality, temperature conditions, and suitable substrate for spawning and incubation, as well as cover, forage and floodplain connectivity for rearing. The current ability of these features to function properly varies across the landscape from poor in areas of high industrial or agricultural development to excellent in headwater wilderness areas (NMFS 2005b; Spence, B.C. et al. 1996; Wissmar, R., C. et al. 1994).

Table 4. Critical habitat, designation date, Federal Register citation, and status summary for critical habitat considered in this opinion.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Middle Columbia River steelhead	9/02/05 (70 FR 52630)	Irrigation withdrawals, over-allocation of flows, removal of riparian vegetation, wetland draining and conversion, livestock grazing, dredging, road construction and maintenance, logging, mining, and, to a limited extent, urbanization have reduced tributary stream flows, impaired passage in tributaries, increased sediment delivery to stream channels, altered stream morphology (i.e., channel modifications and diking), degraded water quality, and generally degraded critical habitat throughout much of the Interior Columbia Recovery Domain. The action area for this project is contained within the Lower Toppenish Creek watershed, which provides 14.1 miles of freshwater spawning/rearing physical and biological features (PBFs), and 116 miles of migration/presence PBFs (NMFS 2005b). The Critical Habitat Analytical Review Team (CHART) concluded the Lower Toppenish Creek has a medium conservation value because the PBFs in this watershed are more degraded than upstream watersheds. However, CHART also noted that this fifth-field hydrologic unit code provides an important migration corridor to high value spawning and rearing habitat upstream.

Toppenish Creek and Snake Creek in the action area are designated MCR steelhead critical habitat, serving primarily as a migration corridor to and from quality upstream spawning and rearing habitat. Steelhead are not known to spawn near or downstream of the TNWR, and summer water temperatures in the subject reach of Toppenish Creek are not suitable for rearing. Juveniles do descend into the lower reaches of Toppenish Creek and beyond during the winter. Within the action area, the primary areas of use by MCR steelhead include the Toppenish and Snake Creek channels, 2a, 2b, and 3b wetlands.

The freshwater PBFs present in the action area relevant to this consultation are for migration and rearing, as listed below in Table 5. The condition of these PBFs in the action area is discussed in greater detail in the Environmental Baseline section, which follows. The O&M of the TNWR affects all of the freshwater PBFs listed in Table 5, below.

Table 5. Critical habitat physical and biological features (PBFs) relevant to this consultation.

PBF Site	PBF Characteristics	Species Life Stage
Freshwater rearing	Water quantity, floodplain connectivity	Juvenile growth and mobility
	Water quality, forage	Juvenile development
	Natural cover	Juvenile mobility and survival
Freshwater migration	Free of artificial obstructions, water quality and quantity, natural cover	Juvenile and adult mobility and survival

The physical and biological attributes of MCR steelhead critical habitat in the Columbia River Basin mainstem corridor are altered by the construction and operation of water storage and hydropower projects, including the run-of-river dams on the mainstem lower Snake and lower Columbia rivers. These alterations have affected juvenile migrants to a much larger extent than adult migrants. However, changing temperature patterns have created passage challenges for summer migrating adults in recent years, requiring new structural and operational solutions (i.e., cold water pumps and exit "showers" for ladders at Lower Granite and Lower Monumental dams). Actions taken since 1995 that have reduced negative effects of the hydrosystem on juvenile and adult migrants include:

- Minimizing winter drafts (for flood risk management and power generation) to save water for augmenting spring flows during the peak juvenile passage period (water quantity).
- Releasing additional water from storage to augment flows for juvenile and adult summer migrants (water quantity).
- Releasing water from Dworshak Dam to reduce peak summer temperatures in the lower Snake River (water quality).
- Constructing juvenile bypass systems and "surface passage" structures, and providing spill at the run-of-river dams to divert smolts, steelhead kelts, and adult salmon falling back downstream away from turbine units (safe passage).
- Maintaining and improving the ladders used by adult salmon and steelhead (safe passage).

Another factor affecting the rangewide status of MCR steelhead and aquatic habitat in the Columbia River Basin is climate change. Several studies have revealed that climate change has the potential to affect ecosystems in nearly all tributaries throughout the state (Battin, J. et al. 2007; ISAB 2007; Mote, P. et al. 2014). While the intensity of effects will vary by region (ISAB 2007), most models project warmer air temperatures, increases in winter precipitation, and decreases in summer precipitation (Luce, C.H. et al. 2013). Warmer air temperatures will lead to more precipitation falling as rain rather than snow. As the snow pack diminishes, seasonal hydrology will shift to more frequent and severe early large storms, changing streamflow timing and increasing peak river flows, which may limit salmonid survival (Luce, C.H. et al. 2013; Mantua, N. et al. 2009). The largest driver of climate-induced decline in salmonid populations is likely to be the impact of increased winter peak flows, which scour the streambed and destroy salmonid eggs (Battin *et al.* 2007).

Higher water temperatures and lower spawning flows, together with increased peak flows, are all likely to increase salmon and steelhead mortality in the Toppenish Creek and throughout the region. As harmful warm water temperatures become more widespread, juvenile salmonids may increasingly rely on confluences of colder tributaries or other areas of cold-water refugia (Mantua *et al.* 2009). Such changes are likely to make it more challenging to conserve diverse salmonid life histories, as the stream-type salmonid life history appears to be dependent on a diminishing habitat (Beechie, T. et al. 2006).

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area is TNWR in the Lower Toppenish Creek watershed and extends from the location where Snake and Toppenish creeks enter the boundaries of the refuge downstream approximately 12 miles to the confluence of the Yakima River. The management of flows on the refuge influences juvenile passage on the refuge during downstream migration and the amount and type of fish habitat both on the refuge and downstream to the Yakima River.

2.4 Environmental Baseline

The “environmental baseline” includes the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

Toppenish Creek enters the Yakima River at Yakima River Mile (RM) 80.4, and supports one of four MCR steelhead populations in the Yakima River subbasin. Snake Creek is a distributary of Toppenish Creek originating several miles upstream of the refuge and rejoining Toppenish Creek within the refuge at approximately Toppenish RM 12.5. Both Toppenish and Snake creeks are designated critical habitat for MCR steelhead.

Threats and limiting factors for the Toppenish Creek steelhead population are described in the 2009 Yakima Steelhead Recovery Plan (Yakima Basin Fish and Wildlife Recovery Board 2009) and the 2016 5-Year Status Review (NMFS 2016). The primary threats affecting conditions in the action area are upstream diversions of water for agriculture and ongoing and historic land management practices, including grazing, logging and use by the TNWR to create and maintain wetlands for waterfowl. Diversions for irrigation uses have reduced flows in both Toppenish and Snake creeks, particularly during the low-flow season, which can begin as early as mid-May and extend into December, resulting in higher water temperatures and reduced channel area available when juveniles are actively migrating in the spring or rearing year-round. Grazing and development of the TNWR have displaced what was once a large alluvial fan that likely contained diverse channel and floodplain habitats which would have provided excellent rearing and refuge habitat for steelhead. The majority of the alluvial fan is now occupied by agriculture and the TNWR, isolating most of the floodplain from the creeks with levees and transportation infrastructure.

Effects of water withdrawals and floodplain development in the action area include: (1) reduced water quality, including increased temperatures and pollutants from agricultural and grazing practices; (2) floodplain development resulting in extensive restriction of the channel migration zone, reducing or eliminating the development and maintenance of diverse in-channel habitat, the amount and functional integrity of riparian vegetation that contribute food, shade, large woody debris, and overhead cover to fish, impairing or preventing normal water, vegetation, and nutrient and sediment exchange between the main channel and off-channel habitats; (3) water management to create and maintain wetland habitat for the express benefit of waterfowl, thereby reducing or eliminating development of off-channel or rearing habitat and increasing the risk of entrainment of smolts within the wetlands of the TNWR, and increased exposure of juvenile salmonids to predation during outmigration through the TNWR wetlands.

The action area is used by MCR steelhead adults for migration and juveniles for migration and limited rearing. Juvenile MCR steelhead can be found in Toppenish and Snake creeks year-round where flows and temperatures are acceptable; however, temperatures and dissolved oxygen (DO) levels within the refuge are unacceptable for juveniles, starting as early as May and extending into the fall until irrigation withdrawals upstream are curtailed or precipitation increases flows. Prior to this consultation, refuge management actions restricted the functionality of rearing habitat as seasonal temperatures increased in the spring and overall out-migration habitat for juvenile salmonids by retaining flows past April 1. Adult MCR steelhead generally move upstream from the Yakima River to spawning areas upstream of the refuge as early as January, if precipitation has caused flows to increase and movement continues as late as May, again based on flows. The entire Toppenish Creek MCR steelhead population migrates through the TNWR to access over 100 miles of good- to high-quality upstream spawning and rearing habitat. Overall, the Lower Toppenish Creek watershed is of moderate value, primarily providing a critical migration corridor to the high-value Upper Toppenish Watershed. The Toppenish Creek MCR steelhead population is a critical component of the Yakima River MPG.

Figures 1 (above) and 2 (below) show the path of Toppenish and Snake creeks through the refuge. The main channel of Toppenish Creek does not flow through any wetlands but still provides a direct path of migration through the refuge, all diversions are screened. However, Snake Creek does flow unscreened through wetlands 2a, 2b, and 3b (see Figures 1 and 3).

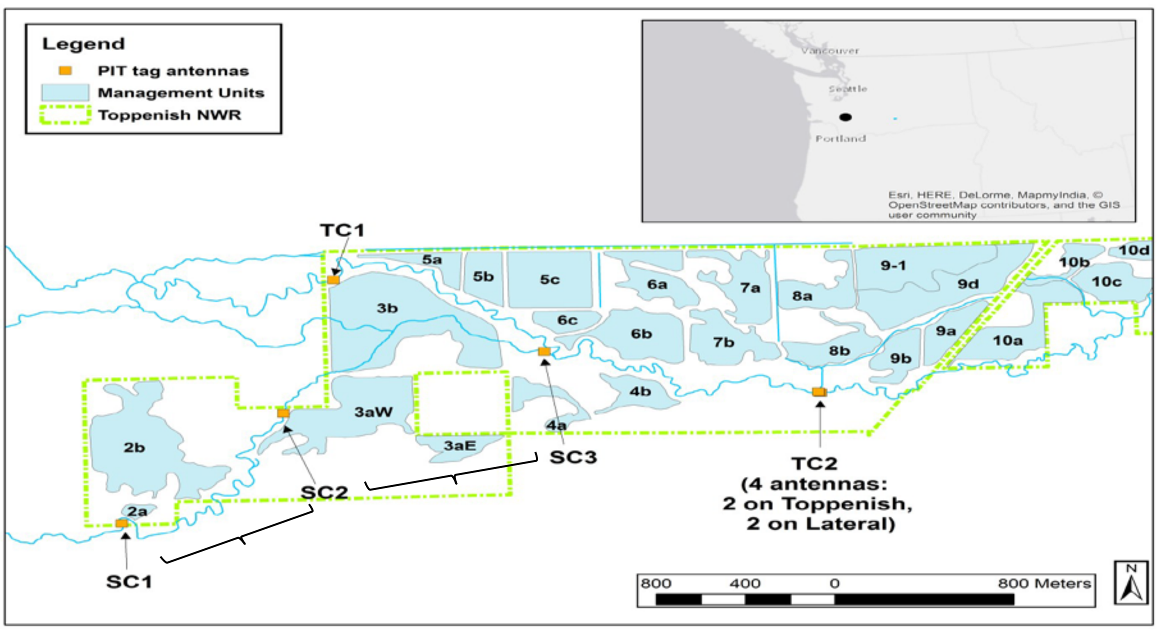

Figure 2. Location of PIT-tag antennas on the Toppenish National Wildlife Refuge during 2017–2018. SC1 is where Snake Creek enters the refuge at wetland 2a, and SC3 is on Snake Creek after it leaves wetland 3b, just before it rejoins Toppenish Creek. TC1 is where Toppenish Creek enters the refuge, and TC2 is where flow from the north side of the creek reenters Toppenish Creek. The U.S. Fish and Wildlife Service survival estimates were 0.942 between SC1 and SC2, and 0.701 between SC2 and SC3. (Randall, R. et al. 2018).

Data collected between by the USFWS and the YN between October 12, 2017, and June 2, 2018, indicate that temperature in Toppenish and Snake creeks on the refuge exceeded 68°F (with corresponding declines in DO below 6 parts per million) by late April (Randall, R. et al. 2018). In the first week of May of 2018, juvenile survival in Snake Creek wetlands dropped 10 percentage points as water temperature exceeded 68 °F and DO declined below 6 ppm in wetland 3b (Randall, R. et al. 2018).

Between October 12, 2017, and June 2, 2018, the USFWS and the YN PIT tagged and released 1,473 juvenile MCR steelhead several miles upstream of the TNWR (Figure 2). Tagged juveniles were tracked through the refuge in both Snake Creek and Toppenish Creek with survival estimates of juveniles using Snake Creek ranging from 0.942 and 0.701 (Figure 3) and 0.953 in Toppenish Creek (Table 6) (Randall, R. et al. 2018)

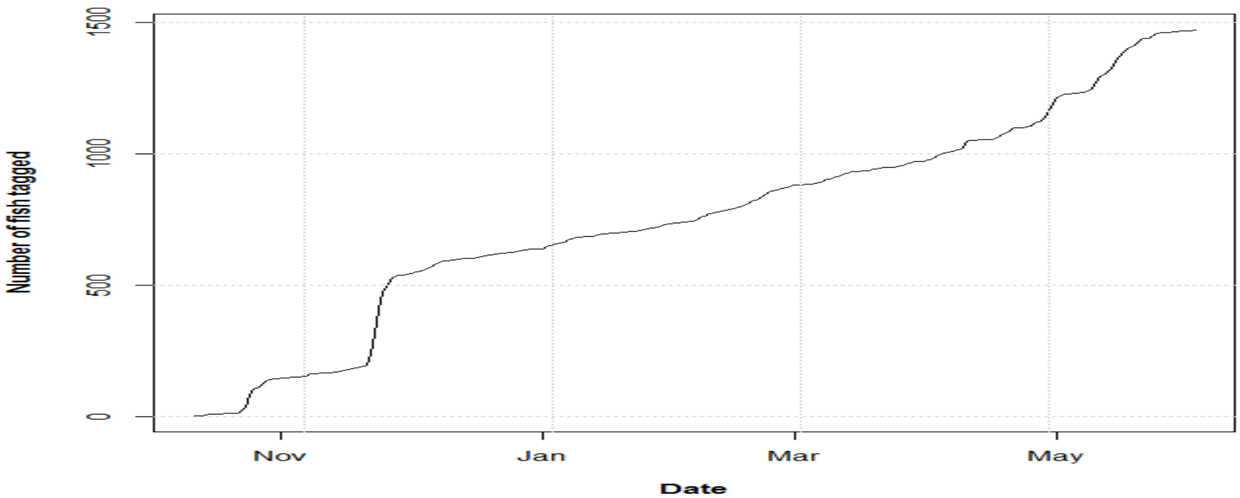

Figure 3. Total number and timing of smolts tagged in Toppenish Creek in 2017–2018 (Randall, R. et al. 2018).

The 2017–2018 PIT-tagging and detection study indicates that the number of out-migrating steelhead juveniles entering the refuge begins increasing in early April (Figure 4) and peaks in May when those using Snake Creek pass through wetlands 2a, 2b, and 3b (Figure 2) before rejoining Toppenish Creek and leaving the refuge.

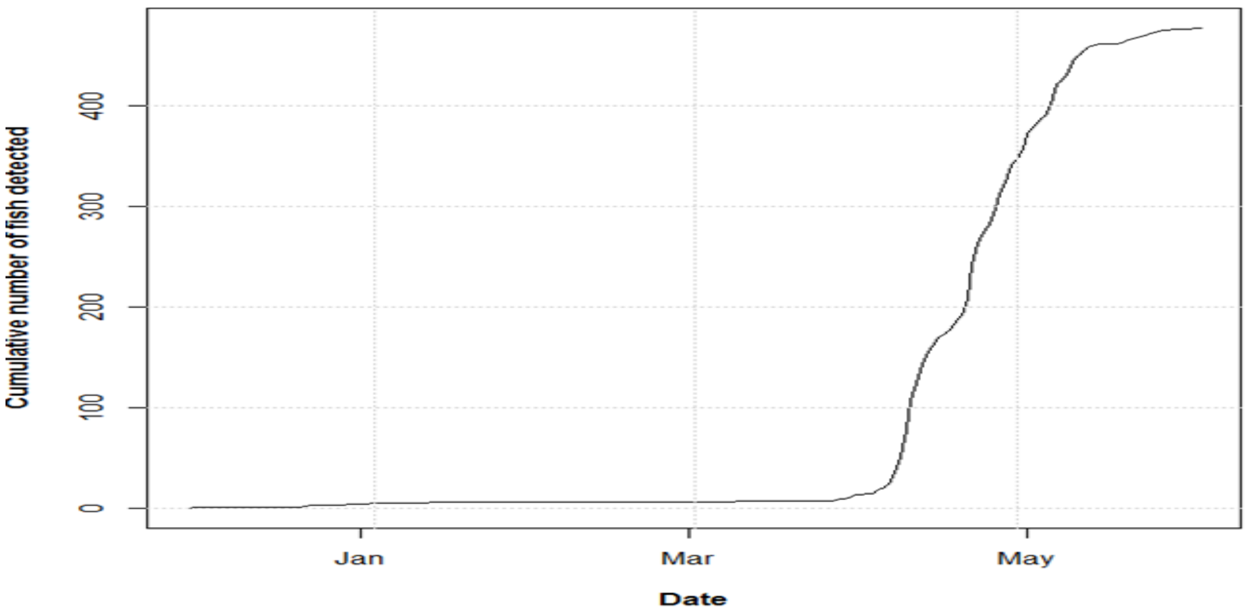

Figure 4. The U.S. Fish and Wildlife Service 2017–2018 PIT-tagging results of the timing of juvenile steelhead arrival at the uppermost end of the Toppenish National Wildlife Refuge (Randall, R. et al. 2018).

Between October 12, 2017, and June 2, 2018, the USFWS and YN PIT tagged and released 1,473 juvenile steelhead several miles upstream of the TNWR. Of the tagged juveniles, 477 (33 percent) were detected entering the refuge and 188 (13 percent of original number tagged) of the 477 that reached the refuge (39 percent) were also detected downstream of the refuge (Table 6).

Table 6. Survival estimates through the refuge and standard error of juvenile Middle Columbia River steelhead from the tagging location on Toppenish Creek, several miles upstream of the refuge through the refuge. High flows in the spring of 2017 overtopped levees, bypassed tagging antennae, and prevented accurate data collection for the entire spring outmigration. The 2018 spring flows allowed a complete outmigration survey (Randall, R. et al. 2018).

Data Collection Year	Convenience Function	Survival Estimate (SE)
2018	Release to Refuge Exit	0.0304 (0.016)
	Snake Creek on Refuge (Wetland 3b)	0.660 (0.045)
	Toppenish Creek on Refuge	0.953 (0.040)
2017 (high flows prevented a full and accurate collection of data)	Release to Refuge Exit	0.267 (0.058)
	Snake Creek on Refuge (Wetland 3b)	0.188 (0.128)
	Toppenish Creek on Refuge	0.657 (0.157)

Total travel times for juveniles after entering the refuge was more than four times longer for fish using the Snake Creek route through wetlands 2a, 2b, and 3b (Table 7) than for those using Toppenish Creek, which does not pass through any wetlands. The increased travel time increases the amount of time that juveniles are exposed to predation and declining conditions of water temperature and DO. After passing through the TNWR, there is no difference in survival between the juveniles that traveled down Toppenish Creek and those that traveled down Snake Creek and through the refuge wetlands.

Table 7. Total travel times for juvenile outmigrants through the TNWR average 27.8 hours for fish in Snake Creek and 6.19 hours for fish using Toppenish Creek (Randall, R. et al. 2018).

Location	**Average Travel Time in Days**	**Minimum**	**Maximum**	**N**
SC1 to SC2	0.400	0.077	2.93	85
SC2 to SC3	0.581	0.072	16.339	62
SC3 to TC2	0.119	0.037	0.776	51
TC1 to TC2	0.255	0.068	5.39	234

Observations by TNWR and YN biologists have documented that flows above an estimated 500 cfs can carry water into potential wetland areas of the refuge that are not ordinarily used by anadromous fish. According to refuge managers, fish are able to escape all the wetlands on the refuge, including the wetlands that do not normally support fish. Between 2008 and 2017, flows over 500 cfs occurred 8 out of 10 years (Table 8). Flows over 500 cfs have occurred as early as October, lasting for a day or two, but more frequently between January into early June, and remained at those high levels for a week up to almost 8 weeks in 2017, potentially stranding outmigrating juveniles. In 2018, refuge managers installed additional flow gages to monitor the amount of flow entering the refuge. The USFWS will use future flow measurements to develop a rating curve for Toppenish Creek and to compare with visual observations of both creeks to determine when the levees are overtopped and the potential for stranding outside the channels takes place.

Table 8. Days of flows over 500 cfs at Indian Church Road from 2008 through 2017 (preliminary data, Yakama Nation 2018) Items in *italics* indicate times periods when juvenile Middle Columbia River steelhead are actively migrating downstream.

Data Year	**Days of Flows Over 500 cfs**
2009	*April 15 and 16*
2011	January 19 to 24; *April 3 to 11; April 21 to 24; May 15 to June 6*
2012	November 6 to 12 and 21 to 28; December 11 to 13; January 3 to 7 and 11 to 14; February 21 to March 1; March 5 to 9
2013	March 29 to *April 10; May 1, and May 28*
2014	Oct 2; March 10 to16
2015	Mar 11 to 16
2016	Feb 19 to 25; Mar 9 to 22; *April 13 to 18*
2017	Feb 19 to Mar 3; *Mar 5 to May 4*

2.5 Effects of the Action

"Effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but are reasonably certain to occur.

Adult MCR steelhead are observed moving upstream in the Yakima River (Prosser Dam) from September through early May, with the peak in October and November. These adults will generally hold in the Yakima River until flows in Toppenish Creek increase and water temperatures decrease with winter precipitation, before moving upstream through Toppenish and occasionally through Snake creeks. Thus, adult presence on the refuge is limited to mid-to-late winter when flows increase and they are unlikely to spend any time holding on or near the refuge.

Because juvenile MCR steelhead spend up to 2 years in freshwater, they could use the TNWR for rearing whenever passage, flow and temperate conditions are appropriate. Normal low summer flows are exacerbated by irrigation withdrawals, thus rearing conditions on the refuge, (temperature, DO, and flow) are unacceptable for juveniles from as early as mid-May until after irrigation withdrawals end for the season, and often not until late November or December. During late winter and early spring, it is common for juveniles to begin moving downstream, holding and rearing while waiting for the high spring flows to move out of the watershed. Juvenile rearing in the action area is primarily a function of water temperature, DO, and flow.

Adult steelhead are unlikely to be in the action area during the summer and fall because of high water temperatures in both Toppenish and Snake creeks as well as the Yakima River. Adults will remain downstream in the Columbia River until tributary water temperatures decrease and flows increase, generally late fall, at the earliest.

Steelhead prefer water temperatures of 48 to 56°F. Temperatures of 70°F and above usually present a migration barrier for adults. Juvenile steelhead can accept slightly higher temperatures than adults but temperatures approaching 75°F are lethal. Therefore, adults and juveniles are not always present in the action area at the same time or exposed to the same O&M actions on the refuge.

The 2017–2018 study also indicated that the operation of the TNWR prior to this consultation resulted in a survival rate of approximately 66 percent of juveniles that used Snake Creek and 95 percent of juveniles that used Toppenish Creek to pass through the refuge (Table 6). The 2017–2018 study indicated that the greatest area of mortality for out-migrating juveniles on the refuge is in Snake Creek and primarily within wetland unit 3b (Table 6). With the caveat that those numbers only represent 1 year of data collection, they suggest much poorer downstream passage and survival of juvenile MCR steelhead smolts using the Snake Creek route than those that use Toppenish Creek.

Figures 1 and 3 (above) show the path of Toppenish and Snake creeks through the refuge. Water is diverted from Toppenish Creek though screened structures and into wetlands on the north side of the creek. The main channel of Toppenish Creek does not flow through any wetlands but still provides a direct path of migration through the refuge. However, Snake Creek does flow unscreened through wetlands 2a, 2b, and 3b.

2.5.1 Effects on Species

Change in Flow Management

Toppenish Creek enters the refuge on the northwest and flows east between the managed wetlands unimpeded, with screened flows diverted October 1 to April 1 to support wetlands on the north side of the creek. Snake Creek enters the refuge from the southwest and flows east unscreened through wetlands 2a, 2b, and 3b, and screened through wetland 3a. After leaving the east side of wetland 3b, Snake Creek rejoins Toppenish Creek.

As described in the proposed action, prior to consultation, flashboard risers were installed on October 1, and not removed until late May or June, to hold back flows in the direct path of outmigration, well past the time that juveniles enter the refuge on their downstream migration, and past the water right date for diversion (Figure 2, above). These flow restrictions can disguise or eliminate flow cues within the wetlands, delaying and/or confusing juveniles trying to move downstream. Such delays not only impede migration but increase the amount of time juveniles are exposed to the risk of predation. Movement delays also increase the risk of exposure to high water temperatures and low DO. Beginning in the spring of 2019, the USFWS will begin pulling flashboards on April 1, to provide better passage for juvenile out-migrants arriving and those already in the Snake Creek route, through wetlands 2a, 2b, and 3b.

NMFS expects survival of juveniles to improve, because smolts will encounter a lotic rather than a lentic environment, with a defined thalwag and increased depth relative to the surrounding wetland. This is expected to speed their movement thought the refuge wetlands, thus reducing both the length of time for exposure to predators and conditions that favor predators and exposure to declining water quality. As documented in the USFWS and YN 2017–2018 study, juvenile MCR steelhead experience some degree of mortality during passage through the TNWR in both Toppenish and Snake creeks, believed to be as a result of predators and declining water quality in the spring (Table 6). NMFS believes the higher mortality experienced by smolts using the Snake Creek route is heavily influenced by the past practice of retaining flows in wetlands 2a, 2b, and 3b until late May or early June.

Juvenile outmigrant travel times (Table 7) through the refuge were tracked in 2017 and 2018, and those that used the Snake Creek route took an average of 27.8 hours to pass through wetlands 2a, 2b, and 3b, and reach the downstream end of the refuge. Juveniles that used the Toppenish Creek route, which does not pass through any wetlands, spent an average of 6.12 hours to move through the refuge. The increased time required to move through the Snake Creek route results in increased time spent exposed to predators and, as the season progresses, the increased likelihood of experiencing higher water temperatures and lower DO for a greater length of time. Both increased risk of predation and declining water quality are believed to be the driving forces behind the lower survival of juveniles that use the Snake Creek route than those that use Toppenish Creek[7] (Table 6). Once all the tagged juveniles left the refuge, there was no differential survival downstream (Randall, R. et al. 2018). The tagging and tracking study will be repeated in 2018–2019 to detect any change in travel times or survival from the revised management action.

[7] Personal communication with Dr. J. Romine, research biologist on the TNWR, August 2018.

The changes in management to allow Snake Creek to function as a lotic system after April 1 is expected to increase survival rates for juveniles using the Snake Creek route. We anticipate that the mortality rate of juvenile MCR steelhead migrating through the Snake Creek path of the TNWR will improve, to mimic the mortality rate of juveniles that use the Toppenish Creek route through the refuge, which has no barriers or wetlands (see Table 6).

Adult MCR steelhead are not likely to be affected by the new timing for removal of flashboards. The majority of adult steelhead moving upstream use Toppenish Creek (one anecdotal account of an adult in Snake Creek within last 10 years). There are no artificial barriers to upstream migration in Toppenish Creek, and the flashboards in the wetlands fed by Snake Creek are not high enough to be a barrier to adult steelhead movement, if that route is used. NMFS does not expect the management of the flashboards to affect adult MCR steelhead.

Mowing

The mowing of various wetland units will only occur when the areas are dry and no fish are present. Therefore, NMFS does not expect mowing to affect MCR steelhead.

Disking/Tilling

Any disking or tilling activities will only occur when the wetland areas are dry and no fish are present. Therefore NMFS does not expect disking or tilling to affect MCR steelhead.

Pesticides

Use of herbicides in wetland units occurs mainly during the summer and fall when plants are actively growing and pond bottoms are dry. Of the herbicides listed for use in wetland bottoms, 2,4-D is toxic to fish and aquatic invertebrates, and cannot be used in or over water. Application of these herbicides on TNWR could result in direct and indirect physical harm or death if spills or applications occur where chemicals can reach streams, and adult or juvenile steelhead are present.

There are three basic ways that pesticides can adversely affect steelhead and their habitat. These are (1) a direct toxicological impact on the health or performance of exposed fish, (2) an indirect impairment of the productivity of aquatic ecosystems, and (3) a loss of aquatic vegetation that provides physical shelter for fish. The analysis of the effects of herbicides on salmonids is evaluated in this opinion by assessing the likelihood that listed fish and other aquatic organisms will be exposed to the herbicides, reviewing the toxicological effects of the chemicals on listed fish and other aquatic organisms, and qualitatively assessing the ecological risk based on the exposure risk and toxicity.

Fish kills are rare when pesticides are used according to their labels. For fish, the vast majority of effects from pesticide exposures are sublethal. Sublethal effects are a concern if they impair the physiological or behavioral performance of individual animals in ways that will decrease their growth or survival, alter migratory behavior, or reduce reproductive success. In addition to early development and growth, key physiological systems affected include the endocrine, immune, nervous, and reproductive systems. Many pesticides have been shown to impair one or more of these physiological processes in fish (Moore, A. and C.P. Waring 1996).

The pathways where herbicides can reach aquatic habitats include spray drift or volatilization, wind-blown soils, surface water runoff, percolation, groundwater contamination, and direct application. The likelihood of herbicides entering the water depends on the type of treatment and mode of transport. Spray drift is largely dependent on droplet size, elevation of the spray nozzle, and wind speed (Rashin, E. and C. Graber 1993). The refuge proposes to spot spray herbicides on small, scattered areas of weed infestations with hand-held backpack sprayers, prohibit spraying when wind speeds are projected to exceed 5 mph and with gusts over 10 mph, or temperatures exceed herbicide application recommendations. Because of the method of application and strict environmental conditions under which any herbicides will be applied, it is unlikely that any spray or drift will enter any waterbody. Further, existing riparian vegetation around any waterbodies will aid in filtering or retarding the introduction of herbicides to any waterbody.

These application constraints will likely eliminate the chance that any herbicides will reach water through spray drift or volatilization or direct application. The likelihood of contamination of aquatic environments through windblown soils is also small considering that the areas where herbicides will be applied are vegetated, dense riparian vegetation surrounds the creek, and only small amounts of herbicides are applied each year. There is a minor possibility that herbicides could reach Toppenish or Snake creeks through surface water runoff, percolation, or groundwater contamination, and these will be further analyzed.

Surface runoff is a potential mechanism for herbicide transport to aquatic habitats from the proposed action, but the potential is minimized through timing spray activities to avoid precipitation and flooding, prohibiting herbicide applications during active irrigation of the pastures, and the use of "no-spray buffers" along stream courses. The no-spray buffers reduce the potential for chemicals to reach Toppenish or Snake creeks from overland flows that might otherwise carry herbicides directly into a stream. The use of riparian buffers for interrupting overland flows is well-established as an effective mitigation technique for reducing sediment delivery to streams, and the same mechanism would reduce delivery of herbicides from surface runoff. Overland flows occur when precipitation or snowmelt rates exceed the infiltration capacity of soils, which occurs infrequently in the action area. Overland flows can occur briefly during intense thunderstorms in summer, during the spring runoff period, or during extended rainy periods.

Spraying activities will occur when treatment areas are no longer susceptible to snow melt or extended rainy periods, and will not occur during active irrigation of wetlands. The proposed action includes provisions to suspend spraying when rain is likely to occur and reduces the likelihood of encountering rainfall. The action area is in an arid region and extended rainfall is rare. The area treated is also a fairly flat valley bottom floor that is covered with pasture grasses where the potential for overland flow is low.

Introduction of herbicides into a stream though percolation occurs when herbicides dissolve in water and, through gravity and capillary action, are transported through the soils into an aquifer connected to the stream channel. Water contamination through groundwater is a highly variable process and is not readily predictable. In general, the distance from the point where herbicides reach an aquifer to a stream likely affects the concentration of the herbicides reaching the particular stream. Herbicide concentrations in the aquifer are reduced through dilution, with increasing discharge as the aquifer approaches the stream and greater amount of contact with soil particles that may adsorb herbicide molecules. The vertical distance to the water table and soil types also affect herbicide transport through groundwater. Highly permeable soils with low organic content, such as alluvium and glacial till, provide little filtering or sorption, and rapidly deliver pollutants. Soils with high amounts of clays can be virtually impermeable, and large amounts of organic matter can bind herbicide molecules for long periods of time. Because the variables affecting transport of herbicides in groundwater are site-specific and highly variable, there is no particular buffer width that works equally well in all settings.

Pesticide movement ratings are derived from soil half-life, sorption in soil, and water solubility, and indicate the propensity for a pesticide to reach a stream through groundwater (Vogue, P.A. et al. 1994). Glyphosate is least likely to reach groundwater or move from the site, according to movement ratings, while metsulfuron and dicamba are highly mobile and are likely to be transported by runoff or percolation. All the herbicides proposed for use are susceptible to transport in groundwater or surface runoff, especially if applications are followed immediately by high rainfall events, or if the water table is relatively shallow. Although no-spray buffers can reduce the likelihood of water contamination from herbicides, there is no general rule to determine appropriate buffer widths. The buffer distances in the proposed action are based on the presumption that herbicides applied near water can more readily reach water than herbicides that are applied well away from the water, and the specific distances for ground-based spraying are based on practical weed control considerations. The effectiveness of no-spray buffers for preventing water contamination through runoff or percolation is generally unknown, but riparian vegetation is anticipated to provide some degree of filtering and sorption of herbicides in the event of an accidental spill or misapplication event.

Ecological Risk of the Herbicides Proposed for Use—2,4-D (Amine Salt Only)

Exposure. The herbicide 2,4-D is soluble in water, but it rapidly degenerates in most soils, and is rapidly taken up by plants. Mobility of 2,4-D ranges from being mobile to highly mobile in sand, silt, loam, clay loam, and sandy loam. Consequently, 2,4-D is likely to contaminate surface waters when rains occur shortly after application, but otherwise is likely to degrade or be taken up by plants before it reaches surface or ground water.

Toxicity. In rainbow trout (*O. mykiss*), tests of the 2,4-D dodecyl/tetradodecyl amine salt on several life stages yielded lethal concentrations (LC50s) [8] of 3.2 mg/L for fingerlings, 1.4 mg/L for swim-up fry, 7.7 mg/L for yolk-sac fry, and 47 mg/L for eggs (USFWS 1980). For Chinook salmon in the fingerling stage, tests of the dodecyl/tetradodecyl amine salt yielded a 96-hour LC50 of 4.8 mg/L and, at the yolk-sac stage, a 96-hour LC50 of 2.9 mg/L (USGS 2001).
Most of the potential sub-lethal effects from exposure to 2,4-D have not been investigated for endpoints important to the overall health and fitness of salmonids. Exposure to 2,4-D has been reported to cause changes in schooling behavior, red blood cells, reduced growth, impaired

[8] LC50s: The dose or concentration level of a chemical(s) at which 50 percent of the test sample is killed.

ability to capture prey, and physiological stress (Cox, C. 1994; Gomez, L. et al. 1998; NIH 2002a). Sublethal effects for the 2,4-D amine salt form at 5 mg/L include the reduction in the ability of rainbow trout to capture food (Cox 1994). Little et al. (1990) examined behavior of rainbow trout exposed for 96 hours to sublethal concentration of 2,4-D amine, and observed inhibited spontaneous swimming activity and swimming stamina.

Indirect Effects on Aquatic Organisms. The SERA (1998) report suggests that amine and acid formulations have relatively low toxicity to aquatic invertebrates and aquatic plants, although the effects are highly variable. Insect larvae are most susceptible to adverse effects, while zooplankton are the least susceptible. The EPA (1989) reported for the dimethylamine salt, an LC50 for grass shrimp of 0.2 mg/L. SERA (1998) concluded that some species of aquatic algae are sensitive to concentrations of approximately 1 mg/L of 2,4-D; however, low levels of the compound may stimulate algal growth in some species. Ester formulations have much greater toxicity, but are not proposed for use by refuge managers.

Ecological Risk of the Herbicides Proposed for Use—Imazapyr

Exposure. Imazapyr is an anionic, organic acid that is non-volatile, degrades through photolysis in clear shallow waters, and is both persistent and mobile in soil. Imazapyr is mainly present in anionic form at typical environmental pHs, and the behavior of the acid and salt forms are expected to be similar. Soil-to-water partitioning coefficients for imazapyr are low (ranging from 0.04 to 3.4), indicating that imazapyr will be mobile in surface waters. Imazapyr is soluble in water and has the potential to leach into ground water. For anionic compounds, sorption would tend to diminish with increasing environmental pH. Since imazapyr is not expected to sorb strongly to either soils or sediments, it is not expected to accumulate in benthic systems or bioconcentrate in fish. Imazapyr, under aerobic aquatic conditions has half-lives of 2.5 to 5.3 days.

Toxicity. There is minimal risk of direct acute effects to fish and aquatic invertebrates at maximum application rates. In addition, there are no chronic risks to fish and invertebrates; however, there is an uncertainty for estuarine/marine fish and invertebrates, since no toxicity data were available to observe the prolonged effects of imazapyr to estuarine/marine fish and invertebrates. Consequently, fish and invertebrates inhabiting surface waters adjacent to an imazapyr-treated field would not be at risk for adverse acute and/or chronic effects on reproduction, growth and survival when exposed to imazapyr directly or in residues in surface runoff and spray drift as a result of ground and/or aerial spray application. Risk to benthic organisms is also not likely, based on the available toxicity data and that imazapyr is not expected to accumulate in benthic systems.

Ecological Risk of the Herbicides Proposed for Use – Imazamox

Exposure. Imazamox is a systemic herbicide that moves throughout the plant tissue and prevents plants from producing a necessary enzyme, acetolactate synthase, which is not found in animals. Susceptible plants will stop growing soon after treatment, but plant death and decomposition will occur over several weeks. Imazamox is only moderately persistent, and it degrades aerobically in the soil to a non-herbicidal metabolite that is immobile or moderately mobile. Imazamox also degrades by aqueous photolysis. Imazamox is metabolized under aerobic soil conditions. The degradation products are not herbicidal. Loss from hydrolysis, photo decomposition, and/or volatilization: Imazamox is hydrolytically stable at pH 5, 7, and 9. Photo degradation is rapid in water (half-life of 6.8 hours) but slow on soil. Volatilization is not significant. Resultant average persistence: The range of dissipation half-lives is 15 to 130 days with the more representative half-lives appearing to be 35 and 50 days. The limited persistence will restrict much of imazamox from reaching ground water (EPA 1997).

Toxicity. Laboratory tests using rainbow trout, bluegill, and water fleas (*Daphnia magna*) indicate that imazamox is not toxic to these species at label application rates. Imazamox is rated practically non-toxic to fish and aquatic invertebrates. Imazamox does not bioaccumulate in fish.

Ecological Risk of the Herbicides Proposed for Use—Glyphosate

Exposure. Glyphosate is strongly adsorbed to most soils, and dissolves easily in water. The potential for leaching is low due to the soil adsorption; however, glyphosate can move into surface water when the soil particles to which it is bound are washed into streams or rivers (EPA 1993). Studies examined glyphosate residues in surface water after forest application in British Columbia, with and without no-spray streamside zones. With a no-spray streamside zone, very low concentrations were sometimes found in water and sediment after the first heavy rain.

Biodegradation represents the major dissipation process. After glyphosate was sprayed over two streams in the rainy coastal watershed of British Columbia, glyphosate levels in the streams rose dramatically after the first rain event, 27 hours after application, and fell to undetectable levels in 96 hours (NIH 2002b). The highest residues were associated with sediments, indicating that they were the major sink for glyphosate. Residues persisted throughout the 171-day monitoring period. Suspended sediment is not a major mechanism for glyphosate transport in rivers, but glyphosate sprayed in road ditches could readily be transported as suspended sediment and cause acute exposures following rain events.

Toxicity. Glyphosate is low in toxicity to fish (Henderson, A.M. et al. 2010). Reported tests of glyphosate (technical grade or formulations without surfactants) toxicity to fish for 24- to 96-hour LC50 values, ranges from approximately 10 mg/L at a pH of 6, to greater than 200 mg/L at a pH of 10 (EPA 1993; Smith, E.A. and W.F. Oehme 1993). The 96-hour LC50 for technical grade glyphosate in rainbow trout ranges from 1.3 mg/L (USGS (U.S. Geological Survey) 2002), to a range of 86–140 mg/L reported in SERA (1996). The results of a rainbow trout yolk-sac 96-hour LC50 static bioassay ranged from 3.4–5.3 mg/L (USGS 2002). The potential environmental concentrations of glyphosate from the proposed action are unknown. Information on sublethal effects of glyphosate is available for many of the endpoints important to the overall health and fitness of salmonids. Of those reported, glyphosate appears to carry a low risk for sublethal effects (SERA 1996).

Indirect Effects on Aquatic Organisms. Glyphosate is highly toxic to all types of terrestrial plants and is used to kill floating and emergent aquatic vegetation. Glyphosate does not appear to have similar toxicity to algae. Glyphosate is considered by EPA to be “slightly toxic” to aquatic invertebrates (SERA 1996). LC50 values of 780 and 930 mg/L have been reported for *Daphnia*. Hildebrand et al. (1980) found that Roundup® treatments at concentrations up to 220 kg/ha did not significantly affect the survival of *Daphnia* or its food base of diatoms under laboratory conditions. In addition, Simenstad et al. (1996) found no significant differences between benthic communities of algae and invertebrates on untreated mudflats and mudflats treated with Roundup®. It appears that under most conditions, rapid dissipation from aquatic environments of even the most toxic glyphosate formulations prevents build-up of herbicide concentrations that would be lethal to most aquatic species.

Ecological Risk of the Herbicides Proposed for Use—Triclopyr

Exposure. There are two basic formulations of triclopyr**—**a triethyamine salt and a butoxyethyl ester. In soils, both formulations degrade to the parent compound, triclopyr acid. Most triclopyr is soluble in water, meaning it dissolves easily. However, the ester form is less soluble and can be extremely toxic to fish and aquatic invertebrates. In soils, both formulations degrade to the parent compound, triclopyr acid. Degradation occurs primarily through microbial metabolism, but photolysis and hydrolysis can be important as well. The average half-life of triclopyr acid in soils is 30 days. Offsite movement through surface or subsurface runoff is a possibility with triclopyr acid, as it is relatively persistent and has only moderate rates of adsorption to soil particles. In water, the salt formulation is soluble, and with adequate sunlight, may degrade in several hours (EPA 1998). Triclopyr in water breaks down faster with light. The half-life of triclopyr in water with light is around 1 day. Without light, it is stable in water with a half-life of 142 days (Petty, D.G. et al. 2003). Triclopyr breaks down relatively quickly in soils. It is mainly broken down by microbes. The soil half-life ranges from 8 to 46 days (EPA 1998; Shaner 2014). In deeper soils with less oxygen, the half-life is longer. Triclopyr is mobile in soils. However, movement studies show that triclopyr was not measured in soils deeper than 15 to 90 centimeters (about 6 to 35 inches) (EPA 1998). Its movement in soil is affected by the amount of compost and rain, among other factors (California Environmental Protection Agency 1997; Shaner, D.L. 2014).

Toxicity. For fish, the acid and salt forms are practically non-toxic, but the ester form is moderately to highly toxic. The ester form can bioaccumulate (build up) in fish. However, the ester form rapidly degrades to the acid form in the environment and fish are not likely to contact large amounts of the pesticide (EPA 1998; Petty, D.G. et al. 2003).

Triclopyr acid and the salt formulation are slightly toxic to fish and aquatic invertebrates. The LC50 of the acid and the salt formulation for rainbow trout are 117 mg/L and 552 mg/L, respectively, and for bluegill sunfish 148 mg/L and 891 mg/L, respectively. The ester formulation is highly toxic to fish and aquatic invertebrates, with an LC50 (96-hour) of 0.74 mg/L in rainbow trout and 0.87 mg/L in bluegill sunfish (WSA 1994). The hydrophobic nature of the ester allows it to be readily absorbed through fish tissues where is it rapidly converted to triclopyr acid. The acid can be accumulated to a toxic level when fish are exposed to sufficient concentrations or for sufficient durations.

The extent to which the toxic effects of the ester are reduced by degradation is poorly understood. Studies have shown that the ester formulation degrades rapidly to less toxic forms (Thompson, D.G. et al. 1991). Kreutzweiser et al. (1994), however, has shown that there is a significant chance of acute lethal effects to fish exposed to low level residues for more than 6 hours. In addition, delayed lethal effects were seen in fish exposed to high concentrations for a short duration. Considering that Thompson et al. (1991) concluded that organisms subjected to direct overspray were exposed to a high level of herbicide for short periods of time while organisms downstream were exposed to low levels for longer periods, the findings of Kreutzweiser et al. (1994) are of concern. Nevertheless, most authors including the authors of the fish mortality study have concluded that if applied properly, triclopyr would not be found in concentrations adequate to kill aquatic organisms.

Ecological Risk of the Herbicides Proposed for Use—Metsulfuron-methyl

Exposure. Metsulfuron-methyl is generally active in the soil. It is usually absorbed from the soil by plants. The adsorption of metsulfuron-methyl to soil varies with the amount of organic matter present in the soil, and with soil texture and pH. Adsorption to clay is low. The half-life of metsulfuron-methyl can range from 120 to 180 days (in silt loam soil). There are major areas of uncertainty and variability in assessing potential levels of exposure in soil. In general, metsulfuron-methyl adsorption to a variety of different soil types will increase as the pH decreases (i.e., the soil becomes more acidic). The persistence of metsulfuron-methyl in soil is highly variable, and reported soil half-lives range from a few days to several months, depending on factors like temperature, rainfall, pH, organic matter, and soil depth. Off-site movement of metsulfuron-methyl is governed by the binding of metsulfuron-methyl to soil, the persistence in soil, as well as site-specific topographical, climatic, and hydrological conditions.

Metsulfuron-methyl will degrade faster under acidic conditions, and in soils with higher moisture content and higher temperature. Soil microorganisms break down metsulfuron-methyl to lower molecular weight compounds under anaerobic conditions. Metsulfuron-methyl in the soil is broken down to nontoxic and non-herbicidal products by soil microorganisms and chemical hydrolysis. Metsulfuron-methyl dissolves easily in water. There is a potential for metsulfuron-methyl to contaminate ground waters at very low concentrations. Metsulfuron-methyl readily leaches through silt loam and sand soils.

Metsulfuron-methyl environmental fate and transport simulations reported in SERA (2004) were conducted for clay and sand at annual rainfall rates ranging from 5 to 250 inches and the typical application rate of 0.02 lb a.i./ac. In sand or clay under arid conditions (i.e., annual rainfall of about 10 inches or less), there is no percolation or runoff, and the rate of decrease of metsulfuron-methyl concentrations in soil is attributable solely to degradation rather than dispersion. At higher rainfall rates, plausible concentrations in soil range as high as 0.007 mg/L and, under a variety of conditions, concentrations of 0.0005 mg/L and greater may be anticipated in the root zone for appreciable periods of time. Metsulfuron-methyl exposure to aquatic species is affected by the same factors that influence terrestrial plants, except the directions of the impact are reversed. In very arid environments (i.e., where the greatest persistence in soil is expected) substantial contaminations of water is unlikely. In areas with increasing levels of rainfall, toxicologically significant exposure to aquatic plants is more likely to occur. As summarized in SERA (2004), peak water levels of about 0.003 to 0.006 mg/L can be anticipated under worst-case conditions at rainfall rates of 25 to 50 inches per year after a single application.

Toxicity. Metsulfuron-methyl is non-lethal to fish at the peak concentrations likely to be encountered by listed steelhead, and peak concentrations are many orders of magnitude lower than the concentrations where various sublethal effects were observed in rainbow trout.

Metsulfuron-methyl does not bioaccumulate in fish. The lowest concentration at which mortality was observed in any species of fish is 100 mg/L for rainbow trout; however, in the same study, no mortality was observed in fish exposed to 1000 mg/L (Hall 1984) . SERA (2004b) concluded that mortality is not likely to occur in fish exposed to metsulfuron-methyl concentrations less than or equal to 1000 mg/L.

Debilitating sublethal effects (erratic swimming, rapid breathing, and lying on the bottom of the test container) were observed by Muska and Hall (1982) after exposure to 150 mg/L for 24 hours. In tests with rainbow trout, no significant long-term effects (90-day exposure) were observed by Kreamer (1996) on hatch rate, last day of hatching, first day of swim-up, larval survival, and larval growth at concentrations up to 4.7 mg/L. Concentrations greater than 8 mg/L resulted in small but significant decreases in hatching and survival of fry.

Indirect Effects on Aquatic Organisms. Toxicity studies on aquatic invertebrates are reported only for *Daphnia*, which for acute exposure, a 48-hour no observable effect concentration (NOEC) for immobility of 420 mg/L is used. For chronic exposures, the NOEC of 17 mg/L for growth inhibition is used, although higher chronic NOECs, ranging from 100 to150 mg/L, have been reported for survival, reproduction and immobility (SERA 2004b). The only effect reported by Hutton (1989) in a 21-day *Daphnia* study was a decrease in growth at concentrations as low as 5.1 mg/L, but decreased growth at concentrations less than 30 mg/L was not statistically significant. In aquatic invertebrates, decreased growth appears to be the most sensitive endpoint. Wei et al. (1999) reported that neither metsulfuron-methyl nor its degradation products are acutely toxic to *Daphnia* at concentrations that approach the solubility of the compounds in water at neutral pH. Although the results of *Daphnia* studies suggest that metsulfuron-methyl is relatively non-toxic to invertebrates, toxic effects concentrations for different invertebrate species often vary widely, as seen in several herbicides reviewed in this opinion. Consequently, given the limited data available on invertebrate effects, there is insufficient information to draw any conclusion about the toxicity of metsulfuron-methyl on invertebrates consumed as prey by listed steelhead.

There are substantial differences in sensitivity to effects of metsulfuron-methyl among algal species, but all EC50 values reported in SERA (2004) are above 0.01 mg/L, and some values are substantially higher. Toxicity in algae increases with lower pH, most probably because of decreased ionization leading to more rapid uptake. One field study cited in SERA (2004) on the effects of metsulfuron-methyl in algal species found that concentrations of metsulfuron-methyl as high as 1 mg/L are associated with only slight and transient effects on plankton communities in a forest lake.

Ecological Risk of the Herbicides Proposed for Use—Aminopyralid

Exposure. In aquatic systems, the primary route of degradation is photolysis, where a laboratory experiment yielded a half-life of 0.6 days. In addition to CO2, oxamic and malonamic acid were identified as major degradates. Aminopyralid was stable to direct hydrolysis and in anaerobic sediment-water systems. In aerobic sediment-water systems, degradation proceeded slowly, with observed total system half-lives of 462 to 990 days. The degradation resulted in the formation of non-extractable residues and no other major products.

Aminopyralid persists in soils with a half-life ranging from 32 to 533 days, with a typical time of 103 days. It is soluble in water and has moderate to high mobility with the ability to leach through soils and possibly contaminate groundwater. Aminopyralid is stable in water but in sunlight breaks down quickly with an estimated half-life of 0.6 days. This is therefore an important route of degradation for shallow water bodies with little to no suspended sediment. Aminopyralid is only moderately broken down in soil. The main mode of degradation in the environment is expected to be microbial metabolism in soils; however, microbial metabolism can be slow in some soils, especially at lower soil depths, and appears generally to be very slow (half-lives well above a year) in aquatic systems (EPA 2005; USDA/Forest Service, S.R. 2007).

Toxicity. Aminopyralid has been shown to be practically non-toxic to birds, fish, honeybees, earthworms, and aquatic invertebrates. The log Kow[9] is less than 3, and thus aminopyralid is not expected to bioaccumulate in fish tissue (EPA 2005).

Indirect effects on aquatic organisms. Amionopyralid is practically non-toxic to slightly toxic to aquatic invertebrates based on acute toxicity tests reviewed by U.S. EPA. For *Daphnia,* a 48-hour EC50 >98.6 mg/L was reported. For estuarine marine invertebrates, U.S. EPA reported a 48-hour EC50 >89 mg/L for Eastern oyster and an LC50 >100 mg a.e./L for Mysid. A study reviewed by the manufacturer reported an EC50 of >460 mg/L for acute immobilization in *Daphnia* (EPA 2005; USDA/Forest Service, S.R. 2007).

Ecological Risk of the Herbicides Proposed for Use—Chlorosulfuron

Exposure. Adsorption and leaching characteristics in basic soil types: Adsorption to clay is low while organic matter has some affinity. Rate of leaching is correlated with net movement of soil moisture with less leaching if pH is less than 6.0. Microbial breakdown: Initial deactivation of the molecule is through hydrolysis followed by complete metabolism to low molecular weight compounds through normal soil microbial processes. Loss from photodecomposition and/or volatilization: In the field decomposition and volatilization play minor roles in its disappearance. Hydrolysis into nonherbicidal compounds is the major form of degradation, and its rate is influenced by soil temperature, pH, and levels of oxygen and moisture. Resultant average persistence at recommended rates: Under growing season conditions the half-life is 4 to 6 weeks. Soil temperature influences length of half-life with shorter persistence at higher temperatures. Low pH accelerates hydrolysis, while soil texture does not appear to be a major factor in rate of degradation (Cornell University 2019; ENSR International 2005)

Toxicity. Chlorsulfuron is practically non-toxic to birds and mammals on an acute exposure basis and is also practically nontoxic to birds on a subacute dietary exposure basis. Chlorsulfuron is also practically nontoxic to honeybees on an acute contact basis. Chlorsulfuron is practically nontoxic to both freshwater and estuarine/marine fish on an acute exposure basis and is slightly toxic to estuarine/marine invertebrates.

[9] Kow is the relative indicator of the tendency of an organic compound to adsorb to soil and living organism. Log Kow are generally inversely related to water solubility. Chemicals with very high log Kow values (i.e., > 4.5) are of greater concern because they may have the potential to bioconcentrate in living organisms.

Ecological Risk of the Herbicides Proposed for Use—Imazapic

Exposure. Imazapic is relatively non-toxic to terrestrial and aquatic mammals, birds, and amphibians. Imazapic has an average half-life of 120 days in soil, Imazapic is degraded primarily by soil microbial metabolism. The extent to which imazapic is degraded by sunlight is believed to be minimal when applied to terrestrial plants or soil, but it is rapidly degraded by sunlight in aqueous solutions. However, it is not registered for use in aquatic systems. Imazapic is not degraded by other uncatalyzed chemical reactions in the environment. It is moderately persistent in soils, and has not been found to move laterally with surface water. Imazapic does not volatilize when applied in the field.

Toxicity. Standard toxicity bioassays to assess the effects of imazapic on fish evidenced relatively low toxicity with 96-hour LC values of >100 mg/L (i.e., nominal concentrations of 100 mg/L caused less than 50 percent mortality over the 96-hour exposure period). The very low toxicity of imazapic to fish is probably related to very low rate of uptake of this compound by fish. In a 28-day flow-through assay, the bioconcentration of imazapic was measured at 0.11 L/kg, indicating that the concentration of imazapic in the water was greater than the concentration of the compound in fish (SERA 2004a).

Indirect effects on aquatic organisms. Standard toxicity bioassays to assess the effects of imazapic on aquatic invertebrates indicated no adverse effects at nominal concentrations of up to 100 mg/L in acute toxicity studies with aquatic invertebrates as well as a life-cycle study in *Daphnia* (SERA 2004a)

Ecological Risk of the Herbicides Proposed for Use—Dicamba

Exposure. In soil, dicamba is very mobile because it is poorly adsorbed to most soils. Dicamba is also readily soluble in water, so its transport is influenced by precipitation. At low rainfall rates, dicamba dissipation had a half-life of about 20 days. At high rainfall rates using modeled runs, virtually all the dicamba was washed from the soil. As detailed in SERA (1995), the environmental fate of dicamba has been extensively studied. In general, dicamba is very mobile in most soil types with peat, to which dicamba is strongly adsorbed, the only reported exception (Grover, R. and A.E. Smith 1974). For many soil types, the extent of soil adsorption is positively correlated with and can be predicted from the organic matter content and exchangeable acidity of the soil (Johnson, R.M. and J.T. Sims 1993). A monitoring study by Scifres and Allen (1973) found that after 14 days, no dicamba was detected, with the limit of detection of 0.01 µg/L, in the top 15 cm of soils, and residues at all depths were less than 0.1 µg/L. The rates of dissipation in clay and loam were essentially identical.

Available monitoring data indicate that ambient water may be contaminated with dicamba after standard applications of the product. The range of average to maximum dicamba levels in water reported in a monitoring study by Waite et al.(1992) are from 0.1 to 0.4 µg/L. SERA (1995) characterized the water concentration of dicamba in a severe spill as approximately 10 mg/L, which could result in some fish mortality.

Toxicity. There is wide variation in the reported acute toxicity of dicamba to fish, with 24-hour LC50 values ranging from 28 mg/L to more than 500 mg/L. Most laboratory assays in SERA

(1995) reported LC50 values >100 mg/L. In bluegill sunfish, the standard 96-hour LC50 is 600 mg/L, but when the herbicide was adsorbed onto vermiculite, the LC50 dropped to around 20 mg/L (USDA 1984). In a study by Lorz et al. (1979), yearling coho mortality was observed at 0.25 mg/L during a seawater challenge test, which simulates their migration from rivers to the ocean. An LC50 of 28 mg/L in trout was reported by Johnson and Finley (1980). Little is known about effects on fish other than acute toxicity.

Indirect Effects on Aquatic Organisms. The range of toxicity of dicamba to aquatic invertebrates suggests wide variation among species. Consequently, available assays provide little insight about the toxicity of dicamba to invertebrate species consumed by listed salmon and steelhead.

Seed shrimp, glass shrimp, and fiddler crabs are killed by concentrations over 100 mg/L, while *Daphnia* and amphipods are killed by concentrations in the range of 3.9–11 mg/L (Cox, C. 1994). The low end of this range is several orders of magnitude higher than water concentrations observed by Waite et al. (1992), but within the range of concentrations SERA (1995) describes for a moderate to severe spill. Sublethal effects on aquatic invertebrates are unknown. The only endpoints that have been examined are acute lethal responses for aquatic animals (LC50 values) and growth inhibition in unicellular algae (EC50 values). Algae species are much more sensitive to dicamba than fish (SERA 1995).

Summary of Herbicide Effects

With the exception of 2,4-D, the herbicides proposed for use in dry wetland bottoms are considered non-toxic to fish. The herbicides to be used in wetland bottoms are known to be rapidly taken up by plants, volatilize, photodegrade or bind to soil particles within days or weeks and are therefore unlikely to have a residual effect when water is returned to the wetlands. Neither juvenile nor adult MCR steelhead are likely to be in the action area during the time when the wetlands are dry, as flows are extremely low and water temperatures in Toppenish and Snake Creek get too warm for salmonids during the low-flow season. Based on the timing and method of application of the proposed herbicides in the dry wetland bottoms, NMFS does not believe steelhead will be affected by this treatment.

Herbicides used for upland areas are not likely to affect fish when used following label restrictions and maintaining a 25-foot buffer from the creek channels. Upland herbicide use may occur when juveniles are present but using only the specified herbicides, following label restrictions and maintaining a 25-foot buffer makes it highly unlikely that there will be any effect to wetted areas.

Any herbicide used while water is present will be approved for aquatic use and will be applied manually to avoid contact with water. The possible application while water is present will require individual plant hand application. If this kind of treatment occurs when water temperatures are less than approximately 70°F, then it is possible that juvenile steelhead could be present in the area. If water temperatures are higher than 70°F (possible by late spring or early summer), then the likelihood of juvenile presence is very low. If this occurs when juvenile steelhead could be present, then there is some risk of exposure. When a small amount of aquatic-labeled herbicide is applied directly to a plant, there is still some risk of the herbicide reaching the water. However, upon reaching the water it would immediately be diluted by the surrounding water.

Under reasonably anticipated conditions, use of herbicides is likely to modify habitat in a way that changes fish behavior. The toxicological effects of exposure will also injure fish. Those instances would be when various combinations of factors occur. Examples of these factors include: (1) when precipitation occurs before the chemicals break down, binds to soil particles, or is taken up by plants; or (2) if a chemical is spilled near water in sufficient concentrations to reach and modify fish behavior or injure them. Specific locations where harm is likely to occur and the extent of harm cannot be identified at this time, since the above factors cannot be predicted.

Because of the described application methods, environmental conditions under which herbicide applications will be conducted, and the use of no-spray vegetated buffer zones, it is believed that little, if any, herbicides will reach any potential fish-bearing waterbodies (Toppenish or Snake creeks) or persist until water is reintroduced and fish reoccupy a treated area. Given the small amount of herbicides applied at any one time in the action area and the no-spray vegetated buffers, even in worst-case circumstances where chemicals from a spill or misapplication reach the water, the concentrations are likely to be below lethal levels.

Repair of Levees, Spillways, Roads

Regular repair of levees, spillways or ditch-bank roads will only occur when the wetlands are dry and no fish are present. These actions will have no effect on adult or juvenile MCR steelhead.

Ditch Cleaning

Ditch cleaning only occurs when the ditches are dry and will not affect adult or juvenile MCR steelhead.

Treating, Cutting, or Removing Trees

Trees within the riparian corridors of Toppenish or Snake Creek are not cut except to access utilities or keep roads clear. Within the wetland area, the refuge minimizes the establishment of trees to promote waterfowl habitat. Vegetation management only occurs on dry ground and is therefore not likely to affect adult or juvenile MCR steelhead in the action area. The removal or reduction in riparian habitat along the main channels of Toppenish and Snake creeks could contribute to increased exposure to solar radiation during the late spring and summer, and the restriction of tree growth in the wetland areas does increase exposure to solar radiation and thus earlier warming water temperatures starting in the late spring. The restriction of tree development in wetland areas is designed to improve waterfowl habitat. To account for the potentially harmful conditions that may develop for fish because of warming temperatures, it is important that flashboards are removed by April 1, so juvenile outmigrants can move quickly through the wetlands.

Swale Construction and Maintenance

Ground disturbing activities to construct or maintain swales in the wetlands to promote the development of a thalwag through the wetland will only take place when the wetlands are dry. The ground disturbance may result in areas of exposed soil when flows are reintroduced into the wetland. Flows are introduced into the wetlands quite slowly over the fall and winter, minimizing the likelihood that exposed soils will be introduced into the water column, and the slack water environment of the wetlands will encourage quick resettlement of soil particles. There will be no fish in the dry wetlands when this disturbance occurs, and the likelihood of any sediment redistribution effecting fish is negligible.

Installing, Replacing, or Removing Water Control Structures

Regular maintenance work on water control structures only occurs when the area is dry and thus no steelhead are present. If repair or replacement is necessary in wetted areas, refuge managers will use a cofferdam to isolate the area, dipnet any visible fish out of the isolated area and pump water from within the cofferdam to an upland location. Non-emergency replacements and repairs will be scheduled and conducted in the agreed upon summer in-water work window between July 15 and September 15.

Prescribed Fire

As described in the proposed action, prescribed fire occurs periodically and primarily in the upland areas, where there will be no effects to fish. Any burning of wetland bottoms would by necessity occur in the late fall when there are no fish in the wetland areas and the county burn bans have been lifted. The effects of prescribed fire on vegetation in wetlands are short-term and may only last until the next growing season. NMFS does not believe the periodic use of prescribed fire to manage vegetation on the refuge will have any measurable effect to MCR steelhead.

2.5.2 Effects to Critical Habitat

Designated critical habitat within the action area consists of fair- to poor-quality freshwater migration and rearing PBFs. Although there is a great deal of anthropomorphic disturbance in the action area and in the watershed, the overall quantity and quality of critical habitat upstream of the action area is very good in many areas, and it continues to support a strong population of MCR steelhead (Table 3). The essential elements of PBFs affected by the proposed action in Toppenish and Snake creeks are water quantity, quality, and freedom from artificial obstructions (passage), all of which support adult and juvenile survival, growth, and mobility. In the action area, the freshwater habitat elements of water quantity, quality and passage are present but of varying levels of functionality.

The refuge management actions are designed to support waterfowl habitat, i.e., withdrawals from the main channel, retention of flows with flashboards to inundate wetlands and create large open areas of slack water, vegetation manipulation to increase aquatic plants and decrease overstory within wetland units. The development and support of wetlands as waterfowl habitat can also provide good quality juvenile salmonid rearing habitat when water temperatures are appropriate. Juvenile steelhead primarily eat zooplankton, which are in large supply in wetlands, and they can also use the vegetation as cover to hide from predators. However, this same vegetation provides cover for predators of juvenile steelhead on the TNWR such as smallmouth bass, and, if there is not a detectable flow through the wetland, juveniles can become confused and delayed in their downstream migration, increasing the amount of time they are exposed to predators and warming water. The TNWR wetlands can also provide juveniles with refuge during high flows.

Prior to this consultation, the refuge has generally managed flows to restrict or eliminate channel habitat-forming flows through the wetland units. The lack of a defined channel within a wetland limits any volitional assistance to guide fish downstream, and contributes to juveniles failing to find egress from the wetlands before water temperatures increase and DO decreases, and increases the amount of time they are exposed to predators. Large areas of relatively shallow slack water often warm up quickly in the spring. As shown previously in Figure 3, in 2018, temperatures in wetland 3b reached and exceeded the preferred 15.9°C (60.6°F) by early May, and approached lethal levels 23.9 °C (75°F) by mid-May. In conjunction with increasing water temperatures, when DO levels 6.0 ppm, salmonids begin experiencing initial distress symptoms ((Bjornn, T.C. and D.W. Reiser 1991). Warm, slack water areas also conveys advantage to salmonid predators (both waterfowl and fish), and refuge managers have observed small mouth bass within wetlands of the refuge. In 2018 the refuge conducted work in wetland 3b to ensure there was an unobstructed swale that would function as a main channel or thalwag through the wetland, assisting juvenile fish in downstream passage.

Toppenish Creek flows directly through the refuge with screened flows diverted into wetlands toward the north side of the creek from October 1 to April 1, providing juvenile salmon with relatively properly functioning rearing and migration habitat in the main channel. Between October and April 1, Snake Creek is diverted into 2a (unscreened) and 3a (screened) where flows are confined using flashboards at the exits of wetlands 2b, 3a, and 3b to flood the associated wetlands. In the units that use flashboards to retain flow, there is functional rearing habitat but until the flashboards are removed, the migratory function of these areas for juvenile is severely limited.

Beginning in 2019, refuge managers will revise flow management actions to remove flashboards on or before April 1. In conjunction with the actions taken to ensure there is a thalwag through wetland 3b, the downstream passage of juvenile MCR steelhead will be markedly improved through the Snake Creek route. By improving the flow through the fish bearing wetlands, NMFS anticipates improvements in water quantity (less retained on the refuge) and, potentially, water quality with increased movement and mixing of flows that could improve temperatures and DO conditions during the juvenile out-migration period, and passage with a reduction of impediments within the migration corridor to juveniles after April 1. Both of these actions, defining the thalwag and improving flow through the wetlands after April 1, are anticipated to improve the function of the specific PBFs of water quantity, water quality, and passage and increase juvenile survival in Snake Creek to levels similar to those documented in Toppenish Creek (Table 6).

2.6 Cumulative Effects

"Cumulative effects" is defined at 50 CFR 402.02).

The refuge itself is federal property. However, the 12 miles downstream to the Yakima River are a mixture of private and YN ownership. Because of the existing infrastructure in the action area, NMFS assumes that current tribal, private and state land use associated effects will continue into the future at their current rate.

2.7 Integration and Synthesis

In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's opinion as to whether the proposed action is likely to: (1) appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat for the conservation of the species.

The threatened status of the MCR steelhead DPS is largely a result of low viability (abundance, productivity, diversity) in four populations. Seven populations have moderate or maintained viability, while six populations are viable or highly viable. The Toppenish Creek population, currently at an overall low risk for abundance, productivity, and moderate risk for spatial structure and diversity, is the only population exposed to the effects of the proposed action. The Toppenish Creek population is part of the Yakima River MPG. Maintaining or improving the viability of this population is included in every recovery scenario for the Yakima MPG (NWFSC 2015).

By removing the flashboards by April 1 and thereby decreasing the amount of time that juveniles spend finding their way through the Snake Creek wetlands, the proposed action is anticipated to improve migration and rearing habitat for juvenile MCR steelhead in Snake Creek, increasing survival through Snake Creek from 0.66 percent to something closer to 0.95, as found in Toppenish Creek. Therefore, it is expected to improve the overall abundance of the Toppenish Creek steelhead population. Proposed actions will maintain or improve baseline habitat processes that support existing spatial structure, diversity, and productivity for MCR steelhead in the Toppenish Creek population.

Adult MCR steelhead primarily use Toppenish Creek for upstream migration in the winter and early spring and do not make use of the wetlands except in rare occasions of upstream movement through Snake Creek when flows are high enough. The proposed actions will not change the structure or function of MCR steelhead adult upstream migratory habitat.

The Toppenish Creek MCR steelhead population is an important component of the Yakima River MPG. In the recovery scenarios proposed for the Yakima MPG by NMFS (2009), the Toppenish Creek population is one of two populations that is required to be at an overall low risk, which it currently meets. The proposed actions could have a measureable positive effect, which would be observed in higher adult returns over time, further reducing the overall risk to this population. Although the Toppenish Creek population is currently meeting its minimum recovery target goals, a further reduction in risk from low to very low would be taken into consideration if other populations are unable to attain their desired goals. The proposed action is expected to improve the viability of the Toppenish Creek population and contribute positively to the overall survival and recovery of the Yakima River MPG and thus to the MCR steelhead DPS.

For all the reasons described in the preceding paragraphs of this section, the proposed action will not appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction or distribution.

Critical Habitat. Critical habitat for MCR steelhead is present in the action area in the form of adult migration, juvenile migration and rearing, with the relevant PBFs of water quantity, water quality, and passage. The proposed action will reduce, but not eliminate, interference with juvenile outmigration by pulling flashboards by April 1, and continue to restrict riparian development and function within the wetlands. Overall, the proposed actions will improve the function of water quantity, water quality, and passage on the refuge, therefore the conservation value of critical habitat at the designation scale will not be adversely affected. Based on the information above, NMFS has determined that the proposed action will not reduce the value of designated critical habitat for the conservation of the species.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' opinion that the proposed action is not likely to jeopardize the continued existence of MCR steelhead or destroy or adversely modify its designated critical habitat.

2.9 Incidental Take Statement

Section 7(b)(4) and section 7(o)(2) of the ESA provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1 Amount or Extent of Take

In the opinion, NMFS determined that incidental take of juvenile MCR steelhead is reasonably certain to occur as follows:

Potential sources of incidental take (harm) caused by the adverse effects of proposed actions will include the following: (1) reduced streamflow and increased water temperature that will impair normal rearing and migration behaviors in Toppenish Creek and its side channels. Exposure to predation and declining water quality for juveniles using the Snake Creek route through the wetlands 2a, 2b, and 3a. We expect mortality to continue but to decrease for juvenile steelhead when they rear and migrate through the wetlands after April 1 of each year. This mortality is a consequence of passage through slow water areas that provide excellent predator habitat, increasing likelihood of being injured or killed by predacious birds or fish. The likely types of injury from behavioral changes include degraded health and fitness consequential to decreased space and food for juvenile growth and survival; (2) herbicide-based changes in water quality with toxic or injurious effects on fish; and (3) decreased sources of food (prey base) from the toxic effects of herbicides.

The number of fish that will be harmed cannot be ascertained, because anadromous fish have highly variable presence in any given location, and fish response to environmental conditions will be highly variable among individuals. Because it is not possible to observe the actual number of fish that will be exposed to water management operations on the refuge each year, NMFS will use a quantifiable surrogate that can be monitored. The incidental take surrogates for take associated with O&M of the refuge is: (1) the April 1 removal of flashboards at wetland units 2a, 2b, and 3b, and documented assurance that there is adequate egress from any pond where a fish could be entrained (this take surrogate is causally linked to the amount of take anticipated because the failure to remove the flashboards on the aforementioned wetland units on or before April 1 increases the time juvenile MCR steelhead spend migrating through the wetlands, increasing time spent in declining water quality conditions, increasing predation risk and causing injury and death), and; (2) the application of herbicides within the floodplain, as described in the project proposal, followed by heavy rainfall within 24 hours after application, or a chemical spill near water in sufficient concentrations to reach listed steelhead and modify their behavior or injure them.

The expected extent of take is also the threshold for reinitiating consultation. If flashboards are not removed by the April 1, or the application of herbicides within the floodplain is followed by heavy rainfall within 24 hours, or if a chemical spill occurs near water, the amount of take would be greater than that examined in this consultation, and thus the reinitiating provisions of this opinion would apply.

2.9.2 Effect of the Take

In the opinion, NMFS determined that the amount or extent of anticipated incidental take, is not likely to result in jeopardy to the species.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1) Minimize incidental take resulting from water diversion withdrawals.
2) Minimize incidental take from herbicide applications.
3) Implement a monitoring and reporting program to confirm that the proposed changes in water management operations and terms and conditions in this ITS were effective in avoiding and minimizing incidental take.

2.9.4 Terms and Conditions

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

To be exempt from the prohibitions of section 9 of the ESA, the USFWS must fully comply with the following terms and conditions that implement the RPMs described above. Partial compliance with these terms and conditions may invalidate this take exemption.

1) To implement RPM No. 1 (water diversion withdrawals), the USFWS shall:
    a. Implement a TNWR annual work plan which addresses the TNWR water diversion withdrawals including:
        i. Person(s) responsible for monitoring and implementing all water diversion withdrawal activities.
        ii. Timelines for monitoring water withdrawal activities.
        iii. A process for identifying the amount of flow available for withdrawal at various times and when diversions must be discontinued and when flashboards must be removed.

2) To implement RPM No. 2 (herbicide applications), the USFWS shall ensure that:
    a. Conservation measures and best management practices intended to minimize take resulting from herbicide applications will be used.
    b. A “No-spray buffer” in riparian habitats, adequate to ensure that no chemical enters any surface water, is identified around all waterbodies, including diversion ditches, before herbicide applications begins.
    c. A spill cleanup kit at the temporary storage site and in all vehicles carrying herbicides will be present.
    d. A spill contingency plan will be developed prior to herbicide applications and applicators will be informed on the spill contingency plan and spill control, containment, and cleanup procedures.
    e. Only the quantity of herbicide needed for the day’s operations will be transported from the storage area in the original container or mixing container.
    f. Only the minimum area necessary for the control of undesirable weeds with herbicide applications will be treated.
    g. All equipment used for transportation, storage, or application of herbicides in will be maintained leak-proof condition.
    h. Applications will be outside of a 25-foot buffer on Toppenish and Snake creeks and outside a 25-foot buffer from any other waters.
    i. Water will not be diverted to sprayed areas any sooner than the chemical’s half-life, as listed on each specific herbicide label.

3) To implement RPM No. 3 (monitoring), the USFWS shall:

   a. Report annually. The USFWS will submit a monitoring report to NMFS describing the USFWS' success in meeting the terms and conditions contained in this opinion. Include the following information:
      i. Project identification
      ii. Project name.
      iii. Type of activity.
      iv. Project location.
      v. USFWS contact person.
      vi. Timing of withdrawals, including high or low water events that alter usual withdrawal windows.
      vii. Dates of herbicide applications, the name(s) and position(s) of persons responsible for performing the herbicide applications, and quantity and type of chemicals used.
   b. Provide a summary of any herbicide spills or contamination that occurs in the action area, and efforts to correct such incidences.
   c. Provide project data.
      i. Explanation of why any terms and conditions or minimization measures were not met (if applicable).
      ii. Extent of take and additional measures implemented to reduce future potential take.
   d. Continue to work with the YN to PIT tag and track MCR steelhead use and movement through the TNWR and modify operations as warranted.
      i. Monitor stream flows on Toppenish and Snake creeks to determine at what flow levees are overtopped and fish could be stranded in areas without egress, and develop a plan to address potential stranding.
      ii. Report results of PIT-tagging and flow monitoring data to NMFS by July of each year.
      iii. Discuss monitoring results with NMFS each year to determine if survival rates through Snake Creek have improved and if additional methods of take may be occurring on the refuge that could be eliminated or reduced by modifying operations or maintenance.
      iv. Submit a copy of the report to NMFS Interior Columbia Basin Area Office, Columbia Basin Branch at:

         Attention: Diane Driscoll (WCR-2018-8784)
         National Marine Fisheries Service
         Columbia Basin Branch
         304 South Water Street, Suite 201
         Ellensburg, WA 98926

NOTICE: If a sick, injured or dead specimen of a threatened or endangered species is found in the action area, the finder must notify NMFS Law Enforcement at (206) 526-6133 or

(800) 853-1964, through the contact person identified in the transmittal letter for this opinion, or through the NMFS Columbia Basin Branch Office. The finder must take care in handling sick or injured specimens to ensure effective treatment, and in handling dead specimens to preserve biological material in the best possible condition for later analysis of cause of death. The finder should carry out instructions provided by Law Enforcement to ensure evidence intrinsic to the specimen is not disturbed unnecessarily.

2.10 Conservation Recommendations

Conservation recommendations are defined at 50 CFR 402.02, and, for this consultation, are as follows:

1) Educate local landowners on how their actions may be reducing viability of MCR steelhead.
2) Develop partnerships with local landowners to improve conditions for MCR steelhead on their properties.
3) Continue to partner with the YN to discontinue water diversions when Toppenish Creek flows fall below 30 cfs, monitor abundance and survival of the Toppenish Creek MCR steelhead population, and look for opportunities to support habitat improvements throughout the watershed.

2.11 Reinitiation of Consultation

This concludes formal consultation for the O&M of TNWR in Yakima County, Washington.

As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained or is authorized by law and if: (1) the amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

3. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

3.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are USFWS, the YN, the citizens of the Toppenish Creek watershed, and others interested in the conservation of the Toppenish Creek MCR steelhead population. Individual copies of this opinion were provided to the USFWS.

3.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

3.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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