**APPENDIX 4-8. Additional Qualitative Species Analyses**

1. Step 2a: Is the species exposure pathway considered incomplete?

For atrazine, two types of species characteristics led to a conclusion that the exposure pathway is incomplete: species that predominantly occur in the open ocean and terrestrial species that only occur in caves. Additional explanation of why the exposure pathway is incomplete for these two types of species habitats is provided below.

Species whose ranges only occur on uninhabited islands are not expected to be exposed to atrazine because atrazine is not reasonably expected to be applied in areas not inhabited by humans. According to atrazine’s usage data (**APPENDIX 1-4**) the majority of atrazine’s usage is on residential and agricultural uses, which would not be expected to occur on uninhabited islands.

Exposures to species that predominantly occur in the open ocean (*e.g.,* whales) or rely on ocean species (*e.g.,* seabirds) are reasonably expected to be *de* *minimus*. This is because atrazine is not applied directly to the ocean and does not bioaccumulate.

Atrazine is not registered for applications within caves. Exposures to terrestrial organisms living within caves are expected to be *de minimus*. As discussed in Chapter 3, the major transport routes of atrazine from treatment sites to non-target areas include spray drift and runoff. Since caves are enclosed, spray drift transport is not reasonably expected to result in exposures to cave dwelling organisms. Runoff transport may lead to atrazine reaching ground water that is associated with caves. Therefore, for aquatic species that inhabit caves (e.g., barton springs salamander), exposures and associated risks are assessed in Steps 2e through 2i.

For listed terrestrial species that are obligate to caves (e.g., spiders), exposure from water is expected to be *de minimus*. The atmosphere of the inner cave (where these obligate cave species live) is saturated with water vapor. Species have adapted to this hydrating environment by increasing their permeability such that they “become freshwater animals living in an aereal environment” (Howarth 1987). This means that species get the majority of their water needs met by the atmosphere and from consumption of their prey. For terrestrial obligate cave species, water sources are limited to the condensation in the cave and on cave walls resulting from groundwater sources or from detritus/guano. Atrazine is not expected to volatilize from water (based on the low vapor pressure of 3.0x10-7 torr and Henry’s Law Constant of 2.6x10-9 atm-m3/mol) or guano. As a result, atrazine is not expected to be present in water vapor or condensation water that may occur in caves.

Another possible route of exposure is from leaf litter, animal droppings, and carcasses that may fall or be washed into cave systems. There is evidence in the literature indicating that animal feces (*e.g*., guano) and carcasses contaminated with pesticides have been found in cave systems (*e.g*., Land, *et al.* 2019; Eidels, *et al*. 2012; Eidels, *et al.* 2007; Land 2001; MacFarland 1998; and Sandel 1999). While atrazine was not measured, residues of a carbamate, carbaryl, were either not detected or detected but not quantifiable. Study authors suggest that carbamate residues may not be found because they are rapidly metabolized and excreted from the body (Land, *et at*. 2019). Therefore, exposures to species that rely on food items that are derived from exterior sources are expected to be *de minimus*.

1. Step 2d: Are exposure models considered unreliable for assessed species?

At this time, the current exposure models used in this assessment do not estimate exposures for all types of pesticide applications, all habitat types, or for all potential exposure routes relevant to listed species. Therefore, there may be uncertainty in the exposure values being used for a particular species based on what potential uses its range or critical habitat may overlap with, what type of habitat the species is found in, or what the main potential exposure route(s) might be. For species and critical habitats that have not been determined to be NE or NLAA based on the above analyses, consideration is given to how well the conceptual model of the relevant exposure model(s) matches up with the specific species being assessed. If the model estimates are not considered representative of the exposure of the species (due to an inconsistency in the exposure model and assessed species’ habitat), a qualitative analysis is conducted.

The qualitative analysis considered whether exposures to atrazine are reasonably certain to occur given the habitat of the listed species (e.g., ocean, beach, and/or freshwater habitats) and, if exposures are expected to occur, are impacts to an individual likely. The analysis also considered the potential for effects to the PPHD of the species and whether those effects would rise to the level of impacting an individual of a listed species.

## LAA determinations

***Aquatic Species***

The killer whale (*Orcinus orca*, Southern resident DPS), is found in the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound, and has an obligate relationship with Pacific salmon (which are anadromous), including several species (Chinook, chum, and coho) that are themselves considered threatened or endangered. Atrazine exposures are reasonably expected to be *de minimus* in these waters due to dilution and the fate characteristics of atrazine (i.e., not persistent, and not expected to bioaccumulate); therefore, exposures to killer whales are not expected. Because LAA determinations with strong evidence of risk were made for listed species of Pacific salmon (upon which the killer whales depend) (see **APPENDIX 4-3** for details on how many individuals of the salmon population may be impacted), there is a potential for effects to the PPHD of the listed killer whale DPS. The same conclusions and rationale apply to the designated critical habitat associated with this species. Therefore, a “Likely to Adversely Affect” (LAA) determination is made for the killer whale (Southern resident DPS) and its designated critical habitat from the use of atrazine based on effects to the PPHD. An LAA determination is made for the killer whale with moderate evidence of risk because while effects to the orca are not anticipated, there is strong evidence of effects to the PPHD (i.e., salmon) based on potential effects to an individual of the listed salmon species. There is uncertainty, however, that effects to an individual of a listed salmon will result in effects to the orca. In addition, there are other species of non-listed salmon that may be available for the forage-base which were not assessed.

The Western manatee forages in freshwater, as well as marine environments and requires freshwater on a regular basis. There is a great deal of uncertainty in estimating potential atrazine exposures in marine environments that support the Western manatee, but it is possible to use Estimated Environmental Concentrations (EECs) for the large flowing bins (3 and 4) to estimate exposures in freshwater environments (max daily EECs for HUC 3 = 529 µg/L). In addition, while there are uncertainties in the potential for effects due to uncertainties in the toxicity database, which utilizes small mammals as a surrogate for the manatee, the sublethal effects thresholds for atrazine are relatively low (LD50 = 1,869 and LOAEC = 3.7 mg-kg/bw/day based on 15% decrease in body weight). Therefore, there is a potential for the manatee to be exposed to concentrations of atrazine that may result in impacts to an individual. Manatees primarily forage on aquatic vegetation and algae, which may also be impacted by exposure to atrazine in freshwater environments resulting in effects to the PPHD of the manatee (IC50 = 14.4 µg/L based on the HC05 species from the all aquatic plant SSD). Therefore, a LAA determination is made for the Western manatee with weak evidence of risk because the potential for exposure and effects are uncertain.

NLAA determinations

***Aquatic Species***

Effects to marine mammals (e.g., pinnipeds, mustelids, polar bear, manatee), sea birds, and sea turtles are considered for both aquatic and terrestrial exposures. Effects to fish and corals are considered for aquatic exposures only. Since atrazine is not considered bioaccumulative and is not expected to accumulate in the tissue of prey, exposure from eating contaminated fish would be very low. In the marine environment, exposure of these species to conventional pesticides is not reasonably expected to reach the estuarine/marine environments at concentrations high enough to impact an individual of a species because of dilution. Additionally, tidal reversal in freshwater streams and vertical stratification of the freshwater inflow due to differences in salinity and temperature can enhance the mixing process at the freshwater/marine interface and disperse potential pesticide concentrations that may occur in freshwater streams and rivers that discharge into marine environments, limiting the potential for a pesticide to reach individuals of the listed species. See **APPENDIX 4-1** for the complete list of species considered for exposure in the marine environment.

Marine mammals, sea birds, and sea turtles may also spend a portion of their life-cycle (*i.e.,* breeding and basking) on shore, so the potential for exposure in the terrestrial environment is also considered. See **APPENDIX 4-1** for the complete list of aquatic species with the potential for terrestrial exposure. Potential exposure routes include inhalation and dermal interception of spray droplets on the day of application. Since these species do not forage while on land, dietary exposure while in terrestrial habitats is not expected. Based on the points below, exposure at concentrations high enough to impact an individual are not reasonably expected to occur for these species.

* In a quantitative assessment, the overlap analysis assumes that all individuals of the species are in the terrestrial portion of their range, which represents a relatively small fraction of the entire range of the species. This artificially inflates the overlap numbers resulting in low confidence in the potential for exposure.
* While in the terrestrial environment, exposure of these species would be limited to spray drift from use sites adjacent to nesting or basking sites. The potential for exposure in the terrestrial environment is limited because on the day of application, atrazine would have to be transported by wind blowing from the application site toward the beach with little opportunity for interception of spray droplets.
* The duration of potential exposures would be limited as these species spend a relatively short amount of time on the shore for basking and/or breeding purposes. For example, sea turtles utilize beaches to lay their eggs, while some species use beaches to bask, however, sea turtles spend the vast majority of their lives in aquatic habitats.

Effects to the PPHD of marine mammals, fish, sea birds, sea turtles, and corals are also considered. The listed species considered rely on more than one dietary item, most of which are entirely marine. In estuarine/marine environments, exposures to conventional pesticides are not reasonably expected to decrease prey populations. Therefore, an NLAA determination is made for these species (**APPENDIX 4-1**).

Of the 27 species with NLAA determinations, 10 have designated critical habitats. NE determinations are made for 3 of the designated critical habitats (as they are outside the Action Area for atrazine) and 7 NLAA determination is made (**APPENDIX 4-1**).

1. References

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